Lung Function Test

Physiology Lab-7

Lung Function Tests

- Also called pulmonary function tests (PFTs)
- Evaluate how well your lungs work.
- The tests determine how much air your lungs can hold, how quickly you can move air in and out of your lungs, and how well your lungs add oxygen and remove carbon dioxide from your blood.
- The tests can diagnose lung diseases and measure the severity of lung problems

Clinical Significances:

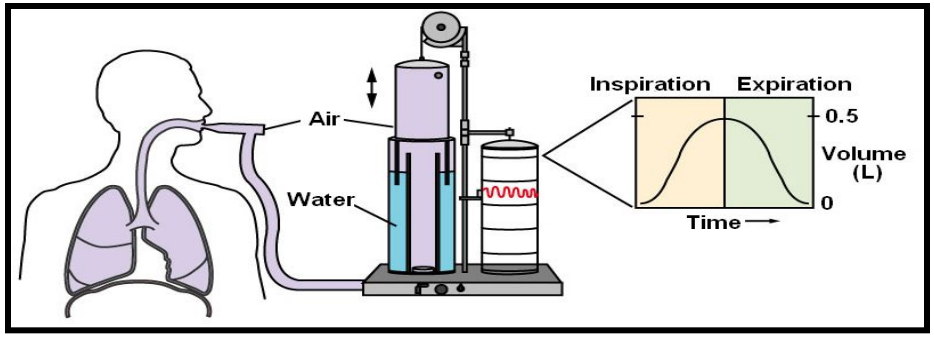
Lung function tests are valuable because they give some measure of

- Lung compliance or elasticity
- Airway resistance
- Respiratory muscle strength

These three factors determine how much air a person can move into lungs per unit of time and this is what the pulmonary function tests measure.

Spirometry

- Is the first lung function test done. It measures how much and how quickly you can move air out of your lungs. For this test, you breath into a mouthpiece attached to a recording device (spirometer).



Spirometer

- There are tow types of spirometer:

1- Mechanical devices:

(Incentive spirometer)

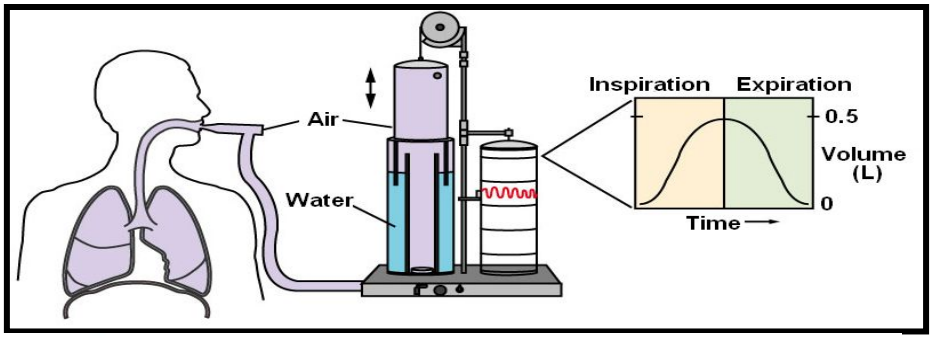
2- Electronic devices

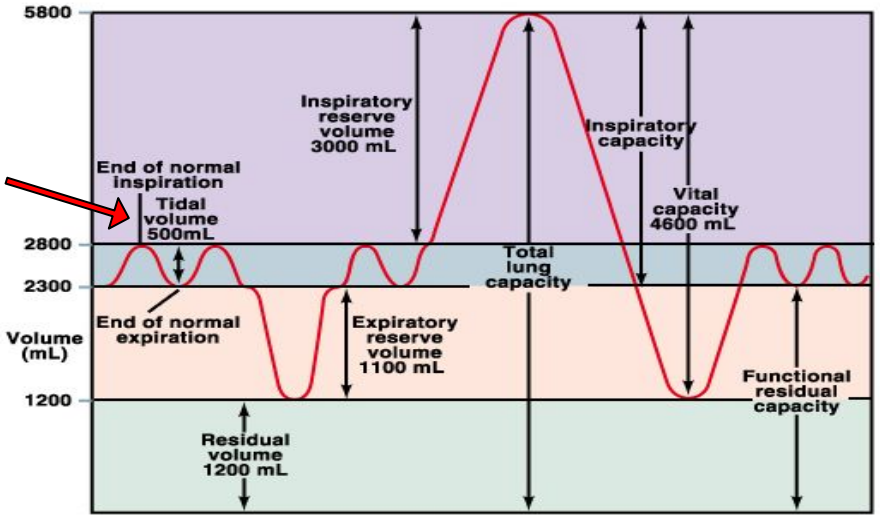
Respiratory Volumes

- The total capacity of the lungs is divided into various volumes and capacities according to the function of these in the intake or exhalation of air. For a proper understanding of respiratory processes it is necessary that you became familiar with these volumes and capacities.
- The average total lung capacity of an adult human male is about 6 liters of air, but only a small amount of this capacity is used during normal breathing.
- The average human respiratory rate is 30-60 breaths per minute at birth, decreasing to 12-20 breaths per minute in adults.
- The total amount of air one's lung can possibly hold can be subdivided into four **Volumes** defined as follow:

[1] The Tidal Volume (TV):

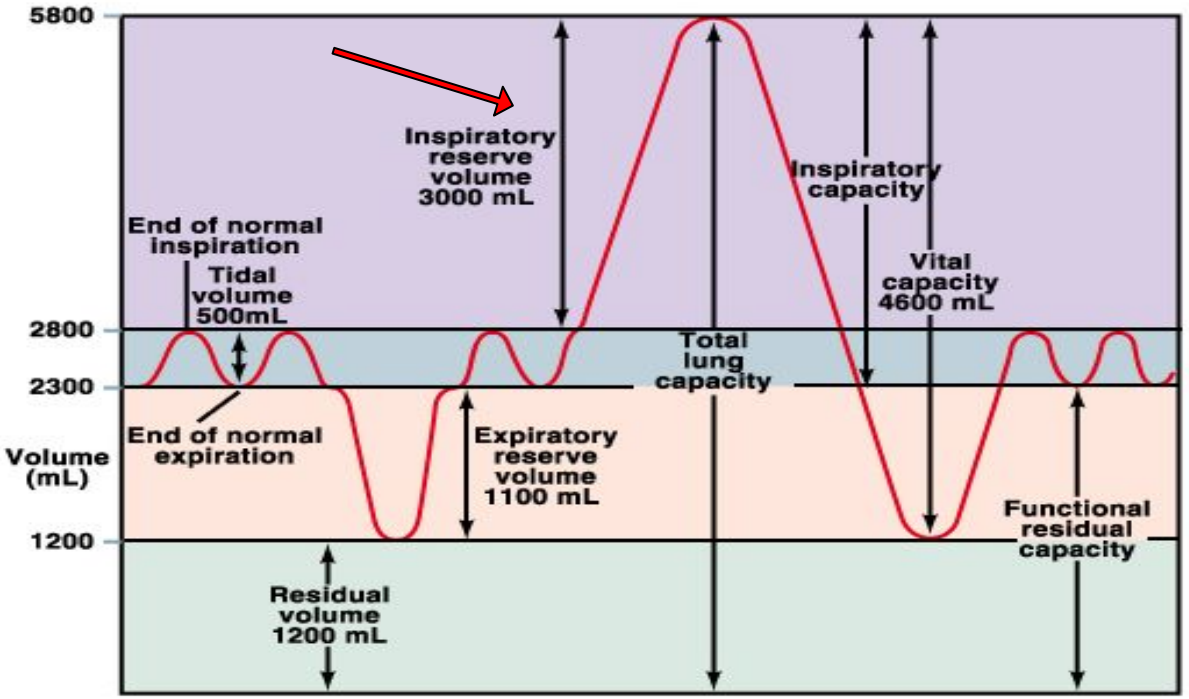
- Is the volume of air inspired or expired with each normal breath and it is about **500 ml** in average young adult man.





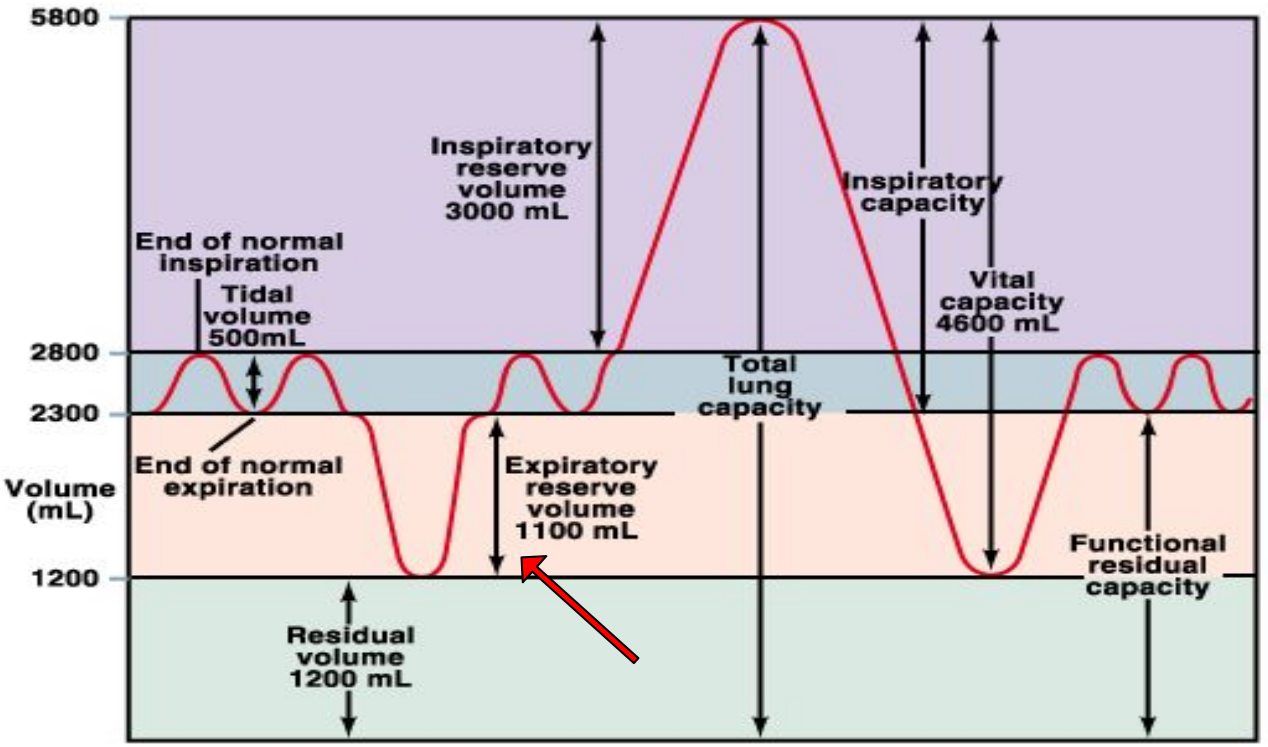
[2] The inspiratory reserve volume (IRV):

- Is the extra volume of air that can be inspired over and beyond tidal volume and it is about **<u>3000 ml</u>**.



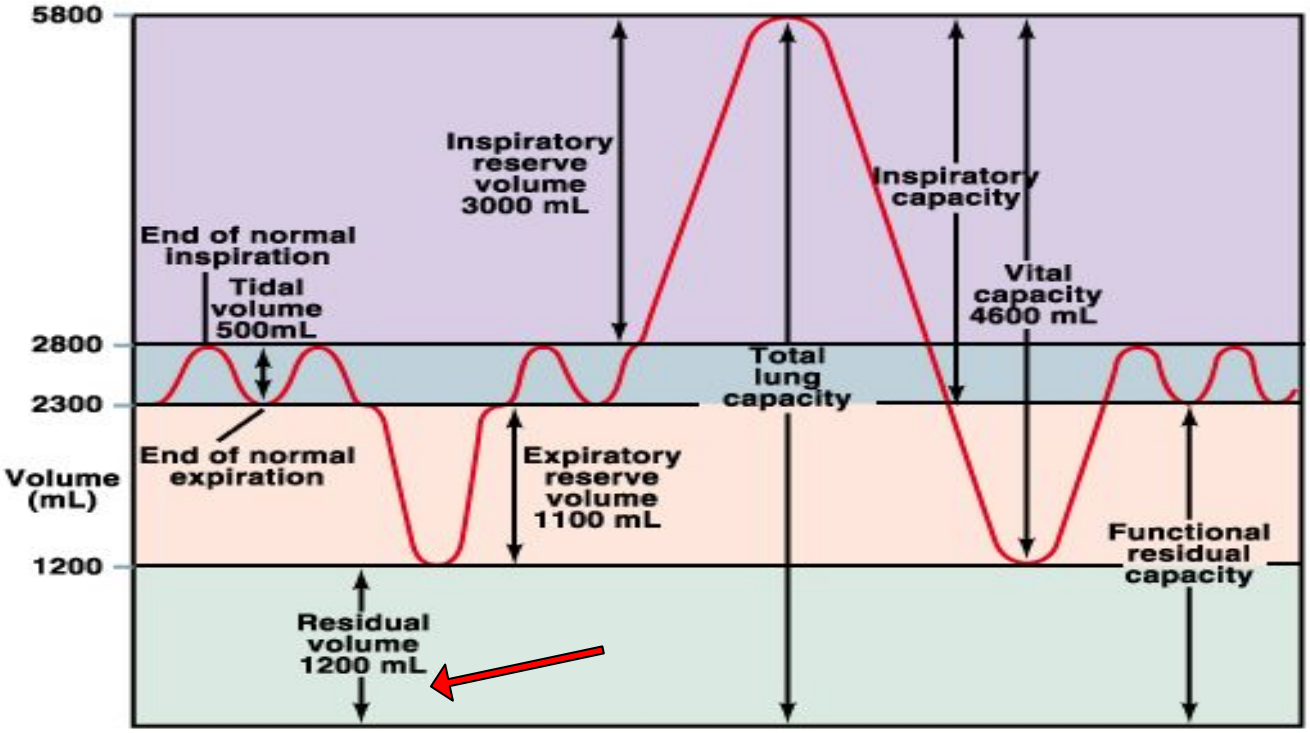
[3] The expiratory reserve volume (ERV):

- Is the amount of air that can be expired after the normal tidal expiration, which is about **<u>1100 ml</u>**



[4] The residual volume (RV):

- Is the volume of air still remaining in the lungs after the most forceful expiration, which is about **1200 ml**.
- This volume can not be measured directly by spirometer. Therefore, an indirect method must be used usually the helium dilution method.

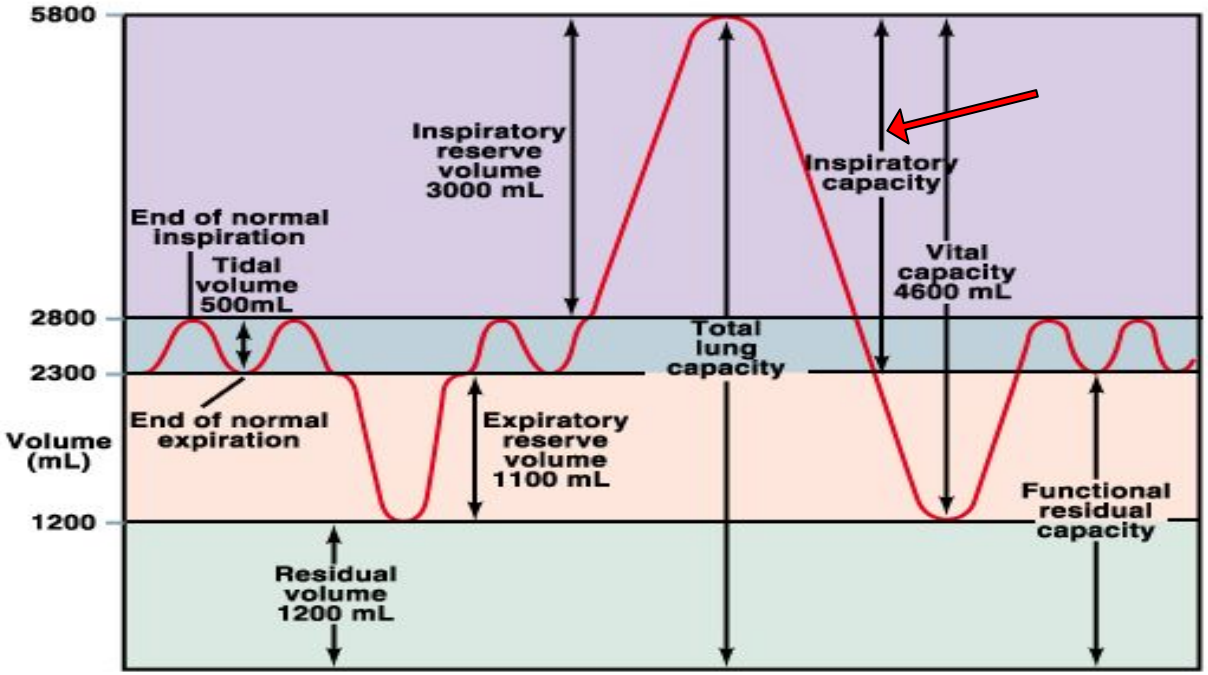


Lung Capacities

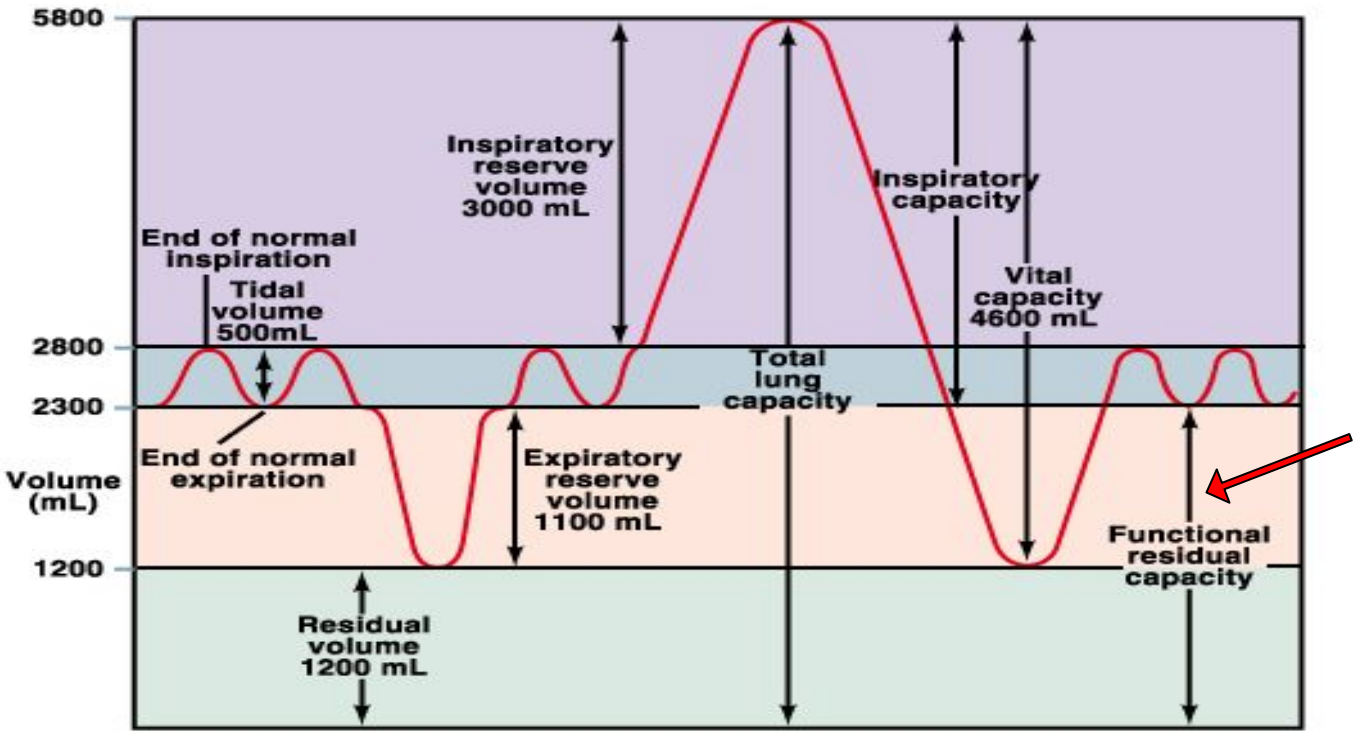
In addition to four volumes, which don't overlap, there are four **capacities**

,which are combined of two or more volumes:

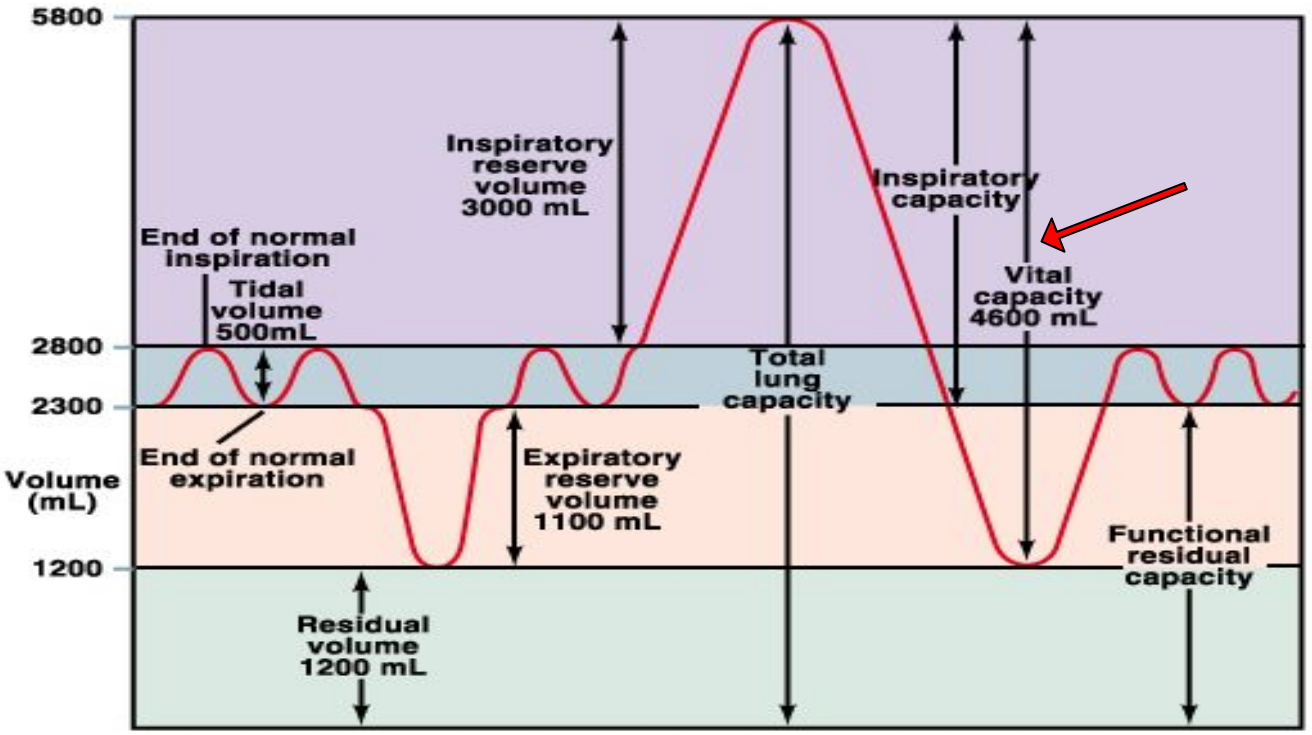
[1] The inspiratory capacity (IC) = TV +IRV = 500 +3000 = **3500 ml**. This is the amount of air that a person can breathe beginning at the normal expiratory level and distending the lungs to the maximum amount.



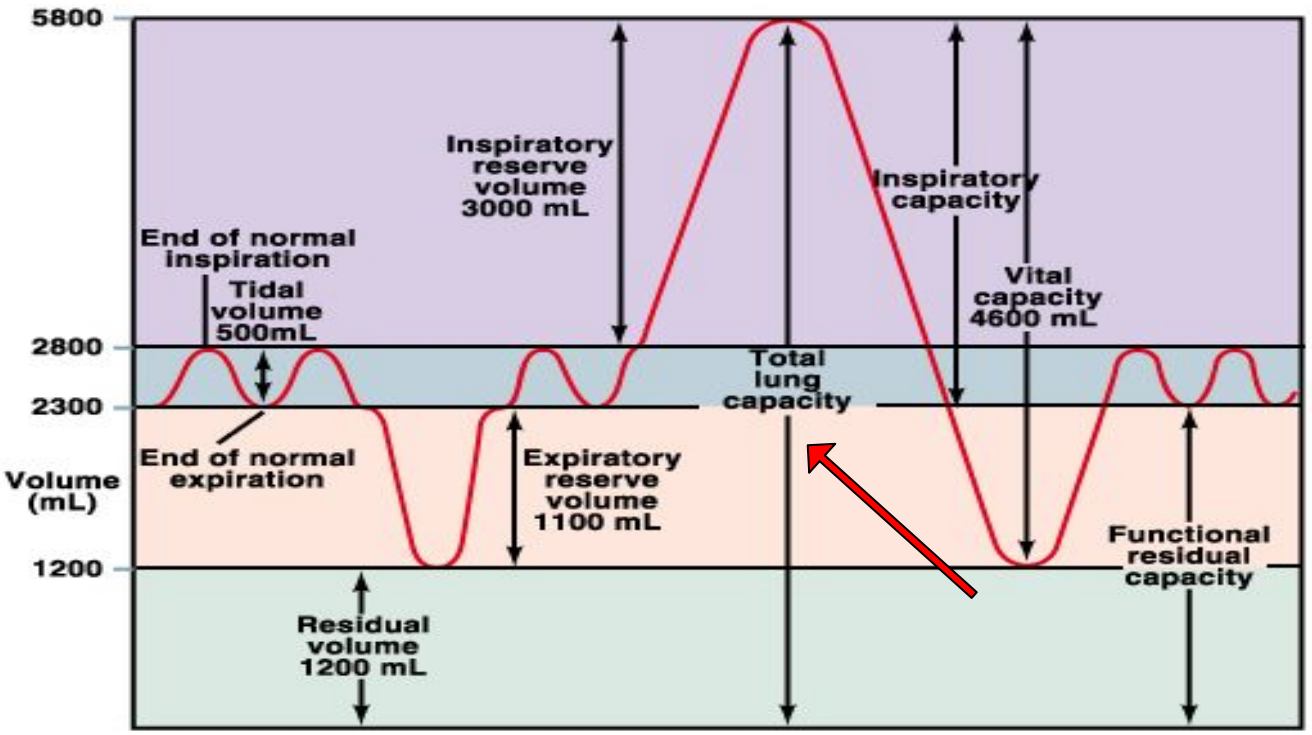
[2] The functional residual capacity (FRC) = ERV + RV = 1100 + 1200 = **2300 ml**. This is the amount of air remaining in the lungs at the end of normal expiration.



[3] The vital capacity (VC) = IRV + TV + ERV = 3000 + 500 + 1100 = **4600 ml**. This is the maximum amount of air that a person can expel from the lungs after filling the lungs first to their maximum extent, and then expiring to the maximum extent.



[4] The total lung capacity (TLC) = VC + RV = 4600 + 1200 = **5800 ml**. This is the maximum volume to which the lungs can be expanded with the greatest possible inspiratory effort.



Peak expiratory flow (PEF):

- Is the maximum or peak rate (or velocity), in liters per minute, with which air is expelled with maximum force after a deep inspiration.
- It can be measured by *wright peak flow meter*. The maximum expiratory flow is much greater when the lungs are filled with a large volume of air than when they are almost empty

Is spirometry the same as peak flow readings?

- No. A peak flow meter is a small device that measures the fastest rate of air that you can blow out of your lungs.
- Like spirometry, it can detect airways narrowing. It is more convenient than spirometry and is commonly used to help diagnose asthma.

Normal ranges of PEF

- Normal values are related to the patient's height as follows:

Height (cm)	PEFR (L/min)*
120	215
130	260
140	300
150	350
160	400
170	450
180	500

- An easy to remember approximation is:
  PEFR (L/min) = [Height (cm) - 80] x 5

Factors affecting lung volume

Several factors affect lung volumes, some that can be controlled and some that can not. These factors include:

Larger volumes	Smaller volumes
Males	females
Taller people	shorter people
Non-smokers	heavy smokers
Professional athletes	non-athletes
People living at high altitudes	people living at low altitudes

Restrictive and obstructive Pulmonary disease

Pulmonary function testing primarily detects two abnormal patterns:

1- Obstructive ventilatory defects

- such as asthma and COPD.
- There is obstruction to the outflow of air
- The main feature is a decrease in expiratory flow rate throughout expiration

2- Restrictive (constricted) ventilatory defects

- such as interstitial fibrosis and chest wall deformities.
- That reduce the air in the lungs. There is no obstruction to the outflow of air.
- The main feature is reduced lung volume (mainly TLC and RV).

Is there any risk in having spirometry?

Spirometry is a very low risk test. However, blowing out hard can increase the pressure in your chest, abdomen and eye. So, you may be advised not to have spirometry if you have:

1- Unstable angina.

2- Had a recent pneumothorax (air trapped beneath the chest wall).

3- Had a recent heart attack or stroke.

4- Had recent eye or abdominal surgery.

5- Coughed up blood recently and the cause is not known.

Experimental procedure

1- Tidal Volume(TV)

Set the spirometer dial at zero. Take normal inspiration, place your mouth over the mouthpiece into spirometer. You will to make a conscious effort not to exceed your normal volume.

Read the amount exhaled on the dial

2- Expiratory Reverse Volume (ERV)

Set the Spirometer dial at zero. After a normal expiration, place your mouth over the mouthpiece and the forcefully exhale as much air as possible into the spirometer.

3- Vital Capacity(VC)

Set the spirometer dial at zero, inhale as deeply as possible; place your mouth over the mouthpiece, hold your nose, and exhale into spirometer with a maximal effort .

4- inspiratory reverse Volume (IRV) and inspiration Capacity (IC):

from the three previous volume measurements you can calculate the IRV and the IC

Question

A person who is born and lives at sea levelA person who is born and lives at sea level will develop a slightly smaller lung capacity than a person who spends their life at a high altitude.

Answer

This is because the partial pressure of oxygen is lower at higher altitude which, as a result means that oxygen less readily diffuses into the bloodstream. In response to higher altitude, the body's diffusing capacity increases in order to process more air.