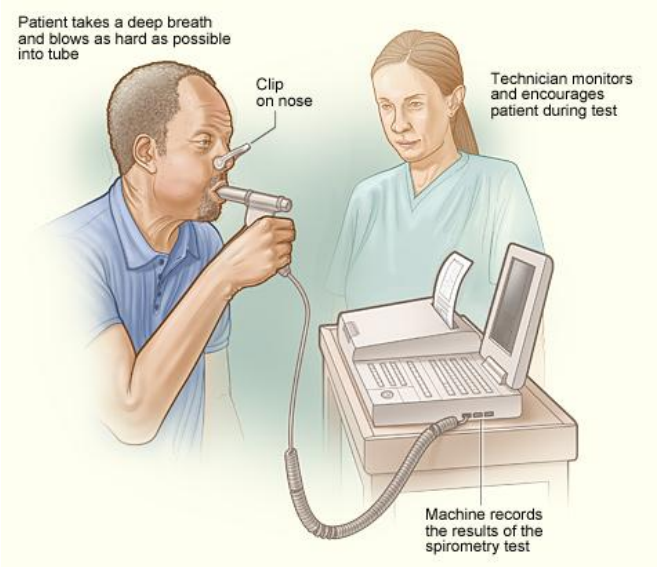
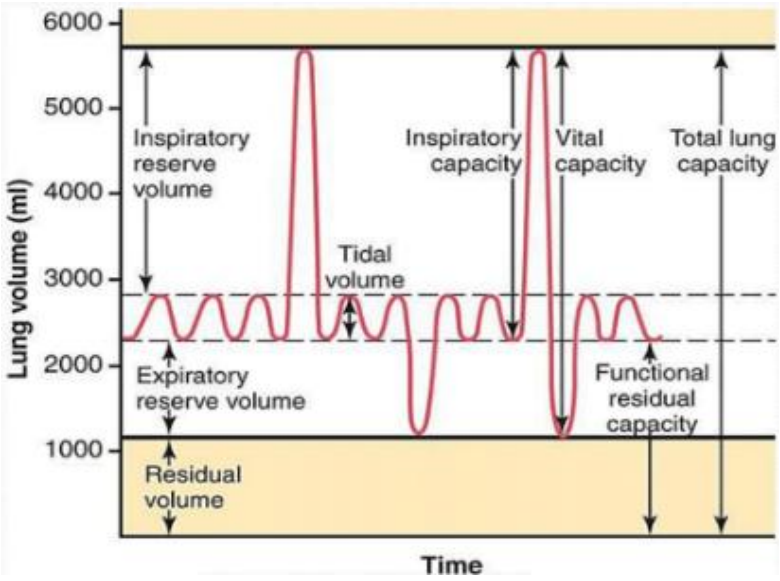
# Unit II – Problem 3 – Physiology Lab: Pulmonary Function Tests (PFTs)

- **What is the importance of Pulmonary Function Tests (PFTs)?**
  - They help in the diagnosis of a disease (differentiate if it is from a cardiac cause or pulmonary cause).
  - They will help you in choosing a plan of treatment for your patient depending on the process of his disease.
  - To monitor the progression of a disease and effectiveness of your treatment.
  - They aid in pre-operative assessment of certain patients.
- **What is spirometry?**
  - It is a device which measures the volume of air inspired or expired and records the time over which the volume changes occur.




- **What are the contraindications to perform spirometry?**
  - Hemoptysis of unknown origin.
  - Pneumothorax.
  - Unstable cardiovascular status or recent myocardial infarction or pulmonary embolus.
  - Thoracic, abdominal or cerebral aneurysms.
  - Recent eye, thorax or abdominal surgery.
  - Patients with a history of syncope associated with forced exhalation.
- **There are four lung volumes:**
  - **Inspiratory Reserve Volume (IRV):** it is the air which can still be breathed in after normal inspiration. This volume is used during exercise.
  - **Tidal Volume (TV):** it is air which is moving into the lung with each quiet inspiration (around 500 ml).
  - **Expiratory Reserve Volume (ERV):** it is air which can still be breathed out after normal expiration.
  - **Residual Volume (RV):** it is air in the lung after maximal expiration (notice that residual volume cannot be measured by spirometry).



- **There are four lung capacities:**
  - **Inspiratory Capacity (IC):** it is the sum of tidal volume and IRV.
  - **Functional Residual Capacity (FRC):** ERV + RV (it is the volume in lungs after normal expiration. Notice that FRC cannot be measured by spirometry).
  - **Vital Capacity (VC):** it is the maximum volume of gas which can be expired after a maximal inspiration (IRV + TV + ERV). VC is decreased in restrictive lung diseases but is normal or slightly decreased in obstructive lung diseases.
  - **Total Lung Capacity (TLC):** it is the volume of gas present in lungs after a maximal inspiration (IRV + TV + ERV + RV). Notice that TLC cannot be measured by spirometry.
- **Ambient Temperature and Pressure Saturated (ATPS) vs. Body Temperature and Pressure Saturated (BTPS):**
  - **Gas in a spirometer is at ambient temperature, pressure and water vapor saturation (ATPS), so the volumes of gas collected in a spirometer must be converted to equivalent volumes in the body (BTPS):**

| ATPS | BTPS |
|---|---|
| • Ambient temperature is less than body temperature<br>• Volume of air measured by spirometer is slightly less than the volume actually exhaled<br>• Measurements made by systems must be converted | • Requires knowing the ambient temperature, barometric pressure and humidity level<br>• ATPS is multiplied by the correction factor to obtain the higher BTPS values |

- **Classification of lung defects:**

| Obstructive lung disease | Restrictive lung disease |
|---|---|
| • Expiratory flow is below normal<br>• Examples include: asthma, emphysema and cystic fibrosis | • Lung volumes are reduced<br>• Examples: lung fibrosis, obesity, neuromuscular/ cardiovascular diseases and trauma/chest wall dysfunction |

- **Additional information (more detailed):**
  - **Pulmonary Function Test (PFT):**
    - ✓ It is a non-invasive test which is used to:
      - ❖ Differentiate between obstructive and restrictive pulmonary diseases.
      - ❖ Assessing severity of the disease and prognosis.
      - ❖ Evaluating post-treatment lung function.
    - ✓ PFT consists of different tests:
      - ❖ *Static lung compartments*: Vital Capacity (VC) + Residual Volume (RV) = both of them making the Total Lung Capacity (TLC).
      - ❖ *Airflow*: measured by ratio of Forced Expiratory Volume in 1 second to Forced Vital Capacity FEV1/FVC.
      - ❖ *Alveolar membrane permeability*: measured by diffusing gas capacity (DLco).
      - ❖ *Methacholine challenge test*: when you suspect clinically that a patient has asthma and his PFT is normal → you will do methacholine challenge test to confirm your diagnosis.
    - ✓ <80% of predicted in any lung volume or flow rate is considered abnormal, while > 120% of predicted is consistent with air trapping:
      - ❖ *When you receive a PFT of a patient watch FEV1:*
        - ➢ If it is >80% → this is normal.
        - ➢ If it is <80% → this is abnormal and you must look for FEV1/FVC ratio:
          - If it is ≥80% → this is a restrictive lung disease.

- If it is <80% → this is an obstructive lung disease (e.g. COPD and asthma).

✓ Carbon Monoxide Diffusing Capacity (DLco):
- ❖ This is measuring how good oxygen can pass from alveoli to the blood (checking alveolar membrane permeability).
- ❖ *Patient will inhale DLco gas which is composed of*: Carbon Monoxide (CO), helium and room air.
- ❖ *DLco is decreased in 2 conditions:*
  - ➢ PFT with an obstructive pattern and decreased DLco → emphysema (destruction of alveolar wall).
  - ➢ PFT with a restrictive pattern and decreased DLco → interstitial lung disease such as fibrosis (in which the alveolar capillary membrane is thickened).

✓ Methacholine challenge test:
- ❖ This is done when you suspect clinically that a patient has asthma but PFT is normal (because patient might not have bronchoconstriction at the time the test was done).
- ❖ *How to do it?*
  - ➢ You will do PFT before giving methacholine.
  - ➢ Then, you will let the patient inhale methacholine which is a muscarinic agnoist mimicing the action of Ach and causing bronchoconstriction (asthmatic crisis).
  - ➢ You will do PFT again and check FEV1 → if there is a decrease by ≥ 20% from baseline FEV1 → test is considered to be positive and patient has asthma.

✓ Bronchodilator reversibility:
- ❖ This is done when you have a PFT showing an obstructive pattern and you want to differentiate between COPD and asthma (because asthma is a reversible obstructive lung disease while COPD is irreversible).
- ❖ You will let the patient inhale a short-acting β2 agonist (albuterol) and then do a PFT again for him.
- ❖ Patient is considered to be asthmatic if there is a reverse in results by > 12% after using the bronchodilator.

- **Flow Volume Loops:**

✓ In restrictive lung disease, the loop is shifter to the right (on the x-axis) indicating decreased lung volume.

✓ In obstructive lung disease, the y-axis of the loop is altered indicating decreased flow rate.

✓ In fixed airway obstruction (tracheal stenosis; tracheal tumor or foreign object) , the flow volume loop is flattened on the top and bottom.