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Anatomy

Most Needed 60 Days Revision Plan

As per the Competency-based Medical Education Curriculum (NMC)



Archana Kalyankar

Forewords
Pravin H Shingare
Sanjay Rathod

JAYPEE

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4 CHAPTER

Thorax

SAQ1. Movements of respiration.

AN 21.9: Describe and demonstrate mechanics and types of respiration (Y).

Ans. The lungs expand during inspiration and retract during expiration. These movements are governed by the following two factors:

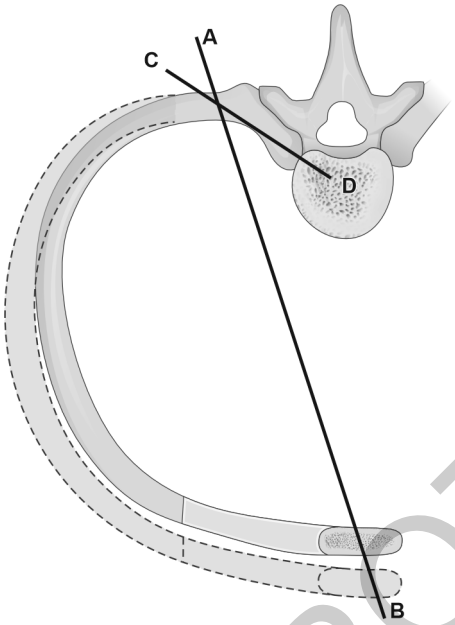
1. Alterations in the capacity of the thorax are brought about by movements of the thoracic wall. Increase in volume of the thoracic cavity creates a negative intrathoracic pressure, which sucks air into the lungs. Movements of the thoracic wall occur chiefly at the costovertebral and manubriosternal joints.
2. Elastic recoil of the pulmonary alveoli and of the thoracic wall expels air from the lungs during expiration.

Principles of Movements

1. Along with the up and down movements of the second to sixth ribs, the body of the sternum also moves up and down called pump-handle movements. The anteroposterior diameter is increased mainly by the pump-handle movements of the sternum brought about by elevation of the vertebrosternal second to sixth ribs and partly by elevation of the seventh to tenth vertebrochondral ribs **(Figs. 4.1 and 4.2)**.
2. During elevation of the rib, the shaft also moves outwards. This causes increase in the transverse diameter of the thorax. Such movements occur in the seventh to tenth vertebrochondral ribs, and are called bucket-handle movements. Partly, it is increased by elevation of the second to sixth vertebrosternal ribs.
3. The vertical diameter is increased by descent of the diaphragm as it contracts. This is called piston mechanism. During inspiration, the diaphragm contracts and it comes down by 2 cm. It is aided by relaxation of muscles of anterior abdominal wall. During expiration, abdominal muscles contract, and diaphragm is pushed upward. It facilitates in inspiration of at least 400 mL of air during each contraction **(Figs. 4.3 and 4.4)**.

In females, respiration is thoracoabdominal and in males, it is abdominothoracic type. Expiration is passive process.

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The axes of movement (AB and CD) of a vertebrosternal rib.
The interrupted lines indicate the position of the rib in inspiration.

Fig. 4.1: Axes of movement.

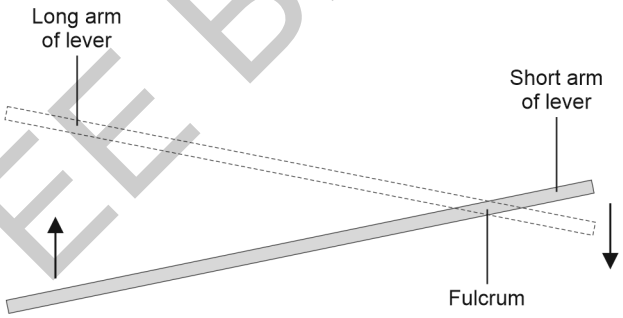


Fig. 4.2: Comparison between a rib to a lever.

Respiratory muscle involved are:

For inspiration: Diaphragm, external intercostals muscle, and interchondral part of internal intercostals of contralateral side.
For deep inspiration: Erector spinae, scalene muscles, pectoral muscles.
Forced expiration: Muscles of anterior abdominal wall.

Following movements occur in:

1. **Quiet inspiration**
   a. The anteroposterior diameter of the thorax is increased by elevation of the second to sixth ribs. The first rib remains fixed.

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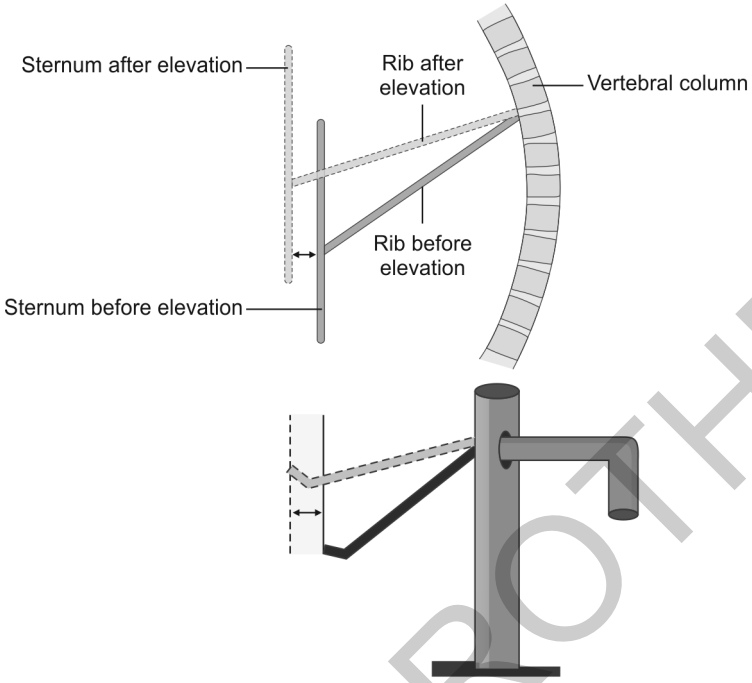


Diagram showing how 'pump-handle' movements of the sternum bring about an increase in the anteroposterior diameter of the thorax

Fig. 4.3: Pump-handle movements of the sternum.

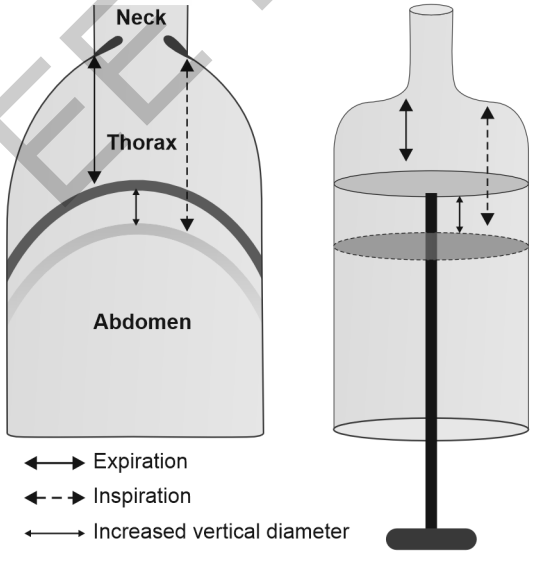


Diagram showing how piston movements of thoracoabdominal diaphragm bring about an increase in the vertical diameter of the thorax

Fig. 4.4: Piston movements of thoracoabdominal diaphragm.

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b. The transverse diameter is increased by elevation of the seventh to tenth ribs.
c. The vertical diameter is increased by descent of the diaphragm.

2. Deep inspiration
a. Movements during quiet inspiration are increased.
b. The first rib is elevated directly by the scalene, and indirectly by the sternocleidomastoid.
c. The concavity of the thoracic spine is reduced by the erector spinae.

3. Forced inspiration
a. All the movements are exaggerated.
b. The scapulae are elevated and fixed by the trapezius, the levator scapulae and the rhomboids, so that the serratus anterior and the pectoralis minor muscles may act on the ribs.
c. The action of the erector spinae is appreciably increased.

4. Quiet expiration
The air is expelled mainly by the elastic recoil of the chest wall and pulmonary alveoli, and partly by the tone of the abdominal muscles.
Deep and forced expiration: It is brought about by strong contraction of the abdominal muscles and of the latissimus dorsi.

Clinical Anatomy

1. In dyspnea or difficulty in breathing, the patients are most comfortable on sitting up, leaning forward and fixing the arms. In the sitting posture, the position of diaphragm is lowest allowing maximum ventilation. Fixation of the arms fixes the scapulae, so that the serratus anterior and pectoralis minor may act on the ribs to good advantage.
2. The height of the diaphragm in the thorax is variable according to the position of the body and tone of the abdominal muscles. It is highest on lying supine, so the patient is extremely uncomfortable, as he/she needs to exert immensely for inspiration. The diaphragm is lowest while sitting. The patient is quite comfortable as the effort required for inspiration is the least.
3. The diaphragm is midway in position while standing, so the patient feels exhausted to stand. Dyspneic patients feel comfortable while sitting.
4. Most prominent role in respiration is played by diaphragm. Respiration occurs in two phases. Inspiration (active phase of 1 second) Expiration (passive phase of 3 second).

In young children (up to 2 years of age), the thoracic cavity is almost circular in cross-section so the scope for anteroposterior or side-to-side expansion is limited. The type of respiration in children is abdominal.

In women of advanced stage of pregnancy, descent of diaphragm is limited, so the type of respiration in them is mainly thoracic.

LAQ1. Intercostal spaces.

AN21.5: Describe and demonstrate origin, course, relations, and branches of a typical intercostal nerve (Y).

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The gaps between the ribs are called intercostal spaces. They are filled by the intercostals muscles and contain the intercostal nerves, vessels, and lymphatics. There are nine intercostal spaces anteriorly and eleven intercostal spaces posteriorly.

1. **Intercostal muscles: These are:**
   a. *External intercostal muscle:* The external intercostal muscle extends from the tubercle of the rib posteriorly to the costochondral junction anteriorly. Between the costochondral junction and the sternum, it is replaced by the external or anterior intercostal membrane. In the anterior part of the intercostal space, the fibers of the external intercostal muscle run downward, forward, and medially in front. Origin of external intercostalis is on lower border of the rib above the space. Insertion is on outer lip of the upper border of the rib below.
   b. *Internal intercostal muscle:* The internal intercostal muscle extends from the lateral border of the sternum to the angle of the rib. Beyond the angle it becomes continuous with the internal or posterior intercostal membrane. Internal intercostal muscle originates from floor of the costal groove of the rib above and inserted on inner lip of the upper border of the rib below. The fibers of the internal intercostal run downward, backward, and laterally, i.e., at right angle to those of the external intercostals.
   c. The transversus thoracis muscle, which is divisible into three parts, namely the subcostalis, the intercostales intimi (innermost intercostal) and the sternocostalis (**Fig. 4.5**).

      Transversus thoracis

      i. **Subcostalis**
      Origin: Inner surface of the rib near the angle.
      Insertion: Inner surface of two or three ribs be low.

      ii. **Intercostalis intimi**
      Origin: Middle two-fourth of the ridge above the costal groove.
      Insertion: Inner lip of the upper border of the rib below.

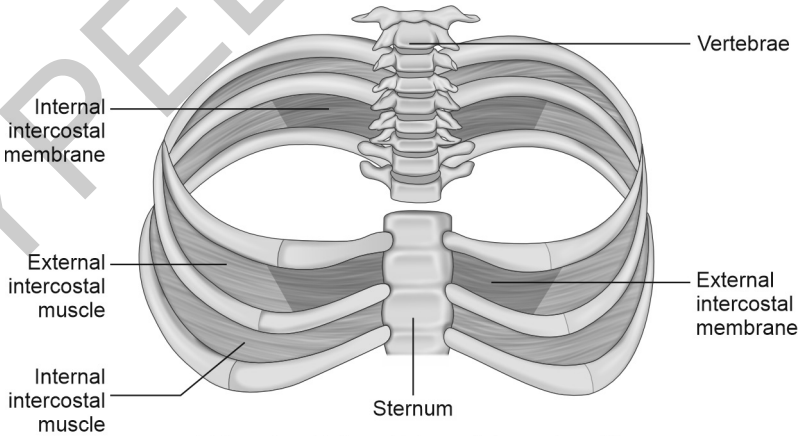


Fig. 4.5: External and internal intercostal muscles.

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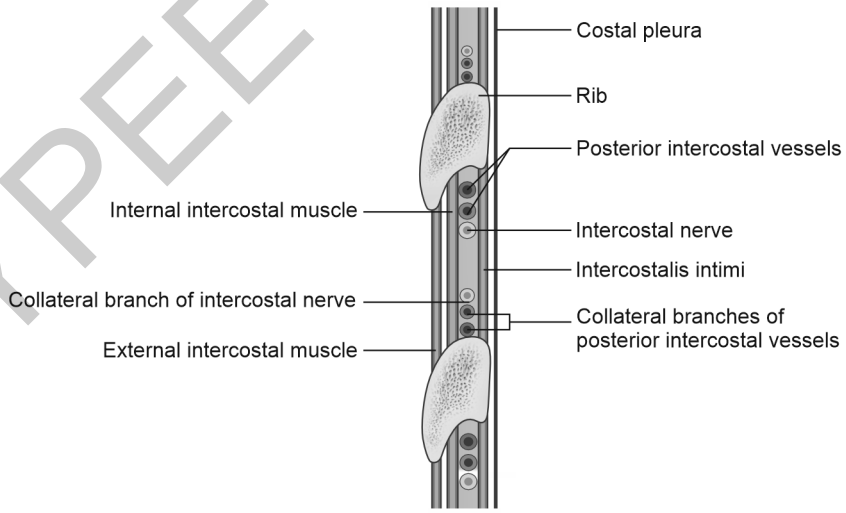
iii. **Sternocostalis**
Origin: Lower one-third of the posterior surface of the body of sternum. Posterior surface of the xiphoid, posterior surface of the costal cartilages of the lower 3rd or 4th true ribs near the sternum.
Insertion: Costal cartilages of the 2nd to 6th ribs. The fibers of the transversus thoracis run in the same direction as those of the intimal intercostals.
Nerve supply: All intercostal muscles are supplied by the intercostals nerves of the spaces in which they lie.

2. **Intercostal nerves:** The intercostal nerves are the anterior primary rami of thoracic one to thoracic eleven spinal nerves after the dorsal primary ramus has been given off. Third to sixth intercostal nerves supply only the thoracic wall, they are called typical intercostal nerves. Intercostal nerve runs in the costal groove and ends near the sternum (**Fig. 4.6**).

In the costal groove, the nerve lies below the posterior intercostals vessels. The relationship of structures in the costal groove from above downwards is, posterior intercostal vein, posterior intercostal artery, and intercostal nerve.

Branches

1. Muscular branches supply the intercostal muscles, the transversus thoracis and the serratus posterior superior. Collateral branch arises near the angle of the rib and runs in the lower part of the space in the same neurovascular plane. It supplies muscles of the space.
2. Sensory branches supply parietal pleura, periosteum of the ribs, parietal peritoneum. The lateral cutaneous branch arises near the angle of the rib and divides into anterior and posterior branches. The anterior cutaneous branch supplies the overlying skin after dividing into medial and lateral branches.



Section through intercostal space showing neuro-vascular bundle and its collateral branches

Fig. 4.6: Intercostal nerves.

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3. **Intercostal arteries:** Each intercostal space contains one posterior intercostal artery with its collateral branch and two anterior intercostal arteries. The greater part of the space is supplied by the posterior intercostal artery.

Posterior Intercostal Arteries

These are 11 in number on each side, one in each space. The first and second posterior intercostal arteries arise from the superior intercostal artery, which is a branch of costocervical trunk of the subclavian artery.

Anterior Intercostal Arteries

There are nine intercostal spaces anteriorly as only ten ribs reach front of body. There are two anterior intercostal arteries in each space.

Intercostal Veins

There are two anterior intercostal veins in each of the upper nine spaces. There is one posterior intercostal vein and one collateral vein in each intercostal space. Each vein accompanies the corresponding artery and lies superior to the artery.

4. **Lymphatics of an intercostal space:** Lymphatics from the anterior part of the spaces pass to the anterior intercostal or internal mammary nodes.
Lymphatics from the posterior part of the space pass to the posterior intercostal nodes which lie on the heads and necks of the ribs.

Clinical Anatomy

1. Irritation of the intercostal nerves causes severe pain, which is referred to the front of the chest or abdomen, i.e., at the peripheral termination of the nerve. This is known as root pain or girdle pain.
2. Herpes virus may cause infection of intercostal nerves. If herpes infection is in 2nd thoracic nerve, there is referred pain via intercostobrachial nerve to the medial side of arm.
3. Internal thoracic artery is mobilized and its distal cut end is joined to the coronary artery distal to its narrowed segment.
4. Pus from the vertebral column tends to track around the thorax along the course of the neurovascular bundle, and may point at any of the three sites of exit of the branches of a thoracic nerve; one dorsal primary ramus and two cutaneous branches.
5. Aspiration of any fluid from the pleural cavity is called paracentesis thoracis. It is usually done in the eighth intercostal space in the midaxillary line. The needle is passed through the lower part of the space to avoid injury to the principal neurovascular bundle, i.e., vein, artery, and nerve (VAN).

SAQ2. Pulmonary ligament.

Ans. The parietal pleura surrounding the root of the lung extend downward beyond the root as a fold called the pulmonary ligament. The fold contains a thin layer of loose areolar tissue with a few lymphatics. Actually, it provides a dead space into which the pulmonary veins can

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expand during increased venous return as in exercise. The lung roots can also descend into it with the descent of the diaphragm.

SAQ3. Roots of the lungs

AN24.2. Identify side, external features, and relations of structures which form root of lung and bronchial tree and their clinical correlate (Y).

Ans. The root of each lung is made up of the following structures **(Fig. 4.7)**:

1. Principal bronchus on the left side, and eparterial and hyparterial bronchus on the right side
2. One pulmonary artery
3. Two pulmonary veins, superior and inferior
4. Bronchial arteries, one on the right side and two on the left side
5. Bronchial veins
6. Anterior and posterior pulmonary plexuses of nerves
7. Lymphatics of the lung
8. Bronchopulmonary lymph nodes
9. Areolar tissue

Arrangement of structures in the root

From anterior to posterior, it is similar on both sides.

a. Superior pulmonary vein
b. Pulmonary artery
c. Bronchus

From above downward, it is different on the two sides.

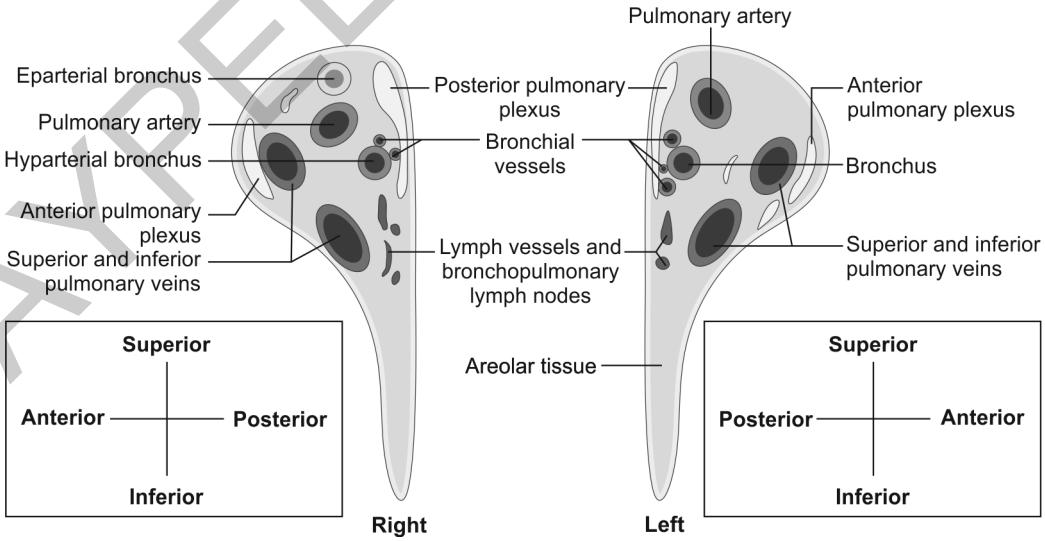


Fig. 4.7: Roots of the right and left lungs.

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Right Side

a. Eparterial bronchus
b. Pulmonary artery
c. Hyparterial bronchus
d. Inferior pulmonary vein

Left Side

a. Pulmonary artery
b. Bronchus
c. Inferior pulmonary vein

Relations of the Root

Anterior, following structures are common on the two sides (**Fig. 4.8**)

Phrenic nerve, pericardiacophrenic vessels, and anterior pulmonary plexus. On the right side superior vena cava and part of the right atrium are related.

Posteriorly, vagus nerve, and posterior pulmonary plexus are related on both sides. On left side, descending thoracic aorta is present.

Superiorly, on right side terminal part of azygos vein and on left side arch of the aorta. Inferiorly pulmonary ligament on both sides related.

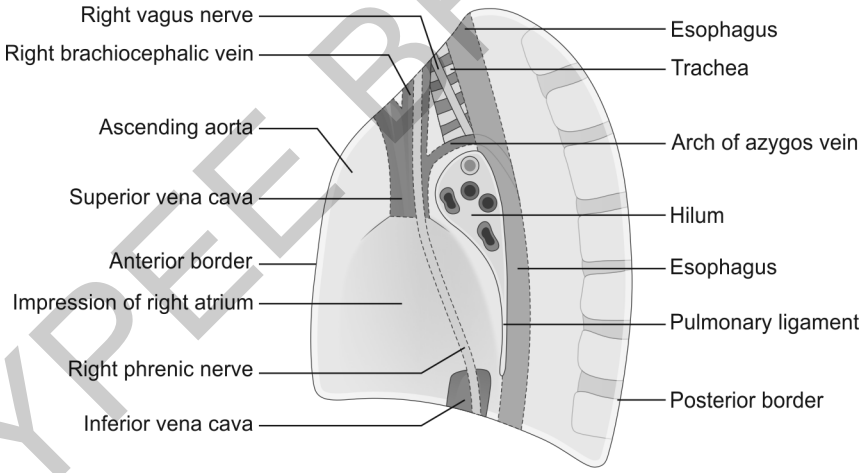


Fig. 4.8: Mediastinal surface of the right lung.

SAQ4. Structures related to the mediastinal surfaces of the right lung.

AN24.2: Identify side, external features, and relations of structures which form root of lung and bronchial tree and their clinical correlate (Y).

1. Right atrium and auricle
2. Small part of the right ventricle
3. Superior vena cava

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4. Lower part of right brachiocephalic vein
5. Azygos vein
6. Esophagus
7. Inferior vena cava
8. Trachea
9. Right vagus nerve
10. Right phrenic nerve

SAQ5. Structures related to the mediastinal surfaces of the left lung.

AN 24.2: Identify side, external features, and relations of structures which form root of lung and bronchial tree and their clinical correlate (Y).

1. Left ventricle, left auricle, infundibulum, and adjoining part of the right ventricle (**Fig. 4.9**).
2. Pulmonary trunk
3. Arch of aorta
4. Descending thoracic aorta
5. Left subclavian artery
6. Thoracic duct
7. Esophagus
8. Left brachiocephalic vein
9. Left vagus nerve
10. Left phrenic nerve
11. Left recurrent laryngeal nerve

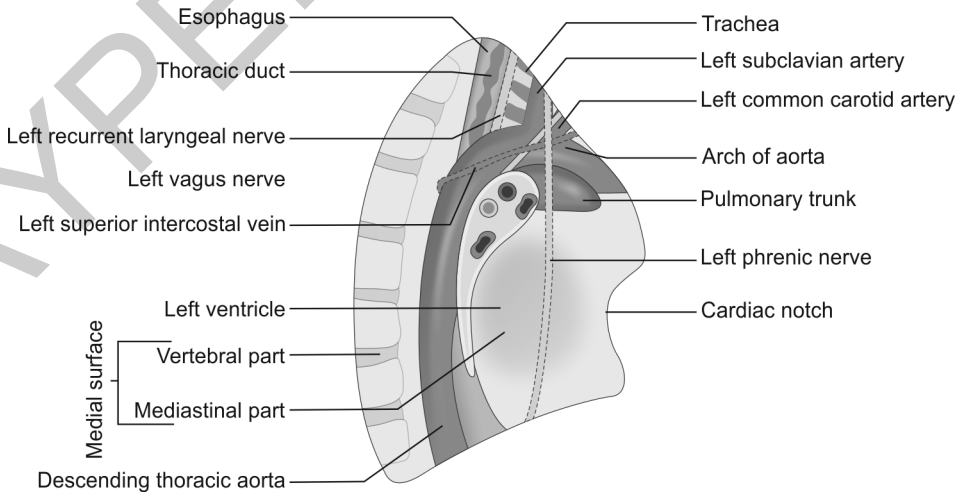


Fig. 4.9: Mediastinal surface of left lung.

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SAQ6/LAQ2. Bronchopulmonary segments.

AN24.2: Identify side, external features, and relations of structures which form root of lung and bronchial tree and their clinical correlate (Y).

Ans. Each principal bronchus enters the lung through the hilum, and divides into secondary lobar bronchi, one for each lobe of the-lungs. Thus, there are three lobar bronchi on the right side, and only two on the left side. Each lobar bronchus divides into tertiary or segmental bronchi, one for each bronchopulmonary segment which are 10 on the right side and 10 on the left side (**Fig. 4.10**).

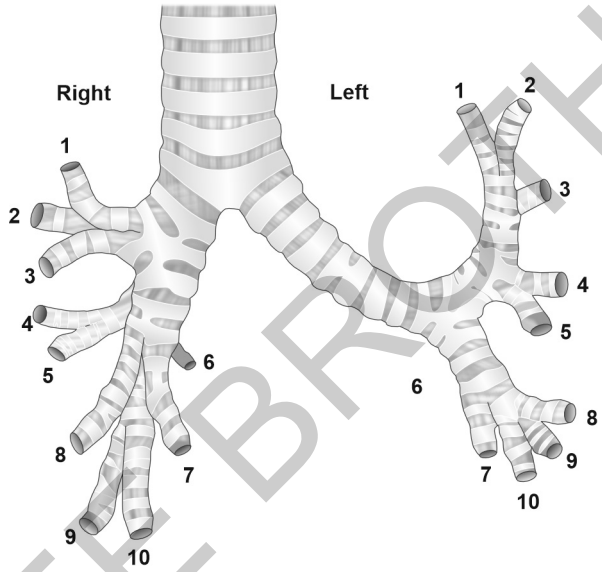


Fig. 4.10: Bronchopulmonary segments of the lungs (both sides 1 to 10).

Bronchopulmonary segments are classified as (Figs. 4.11 and 4.12):

Right lung:

A. Upper lobe—Segments are:
1. Apical
2. Posterior
3. Anterior

B. Middle lobe—Segments are:
1. Lateral
2. Medial

C. Lower lobe—Segments are:
1. Superior
2. Anterior basal
3. Medial basal
4. Lateral basal
5. Posterior basal

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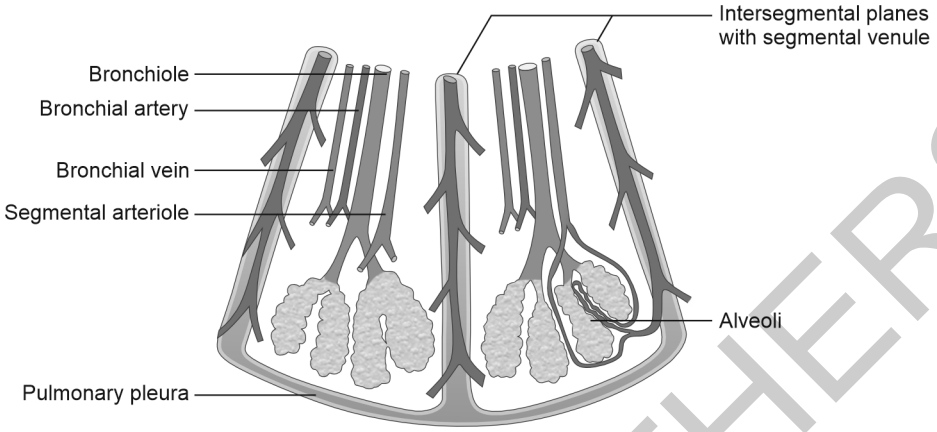
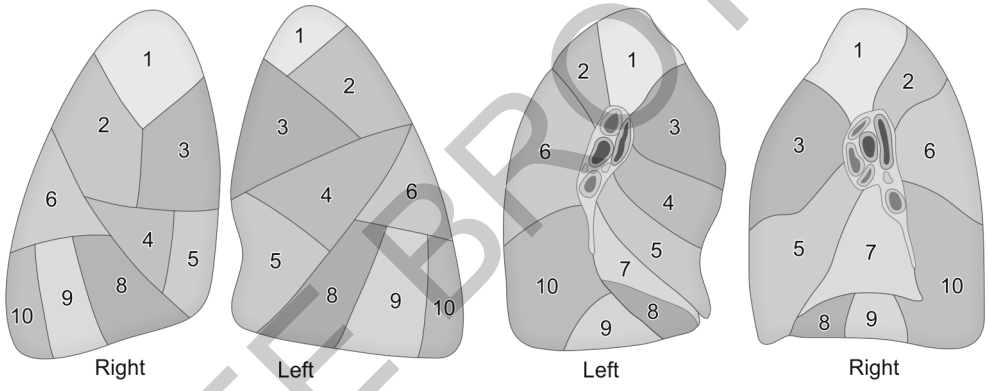


Fig. 4.11: Distal portions of adjacents bronchopulmonary segments.



(A)

Right lung		
Upper lobe	Middle lobe	Lower lobe
1. Apical	4. Lateral	6. Superior
2. Posterior	5. Medial	7. Medial basal
3. Anterior		8. Anterior basal
		9. Lateral basal
		10. Posterior basal

(B)

Left lung	
Upper lobe	Lower lobe
1. Apical	6. Superior
2. Posterior	7. Medial basal
3. Anterior	8. Anterior basal
4. Superior lingular	9. Lateral basal
5. Inferior lingular	10. Posterior basal

Fig. 4.12: The bronchopulmonary segments as seen on: (A) The costal aspects of the right and left lungs. Medial basal segments (no. 7) are not seen, and (B) segments seen on the medial surface of left and right lungs. Lateral segment of middle lobe (no. 4) is not seen on right side.

Left lung

Upper Lobe

A. **Upper division—Segments are:**
- Apical
- Posterior
- Anterior

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Archana Kalyankar MBBS MD is Associate Professor, Department of Anatomy, Government Medical College, Aurangabad, Maharashtra, India. She did her graduation from Vaishampayan Memorial Medical College (VMMC), Solapur, Maharashtra and postgraduation from Grant Government Medical College, Mumbai, Maharashtra. She is a member of various anatomical societies of India. She has numerous publications in national and international journals to her credit. She has keen interest in teaching and have more than 18 years of UG and PG teaching experience.

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