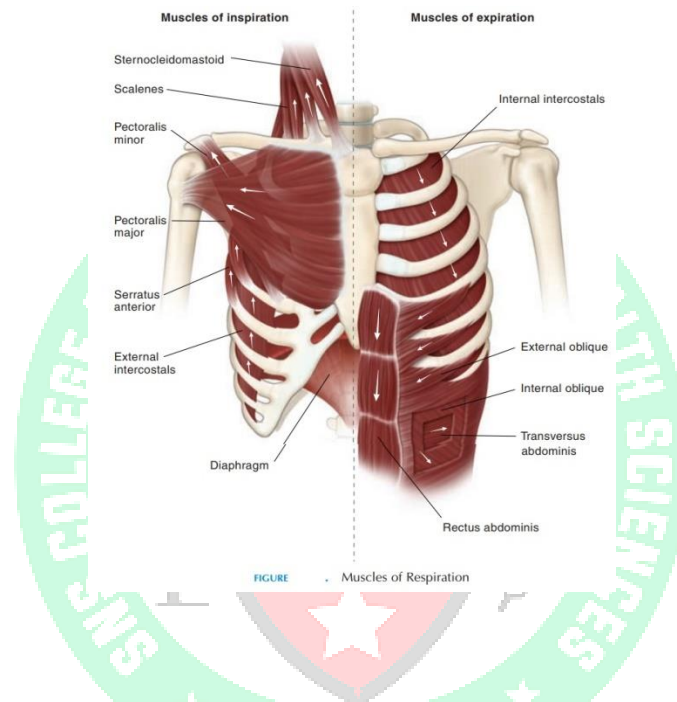




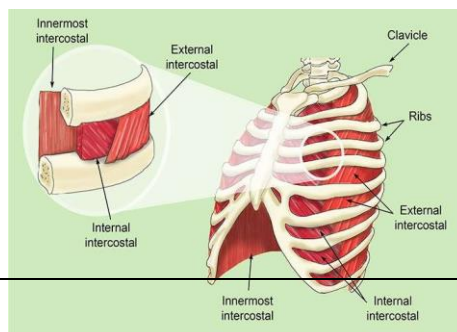
### UNIT-3 MECHANISM OF RESPIRATION

#### MUSCLES OF RESPIRATION:



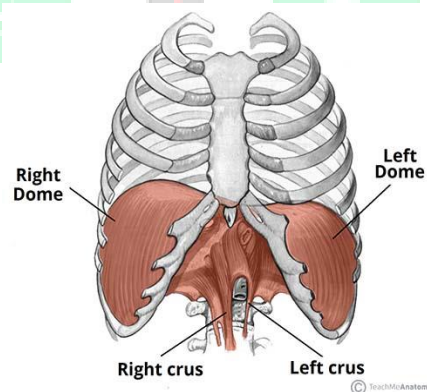
- The expansion of the chest during inspiration occurs as a result of muscular activity, partly voluntary and partly involuntary.
- The main muscles of respiration in normal quiet breathing are the *intercostal muscles* and the *diaphragm*.
- During difficult or deep breathing they are assisted by the muscles of the neck, shoulders and abdomen.

#### INTERCOSTAL MUSCLES:



- There are 11 pairs of intercostal muscles that occupy the spaces between the 12 pairs of ribs.
- They are arranged in two layers, the external and internal intercostal muscles.
- *The external intercostal muscle fibres* - These extend in a downwards and forwards direction from the lower border of the rib above to the upper border of the rib below.
- *The internal intercostal muscle fibres* - These extend in a downwards and backwards direction from the lower border of the rib above to the upper border of the rib below, crossing the external intercostal muscle fibres at right angles
- The first rib is fixed. Therefore, when the intercostal muscles contract they pull all the other ribs towards the first rib.
- Because of the shape of the ribs they move outwards when pulled upwards.
- In this way the thoracic cavity is enlarged anteroposteriorly and laterally.
- The intercostal muscles are stimulated to contract by the *intercostal nerves*.

### **DIAPHRAGM:**



- The diaphragm is a dome-shaped structure separating the thoracic and abdominal cavities. It forms the floor of the thoracic cavity and the roof of the abdominal cavity

- Consists of a central tendon from which muscle fibers radiate to be attached to the lower ribs and sternum and to the vertebral column by two crura.
- When the muscle of the diaphragm is relaxed, the central tendon is at the level of the 8th thoracic vertebra.
- When it contracts, its muscle fibers shorten and the central tendon is pulled downwards to the level of the 9th thoracic vertebra, enlarging the thoracic cavity in length.
- This decreases pressure in the thoracic cavity and increases it in the abdominal and pelvic cavities.
- The diaphragm is supplied by the *phrenic nerves*.
- The intercostal muscles and the diaphragm contract *simultaneously* ensuring the enlargement of the thoracic cavity in all directions, that is from back to front, side to side and top to bottom
- The diaphragm is a dome-shaped structure separating the thoracic and abdominal cavities. It forms the floor of the thoracic cavity and the roof of the abdominal cavity
- Consists of a central tendon from which muscle fibers radiate to be attached to the lower ribs and sternum and to the vertebral column by two crura.
- When the muscle of the diaphragm is relaxed, the central tendon is at the level of the 8th thoracic vertebra.

### **RESPIRATION:**

The term respiration means the exchange of gases between blood, body cells and the atmosphere.

It takes place in 3 basic steps:

- Pulmonary ventilation (breathing) – This is the exchange of air between the atmosphere and the air spaces of the lungs. It consists of inhalation and exhalation of air.

- External (pulmonary) respiration – This is the exchange of gases between the air spaces of the lungs and blood in pulmonary capillaries across the respiratory membrane. The blood gains oxygen and loses carbon dioxide.
- Internal (tissue) respiration – This is the exchange of gases between systemic capillary blood and tissue cells. The blood loses oxygen and gains carbon dioxide.

### **INHALATION:**

- Breathing in, is called inhalation (inspiration).
- Just before each inhalation, the air pressure inside the lungs is equal to the pressure of the atmosphere.
- For air to flow into the lungs, the pressure inside the alveoli must become lower than the atmospheric pressure. This condition is achieved by increasing the size of the lungs.
- For inhalation to occur, the lungs must expand.
- This increases lung volume and thus decreases the pressure in the lungs below atmospheric pressure.
- The first step in expanding the alveoli of the lungs during normal quiet breathing involves contraction of the muscles of inhalation—the diaphragm and/or external intercostals.
- It is innervated by fibers of the phrenic nerves, which emerge from both sides of the spinal cord at cervical levels 3, 4 and 5.
- Contraction of the diaphragm causes it to flatten, lowering its dome. This increases the vertical diameter of the thoracic cavity and accounts for the movement of about 75 percent of the air that enters the lungs during normal quiet inhalation.
- The distance the diaphragm moves during inspiration ranges from 1 cm during normal quiet breathing up to about 10 cm during strenuous exercise.
- At the same time the diaphragm is contracting, the external intercostals contract.

- These skeletal muscles run obliquely downward and forward between adjacent ribs and when these muscles contract, the ribs are pulled superiorly and the sternum is pushed anteriorly.
- This increases the anteroposterior and lateral diameters of the thoracic cavity.
- As the diaphragm and external intercostals contract and the overall size of the thoracic cavity increases, the walls of the lungs are pulled outward.
- The parietal and visceral pleurae normally adhere strongly to each other because of the below-atmospheric pressure between them and because of the surface tension created the parietal pleura lining the cavity is pulled outward in all directions, and the visceral pleura and lungs are pulled along with it, increasing the volume of the lungs.
- When the volume of the lungs increases, alveolar pressure decreases from 760 to 758 mmHg. A pressure gradient is thus established between the atmosphere and the alveoli.
- Air rushes from the atmosphere into the lungs due to a gas pressure difference, and inhalation takes place.
- Air continues to move into the lungs as long as the pressure difference exists.
- During deep, forceful inhalation, accessory muscles of inhalation (include the sternocleidomastoid muscles, which elevate the sternum; the scalene muscles, which elevate the first two ribs; and the pectoralis minor muscles, which elevate the third through fifth ribs), also participate in increasing the size of the thoracic cavity.
- The muscles are so named because they make little, if any, contribution during normal quiet inhalation, but during exercise or forced inhalation they may contract vigorously.
- The process of inspiration is **ACTIVE**, as it needs energy for muscle contraction.
- Inspiration lasts about 2 seconds.

## EXHALATION

- Breathing out, called exhalation (expiration), is also achieved by a pressure gradient, but in this case the gradient is reversed: The pressure in the lungs is greater than the pressure of the atmosphere.
- Normal exhalation during quiet breathing depends on two factors:
  - (1) the recoil of elastic fibers that were stretched during inspiration and
  - (2) the inward pull of surface tension due to the film of alveolar fluid.
- Exhalation starts when the muscles of inhalation relax.
- As the external intercostals relax, the ribs move inferiorly; as the diaphragm relaxes, its dome moves superiorly owing to its elasticity.
- These movements decrease the vertical, anteroposterior, and lateral diameters of the thoracic cavity.
- Also, surface tension exerts an inward pull between the parietal and visceral pleurae, and the elastic basement membranes of the alveoli and elastic fibers in bronchioles and alveolar ducts recoil.
- As a result, lung volume decreases and the alveolar pressure increases to 762 mmHg.
- Air then flows from the area of higher pressure in the alveoli to the area of lower pressure in the atmosphere.
- During labored breathing and when air movement out of the lungs is impeded, muscles of exhalation—abdominal and internal intercostals—contract.
- Contraction of the abdominal muscles moves the inferior ribs inferiorly and compresses the abdominal viscera, thus forcing the diaphragm superiorly.
- Contraction of the internal intercostals, which extend inferiorly and posteriorly between adjacent ribs, also pulls the ribs inferiorly.

- Respirations also provide humans with methods for expressing emotions such as laughing, sighing, and sobbing.
- Moreover, respiratory air can be used to expel foreign matter from the lower air passages through actions such as sneezing and coughing.
- Respiratory movements can also be modified and controlled when you talk or sing.
- All of these movements are reflexes, but some of them can be initiated voluntarily.
- Exhalation process is **PASSIVE** as it does not require the expenditure of energy.

