Respiratory system

Respiratory pressures

Two types of pressures are exerted in the thoracic cavity and the lungs during the process of respiration:

1. Intrapleural pressure or intrathoracic pressure.

2. Intra-alveolar pressure or intrapulmonary pressure.

I-Intrapleural pressure

It is the pressure existing in pleural cavity, that is, in between the visceral and parietal layers of pleura. It is exerted by the suction of the fluid that lines the pleural cavity

- **Cause for Negativity of Intrapleural Pressure**

The pleural cavity is always lined by a thin layer of fluid that is secreted by the visceral layer of pleura. This fluid is constantly pumped from the pleural cavity into lymphatic vessels. The pumping of fluid creates the negative pressure in the pleural cavity.

- **Significance of Intrapleural Pressure**

Throughout the respiratory cycle intrapleural pressure remains lower than intra-alveolar pressure. This keeps the lungs always inflated.

The intrapleural pressure has two important functions:

1. It prevents the collapsing tendency of lungs.

2. It causes dilatation of vena cava and larger veins in thorax. Also, the negative pressure acts like suction pump and pulls the venous blood from lower part of body towards the heart against gravity. Thus, the intrapleural pressure is responsible for the venous return.

2-Intra-alveolar pressure

It is the pressure existing in the alveoli of the lungs.

- **Significance of Intra-alveolar Pressure**

1. It causes flow of air in and out of alveoli. During inspiration, the intra-alveolar pressure becomes negative, so the atmospheric air enters the alveoli. And, during expiration, the air is expelled out of alveoli

2. It also helps in the exchange of gases between the alveolar air and the blood.

Compliance

Compliance is the ability of the lungs and thorax to expand. It is defined as the change in volume per unit change in the respiratory pressure. Determination of compliance is useful as it is the measure of stiffness of lungs. Stiffer the lungs, less is the compliance.

- Compliance is the volume increase in lungs per unit increase in the intra-alveolar pressure:

1. Compliance of lungs and thorax together: 130 ml/1 cm H_2O pressure

2. Compliance of lungs alone: 220 ml/1 cm H_20 pressure.

- Compliance is the volume increase in lungs per unit decrease in the intrapleural pressure:

1. Compliance of lungs and thorax together 100 m/1 cm H_2O pressure

2. Compliance of lungs alone- 200 ml/1 cm H_2O pressure.

Thus, if lungs are removed from thorax, the expansibility (compliance) of lungs alone doubled. It is because of the absence of the inertia and the restriction exerted by the structures of thoracic cage, which interfere with expansion of lungs.

The work of breathing

It is the work done by the respiratory muscles during breathing to overcome the resistance in the thorax and respiratory tract. During the respiratory processes, inspiration is active process and the expiration is a passive process. So, during quiet breathing, the respiratory muscles perform the work only during inspiration and not during expiration.

The energy obtained during the work of breathing is utilized to overcome three types of resistance

1. Airway resistance

2. Elastic resistance of lungs and thorax (compliance work).

3. Non-elastic viscous resistance (tissue resistance work).

Pulmonary function tests

Pulmonary function tests or lung function tests are useful in assessing the functional status of the respiratory system. These tests involve measurement of lung volumes and capacities.

The air in lung is classified into two divisions:

1. Lung volumes

2. Lung capacities

Pulmonary function tests are carried out mostly by using spirometer. The graphical recording of lung volumes and capacities is called spirogram.

Lung volume

Lung volumes are the static volumes of air breathed by an individual. The lung volumes are of four types:

1. Tidal volume (TV)

Tidal volume is the volume of air breathed in and out of lungs in a single normal quiet respiration. Tidal volume signifies the normal depth of breathing. Normal value- 500 mL (0.5 L).

2. Inspiratory reserve volume (IRV)

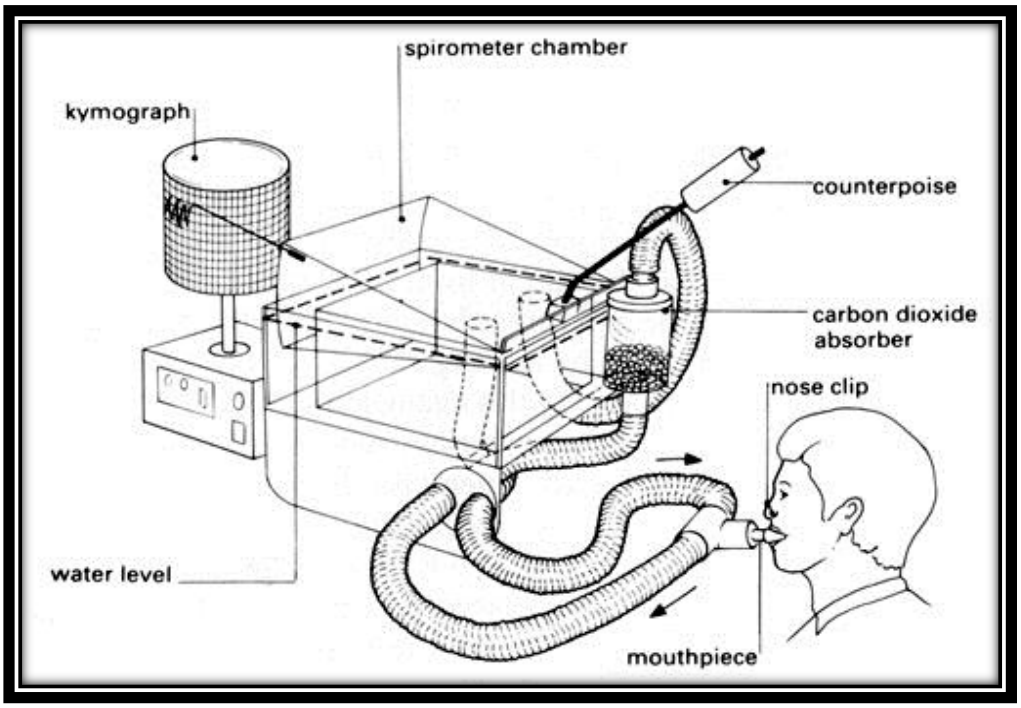
Inspiratory reserve volume is an additional volume of air that can be inspired forcefully after the end of normal inspiration. Normal value 3300 mL (3.3 L).

3. Expiratory reserve volume (ERV)

Expiratory reserve volume is the additional volume of air that can be expired out forcefully, after normal expiration Normal value 1000 mL (1 L)

4. Residual volume (RV)

Residual volume is the volume of air remaining in the lungs even after forced expiration. Normally, lungs cannot be emptied completely even by forceful expiration. Some quantity of air always remains in the lungs even after the forced expiration. Normal value- 1200 mL (1.2 L)



Lung capacity

Lung capacities are the combination of two or more lung volumes. Lung capacities are of four types:

1. Inspiratory capacity (IC)

Inspiratory capacity is the maximum volume of air that is inspired after normal expiration (end expiratory position). It includes tidal volume and inspiratory reserve volume

IC= TV+IRV=500+3300- 3800 mL

2. Vital capacity (VC)

It is the maximum volume of air that can be expelled out forcefully after a deep (maximal) inspiration. Vital capacity includes inspiratory reserve volume, tidal volume and expiratory reserve volume.

VC= IRV+ TV+ERV= 3300+500+1000= 4800 mL.

3. Functional residual capacity (FRC)

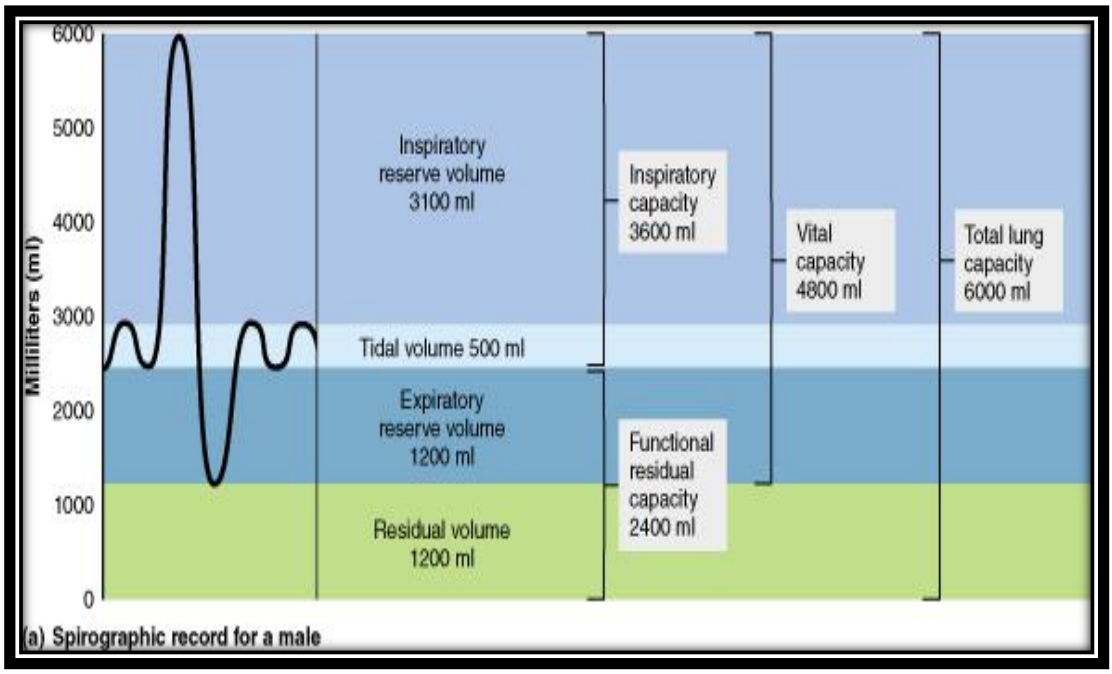
It is the volume of air remaining in the lungs after normal expiration (after normal tidal expiration). Functional residual capacity includes expiratory reserve volume and residual volume

FRC=ERV+RV=1000 +1200=2200 mL

4. Total lung capacity (TLC)

Total lung capacity is the volume of air present in the lungs after a deep (maximal) inspiration. It includes all the volumes.

TLC= IRV+TV+ERV+RV=3300+500+1000 +1200=6000 mL


6000
5000
4000
3000
2000
1000
0
Milliliters (ml)
Inspiratory reserve volume 3100 ml
Tidal volume 500 ml
Expiratory reserve volume 1200 ml
Residual volume 1200 ml
Inspiratory capacity 3600 ml
Functional residual capacity 2400 ml
Vital capacity 4800 ml
Total lung capacity 6000 ml
(a) Spirographic record for a male