First-year – Ashur Medical College 2023/2024
Module: systemic (physiology)

RESPIRATORY INVESTIGATIONS

Dr Tareef Fadhil: Assistant professor & consultant pediatrician

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OBJECTIVES

- To Determine:
- The Physiology of Lung volumes and capacities.
- Respiratory investigations especially spirometry.
- Key words:
- **Tidal volume (TV), inspiratory reserve volume (IRV), expiratory reserve volume (ERV), and residual volume(RV).**
- **Inspiratory capacity (IC), functional residual capacity (FRC), Vital capacity (VC), and total lung capacity (TLC).**
- **Spirometry, Peak Expiratory Flow (PEF) ,** lung plethysmography, lung volumes, lung capacities, Pulmonary Function Test

RESPIRATORY INVESTIGATIONS

Blood Tests:

Arterial Blood Gas (ABG), C-reactive Protein (CRP), Erythrocyte Sedimentation Rate (ESR) , and **Complete Blood Count (CBC).**

Imaging:

Chest X-ray (CXR) , **High-Resolution Computed Tomography (HRCT)**, **Computed Tomography (CT)of chest, Magnetic Resonance Imaging (MRI)**, **Positron Emission Tomography (PET)**

Sample analysis:

Sputum Analysis, **Bronchoalveolar Lavage (BAL) analysis**, **Pleural Fluid Analysis**,**Blood Culture,**

Specialized Tests:

Allergy Testing , **Endobronchial Ultrasound (EBUS)** , **Interferon Gamma Release Assay (IGRA)**

Sample analysis:

1. **Sputum Analysis**: Identifies infections or inflammatory markers.
2. **Bronchoalveolar Lavage (BAL) analysis**: Retrieves fluid from lung segments.
3. **Pleural Fluid Analysis**.
4. **Blood Cultures**: Detects systemic infections.

Specialized Tests:

1. **Allergy Testing**: Identifies allergic triggers.
2. **Endobronchial Ultrasound (EBUS)**: Assists in lung biopsies.
3. **Interferon Gamma Release Assay (IGRA)**: Detects tuberculosis (latent or active).
4. **Pulmonary function tests.**



PULMONARY FUNCTION TEST

Pulmonary Function Tests (Measuring Volumes, rates and capacities):

1- Spirometry

- **Standard (Traditional) spirometry did not measure Residual volume , FRC, and TLC. (one volume and 2 capacities).**
- **Spirometry** did not measure residual volume (RV)
- and related capacities :FRC and TLC

2-Peak Expiratory Flow (PEF)

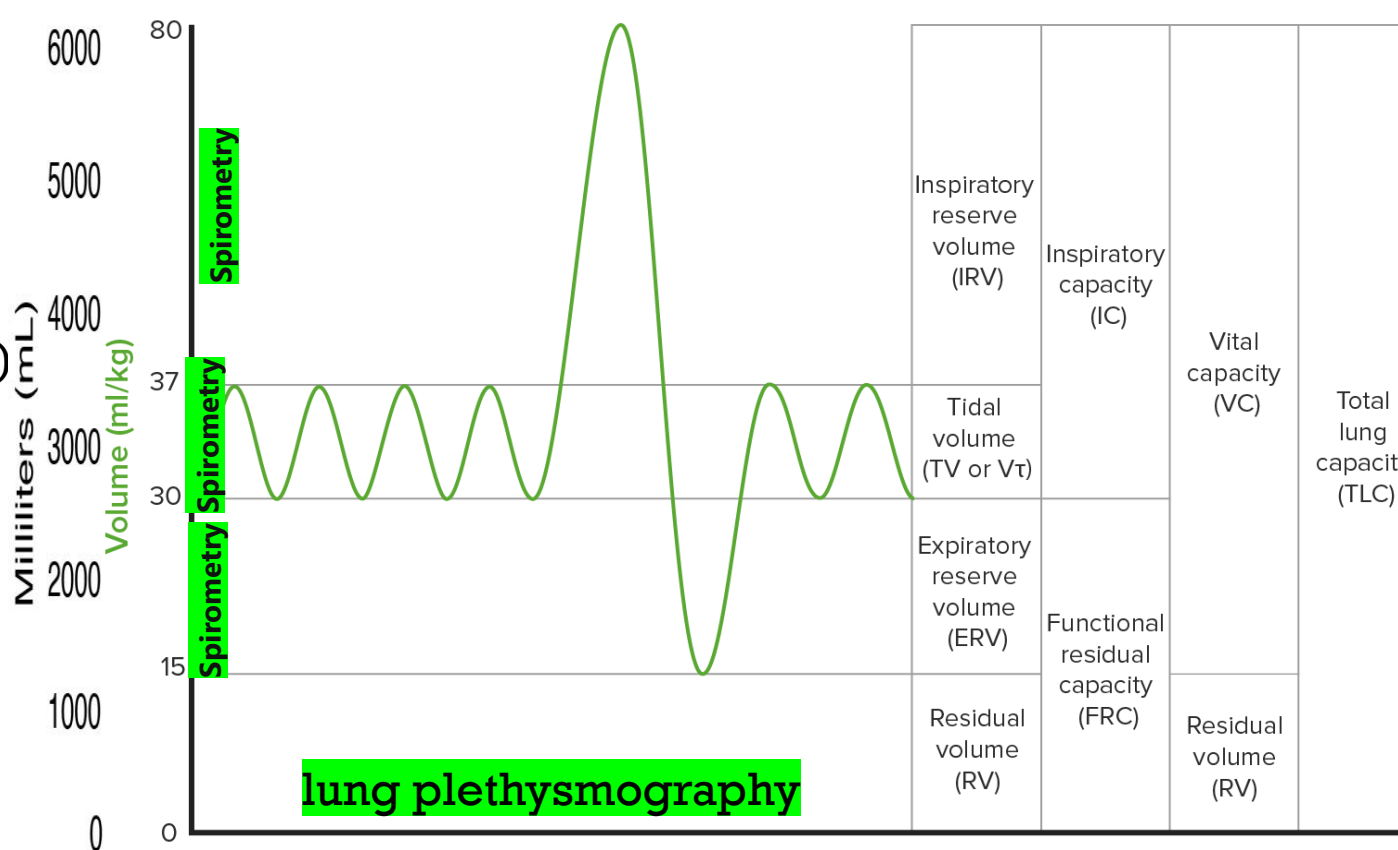
3-Measuring residual volume (RV) FRC and TLC.

A- The **helium dilution technique**

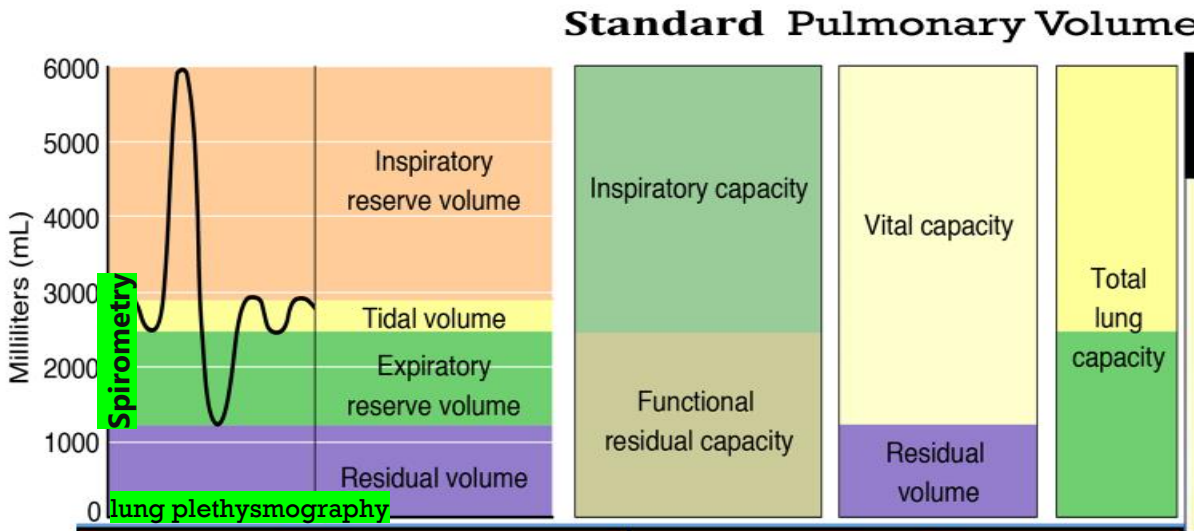
B- The nitrogen washout test

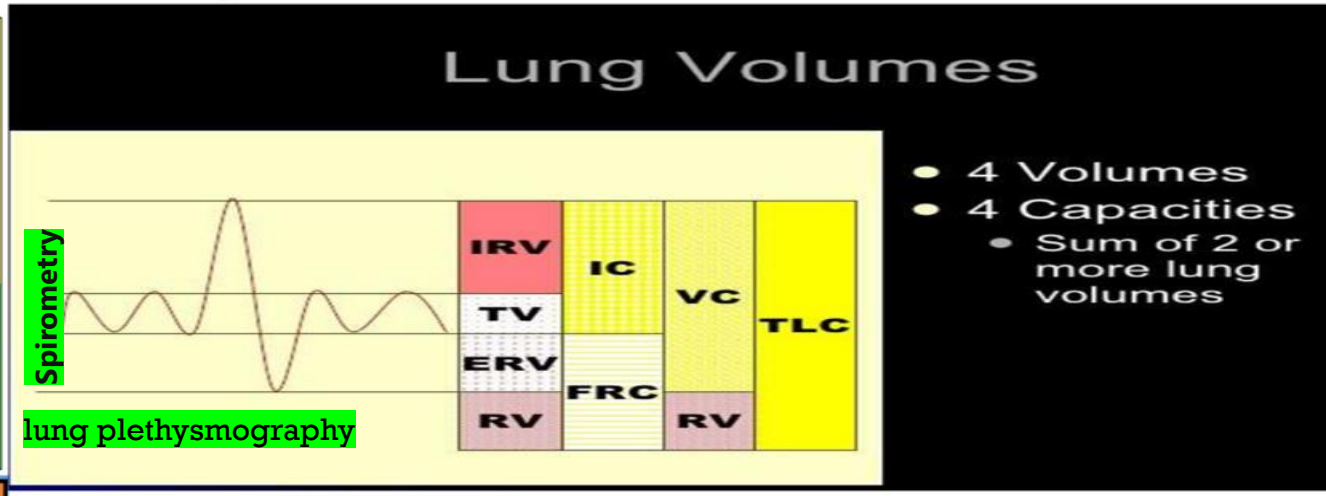
C-lung plethysmography

4- Diffusing capacity testing

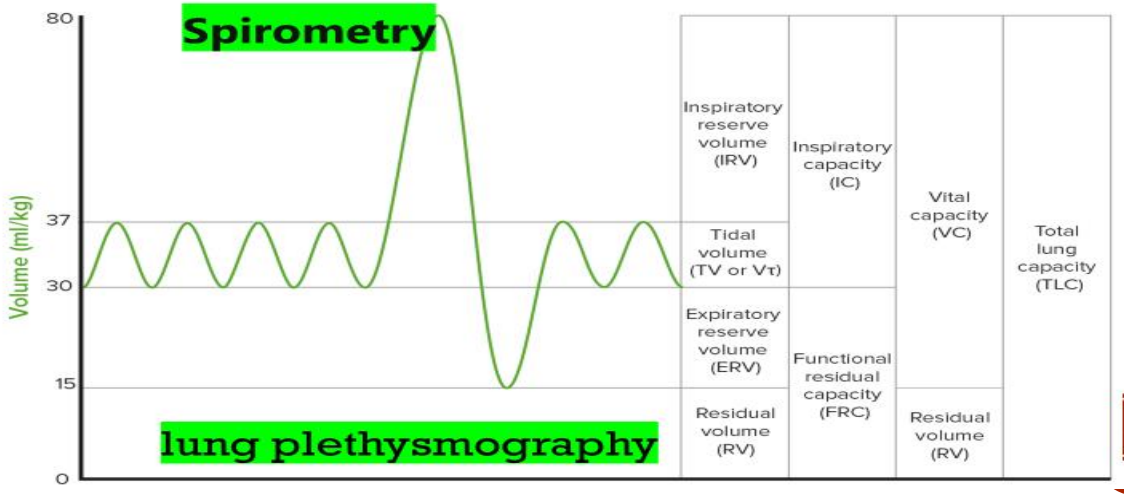


LUNG VOLUMES AND CAPACITIES



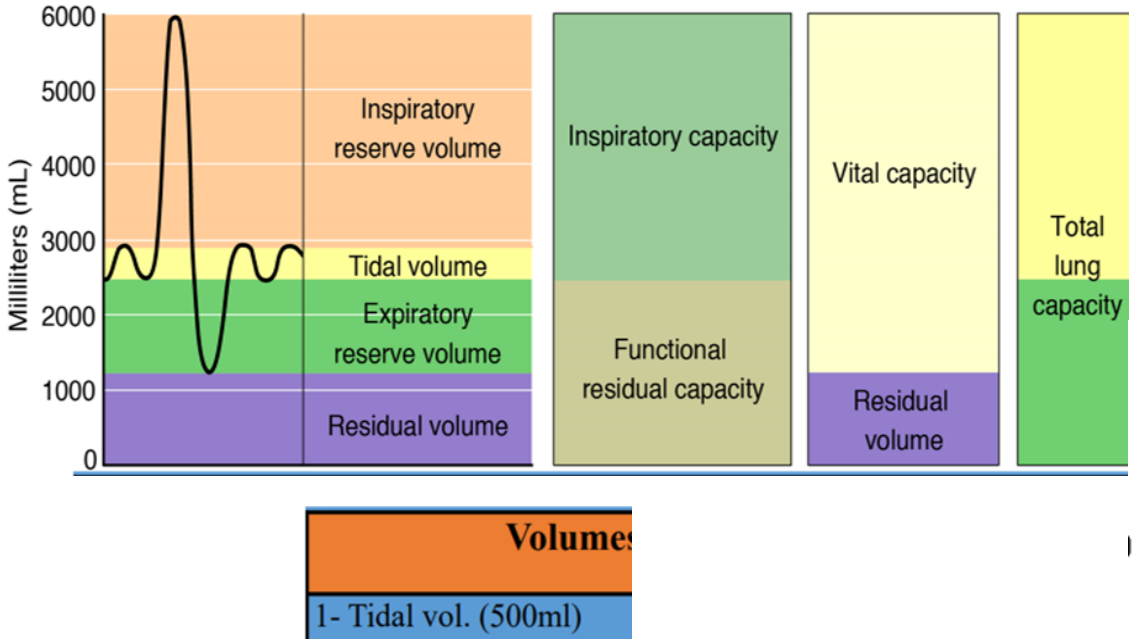


Volumes	Capacities
1- Tidal vol. (500ml)	1- Inspiratory cap. (3500ml)
2- Inspiratory reserve vol. (3000ml)	2- Functional residual cap. (2300ml)
3- Expiratory reserve vol. (1100ml)	3- Vital cap. (4600ml)
4- Residual vol. (1200ml)	4- Total lung cap. (5800ml)



LUNG VOLUMES

1-TIDAL VOLUME



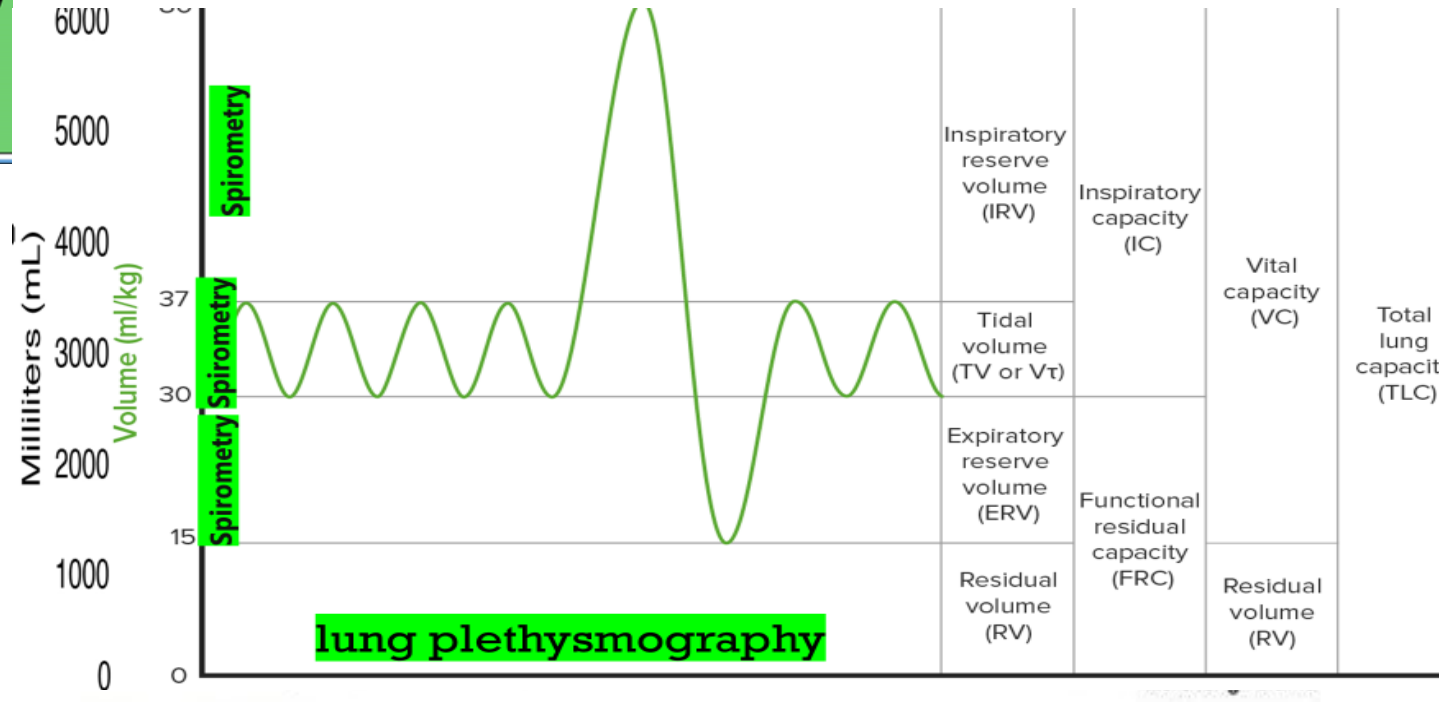
Volume

1- Tidal vol. (500ml)

N — 6-8 ml/kg.

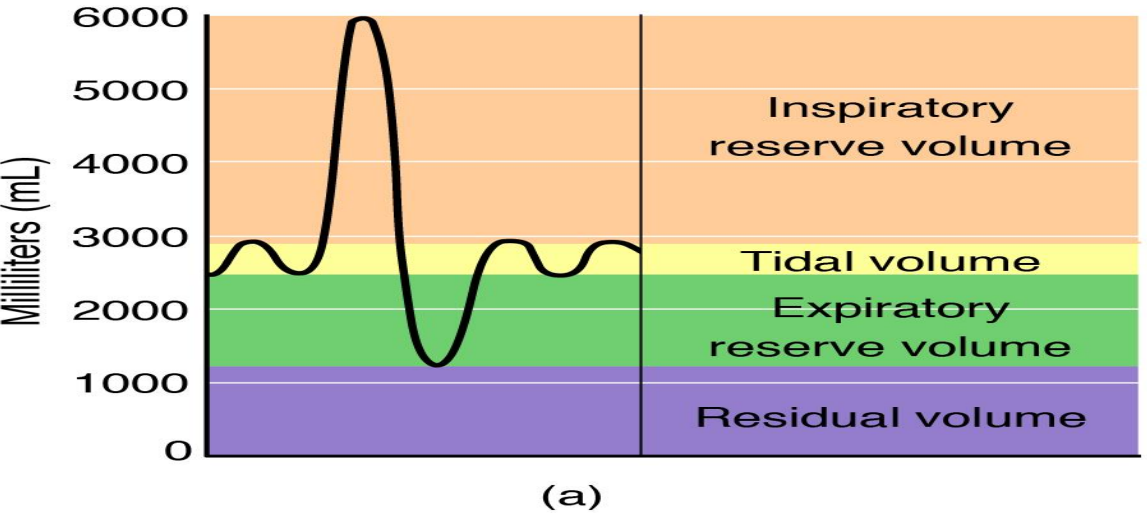
Minute volume = Tv X RR

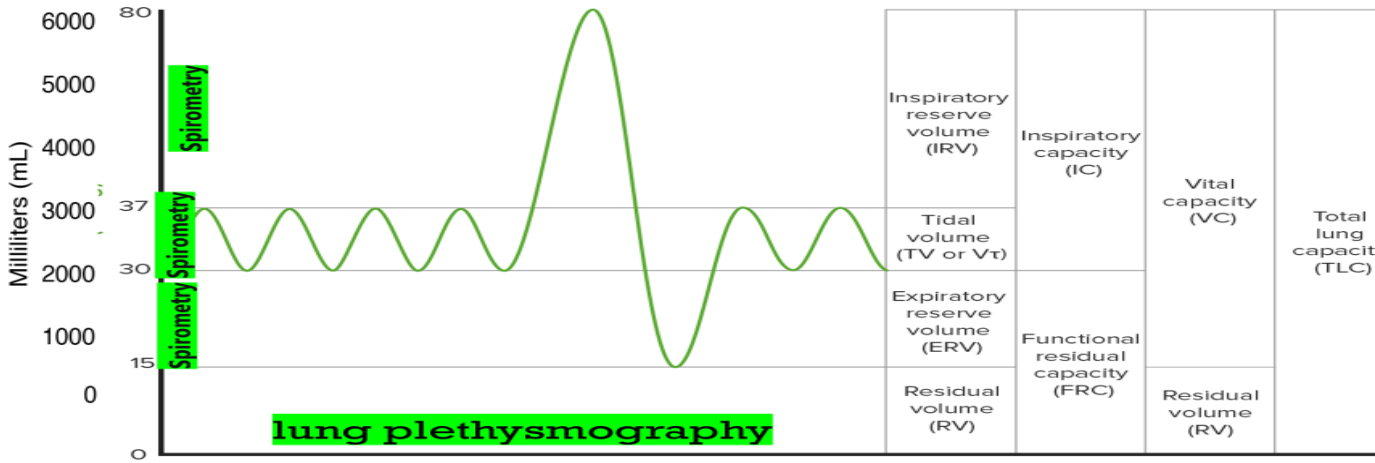
Tidal volume (TV) is the volume of air moved into or out of the lungs in one breath. It increases during exercise.



An increase in ‘tidal volume’ which refers to the quantity of air that is inhaled and exhaled with every breath.

2- INSPIRATORY RESERVE VOLUME (IRV)





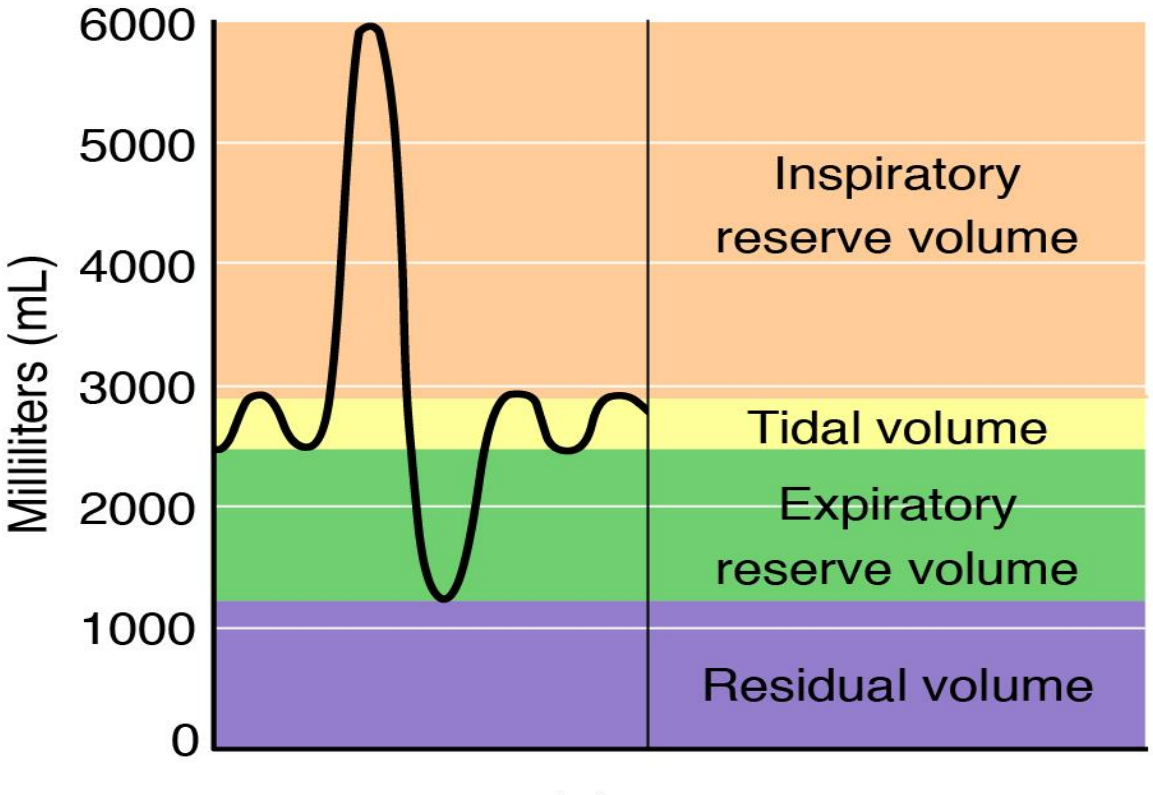
INSPIRATORY RESERVE VOLUME (IRV):

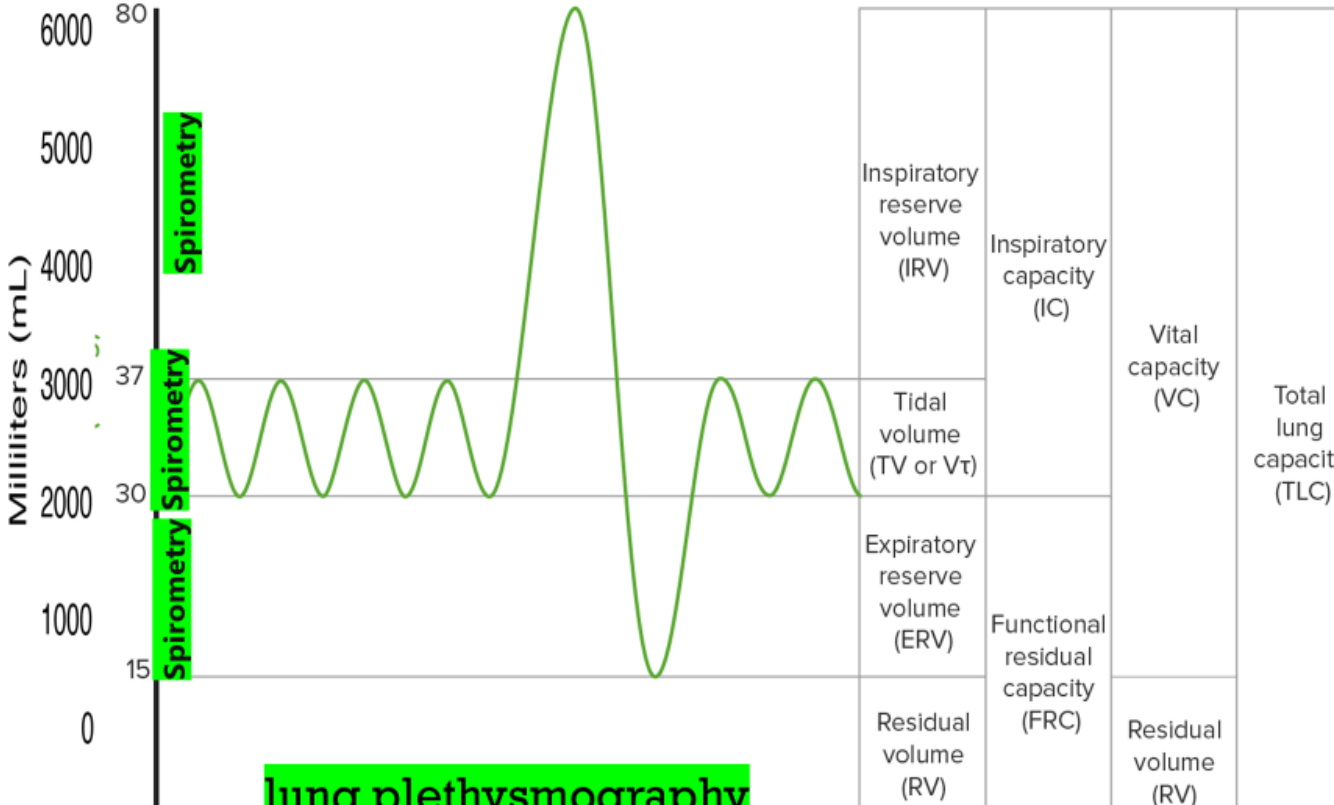
MAX. VOL. OF AIR WHICH CAN BE INSPIRED AFTER A NORMAL TIDAL INSPIRATION i.e. FROM END INSPIRATION PT.

N- 1900 ml- 3300 ml.

3- EXPIRATORY RESERVE VOLUME

- The expiratory reserve volume (ERV) is the reserve amount of air that can be exhaled forcefully, after passive exhalation

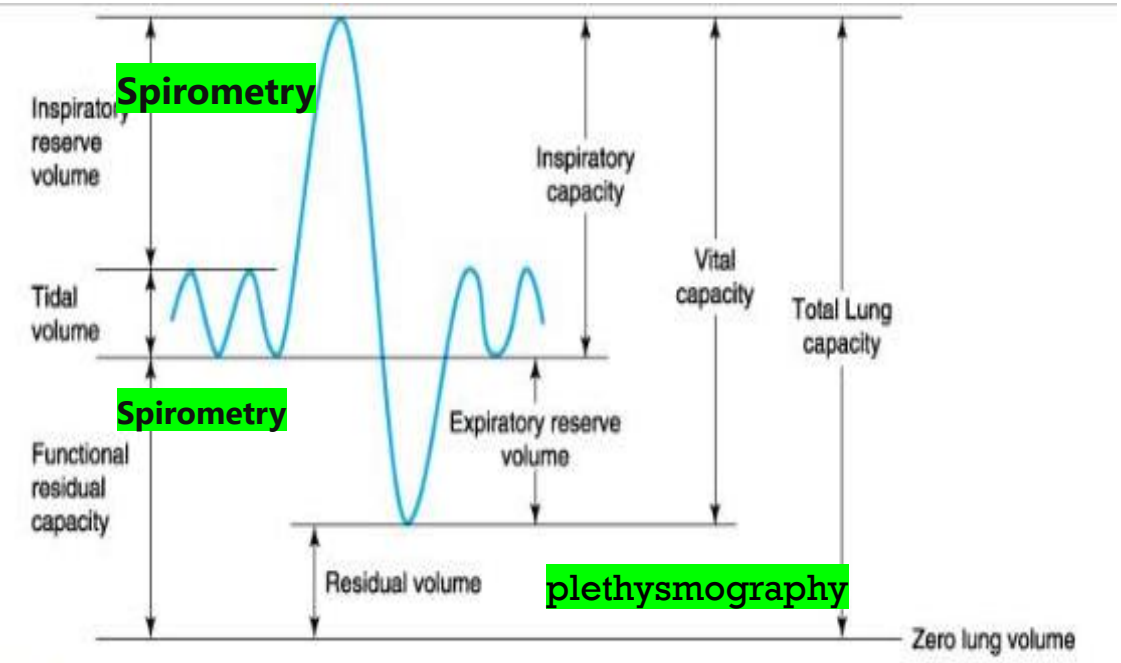


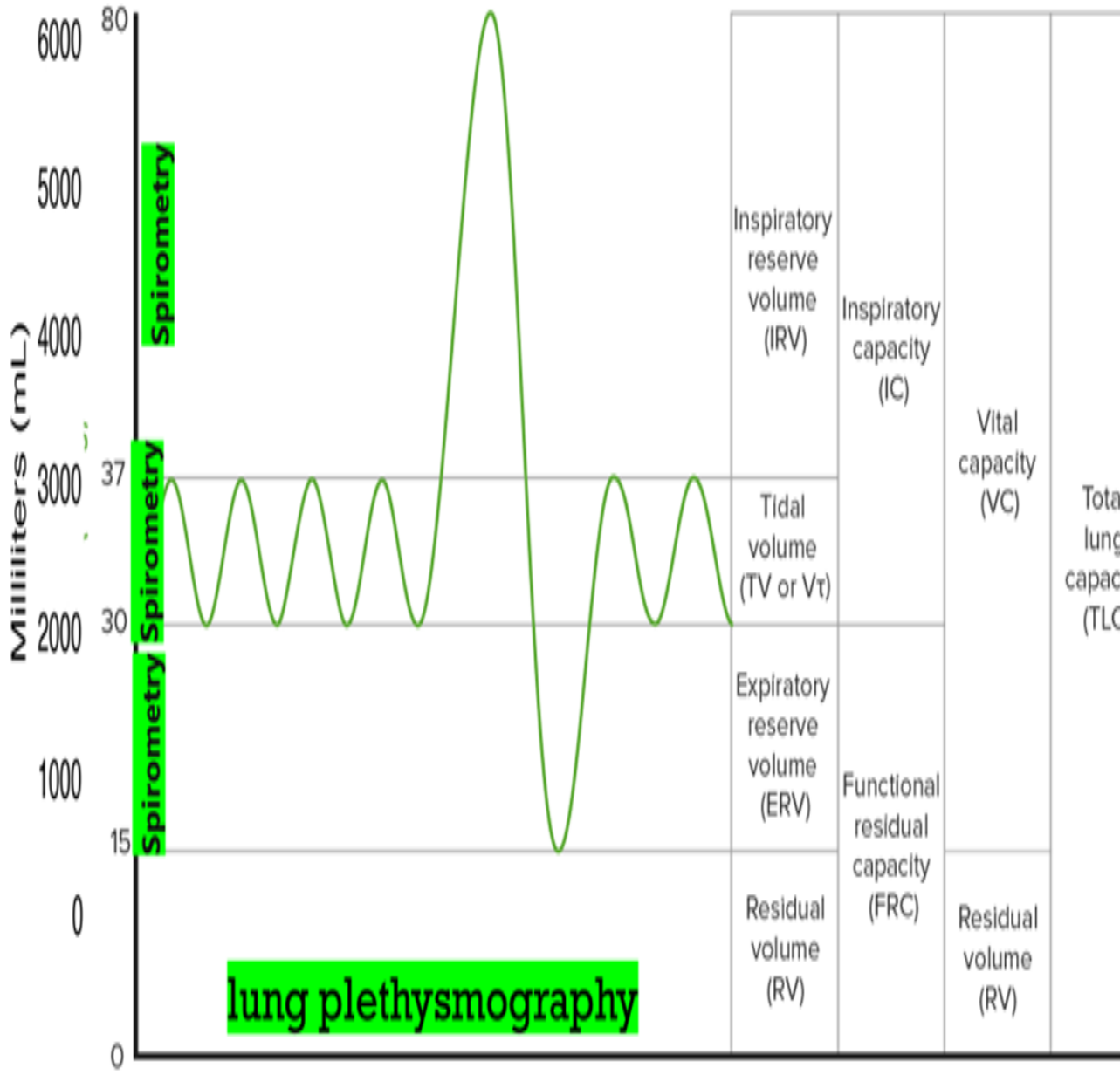


4- RESIDUAL VOLUME

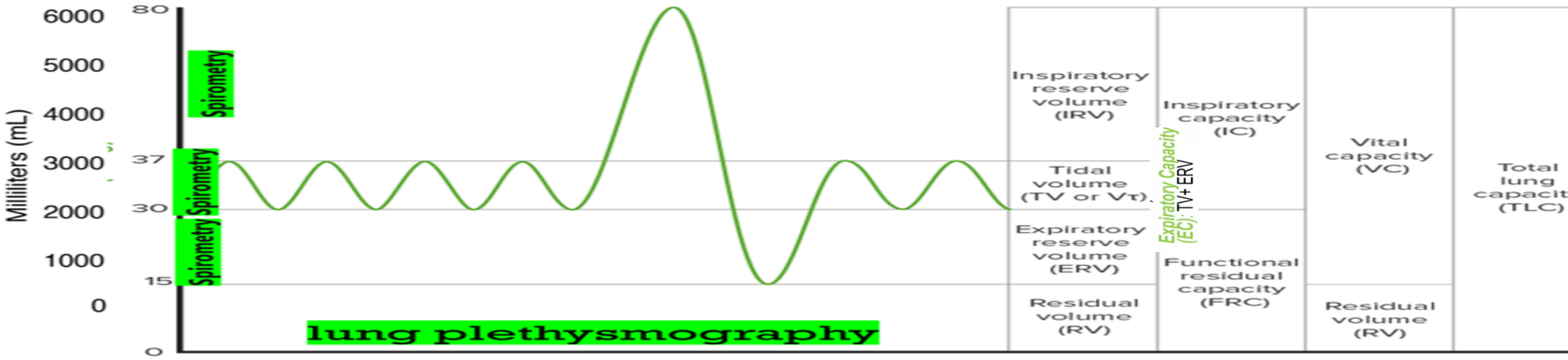
- The volume of air remaining in lungs after maximal inhalation.
- Residual volume is the only volume not estimated by spirometry.

Indirectly measured :
FRC-ERV,TLC-VC





Lung capacities



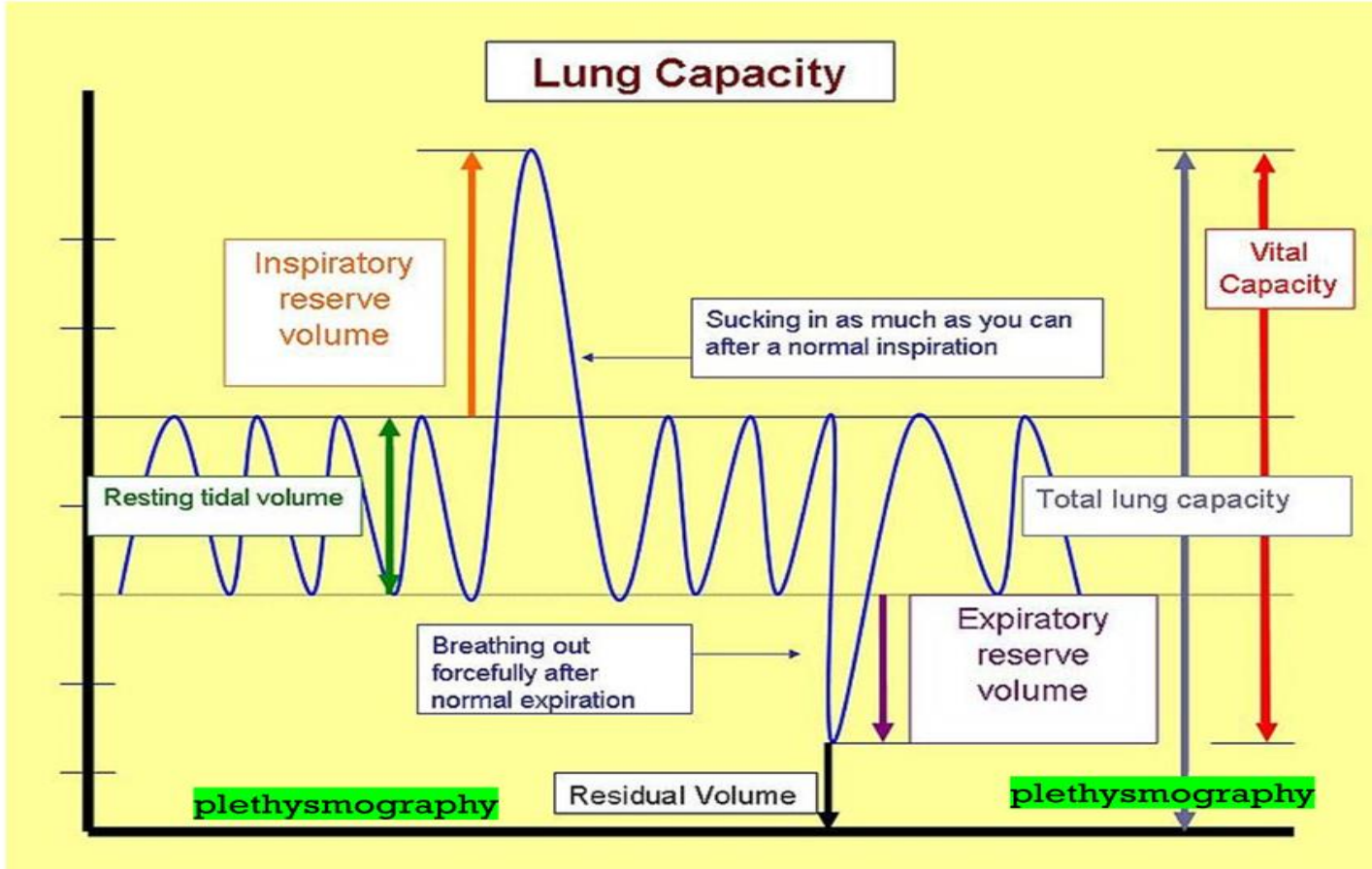
- *Inspiratory Capacity (IC)*: Sum of IRV and TV or the maximum volume of air that can be inhaled from the end-expiratory tidal position. (2400-3800ml). IRV + TV
- *Expiratory Capacity (EC)*: TV+ ERV
- *Functional Residual Capacity (FRC)*:
  - Sum of RV and ERV or the volume of air in the lungs at end-expiratory tidal position.(30-35 ml/kg) (2300-3300ml). ERV + RV
  - It can not be measured by spirometry)
- *Vital Capacity (VC)*: TLC minus RV or maximum volume of air exhaled from maximal inspiratory level. (60-70 ml/kg) (3100-4800ml) IRV + TV + ERV
- *Total Lung Capacity (TLC)*: Sum of all volume compartments or volume of air in lungs after maximum inspiration (4-6 L) IRV + TV + ERV + RV Or VC+RV

RV= FRC-ERV, or TLC-VC

PULMONARY FUNCTION TEST INDICES

Pulmonary function test	*Normal value (95 percent confidence interval)*
FEV_1	80% to 120%
FVC	80% to 120%
Absolute FEV_1/FVC ratio	Within 5% of the predicted ratio
TLC lung plethysmography	80% to 120%
FRC lung plethysmography	75% to 120%
RV lung plethysmography	75% to 120%

SPIROMETRY



RESTRICTIVE& OBSTRUCTIVE LUNG DISEASE

- **Restrictive: such as pulmonary fibrosis . Airflow is normal but lung volume is decreased.**
- **Airflow is decreased but lung volume is normal.**
- **Mixed: Airflow and lung volume are both decreased.**

OBSTRUCTIVE VS. RESTRICTIVE

Obstructive disorders	Restrictive disorders
• **Characterized by:** reduction in airflow. • So, shortness of breath → in exhaling air. (the air will remain inside the lung after full expiration) 1. COPD 2. Asthma 3. Bronchiectasis	• **Characterized by** a reduction in lung volume. • So, Difficulty in taking air inside the lung. (DUE TO stiffness inside the lung tissue or chest wall cavity) 1. Interstitial lung disease. 2. Scoliosis 3. Neuromuscular cause 4. Marked obesity

5-pulmonary fibrosis