

LUNGS AND PLEURA

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In this presentation;

- Anatomy of the lung
- Anatomy of the pleura will be summarized.



References

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THORACIC CAVITY and LUNG

- ❖ Transversely sectioned thoracic cavity is divided into three parts
 - ✓ Two lateral **pulmonary cavities**
 - ✓ Centrally located **mediastinum**
- ❖ Each pleural cavity is completely lined by a mesothelial membrane called the **pleura**.
- ❖ During development, the lungs grow out of the mediastinum, becoming surrounded by the pleural cavities. As a result, the outer surface of each organ is covered by pleura.
- ❖ Each lung remains attached to the mediastinum by a **root** formed by the airway, pulmonary blood vessels, lymphatic tissues, and nerves.



LUNG

- ❖ The lungs are the **organs of respiration**. Air enters and leaves the lungs via **main bronchi**, which are branches of the trachea.
- ❖ Their main function is to oxygenate the blood by bringing the inspired air into close relation with the venous blood in the pulmonary capillaries
- ❖ The pulmonary arteries deliver deoxygenated blood to the lungs from the right ventricle of the heart. Oxygenated blood returns to the left atrium via the pulmonary veins.



LUNG

- ✓ Although cadaveric lungs may be shrunken, firm and discolored, healthy lungs in living people are normally light, spongy and fully occupy the pulmonary cavities.
- ✓ They are also elastic and recoil to approximately one third their size when the thoracic cavity is opened
- ➔ **Clinical Note; Flotation of the lungs**
 - Healthy lungs always contain some air, therefore pulmonary tissue will float in water
 - Diseased lungs filled with fluid, fetal lungs, lungs from a stillborn infant will sink
 - Lung of a live born infant will float
 - This knowledge is important in **forensic medicine**



LUNG

✓ Each lung bears the following features

- **Apex**
- **Three margins** (anterior, posterior and inferior)
- **Three surfaces** (costal, mediastinal and diaphragmatic-base)
- **Root** of the lung, **hilum** of the lung
- **Oblique fissure** in the left lung (has two lobes), **horizontal and oblique fissures** in the right lung (has three lobes)



LUNG

- **Apex;**

- ✓ Projects above rib I and into the root of neck
- ✓ Covered by cervical pleura (pleural cupula)

- **Three margins;**

- ✓ **Anterior;** separates the costal surface from the medial surface and the cardiac notch indents this border of the left lung
- ✓ **Inferior;** separates the base from the costal and mediastinal surfaces
- ✓ **Posterior;** separate the costal surface from the medial surface and unlike others the posterior border is smooth and rounded.



LUNG

- **Three surfaces**

- ✓ **The costal surface;** lies adjacent to the ribs and intercostal spaces

- ✓ **The mediastinal surface;** includes the hilum and some markings that provide clues to the relationships of the lungs,

- ✓ both lungs; esophagus and heart

- ✓ right lung; inferior&superior vena cava, azygos vein, the right subclavian artery&vein etc.

- ✓ left lung; the arch of the aorta and the descending aorta, the left subclavian artery&vein

- ✓ **The diaphragmatic surface;** base of lung, the concavity is deeper in the right lung because of liver



LUNG

- **The root and hilum**

- ✓ **The root of the lung** is a short tubular collection of structures that attach the lung to the structures in the mediastinum
- ✓ It is covered by mediastinal pleura that reflects onto the surface of the lung as visceral pleura
- ✓ **The hilum of the lung** is a wedge-shaped area on the mediastinal surface of each lung through which the structures forming the root of the lung pass to enter or exit the lung
- ✓ Inferior to the root, the continuity of parietal and visceral pleura forms **pulmonary ligament**.
- ✓ The pulmonary ligament stabilize the position of the inferior lobe and may also accommodate the down-and-up translocation of structures in the root during breathing



LUNG

✓ In the mediastinum, **the vagus nerves** pass the roots of the lungs posteriorly, while **the phrenic nerves** pass it anteriorly

✓ **Within each root and located in the hilum** are:

- a pulmonary artery,
- two pulmonary veins,
- a main bronchus,
- bronchial vessels,
- nerves, and
- lymphatics

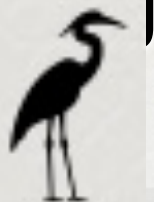
✓ Generally, the pulmonary artery is superior at the hilum, the pulmonary veins are inferior, and the bronchi are somewhat posterior in position.

✓ But on the right side, the superior lobar bronchus branches from the main bronchus in the root (epiarterial bronchus unlike on the left side and become superiormost



RIGHT LUNG

- Normally a little larger than the left lung because the middle mediastinum, containing the heart, bulges more to the left than to the right.
- **Oblique/horizontal fissures**
 - The oblique fissure separates the inferior lobe from the superior and middle lobes, the horizontal fissure separates the superior lobe from the middle one
 - The position of the oblique fissure on the thoracic wall begins roughly at the spinous process of the vertebra T10 level of the spine, crosses the fifth interspace laterally, and then follows the contour of rib VI anteriorly
 - The horizontal fissure follows the fourth intercostal space from the sternum until it meets the oblique fissure as it crosses rib V.
- **The orientations of the oblique and horizontal fissures determine where clinicians should listen for lung sounds from each lobe.**



RIGHT LUNG

- **Three lobes;** superior/middle/inferior
- **Mediastinal surface;**
 - includes the hilum and groove for the esophagus, a cardiac impression for the heart, markings for inferior&superior vena cava, azygos vein, brachiocephalic vein
 - the right subclavian artery and vein arch over and are related to the superior lobe of the right lung as they pass over the dome of the cervical pleura and into the axilla.
- **Diaphragmatic surface;**
 - concavity is deeper
 - bounded by a sharp inferior border laterally and posteriorly that projects into the costodiaphragmatic recess of the pleura



LEFT LUNG

- Smaller than the right lung
- **Oblique fissure**
 - the position of the left oblique fissure on the thoracic wall begins between the spinous processes of vertebrae TIII and TIV, crosses the fifth interspace laterally, and follows the contour of rib VI anteriorly
 - as with the right lung, the orientation of the oblique fissure determines where to listen for lung sounds from each lobe
- **When listening to lung sounds from each of the lobes, it is important to position the stethoscope on the thoracic wall related to the underlying positions of the lobes**



LEFT LUNG

- **Two lobes;** superior/inferior
- **Mediastinal surface;**
 - includes the hilum, a prominent cardiac impression and continuous groove for the arch of the aorta and the descending aorta and the area for the esophagus
 - the left subclavian artery and vein arch over and are related to the superior lobe of the left lung as they pass over the dome of the cervical pleura and into the axilla
- **The anterior border;**
 - the anterior border of the lower part of the superior lobe has the **lingula** of the left lung (a tongue-like extension) which projects over the heart bulge
 - the lingula extends below the cardiac notch and slides in and out of the costomediastinal recess during inspiration and expiration



Clinical Note

➔ Auscultation of the lungs

- Listening to the sound of air as it passes the tracheobronchial tree is called the auscultation and carried by a stethoscope

➔ Percussion of the thorax

- Tapping the thorax over the lungs with fingers
- Helps to establish whether the underlying tissue is air filled (resonant sound), fluid filled (dull sound) or solid (flat sound)



TRACHEA

- ◆ Divides into two main bronchi at the level of the sternal angle (T4-T5 IV disc)
- ◆ The lowest tracheal ring has a hook-shaped structure, the carina, that projects backward in the midline between the origins of the two main bronchi
- ✓ **Right main bronchus**; wider, shorter, runs more vertically
 - Therefore, inhaled foreign bodies tend to lodge more frequently on the right side than on the left
- ✓ **Left main bronchus**; passes inferior to the aortic arch and anterior to the thoracic aorta



TRACHEOBRONCHIAL TREE

- ✓ Each main bronchus enters the root of a lung and passes through the hilum into the lung
- ✓ The main bronchi give branches inside the lungs that form the **bronchial tree**
- ♦ **Lobar bronchi (secondary bronchi);**
 - each supplies a lobe
 - on the right side, the lobar bronchus to the superior lobe originates within the root of the lung.
 - 3 on the right, 2 on the left
- ♦ **Segmental bronchi (tertiary bronchi)**
 - supply the bronchopulmonary segments



BRONCHOPULMONARY SEGMENTS

- ✓ The largest, functionally independent, surgically resectable subdivisions of a lobe
- ✓ Pyramidal-shaped segment with its apex facing the lung root and base at the pleural surface.
- ✓ Supplied independently by a segmental bronchus and a tertiary branch of the pulmonary artery.
- ✓ Drained by intersegmental parts of the pulmonary veins that lie in the connective tissue between and drain adjacent segments.
- ✓ Usually 18–20 in number (10 in the right lung; 8–10 in the left lung, depending on the combining of segments).



TRACHEOBRONCHIAL TREE

- Beyond the tertiary segmental bronchi, there are 20–25 generations of branching *conducting bronchioles* that eventually end as **terminal bronchioles**, the smallest conducting bronchioles. Bronchioles lack cartilage in their walls
- Each terminal bronchiole gives rise to several generations of respiratory bronchioles, characterized by scattered, thin-walled outpocketings (alveoli) that extend from their lumens.
- The pulmonary alveolus is the basic structural unit of gas exchange in the lung.
- Due to the presence of the alveoli, the respiratory bronchioles are involved both in air transportation and gas exchange.
- Each respiratory bronchiole gives rise to 2–11 alveolar ducts, each of which gives rise to 5–6 alveolar sacs.
- Alveolar ducts are elongated airways densely lined with alveoli, leading to common spaces, the alveolar sacs, into which clusters of alveoli open.



TRACHEOBRONCHIAL TREE

- Branching of the tracheobronchial tree
 - Trachea
 - Principal bronchus
 - Lobar bronchi (secondary bronchi)
 - Segmental bronchi (tertiary bronchi)
 - Terminal bronchiol
 - Respiratory bronchiol
 - Alveolar duct
 - Alveolar sac
 - Alveolus



Clinical Note

➔ **Aspiration of foreign bodies**

- Foreign bodies are more likely to enter the right bronchus as it is wider and runs more vertically

➔ **Bronchoscopy**

- It is possible to observe the carina by bronchoscopy
- Carina is the cartilaginous projection of the last tracheal ring and lies between the orifices of the main bronchi
- Carina is quite sensitive to irritation (cough reflex)
- Morphological changes in carina may be an indication of a cancer metastasis to the tracheobronchial lymph nodes



Clinical Note

➔ Lung resections

- ✓ Knowledge of bronchopulmonary segments bears crucial importance in surgical resection of the lung segments
- ✓ Treatment of tumours or abscesses may require pneumonectomy, lobectomy or segmentectomy

➔ Bronchial asthma

- ✓ An allergic situation occurring for short periods (may recover spontaneously)
- ✓ Develops due to the local release of spasmogens and leads to the contraction of the smooth muscles, edema of the mucosa and mucus in the lumen of bronchioles
- ✓ Problem is more to do with expiration than inspiration



PLEURA

- **Visceral pleura** – Invests the lungs
- **Parietal pleura** – Lines the pulmonary cavities and inner surface of the thorax
- **Pleural cavity** – Lies between the two layers of the pleura
 - ✓ Contains a capillary layer of serous fluid
 - ✓ Lubrication of the pleural surfaces allow the two layers slide on each other smoothly during lung movements



PLEURA

◆ **Visceral pleura**

- Closely adheres to lungs
- Covers its all surfaces including the fissures dividing the lungs into lobes
- At the hilum of the lungs (at the medial part of the lungs where the structures enter and leave the lung), the visceral pleura is continuous with the parietal pleura.



PLEURA

◆ Parietal pleura

- The parietal pleura has four parts;

✓ **Costal pleura** – covers the internal surfaces of the thoracic wall

✓ **Mediastinal pleura** – covers the medial aspects of the lungs and lateral aspects of the mediastinum

✓ **Diaphragmatic pleura** – covers the thoracic surface of the diaphragm

✓ **Cervical pleura (pleural cupula)** – extends through the superior thoracic aperture to the root of the neck, cervical extension of pleura (the tip of cervical pleura is 2-3 cm superior to the clavicle)



PLEURA

◆Suprupleural membrane

Pleural cupula is strengthened by the extension of endothoracic fascia known as the suprupleural membrane (Sibson's fascia)

◆Pulmonary ligament

- Inferior to the hilum (root) of the lung, prietal pleura extends inferiorly as a double layer forming the pulmonary ligament.



PLEURA

Pleural reflection

- ◆ **Superiorly**, the pleural cavity can project as much as 3 to 4 cm above the first costal cartilage but does not extend above the neck of rib I.
- ◆ **Anteriorly**, the pleural cavities approach each other posterior to the upper part of the sternum.
- ◆ **Inferiorly**, the costal pleura reflects onto the diaphragm above the costal margin.
 - ✓ In the midclavicular line, the pleural cavity extends inferiorly to approximately rib VIII.
 - ✓ In the midaxillary line, it extends to rib X.
 - ✓ From this point the inferior margin courses somewhat horizontally, crossing ribs XI and XII to reach vertebra TXII.
- ➔ From the midclavicular line to the vertebral column, the inferior boundary of the pleura can be approximated by a line that runs between rib VIII, rib X, and vertebra TXII.



PLEURA

- ◆ The lungs do not completely fill the anterior or posterior inferior regions of the pleural cavities and this results in recesses.
- ◆ Expansion of the lungs into these recesses usually occurs only during forced inspiration
- ◆ Parietal pleura forms two recesses:
 - ✓ Costomediastinal recesses
 - ✓ Costodiaphragmatic recesses



Clinical note

➔ Injury to the cervical pleura and the apex of the lung

- ✓ Lungs and pleural sac may be injured in the wounds of the neck as the cupula of pleura lies here (deep to the inferior attachments of the SCM muscle)
- ✓ This may lead to pneumothorax – presence of air in the pleural cavity

➔ Pneumothorax

- ✓ May occur due to a penetrating wound, tear by fractured ribs etc.
- ✓ Results with collapse of the lungs

➔ Pulmonary collapse

- ✓ If sufficient air enters the pleural cavity, lungs will collapse
- ✓ The amount of air inside the pleural cavity determines the degree of collapse



Clinical note

➔ **Hydrothorax**

✓ May occur due to pleural effusion (escape of fluid into pleural cavities)

➔ **Hemothorax**

✓ Accumulation of blood in the pleural cavity (may occur due to a penetrating wound)



Clinical note

➔ Thoracentesis

- ✓ Performed by inserting a needle through an intercostal space, into the pleural cavity
- ✓ Performed in order to obtain a fluid sample or remove blood or pus
- ✓ When the patient is in upright position, fluid in the pleural cavity accumulates in the costodiaphragmatic recess
- ✓ Inserting the needle through the 9th intercostal space in the midaxillary line and during expiration will avoid the inferior border of the lung
- ✓ The needle should be angled upward to avoid penetrating the deep aspect of the recess



Clinical note

➔ Insertion of a chest tube

- ✓ Major amounts of air, blood, serous fluid, pus or any combination of these in the pleural cavity are removed by placement of a chest tube
- ✓ The tube is inserted into the pleural cavity through a short incision between the 5th or 6th intercostal space at the midaxillary line
- ✓ The outer end of the tube is connected to an underwater drainage system, often with a controlled suction



VASCULATURE OF LUNGS and PLEURA

PULMONARY ARTERIES & VEINS

- ◆ Each lung has
 - **A pulmonary artery;** originate from the pulmonary trunk and carry deoxygenated blood to the lungs
 - **Two pulmonary veins;** begin at the hilum of the lung, pass through the root of the lung, and drain into the left atrium, carry oxygenated blood from the lungs
- ◆ Each lobe and segment has its own artery. Branching of the arteries follow the bronchial tree and terminate as capillaries around the alveols.
- ◆ Intersegmental part of the pulmonary veins drain the segments.
 - Pulmonary veins also drain the visceral pleura
 - Veins of the parietal pleura drain into the systemic veins mainly through the intercostal veins



BRONCHIAL ARTERIES AND VEINS

- ★ The bronchial arteries and veins constitute the “nutritive” vascular system of the pulmonary tissues (bronchial walls and glands, walls of large vessels, and visceral pleura).
- ★ They interconnect within the lung with branches of the pulmonary arteries and veins.
- ★ Bronchial arteries; supply blood to the structures at the root of the lung, supporting tissues of the lung and the visceral pleura, and follow the bronchial tree as far as the respiratory bronchiols
 - ★ Paired left bronchial arteries (from thoracic aorta)
 - ★ Single right bronchial artery (usually arises from 3rd posterior intercostal artery)
 - ★ Parietal pleura is supplied by the arteries of the thoracic wall.
- ★ Bronchial veins; drain only part of the blood supplied to the lungs by the bronchial arteries, primarily that distributed to or near the more proximal part of the roots of the lungs. The remainder of the blood is drained by the pulmonary veins
 - ★ Right bronchial vein drains into the azygos vein
 - ★ Left bronchial vein drains into the accessory hemiazygos vein or the left superior intercostal vein



Clinical note

➔ Pulmonary thromboembolism

- Obstruction of a pulmonary artery or one of its branches by a blood clot, fat globule or air bubble
- Obstruction will lead to a thrombotic infarct
- When a large embolus occludes the pulmonary artery, patient will suffer acute respiratory distress, because of major decrease in the oxygenation of blood (death may occur in a few minutes)



NERVES OF LUNGS

- ◆ Lungs are innervated by pulmonary plexuses, which contains both sympathetic and parasympathetic nerves
- ◆ Innervation of the lungs and visceral pleura by visceral afferent nerves
 - Vagus nerve (bronchoconstrictor, vasodilator to the lung vessels, secretomotor to the glands)
 - Sympathetic trunk (bronchodilator, vasoconstrictor to the lung vessels, inhibitor to the glands)
- ◆ Innervation of the parietal pleura; by somatic afferent fibers
 - The costal pleura is innervated by branches from the intercostal nerves, and pain would be felt in relation to the thoracic wall.
 - The diaphragmatic pleura and the mediastinal pleura are innervated mainly by the phrenic nerves. Pain from these areas would refer to the C3, C4, and C5 dermatomes (lateral neck and the supraclavicular region of the shoulder).



Clinical note

- ◆ Visceral pleura is insensitive to pain, as it receives no nerves of general sensation
- ◆ Parietal pleura is extremely sensitive to pain as it is innervated by the nerves innervating the thoracic wall
 - Irritation causes local pain or referred pain projecting to the dermatomes supplied by the same spinal nerve



LYMPHATIC DRAINAGE

• Lymphatics form a superficial and a deep plexus

- **Superficial plexus;** lies deep to the visceral pleura
drains the lung parenchyma
visceral pleura
terminates in the bronchopulmonary lymph nodes (hilar lymph nodes)
- **Deep plexus;** located in the submucosa of the bronchi and in the peribronchial connective tissue.
drains the structures at the root of the lungs
initially into the intrinsic pulmonary lymph nodes, finally terminates in the bronchopulmonary lymph nodes (hilar lymph nodes)

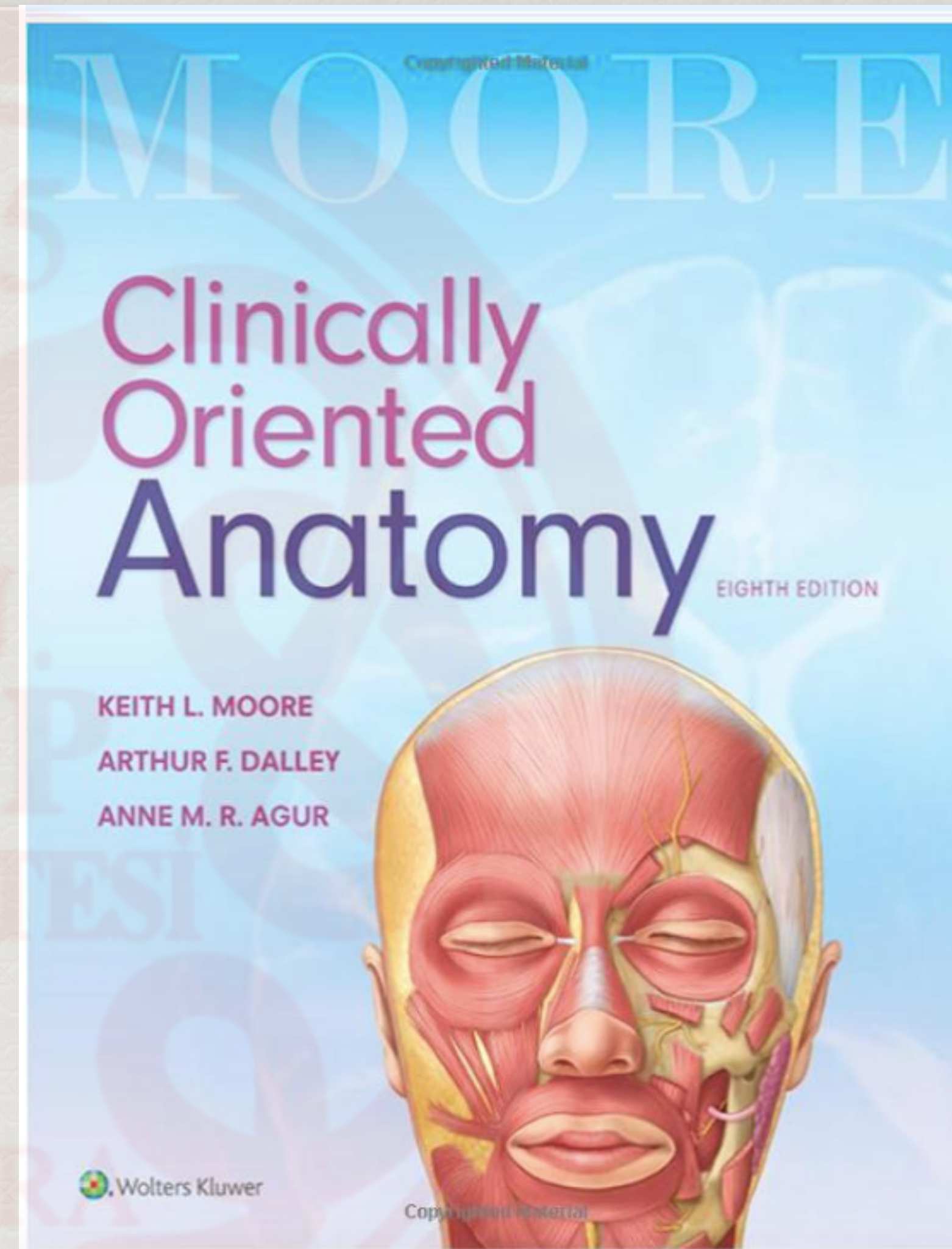
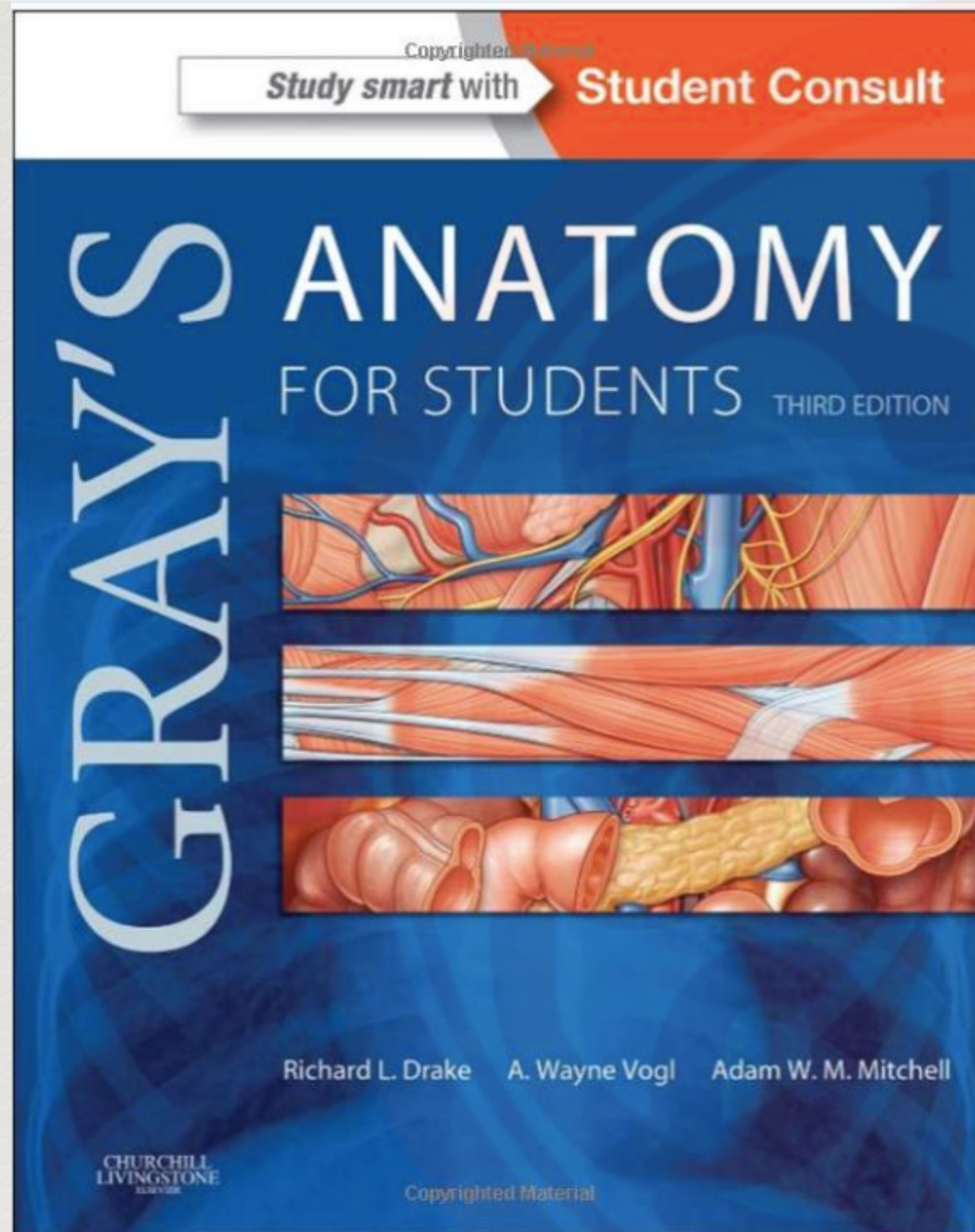
• Course of lymph

- Bronchopulmonary lymph nodes (hilar lymph nodes)
- Tracheobronchial lymph nodes
- Bronchomediastinal lymph trunks
- Venous system

➔ Lymph from the parietal pleura drains into the lymph nodes of the thoracic wall (intercostal, parasternal, mediastinal, and phrenic)

➔ A few lymphatic vessels from the cervical parietal pleura drain into the axillary lymph nodes.





Please read your reference books!!!

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