VISWASS SCHOOL & COLLEGE OF NURSING

GNM 1ST YEAR

ANATOMY AND PHYSIOLOGY

UNIT-6

THE RESPIRATORY SYSTEM

LONG QUESTION AND ANSWER

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1.a)Discuss the structure of lungs with diagram. (7+8)

b)Explain the mechanism of Respiration.

(a)

Structure of lungs:

Lungs

The lungs are the primary organs of the respiratory system in humans.

Position and Gross structure :

There are two cone shaped lungs, one lying on each side of the midline in the thoracic cavity.

Each has an apex, a base, a costal surface and a medial surface.

Apex:

- This is rounded and rises into the root of the neck, about 25mm above the level of the middle third of the clavicle.
- It lies close to the 1st rib and the blood vessels and nerves in the root of the neck.

Base:

- This is concave and semilunar in shape, and lies on the upper(thoracic)surface of the diaphragm.

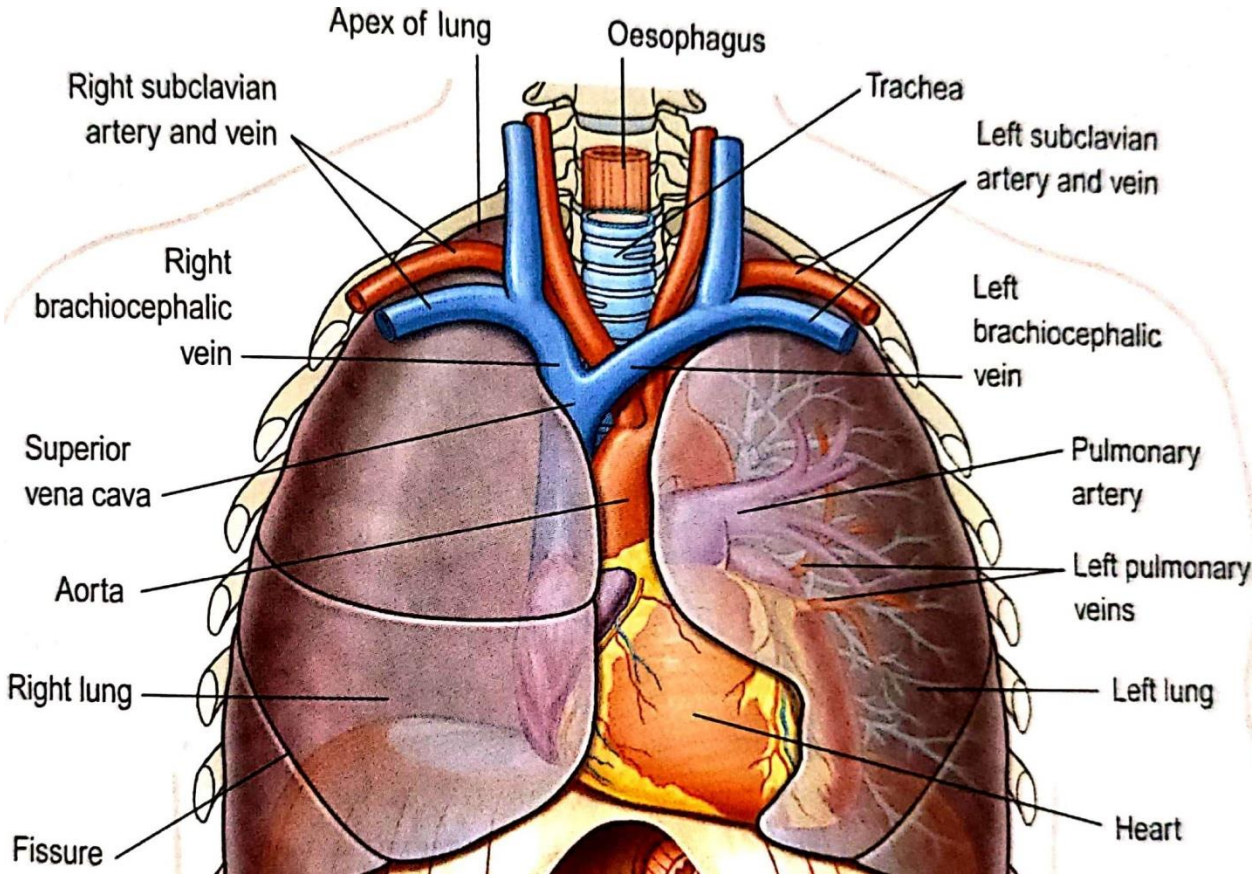
Costal surface:

- This is the broad outer surface of the lung that lies directly against the costal cartilages, the ribs and the intercostals muscles,

Medial surface:

- The middle surface of each lung faces the other directly across the space between the lungs, the mediastinum or mediastinal structure.
- Each is concave and has a roughly triangular-shaped area, called Hilum, at the level of the 5th,6th and 7th thoracic vertebrae.
- The primary bronchus, the pulmonary artery supplying the lung and the two pulmonary veins draining it, the brochial artery and veins,and the lymphatic and nerve supply enter and leave the lung at the hilum.
- The mediastinum contains the heart, great vessels, trachea, right and left bronchi, oesophagus, lymph nodes, lymph vessels and nerves.
- The right lung is divided into three distinct lobes: superior, middle and inferior.

- The left lung is smaller because the heart occupies space left of the midline. It is divided into only two lobes: superior and inferior.
- The divisions between the lobes are called fissures.



Pleura and pleural cavity:

- The pleura consists of a closed sac of serous membrane(one for each lung), which contains a small amount of serous fluid, called pleural fluid.
- The lung can expand and recoil within the pleural sac, lubricated by the pleural fluid.
- Although the pleural membrane is described as two sheets, the **visceral** and the **parietal** .
    - **Visceral pleura**: This adheres to the lung, covering each lobe and passing into the fissures that separate them. it folds back on itself in the region of the hilum to form the parietal pleura

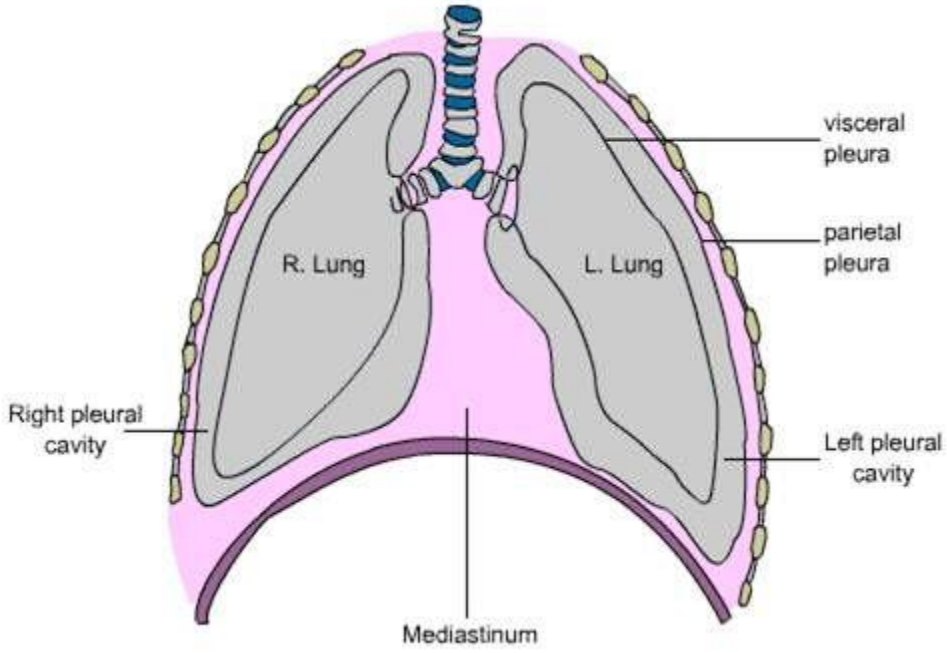
- **Parietal pleura**: This adheres to the inside of the chest wall and the upper surface of the diaphragm. It is not attached to other structures in the mediastinum and simply folds back on itself in the region of the hilum to form the visceral pleura.

Pleural cavity:

- This is only a potential space and contains no air, so the pressure within is negative relative to atmospheric pressure.
- In health, the space between the pleural layers, the pleural space, contains on average between 7-10ml of pleural fluid, which lubricates lung movement during brething.
- The airway and the alveoli of the lungs are embedded in elastic tissue, which constantly pulls the lung tissues towards the hilum, but because pleural fluid holds the two pleura together the lung remains expanded.

<u>Pulmonary blood supply :</u>

- The pulmonary trunk divides into the right and left pulmonary arteries, carrying deoxygenated blood to each lung.
- The exchange of gases between air in the alveoli and blood in the alveoliand blood in the capillaries takes place across these two very fine membrane.
- Two pulmonary veins carrying oxygenated blood from each lung back to the left atrium of the heart.



Bronchi and bronchioles

The two primary bronchi are formed when the trachea divides, at about the level of the 5th thoracic vertebrae.

Right bronchus:

- This is wider, shorter and more vertical then the left bronchus and is therefore more likely to become obstructed by an inhaled foreign body.
- It is approximately 2.5cm long.

Left bronchus:

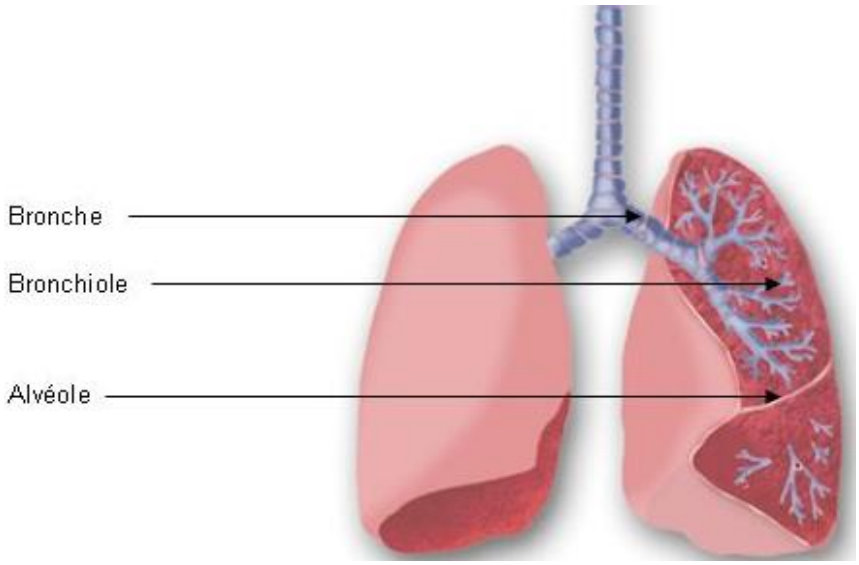
- This is about 5cm long and is narrower then the right.

Structure:

- The bronchial walls contain the same three layers of tissue as the trachea, and are lined with ciliated columnar epithelium.
- The bronchi progressively subdivide into bronchioles, terminal bronchioles, respiratory bronchioles, alveolar ducts and , finally, alveoli.
- The wider passages are called conducting airways because their function is to bring air into the lungs, and their walls are too thick to permit gas exchange.

Blood & nerve supply, lymph drainage

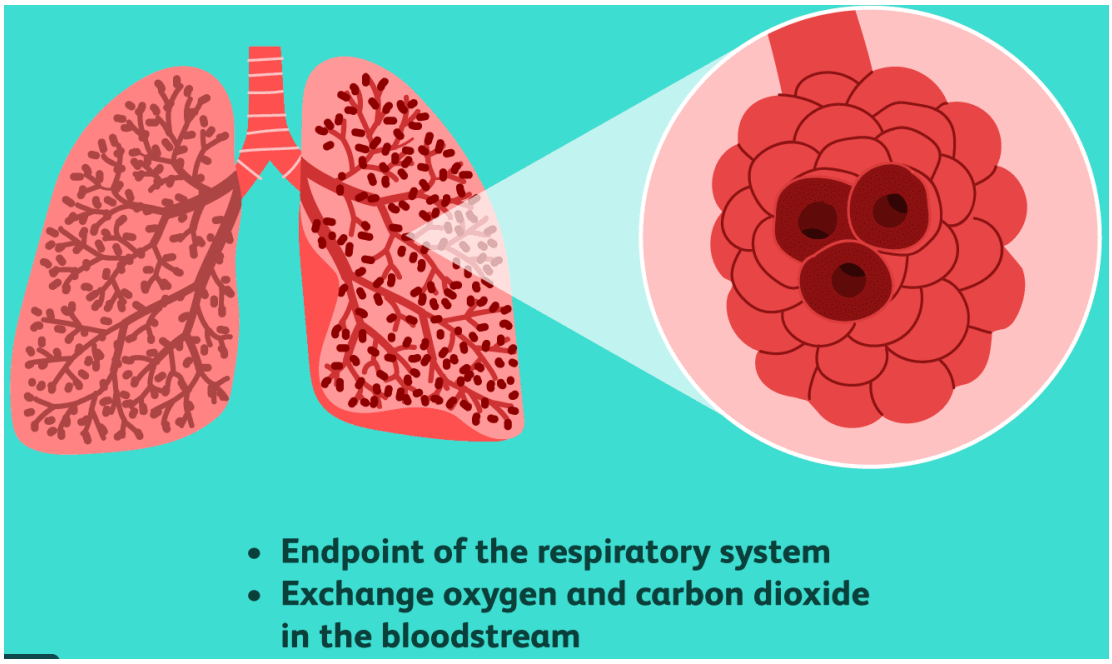
- The arterial supply to the walls of the bronchi and smaller air passage is through branches of the right and left bronchial arteries, and the venous return is mainly through the bronchial vein.
- The vegus nerve stimulate contraction of smooth muscle in the bronchial tree, causing bronchoconsrtiction, and sympathetic stimulation causes bronchodilation.
- Lymph is drained from the wall of the air passages in a network of lymph vessels.



Respiratory bronchioles and alveoli

- With each lobe the lung tissue is further divided by fine sheet of connective tissue into lobules.

- Each lobule is supplied with air by a terminal bronchioles, which further sub divides into respiratory bronchioles, alveolar ducts and large numbers of alveoli.
- These are about 150 million alveoli in the adult lung.
- It is these structures that the process of gas exchange occurs.
- On microscopic examination, the extensive air spaces are clearly seen and healthy lung tissue has a honeycomb appearance.



(b)

Mechanism of respiration:

The average respiratory rate is 12-15 breaths per minute.

Each breath consist of 2 phases **Inspiration** & **Expiration.**

- The visceral pleura adheres to the lungs, and the parietal pleura to the inner wall of the thorax and to the diaphragm.
- Breathing depends on change in pressure and volume in the thoracic cavity.
- Since air flows from an area of high pressure to an area of low pressure, changing the pressure inside the lungs determines the direction of airflow.

<u>Inspiration:</u>

- Simultaneous contraction of the external intercostals muscles and the diaphragm expands the thorax.

- As the parietal pleural sticks to the diaphragm and the inside of the ribcage, it is pulled outwards along with them.
- This pulls the visceral pleura outwards too, since the two pleura are held together by the thin film of pleural fluid.
- Because the visceral pleura is firmly adherent to the lung, the lung tissue is therefore also pulled up and out with the ribs, and downward with the diaphragm.
- This expands the lungs, and the pressure within the alveoli and in the air passages falls, drawing air into the lungs in an attempt to equalise atmospheric and alveolar air pressures.
- The process of inspiration is active, as it needs energy for muscle contraction.
- The negative pressure created in the thoracic cavity aids venous return to the heart and is known as the respiratory pump.
- At rest, inspiration last about 2 seconds.

Expiration:

- Relaxation of the external intercostals muscles and the diaphragm results in downward and inward movement of the ribcage and elastic recoil of the lungs.
- As this occurs, pressure inside the lungs rises and expels air from the respiratory tract.
- At the end of expiration, the lungs still contain some air, and are prevented from complete collapse by the intact pleura.
- This process is passive, as it dose not require the expenditure of energy.
- At rest, expiration lasts about 3 seconds, and after expiration there is a pause before the next cycle begins.

Physiological variables affecting breathing:

Elasticity: Elasticity is the ability of the lung to return to its normal shape after each breath.

Compliance: This is the stretchability of the lungs. i.e. the effort required to inflate the alveoli. The healthy lung is very compliant and inflate with very little effort

Airway resistance: when this is increased, eg: in bronchoconstriction, more respiratory effort is required to inflate the lungs.

Lung volume and capacities

- In normal quite breathing there are about 15 complete respiratory cycles per minute.
- The lungs and the air passages are never empty and, as the exchange of gases takes place only across the walls of the alveolar ducts and alveoli, the remaining capacity of the respiratory passages is called the anatomical dead space(about 150 mL).

❖ Tidal volume:

Tidal volume(TV)is the amount of air passing into and out of the lungs during each cycle of breathing.(about 500 mL)

❖ Inspiratory reserve volume:

Inspiratory reserve volume(IRV) is the extra volume of air that can be inhaled into the lungs during maximal inspiration, i.e over and above normal TV.

❖ Inspiratory capacity:

Inspiratory capacity(IC) is the amount of air that can be inspired with maximum effort. It consist of the tidal volume(500 mL) plus the inspiratory reserve volume.

❖ Functional residual capacity:

Functional residual capacity(FRC) is the amount of air remaining in the air passages and alveoli at the end of quite expiration.

❖ Expiratory reserve volume:

Expiratory reserve volume(ERV) is the largest volume of air that can ve expelled from the lungs during maximal expiration.

❖ Residual volume:

Vital capacity(VC) is the maximum volume of air that can be moved into and out of the lungs.(VC=Tidal volume+IRV+ERV)

❖ Total lung capacity:

Total lung capacity(TLC) is the maximum amount of air the lungs can be hold. In an adult of average build, it is normally around 6 litres. The lung capacity represents the sum of the VC and the RV.

❖ Alveolar ventilation:

This is the volume of air that moves into and out of the alveoli per minute. It is equal to the tidal volume minus the anatomical dead space, multiplied by the respiratory rate.

Alveolar ventilation=TV-anatomical dead space× respiratory rate

=(500-150)mL×15 per minute

=5.25 litres per minute

Exchange of gases

- Although breathing involves the alternating process of inspiration and expiration, gas exchange at the respiratory membrane and in the tissues is a continuous and ongoing process.
- Diffusion of oxygen and carbon dioxide depends on pressure differences.