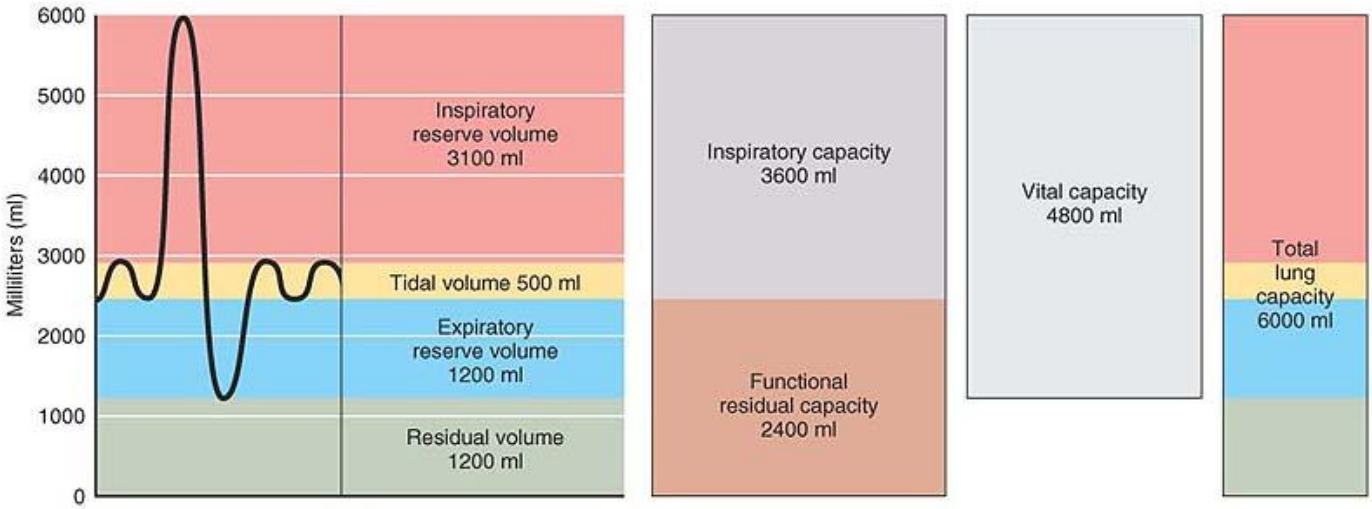
Bell type Spirometry



(a) Spirographic record for a male

	Measurement	Adult male average value	Adult female average value	Description
Respiratory volumes	Tidal volume (TV)	500 ml	500 ml	Amount of air inhaled or exhaled with each breath under resting conditions
	Inspiratory reserve volume (IRV)	3100 ml	1900 ml	Amount of air that can be forcefully inhaled after a normal tidal volume inhalation
	Expiratory reserve volume (ERV)	1200 ml	700 ml	Amount of air that can be forcefully exhaled after a normal tidal volume exhalation
	Residual volume (RV)	1200 ml	1100 ml	Amount of air remaining in the lungs after a forced exhalation
Respiratory capacities	Total lung capacity (TLC)	6000 ml	4200 ml	Maximum amount of air contained in lungs after a maximum inspiratory effort: TLC = TV + IRV + ERV + RV
	Vital capacity (VC)	4800 ml	3100 ml	Maximum amount of air that can be expired after a maximum inspiratory effort: VC = TV + IRV + ERV (should be 80% TLC)
	Inspiratory capacity (IC)	3600 ml	2400 ml	Maximum amount of air that can be inspired after a normal expiration: IC = TV + IRV
	Functional residual capacity (FRC)	2400 ml	1800 ml	Volume of air remaining in the lungs after a normal tidal volume expiration: FRC = ERV + RV

(b) Summary of respiratory volumes and capacities for males and females

(2) Physiological factors that influence lung volumes & capacities include:
- Sex (as seen above)
- Weight (↑ weight ➔ ↓ lung volume
- Age
  - Child hood ➔ adulthood there will be ↑ lung volume
  - Adulthood ➔ elderly there will be ↓ lung volume (especially vital capacity)
- Height (↑ height ➔ ↑ lung volume (especially vital capacity))
- Athletes ↑
- Posture (standing will ↑ lung volume)

(3) Lung volumes and capacities are altered in a variety of pathological conditions including:
a. Obstructive lung disease: normal TLC with ↑ FRC (e.g. asthma & emphysema).
b. Restrictive lung disease: ↓ lung volume & capacity (e.g. pulmonary fibrosis, pleural effusion, pneumothorax, lung tumors).

(4) The physiological significance of the residual volume and the functional residual capacity include the following:
    a. Facilitates the work of breathing.
    b. Prevents the collapse of lungs.
    c. Allows continuous exchange of gases between the breaths.

Dynamic Spirometry

Some Definitions:

- **Forced expiratory volume in 1 sec (FEV1):** the volume of air forcefully expired during the first second after a full breath and normally accounts for > 75% of the FVC.
- **Forced Vital Capacity (FVC):** The volume of air expired with maximal force after maximal inspiratory effort.

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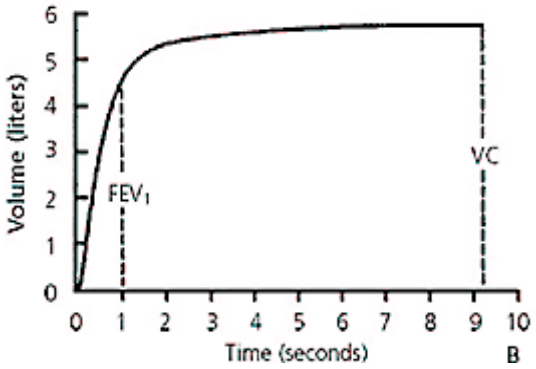
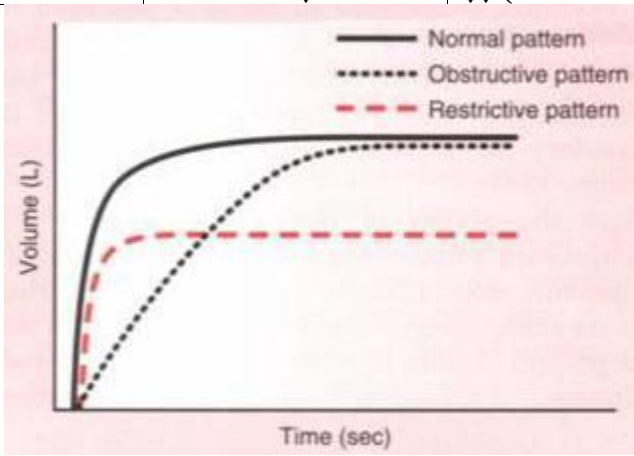
(Answers to a similar graph on page 5):



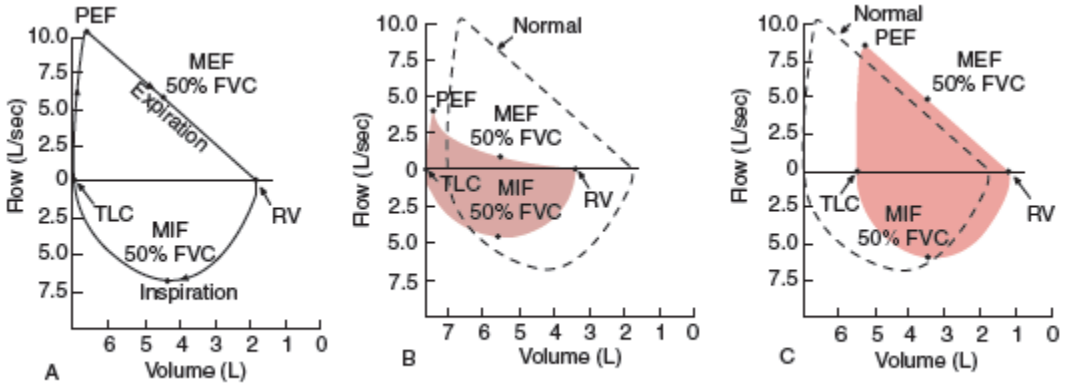
(1) From the FEV_1 produced, calculate:-
    a. **FVC**: 5.5 L (estimate)
    b. **FEV_1:** 4.5 L (estimate)
    c. **FEV_1%:** $FVC/FEV_1 \times 100 = 4.5/5.5 \times 1 = 81\%$ (normal).

(2) The FEV_1% is a good index of airway resistance while expiring.
    a. The values expected for a normal person is >75%
    b. It takes healthy subjects to expire their vital capacity 3-5 seconds.
    c. In pathologies the following effects take place:

	Obstructive	Restrictive
FEV_1/FVC %	↓↓ (far below 80%)	Normal
FEV_1	↓	↓
FVC	Normal or ↓	↓↓ (can reach 3L)



Flow Volume Loop



2. In a normal individual all of the parameters (including FVC MEF50, PEFR, PIFR,…etc) will be within normal ranges.
3. The force-independent part of the expiratory loop is curvilinear in obstructive lung disease is due to narrowing of the smaller airways. (the rising phase in the expiratory loop is force dependent, and the falling phase is force independent).
4. the clinical significance of MEF50 measurements is to diagnose obstructive lung disease (↓ in MEF50 with normal simultaneous PEFR ➔ obstructive lung disease). If there is decrease in MEF50 with simultaneous decrease in PEFR, then it is restrictive lung disease.

Diuresis Answers:

1. The pH of urine does not fall below 4.5 because:
    - ♣ There is a limitation to the rate of active transport of the H+ ions into the distal tubules.
    - ♣ The concentration difference between H+ ions across the tubular cells is too big for H" ion active transport to continue

    The physiological importance of pH not falling below 4.5 is to prevent damage to the walls of the urinary tract.

2. (answers to calculations):
3. It will take 24 hours to excrete 1 liter of ingested isotonic saline because the mechanism of ANP is a slow mechanism. ANP will act on excretion of isotonic saline in 3 ways:
    - ♣ It will inhibit aldosterone secretion from adrenal cortex.
    - ♣ It will ↑ GFR by vasodilation of afferent arteriole.
    - ♣ It will ↑ GFR by relaxation of the mesangial cells and thus ↑ the filtration coefficient.

    Note: ADH mechanism is responsible of excretion of 1 liter of ingested water within 3 hours and begins its action after 30 minutes.
1. Lasix can increase the loss of body fluids by blocking the Na+/K+/2Cl cotransporter in the thick ascending limb of the loop of Henle. This will cause ↓ reabsorption and thus ↑ loss of sodium in urine, and the water and chloride will follow it. This is known as osmotic diuresis.
2. Explanation for sometimes not urinating water within 3 hours after taking 1 liter of water could be due to loss of water by other means (i.e. feces, skin, lungs, etc..)

GTT (Glucose Tolerance Test)

1. The range of normal fasting blood glucose is 70-110 mg/dl (3.9-6.1 mmol/l).
2.
    a. The reason for the rising phase in the GTT curve is the ingestion and absorption of glucose into blood.
    b. The reason for the falling phase in the GTT curve is the action of insulin to ↑ the uptake and utilization of glucose by the cells.
3. The blood glucose may fall below fasting levels approximately 2.5 hours after the glucose load because of insulin overshoot.
4. The renal threshold is the plasma glucose level at and after which glucose will start appearing in urine. The normal value in the venous plasma is 180 mg/dl and in the arterial plasma is 200 mg/dl. The difference between the arterial and venous plasma glucose levels will ↑ when the renal threshold is exceeded due to loss of some glucose into the urine.
5. The causes of glycosuria include:
    a. Diabetes Mellitus (DM).
    b. Congenital Renal Tubular Defect
    c. Alimentary glycosuria:
        i. Liver Disease.
        ii. Hyperthyroidism
        iii. After gatrectomy
        iv. Very high CHO diet.
6. The difference in GTT between the a normal subject and a diabetic person include:
    a. The fasting Plasma Glucose Level (PGL) will be ↑ >126 in diabetic patients while it will be normal in a normal person.
    b. The plasma glucose level will exceed renal threshold in a diabetic person, while it is not the case in a normal person.
    c. The plasma glucose level does not come back to the fasting level in a diabetic person after 2 hours but in a normal subject it will come back to normal.
7. answers:
    a. Glucose can be given in IV in
        i. An unconscious patient
        ii. A patient with the tendency to vomit.
    b. If the glucose is taken IV, then the glucose level will rise more rapidly and to a higher level after the glucose intake because the intestines are bypassed.
8. Other tests for diagnosis of diabetes mellitus are the fasting plasma glucose level, and for the prognosis of diabetes is HbA_{1C}.
9. High Calorie diet should be avoided by a diabetic person.