LUNGS AND PLEURAE

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I – INTRODUCTION:

The lungs are paired, asymmetrical organs where gas exchange takes place, ensuring haematosis. They are located within the thoracic cage and are surrounded by the pleurae.

II – EXTERNAL CONFIGURATION:

1. Location:

Contained within each pleural cavity, the lungs occupy the lateral portions of the thoracic cavity, on either side of the mediastinum, to which they are connected by the pulmonary pedicles.

Note: *Their anatomical continuity explains the* ***interdependence of their pathology and clinical signs****.*

2. Consistency and color :

- The lung has a soft and elastic consistency. It expands easily during inspiration but spontaneously returns to its original shape.
- It appears shiny and pink, turning greyish-blue in older individuals due to the accumulation of pollutants.

Note: *The lung's resistance to distension-retraction can be measured (in terms of compliance and elastance) and may vary in pathological conditions, such as pulmonary fibrosis.*

3. Weight :

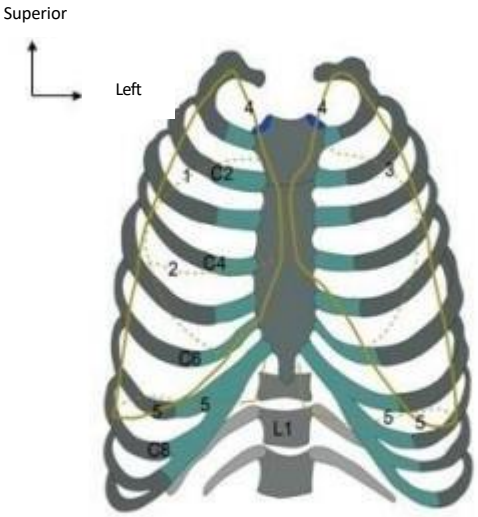
Its average weight in adults is about 700 g for the right lung and 600 g for the left.

Note: *A lung that has breathed is lighter than water, unlike a lung that has never breathed (as in a stillborn infant) or a waterlogged lung in drowning cases — a distinction of medico-legal importance.*

4. External configuration :

The lung has the shape of a **truncated cone**, with the following features: **three surfaces**, **three borders**, and an **apex**.

Thoraco-abdominal Topography: Projection of Pulmonary Borders and Fissures



1- Right oblique fissure
2- Right horizontal fissure
3- Left oblique scissure
4- Anterior borders
5- Inferior borders

a. Lateral (costal) surface :

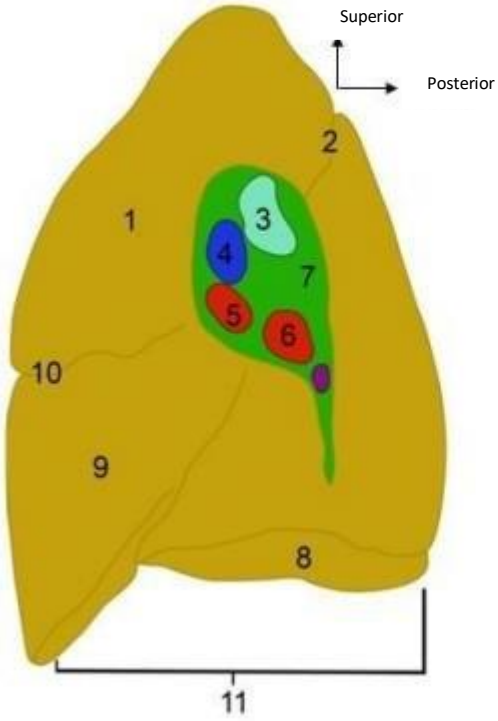
- It is convex in both the vertical and horizontal directions and is moulded to the inner surface of the thoracic wall.
- It is marked by the course of the pulmonary fissures.

❖ Right pulmonary hilium :

It is rectangular in shape and is approached by the main right pulmonary pedicle, which comprises three regions:

- **Posterior:** the right main bronchus,
- **Anterior:** the right pulmonary artery and the right superior pulmonary vein,
- **Inferior:** the right inferior pulmonary vein.

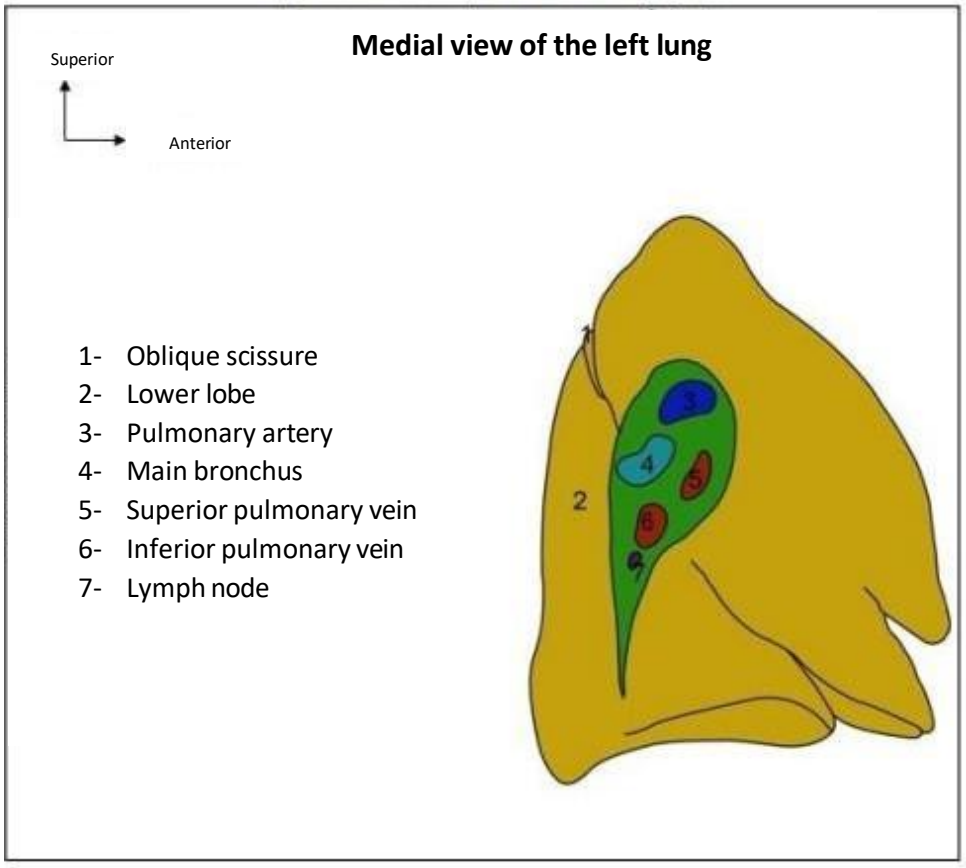
Medial view of the right lung



1- Upper lobe
2- Oblique scissure
3- Main bronchus
4- Pulmonary artery
5- Superior pulmonary vein
6- Inferior pulmonary vein
7- Pulmonary ligament
8- Base
9- Horizontal scissure
10- Diaphragmatic surface

❖ Left pulmonary hilium :

- It is higher and more central than the hilum of the right lung and has a racket-like shape.
- It is approached by the main left pulmonary pedicle, with its three regions — anterior, posterior, and inferior — just like on the right side.



b. Internal (mediastinal) surface :

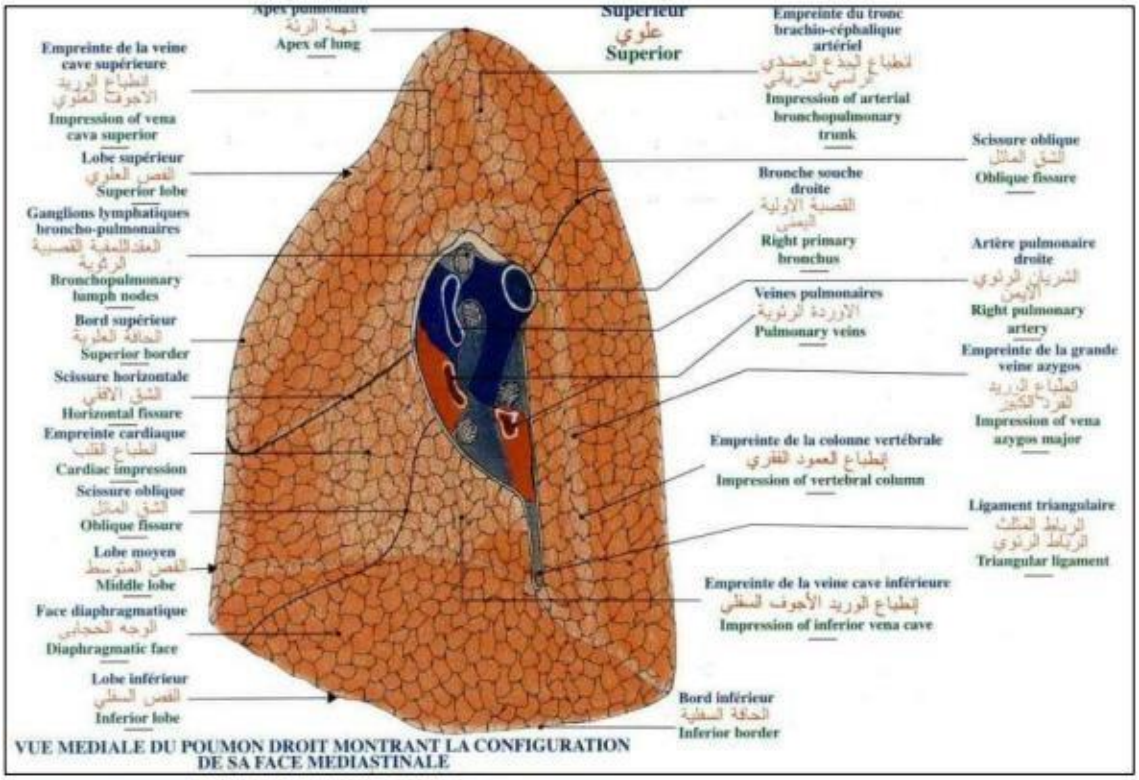
The medial surface of the lung shows a series of impressions corresponding to the various structures of the mediastinum.

On the right side, the surface features are shaped by:

- A deep pre- and sub-hilar depression caused by the heart (specifically the right atrium),
- Vertical depressions (above and in front of the hilum) formed by:
    - the superior vena cava,
    - the brachiocephalic vein,

- the brachiocephalic artery,

- A curved groove made by the azygos vein and its arch.



Medial view of the right lung showing the configuration of its mediastinal surface

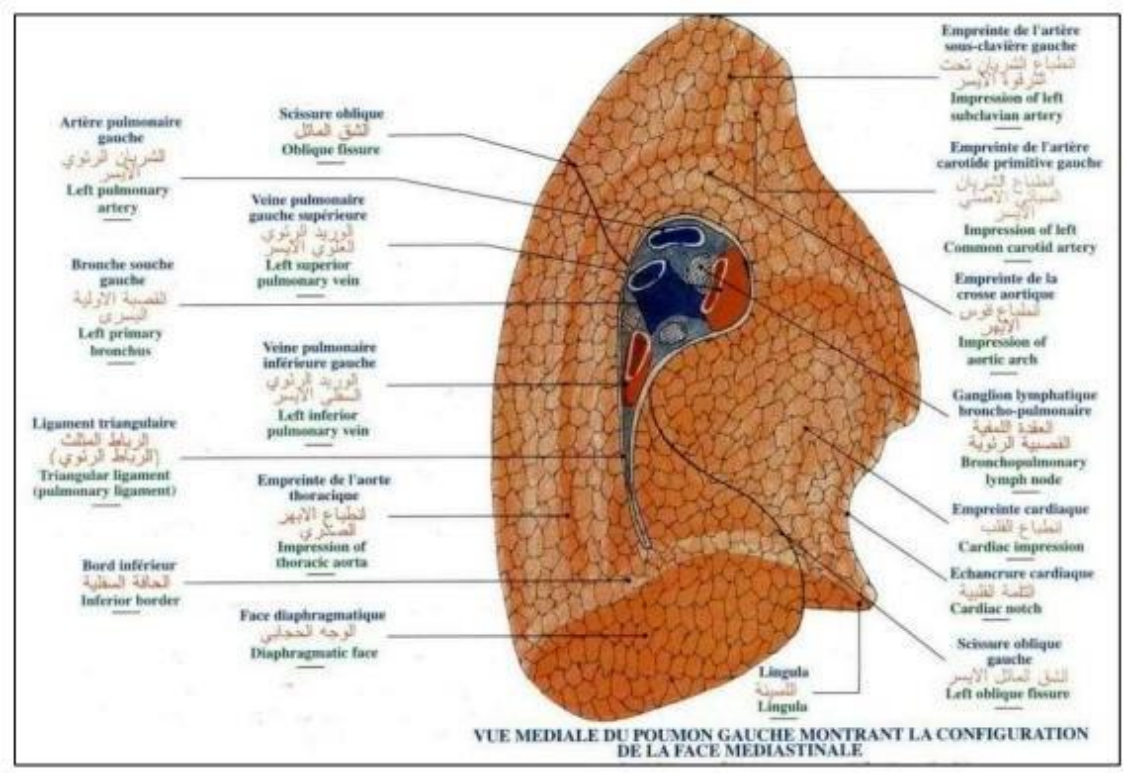
<u>On the lef t side,</u> the impressions are more pronounced:

- A pre- and sub-hilar impression formed by the heart (specifically the left ventricle),

- A broad curved groove left by the thoracic aorta, arching around the hilum,

- And, superiorly and posteriorly, a vertical impression left by the left subclavian artery.

Note: *Surgically, the left pulmonary hilum is less directly accessible than the right pulmonary hilum.*



Medial view of the left lung showing the configuration of its mediastinal surface

c. Diaphragmatic surface :

- The pulmonary base, which is concave in all directions, faces downward and forward.
- It is moulded to the convexity of the diaphragm dome and is transversely crossed by the oblique fissure.

d. Borders :

❖ Anterior border:

It separates the costal and mediastinal surfaces at the front.

- <u>On the lef t lung,</u> it is notched: cardiac notch.
- <u>On the right lung,</u> it is interrupted by the horizontal fissure.

❖ **Posterior border:**

It separates the costal and mediastinal surfaces at the back.

❖ **Inferior border (or circumferential border):**

It defines the base of the lung and is divided into two parts:

- A lateral and posterior portion separating the base from the costal surface,
- A medial and anterior portion separating the base from the mediastinal surface.

e. Apex :

It protrudes outside the thorax (above the superior aperture), with its lower limit marked by the groove of the first rib.

Note: *Tumors of the pulmonary apex are the cause of Pancoast and Tobias syndrome, which associates Claude-Bernard-Horner syndrome, cervicobrachial neuralgias, and apical opacity on chest X-ray.*

f. Pulmonary segmentation :

The lungs are divided into lobes by the interlobar fissures.

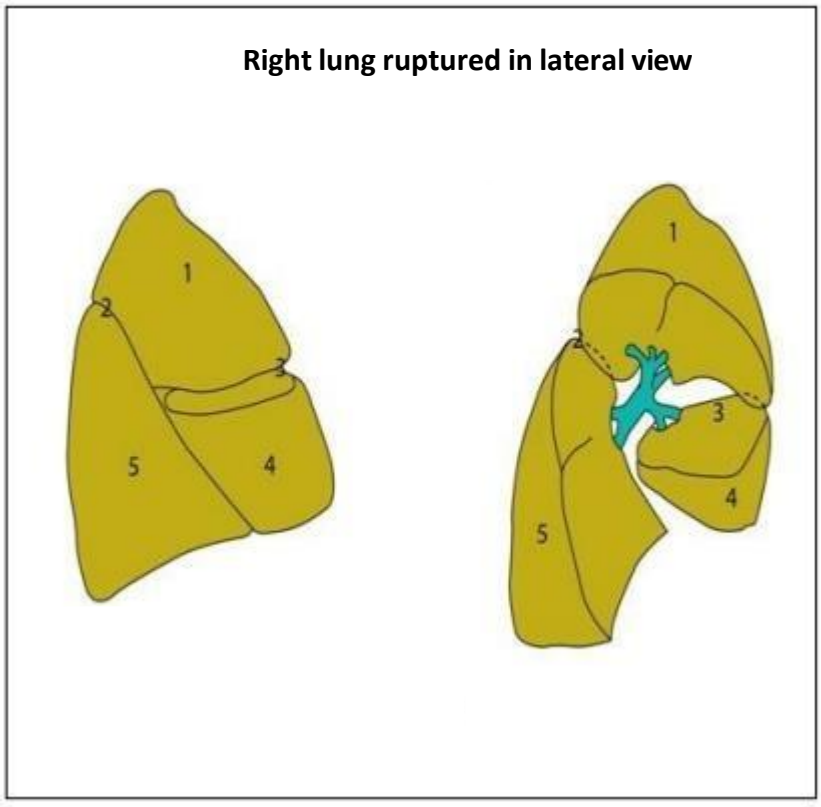
Segmentation of the right lung:

The right lung is divided by two fissures into three lobes: superior, middle, and inferior.

❖ **Fissures:**

- Oblique fissure: oblique, running downward and forward, separating the superior and middle lobes from the inferior lobe.

- Horizontal fissure: branching in front of the oblique fissure, separating the superior and middle lobes.



1- Upper lobe
2- Oblique scissure
3- Horizontal scissure
4- Middle lobe
5- Inferior lobe

❖ Lobes:

- Superior lobe ;
- Middle lobe: the smallest ;
- Inferior lobe: the largest, pyramid-shaped with a lower base.

❖ Segments:

Each lobe of the right lung is subdivided into segments.

- The superior lobe subdivides into three segments:
  - ✓ Apical segment (1)

- ✓ Dorsal segment (2)
- ✓ Ventral segment (3)

- The middle lobe subdivides into two segments:

  - ✓ Lateral segment (4)

  - ✓ Medial segment (5)

- The inferior lobe subdivides into five segments in two groups:

  - Upper group: formed by

    - ✓ Apical segment or Fowler's segment (6)

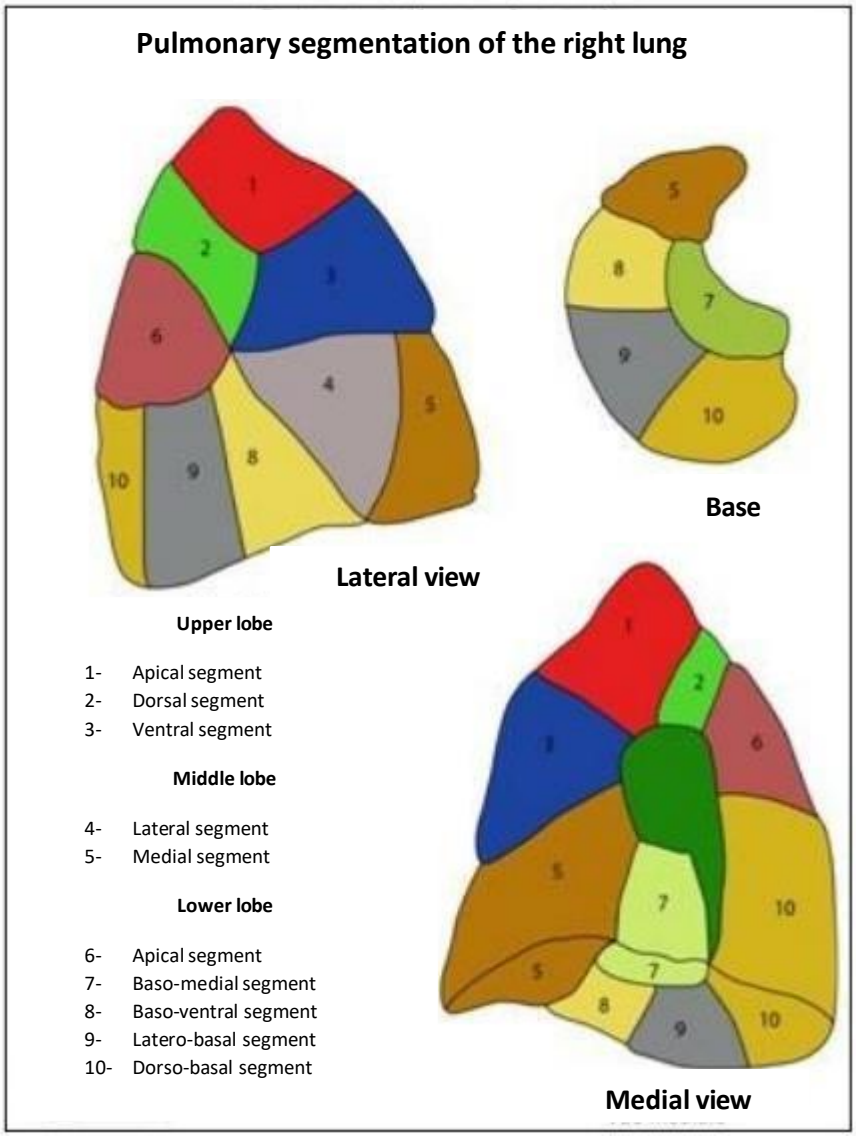
    - ✓ Lower group (or basal pyramid), formed by:

    - ✓ Baso-medial or para-cardiac segment (7)

    - ✓ Baso-ventral or ventro-basal segment (8)

    - ✓ Baso-lateral or latero-basal segment (9)

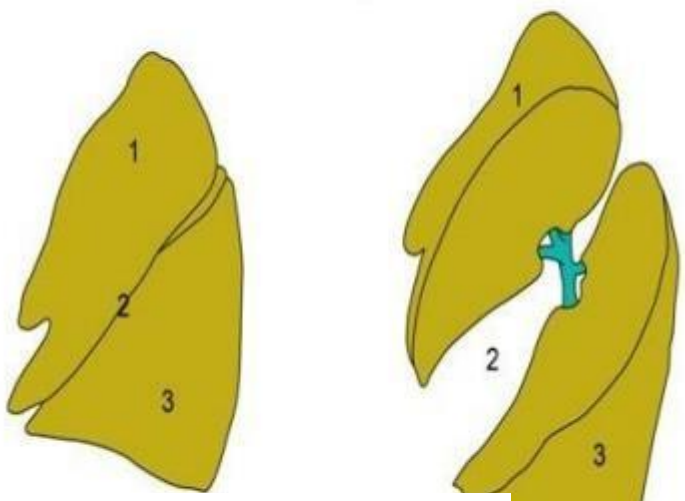
    - ✓ Baso-dorsal or terminal-basal segment (10)



Segmentation of the left lung:

The left lung is divided by the oblique fissure, running downward and forward, into two lobes: superior and inferior.

Left lung ruptured on a lateral view



1- Upper lobe
2- Oblique fissure
3- Lower lobe

❖ Lobes:

- Superior lobe: homologous to the right superior and middle lobes.
- Inferior lobe: approximately symmetrical to the right inferior lobe.

❖ Segments:

The segmentation of the left lung is largely similar to that of the right lung.

- The superior lobe is divided into five segments in two groups:
  - Upper group or culmen, divided into three segments:
    - ✓ Apical segment (1)
    - ✓ Dorsal segment (2)
    - ✓ Ventral segment (3)

- Lower group or lingula, divided into two segments:
  - ✓ Superior segment (4)
  - ✓ Inferior segment (5)

- The inferior lobe is divided into five segments in two groups:

  - Upper group, formed by:
    - ✓ Apical segment or Fowler's segment (6)

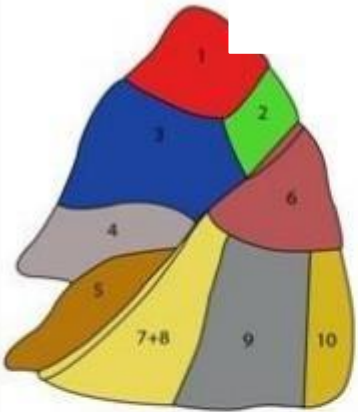
  - Lower group (or basal pyramid), formed by four segments:
    - ✓ Baso-medial or para-cardiac segment (7)
    - ✓ Baso-ventral or ventro-basal segment (8)
    - ✓ Baso-lateral or latero-basal segment (9)
    - ✓ Baso-dorsal or terminal-basal segment (10)

Note:

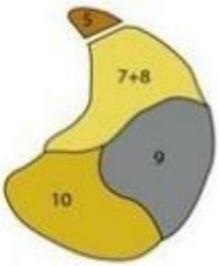
The term parenchymal consolidation syndrome (pneumonia) is used when a lobe or segment no longer performs its ventilation function.

On chest X-ray: this appears as a systematized opacity in a pulmonary territory.

Pulmonary segmentation of the left lung



Medial view



Base

Upper lobe

Upper group or culmina :

1- Apical segment
2- Ventral segment
3- Dorsal segment

Lower group or lingula :

4- Superior segment
5- Inferior segment

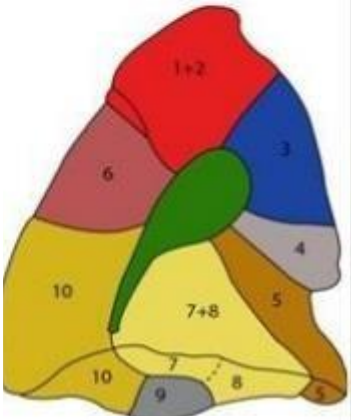
Lower lobe

Superior group :

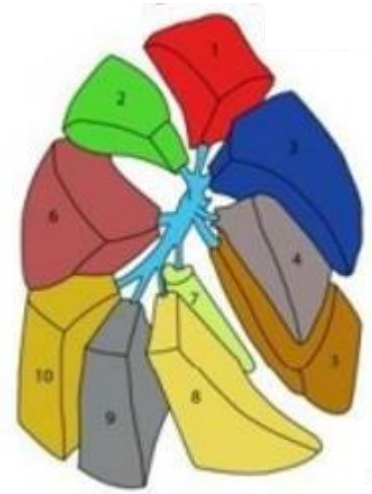
6- Apical segment

Inferior group :

7- Baso-medial segment
8- Baso-ventral segment
9- Baso-lateral segment
10- Baso-dorsal segment



Lateral view



Upper lobe

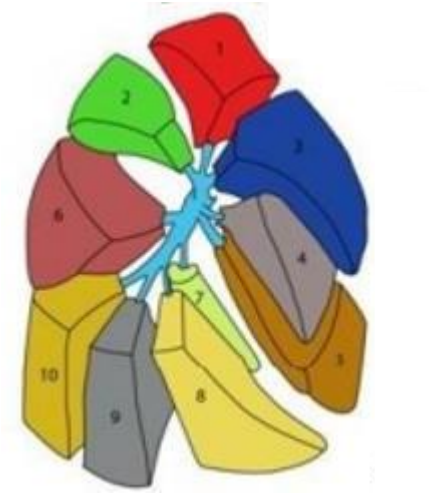
11- Apical segment
12- Dorsal segment
13- Ventral segment

Middle lobe

14- Lateral segment
15- Medial segment

Lower lobe

16- Apical segment
17- Baso-medial segment
18- Baso-ventral segment
19- Latero-basal segment
20- Dorso-basal segment



Upper lobe

Upper group or culmina :

11- Apical segment
12- Ventral segment
13- Dorsal segment

Lower group or lingula :

14- Superior segment
15- Inferior segment

Lower lobe

Superior group :

16- Apical segment

Inferior group :

17- Baso-medial segment
18- Baso-ventral segment
19- Baso-lateral segment
20- Baso-dorsal segment

III – INTERNAL CONFIGURATION:

- The pulmonary parenchyma is segmented into progressively smaller elements, accompanied by bronchial, vascular, and nervous divisions that also reduce in size.
- Together, these form a "tree." Each segment of each lobe is subdivided into a large number of elements, each forming a functional respiratory unit, called **pulmonary lobules**.

The morphological (anatomical) unit of the lung

The **Miller lobule** is variable in size (10 to 25 mm). It is traversed at its apex by a broncho-vascular axis.

- The **lobular bronchus** is a 15th-order bronchus; it branches until the terminal bronchioles, then into the respiratory bronchioles.
- **Lobular arteries** (0.5 to 1 mm) follow the bronchial axis, unlike the veins and pulmonary lymphatics.
- The **veins** are distributed at the periphery of the lobule, in the **perilobular tissue**, from where they return to the pulmonary hilum.

The **Miller lobules**, numbering around 5,000 units, are surrounded by a septal envelope connected to the pleura. Each lobule consists of 3 to 5 **acinous units**, which themselves

subdivide into **alveolar sacs** and then into **alveoli**. The alveoli are surrounded by **arteriovenous capillaries**.

IV – PLEURAE:

Each pleura is a serous membrane that encloses each lung. It consists of two layers: the **visceral pleura** and the **parietal pleura**. These two layers are continuous with each other at the level of the pulmonary hilum, defining the **pleural cavity**.

Note: *The pleural cavity can be visually explored through pleuroscopy.*

1. Visceral pleura :

It is thin and transparent, covering the surface of the lung and the lobar fissures.

Note: *The adhesion of the visceral pleura to the lung explains the pneumothora**x** associated with pulmonary ruptures.*

2. Parietal pleura :

- The parietal pleura lines the deep surface of the compartment containing the lung, to which it is attached by a cellular layer called the endothoracic fascia.
- It is divided into three segments:
  - Costal segment ;
  - Medial segment ;
  - Inferior segment.

a. Costal pleura :

It corresponds to the thoracic wall.

b. Diaphragmatic pleura :

It is strongly adherent to the diaphragm.

c. Mediastinal pleura :

- The **parietal pleura** extends sagittally from the posterior surface of the sternum in the front to the lateral vertebral grooves in the back. It lines the lateral surfaces of the mediastinum and can be subdivided into three sections:

    - **Superior segment** (suprapedicular), where it extends from the posterior surface of the sternum to the lateral vertebral grooves.
    - **Middle segment** (pedicular), where it reflects around the hilum to envelop the two pulmonary pedicles.
    - **Inferior segment** (subpedicular).

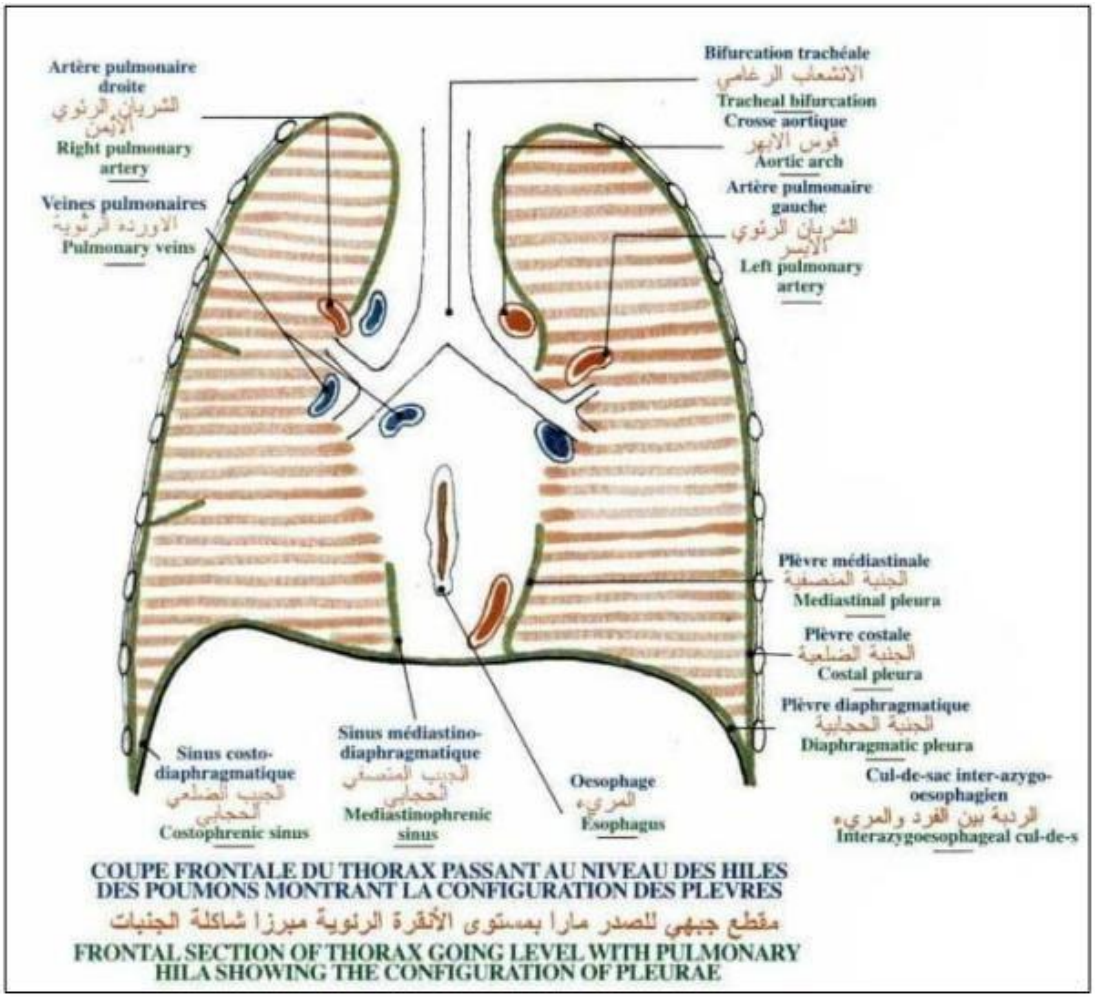
    - The three segments of the parietal pleura are continuous with one another, forming four pleural recesses (or sacs):

        - **Anterior costo-mediastinal recess**
        - **Posterior costo-mediastinal recess**
        - **Mediastino-diaphragmatic recess**
        - **Costo-diaphragmatic recess**

Note: *The posterior costo-mediastinal recess is the site where pleural effusions accumulate. Pleuracentesis for drainage is typically performed at the phrenicomediastinal recess. The puncture point is located along the posterior axillary line, in the 8th intercostal space, just above the upper edge of the 9th rib.*

- The **fixation of the parietal pleura** is primarily ensured by the **endothoracic fascia**, which *consists of a layer of poorly vascularized cellular tissue.*

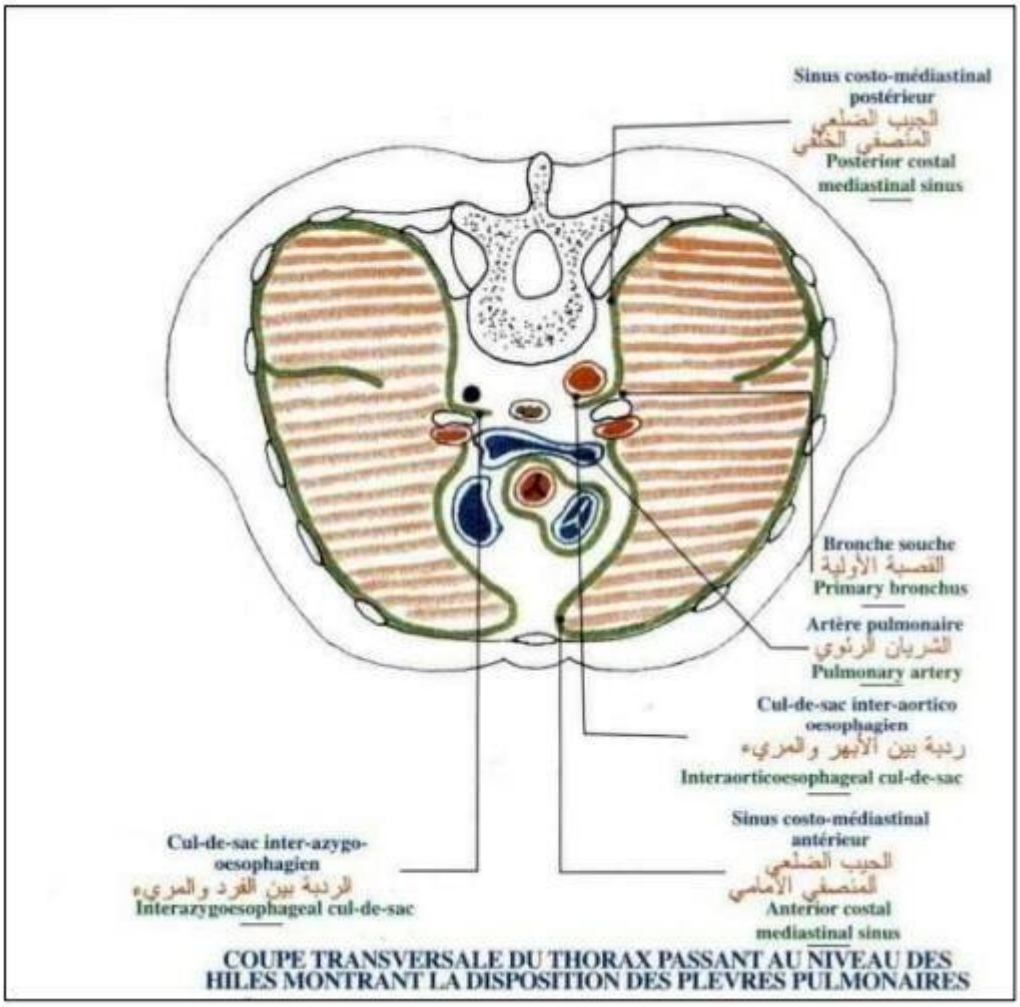
Note: *It may serve as a surgical cleavage plane (extrathoracic plane) when the pleura is adherent or infiltrated, for example, by a neoplastic process.*



COUPE FRONTALE DU THORAX PASSANT AU NIVEAU DES HILES DES POUMONS MONTRANT LA CONFIGURATION DES PLEVRES

مقطع جبهي للصدر مارا بمستوى الأقرة الرئوية مبرزا شاكلة الجنبات

FRONTAL SECTION OF THORAX GOING LEVEL WITH PULMONARY HILA SHOWING THE CONFIGURATION OF PLEURAE



Transverse section of the thorax, at the level of the pulmonary hilium, showing the disposition of the pulmonary pleurae

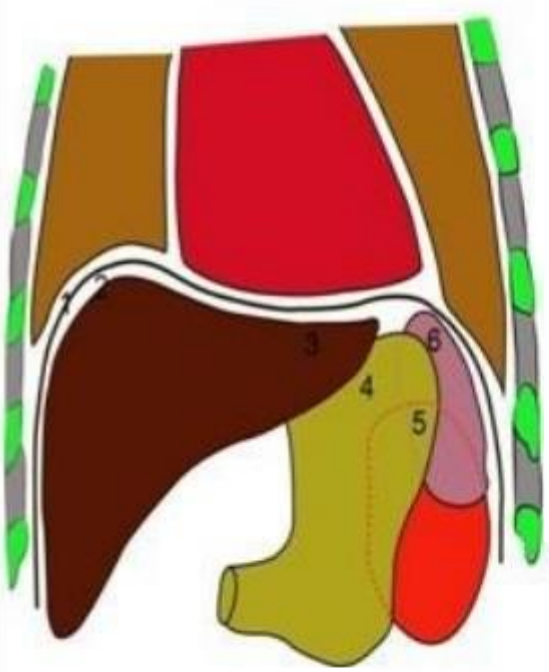
V – ANATOMICAL RELATIONS:

1. Inferior or diaphragmatic relations :

Through the diaphragm, the inferior surface of the lung is in contact with:

- **On the right**: the superior surface of the liver.
- **On the left** (from front to back):
  - The left lobe of the liver,
  - The fundus,
  - The left adrenal gland and the upper part of the left kidney,
  - The upper part of the spleen, more laterally.

Inferior diaphragmatic relations



Frontal section

Superior

inferior

1- Diaphragmatic dome
2- Superior surface of the liver
3- Left lobe of the liver
4- Fundus
5- Superior border of the left kidney
6- Superior border of the spleen

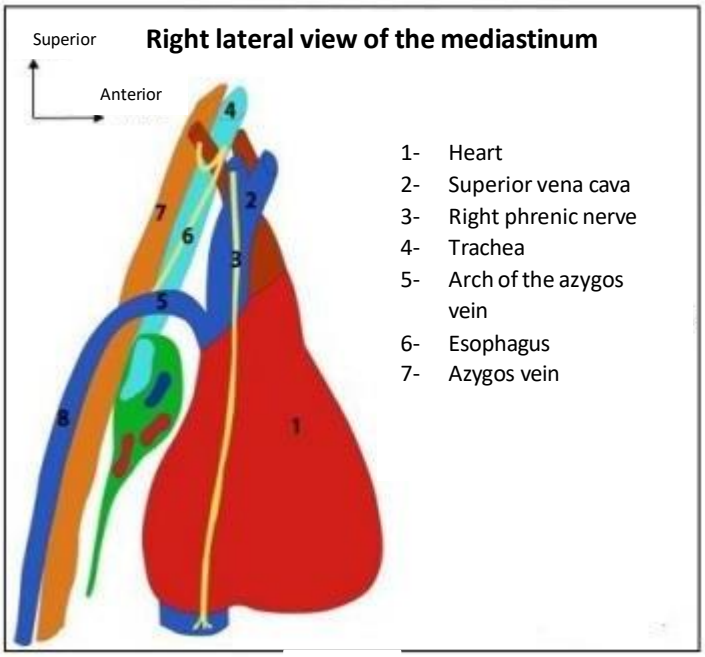
2. Venous vascularization:

The medial surface of the lung is in contact with various components of the mediastinum, which often leave an imprint:

On the right side:

- In the anterior mediastinum, from bottom to top:
  - The heart: the right atrium
  - The superior vena cava and the brachiocephalic trunk
  - The right phrenic nerve
- In the middle mediastinum, above the hilum:
  - The trachea
  - The arch of the azygos vein
  - The right vagus nerve
- In the posterior mediastinum:
  - The esophagus

- The azygos vein
- The sympathetic chain along the lateral vertebral column.



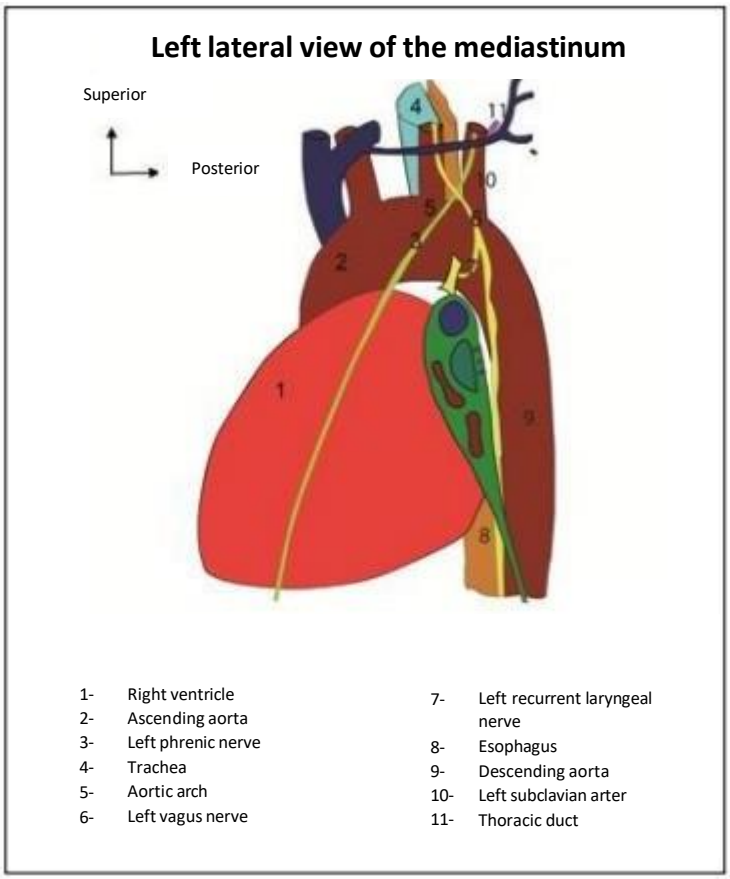
On the left side:

- In the anterior mediastinum, from bottom to top:
  - The heart, primarily the left ventricle ;
  - The ascending aorta ;
  - The left phrenic nerve.

Note: *A pulmonary cancer affecting the phrenic nerve can cause paralysis of the corresponding hemidiaphragm.*

- In the middle mediastinum, above the hilum:
  - The trachea ;
  - The aortic arch ;
  - The left vagus nerve.
- In the posterior mediastinum:
  - The esophagus ;
  - The descending thoracic aorta ;

- The thoracic duct ;
- The sympathetic chain along the lateral vertebral column.



3. External and parietal relations:

The costal surface of the lung, convex in both vertical and horizontal directions, molds to the inner surface of the thoracic wall, to which the parietal pleura is attached.

4. Relations of the apex:

- **Anteriorly**, it is in relation to the subclavian artery, the anterior scalene muscle, the phrenic nerve, and the vagus nerve, with the recurrent laryngeal nerve branching off on the right side.
- **Posteriorly,** it is in relation to the neck of the first rib, the cervicothoracic ganglion, and the first intercostal pedicle.
- **Laterally,** it is in relation to the middle scalene muscle.

- **Medially,** it is in relation to:
    - On the right: the brachiocephalic trunk, the esophagus, and the trachea
    - On the left: the left common carotid artery, the left subclavian artery, the esophagus, and the thoracic duct

Note: *The recurrent laryngeal nerve can be involved in apical pulmonary cancers, usually resulting in hoarseness due to paralysis of one vocal cord.*

VI – VASCULARIZATION – INNERVATION – LYMPHATIC DRAINAGE:

1. Arterial and venous vascularization :

The arteries and veins form two systems:

- **A functional system** including:
    - **Pulmonary trunk**: It arises from the base of the right ventricle and divides into two branches, right and left, which enter the corresponding pulmonary hilum.
        - **Right pulmonary artery**: gives off 3 lobar branches.
        - **Left pulmonary artery**: gives off 2 lobar branches.

          These arteries carry **deoxygenated blood**.

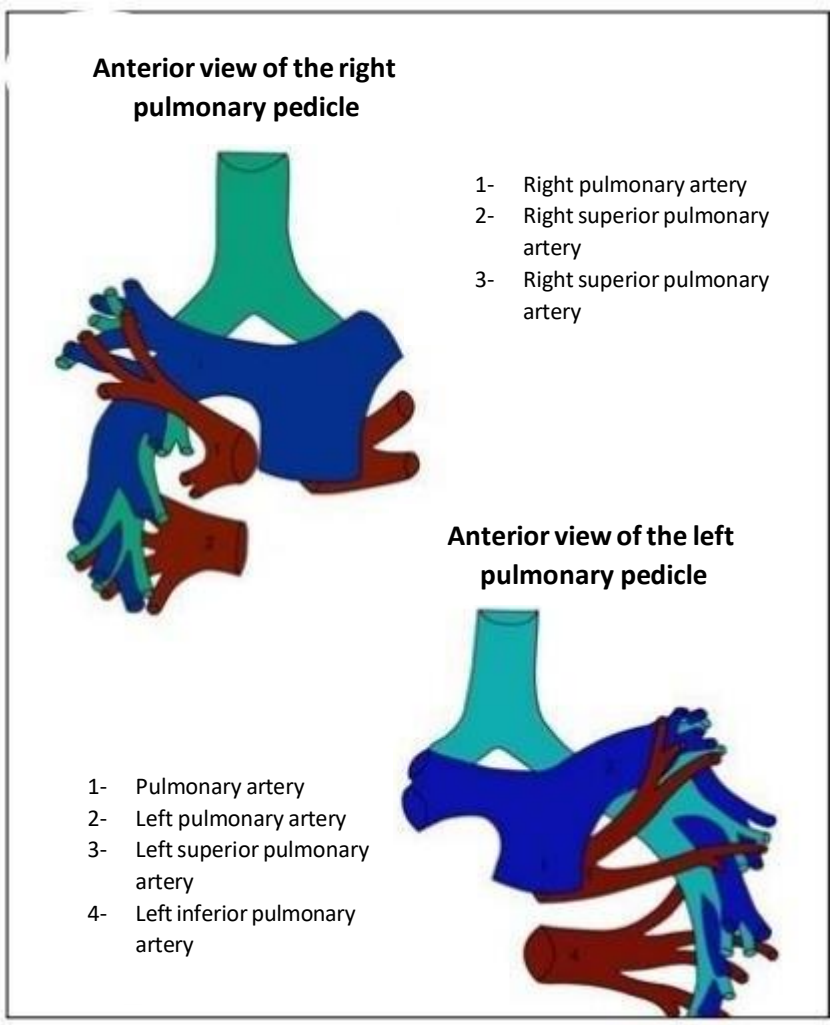
Note*: Pulmonary arteries can be the site of pulmonary arterial hypertension (PAH).*

    - **Pulmonary veins**: These drain oxygenated blood from the lungs to the left atrium. There are four pulmonary veins:
        - Two **right pulmonary veins** (superior and inferior).
        - Two **left pulmonary veins** (superior and inferior).

- **A nutritive system** including:
    - **Bronchial arteries**: These supply oxygenation and nutrition to the bronchial tree and the lung.

***Note**: This function has been particularly highlighted by the development of pulmonary transplantation. Their hypervascularization is the cause of most hemoptyses.*

- And the **bronchial veins**.



2. Lymphatic drainage :

Lymphatic vessels

They form two systems: one superficial (pleural) and the other deep, following the bronchial

tree and pulmonary vessels. These two systems only have anastomoses in the **hilum** region. Along their path, there are **pulmonary nodes** along the segmental bronchi and **bronchopulmonary nodes** located in the hilum.

Each lung has three lymphatic territories:

a. Upper pulmonary territories

- The anteromedial part of the right upper lobe drains into the superior tracheobronchial nodes and right paratracheal nodes.
- The upper part of the left upper lobe drains into the prevascular nodes and superior tracheobronchial nodes on the left side.

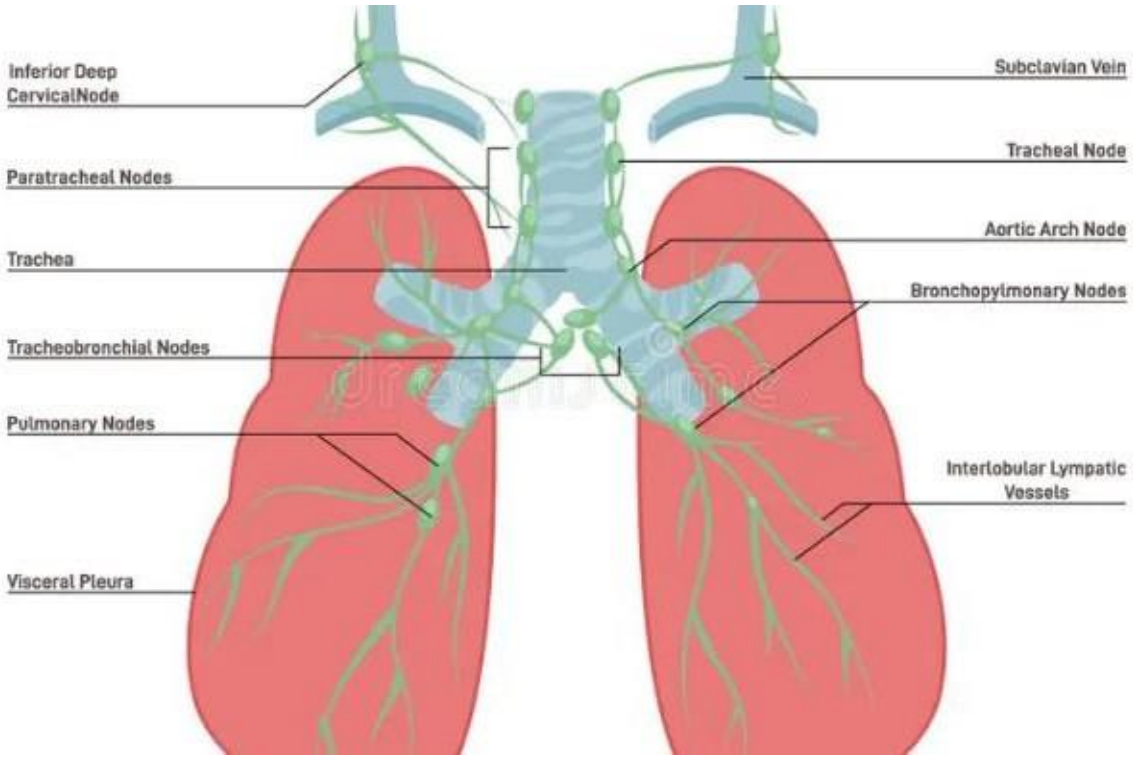
b. Middle pulmonary territories

- These drain into the **superior and inferior tracheobronchial nodes**.
- They include:
    - On the right: the posterolateral part of the upper lobe, the middle lobe, and the superior segment of the lower lobe.
    - On the left: the lingular segments and the upper part of the lower lobe.

c. Lower pulmonary territories

- These include the basal segments of the lower lobes.
- They drain into the **inferior tracheobronchial nodes** and the **juxtaesophageal pulmonary nodes**.

In total, the right paratracheal nodes drain the right lung and the lower half of the left lung.



3. Innervation:

The nerves arise from the **pulmonary plexus**, and are composed of:

- **Parasympathetic fibers** (vagus nerve), which are **bronchodilatory** (promote bronchodilation),
- **Sympathetic fibers**, which are **bronchoconstrictory** (promote bronchoconstriction).

VII – CLINICAL APPLICATIONS:

❖ Lung cancer:

- Lung cancer is a common disease that can be detected on a simple chest X-ray as an opacity. Any doubt requires the performance of a bronchoscopic examination to confirm the diagnosis through the anatomopathological analysis of biopsies. The main risk of this cancer is the dissemination of cancer cells via the lymphatic pathways towards the hilum, followed by the invasion of mediastinal lymph nodes near the large vessels, making surgical resection unfeasible. The staging workup should include, in addition to the standard chest X-ray, a computed tomography (CT) scan of the chest, which evaluates both the pulmonary parenchyma and the mediastinum.

- Its radiological markers are :

  ✓ **Standard chest X-ray (frontal view)**:

  This simple examination is used for screening. It shows the mediastinum centrally, surrounded by the two pulmonary gutters. The mediastinum is occupied by the cardiac silhouette, with the arcs of both sides of the heart visible, topped by the large vessels. The pulmonary fields should display the parenchymal pattern, which must be subtly visible from the hila, but transparency should be preserved. The lungs descend down to the diaphragmatic domes and are adjacent to the thoracic walls. If there is a black space with no parenchyma between the lung border and the rib wall, it indicates a pneumothorax. Similarly, a curvilinear concave opacity upwards and towards the inside, extending towards the axillary fossa, suggests a pleural effusion.

  ✓ **Chest CT scan**:

  CT imaging produces successive horizontal slices of the chest, which can be studied with mediastinal or parenchymal window settings. In pulmonary windows, the pulmonary parenchyma is assessed to evaluate the extent of a tumor opacity and to check for other lesions. In mediastinal windows, the slices of the mediastinum allow for evaluating the relationship between the tumor and large vessels or the pericardium, assessing potential involvement of the pulmonary pedicle, and detecting involved lymph nodes.

VIII- CONCLUSION:

The lung is a respiratory organ that also plays an important role in purification and protection of the body from the environment, with which it maintains constant air contact. A thorough understanding of its anatomy has become essential to make the most of advancements in surgery and modern imaging.