

# **Lung Diseases**

- **Prevalence of lung disease depends on the population, but in general obstructive is 70%, restrictive is 20-25% and vascular the rest 5-10%**

# Pulmonary Pathology

- Obstructive Diseases
  - Increased resistance to flow
- Restrictive Diseases
  - Decreased expansion of the lungs

# **Chronic Obstructive Pulmonary Disease**

- Chronic pulmonary emphysema
  - infection (secretions)
  - obstruction
  - loss of parenchyma
  - Consequences
    - high airway resistance
    - decreased diffusing capacity
    - pulmonary hypertension

# Pathology

## Resistance to airflow

- Lumen
- excessive secretions
- obstruction due to aspiration

## – Airway

- contraction of smooth muscle
- hypertrophy of bronchial wall

## – outside of airway

- destruction of lung

## The work of Breathing:

$$W = \Delta P \times \Delta V$$

Normally  $0.5 \text{ L} \times 5 \text{ cm H}_2\text{O} = 0.25 \text{ J}$ .....*One Joule is equal to = 10 L X cm H<sub>2</sub>O = J*

50% of the work of breathing is used to expand the lungs and 50% to expand the chest wall.

## The work of breathing is used to overcome:

1) Elastic forces (70%) (Contribution to the total work of breathing): They are under static (no-flow conditions). Two types:

A) Elastic fibers (one third)

B) Surface tension (two thirds).

2) Non elastic forces (30%) (Only present during the dynamic phase of breathing).

Again two types:

A) 20% is the tissue viscous resistance, it occurs only during tissue movement. It is frictional R which resists a change in shape. It always opposes motion.

B) 80% is due to air way resistance:

$$T_{\text{Total}} = E_{\text{Elastic}} + P_{\text{Nonelastic}}$$

$E_{\text{Elastic}}$ : elastic recoil P

$P_{\text{Nonelastic}}$ : Is the pressure to overcome resistance to airflow.

When no air movement takes place  $T_{\text{Total}} = E_{\text{Elastic}}$

**Always remember Ohm's law: Flow is directly proportional to the driving force and inversely proportional to the resistance**

**Flow = pressure difference / resistance =  $\Delta P/R$ ....**

**What is the  $\Delta P$ ?** It is the pressure difference between the two opposite ends of the airways:  $(P_{alv} - P_{atm})$

If R is large then  $\Delta P$  must be large too in order to keep air flow constant.

Boyle's law: The pressure and the volume of a gas are inversely related if the temperature is constant.

$R_{airways}$  resides mainly in large airways. In contrast, the small airways have small tiny diameter, but large cross sectional area, thus they offer little resistance to airflow.

The French physician Jean Leonard Marie **Poiseuille's**

$$V = (\Delta P) / \pi r^4 / 8 \eta l$$

\*\*\*The most important point to remember is R is inversely proportional to  $1/r^4$

Small change in "r" results in huge change in R.

$$\text{Air flow} = (P_{\text{atm}} - P_{\text{alv}}) / R$$

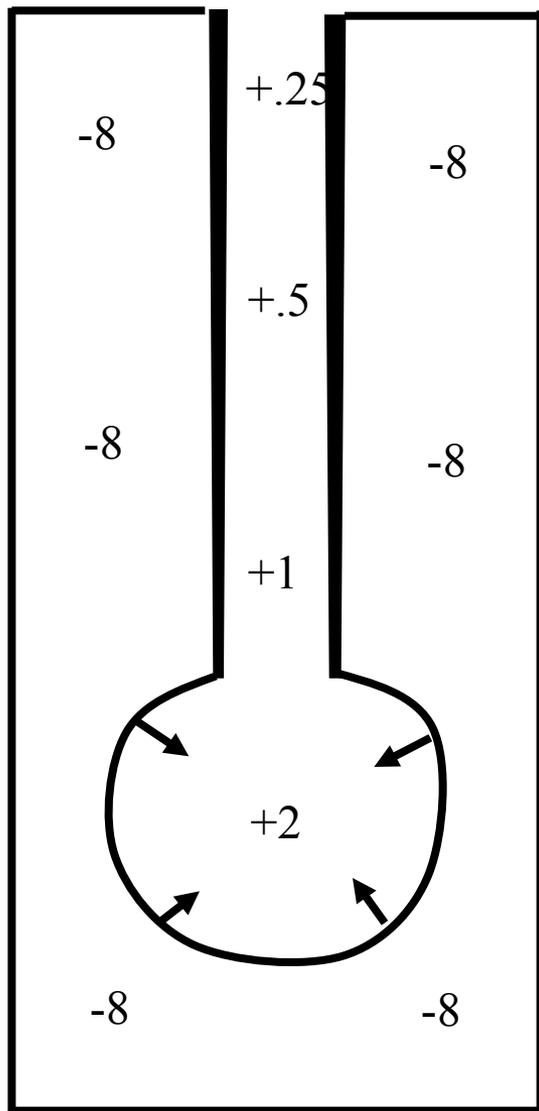
Four Take home messages:

1. Normally: R is small and negligible
2. Normally: R resides in large airways not in the small ones
3. Small airways participate in the increase in R disease condition.
4. R, when increased is Manifested mainly during expiration rather than during inspiration.

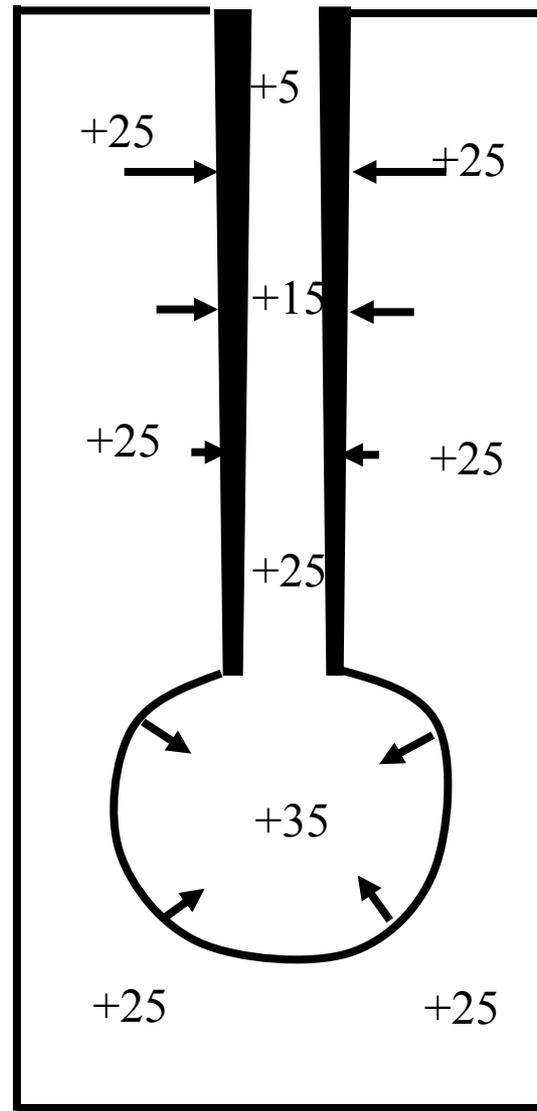
# **Pulmonary Disorders** (continued)

## **– Emphysema:**

- **Is Chronic progressive condition**
  - **Alveolar tissue is destroyed leading to decrease surface area available for diffusion**
  - **Decreases ability of bronchioles to remain open during expiration...bcz of destruction of elastic fibers which keep small airways open**
  - **Cigarette smoking stimulates macrophages and leukocytes to secrete protein digesting enzymes that destroy tissue.**



Passive Expiration



Forced Expiration

# Ventilation

FACTOR	AFFECTED BY	MEDIATED BY
Length of the system	Constant; not a factor	
Viscosity of air	Usually constant; humidity and altitude may alter slightly	
Diameter of airways		
Upper airways	Physical obstruction	Mucus and other factors
Bronchioles	Bronchoconstriction	Parasympathetic neurons (muscarinic receptors), histamine, leukotrienes
	Bronchodilation	Carbon dioxide, epinephrine ( $\beta_2$ -receptors)

# Control of Bronchiolar Diameter

- Nervous
  - Sympathetics
    - $\beta_2$  receptors dilate (salbutamol, dobutamine, albuterol, fenoterol, terbutaline).
  - Parasympathetics
    - Acetylcholine constrict bronchioles
- Humoral
  - Histamine, acetylcholine >> Constrict
  - Adrenergic ( $\beta$  agonists) >> Relax

## **COPD**

1. Emphysema
2. Chronic bronchitis
- ±3. Bronchial asthma

1. ↑ Compliance: mainly in emphysema, due to destruction of the elastic fibers,
2. ↑ FRC:
3. . ↑ Airway R. more fluctuation during dynamic phases mainly in asthma.

Smoking inhibits cilia → accumulation of mucus → bacterial growth → chronic bronchitis.

Smoking induces hyperplasia of Goblet cells → excessive mucus secretion → bacterial growth → chronic bronchitis

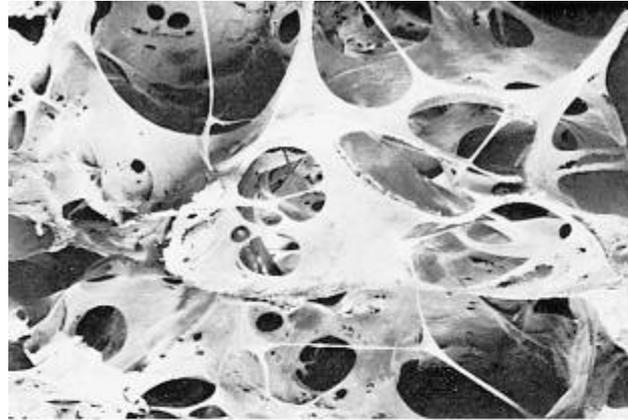
## **Pursed Lip Breathing in COPD patients**

Collapse of your airways on expiration, as your lungs are getting smaller as you breathe out. This is a particularly serious problem in people with Emphysema, as the elastic supporting lung structure helping to keep the airways open is deficient.

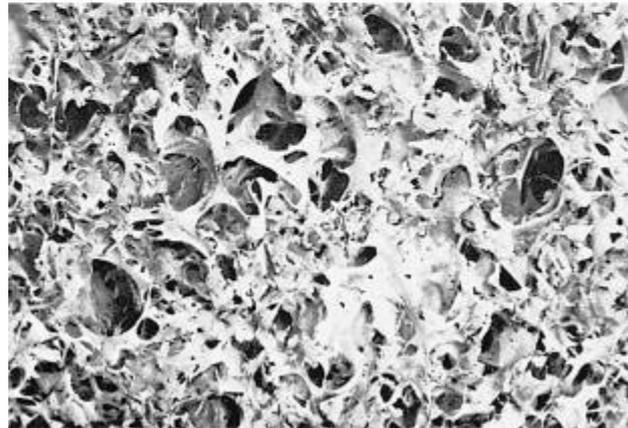
Pursed Lip Breathing simply imposes a slight obstruction to expiration air flow at the mouth, which generates a back pressure throughout the airways, and therefore a stenting effect to help prop open the airways and assist expiration and lung emptying. It must be emphasized, the amount of pressure supplied by you by pursing your lips together must, as usually described, be "minimal," or "gentle."

# Restrictive Diseases

- Decreased expansion of the lungs
- Lung volumes
  - reduced VC, FRC, normal airway resistance
- Diffuse Interstitial Pulmonary Fibrosis
  - thick collagen deposits
- Pneumothorax

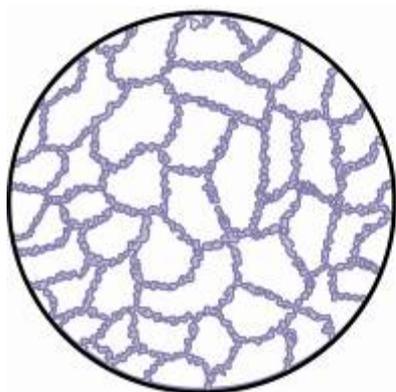


Emphysematous Lung

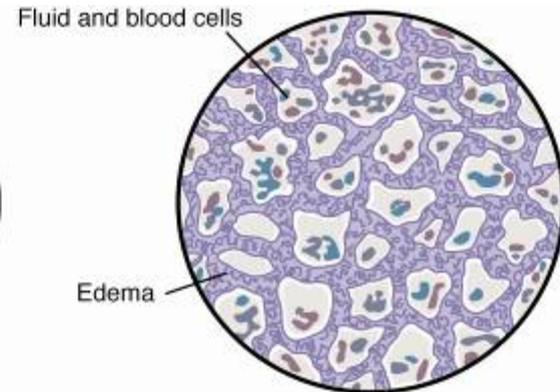


Normal Lung

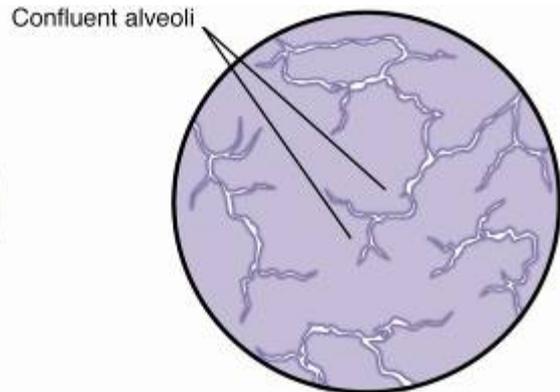
Figure 42-4



**Normal**



**Pneumonia**



**Emphysema**

Figure 42-5

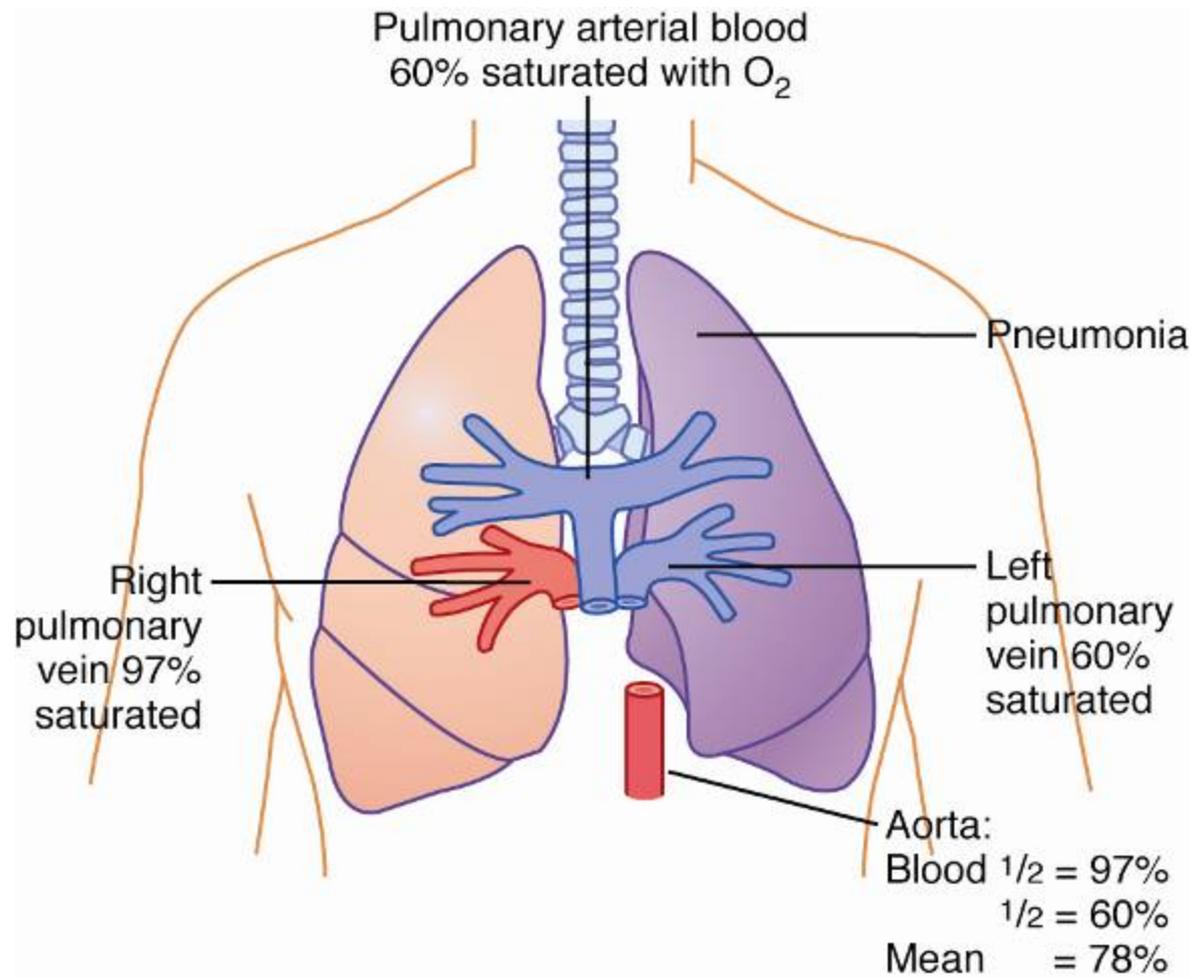


Figure 42-6

# Pathology

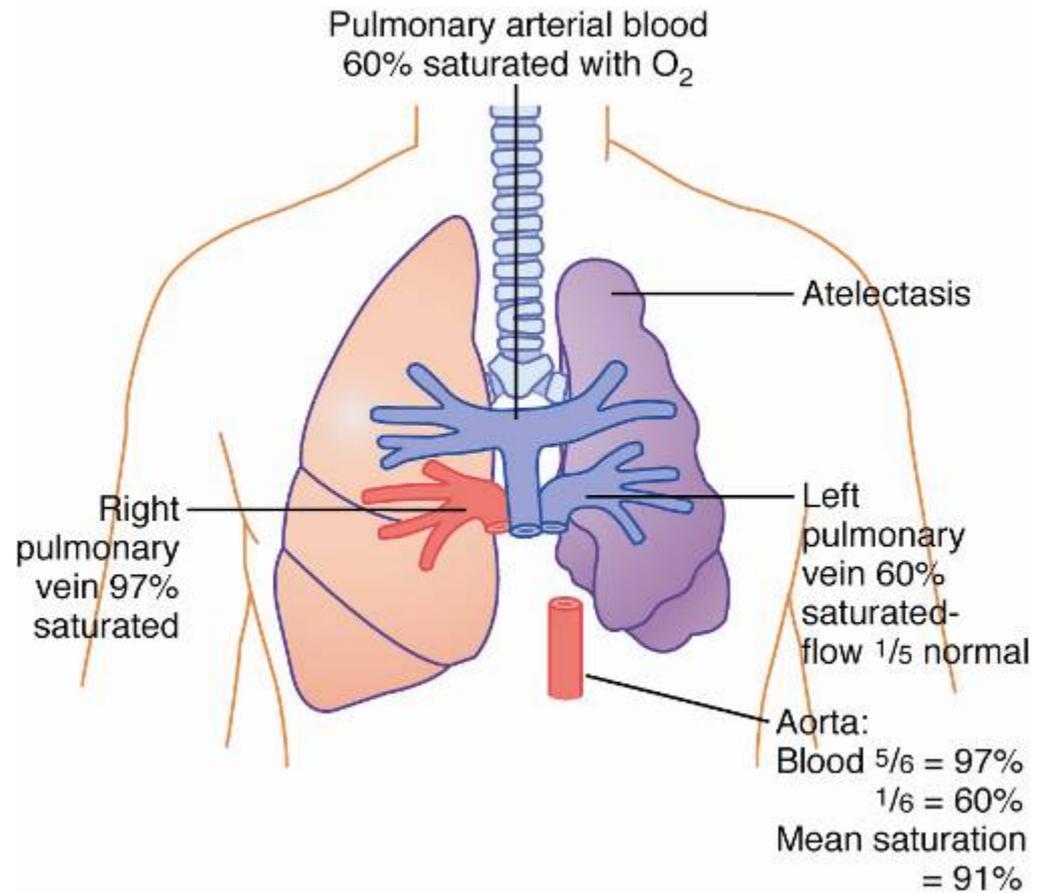
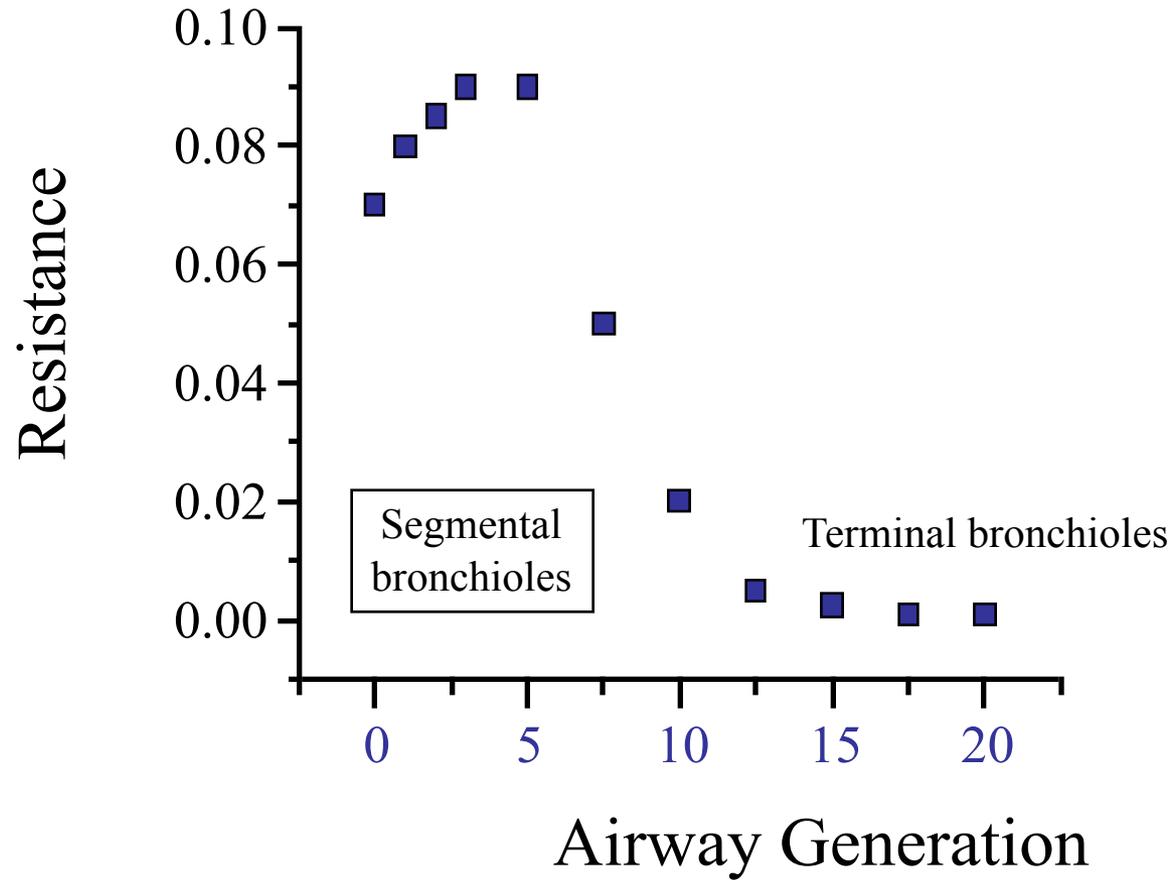


Figure 42-7

# Airway Resistance

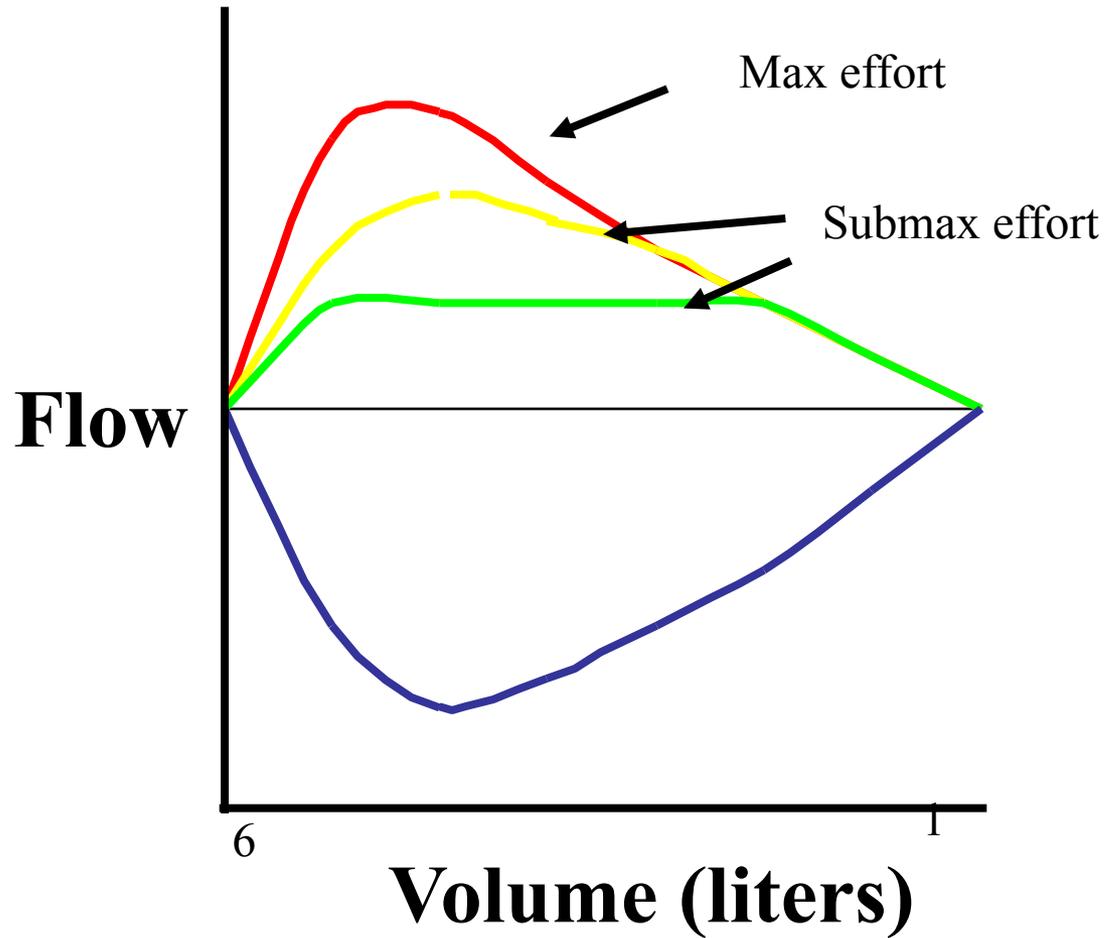


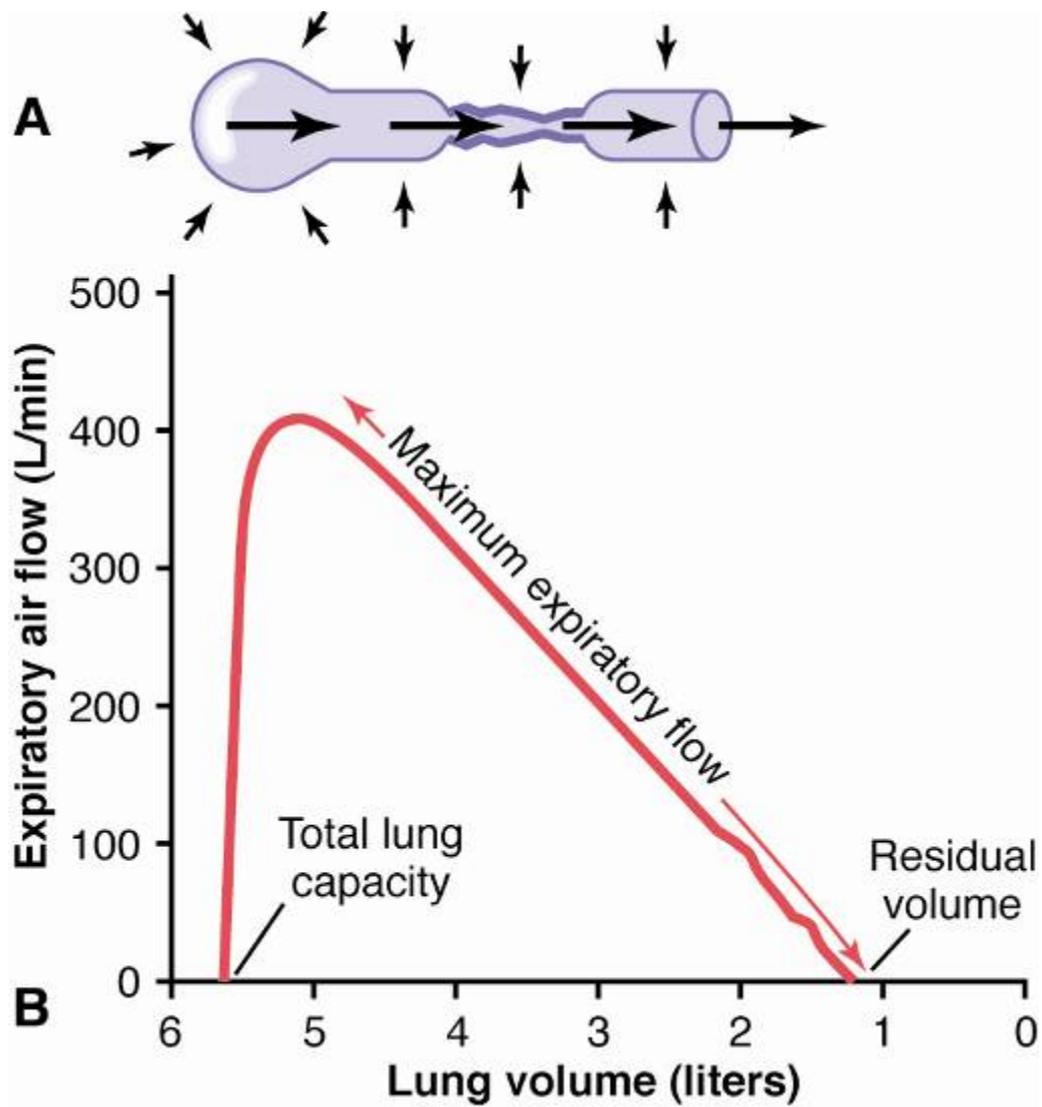
# **Chronic Obstructive Pulmonary Disease**

- Chronic bronchitis
  - excessive mucous production
- Asthma
  - bronchiole constriction

- **About Pulmonary Function Tests in Obstruction:**
- Spirometry provides an objective assessment of airflow obstruction and is important in staging asthma severity. It should be done on initial diagnosis of asthma, after treatment is started and symptoms have stabilized, and every 1 to 2 years afterward. Spirometry is used to measure the rate of airflow during maximal expiratory effort after maximal inhalation. It can be useful in differentiating between obstructive and restrictive lung disorders. In asthma (an obstructive lung disorder) the forced expiratory volume in 1 second (FEV<sub>1</sub>) is usually decreased, **the forced vital capacity (FVC) is usually normal** and the ratio FEV<sub>1</sub>/FVC is decreased. In restrictive disorders the FEV<sub>1</sub> and FVC are both decreased, leaving a normal FEV<sub>1</sub>/FVC.  
Spirometry measurements are usually done before and after administration of a  $\beta_2$  agonists (salbutamol, dobutamine, albuterol, fenoterol, terbutaline).. Reversibility with the use of a bronchodilator is defined as an increase in FEV<sub>1</sub> of 12% or 200 ml. **Patients with severe asthma may need a short course of oral steroid therapy before they demonstrate reversibility.**
- **Common Terms in Spirometry**
- In the next slide is an example of a volume-time curve. It shows the amount of air expired from the lungs as a function of time.

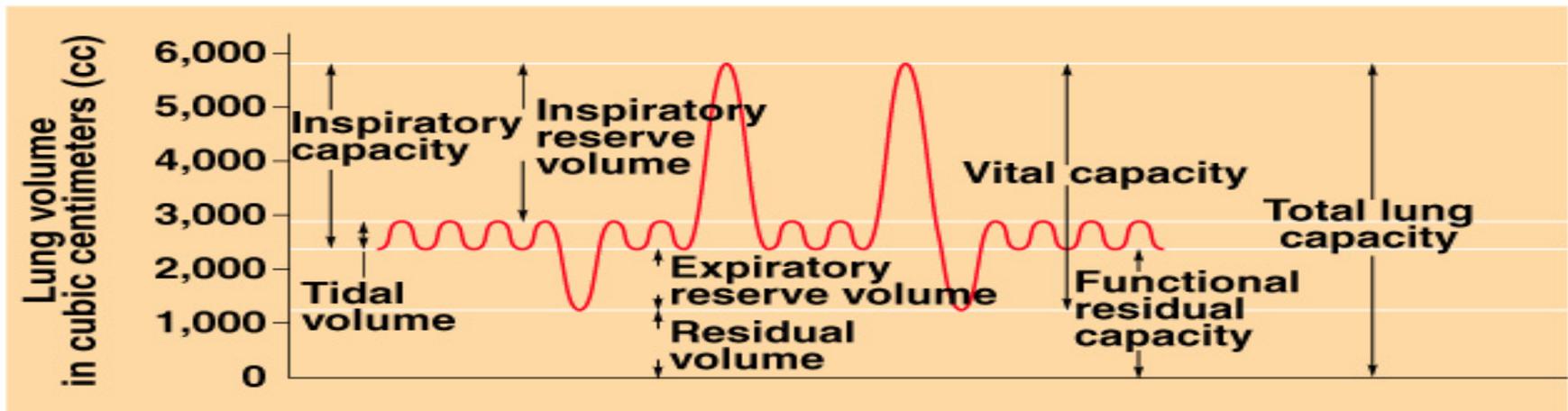
# Flow-volume Curve





# Pulmonary Function Tests

- Subject breathes into a closed system in which air is trapped within a bell floating in H<sub>2</sub>O.
- The bell moves up when the subject exhales



# Terms Used to Describe Lung Volumes and Capacities

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**Table 16.3** Terms Used to Describe Lung Volumes and Capacities

<b>Term</b>	<b>Definition</b>
<i>Lung Volumes</i>	The four nonoverlapping components of the total lung capacity
Tidal volume	The volume of gas inspired or expired in an unforced respiratory cycle
Inspiratory reserve volume	The maximum volume of gas that can be inspired during forced breathing in addition to tidal volume
Expiratory reserve volume	The maximum volume of gas that can be expired during forced breathing in addition to tidal volume
Residual volume	The volume of gas remaining in the lungs after a maximum expiration
<i>Lung Capacities</i>	Measurements that are the sum of two or more lung volumes
Total lung capacity	The total amount of gas in the lungs after a maximum inspiration
Vital capacity	The maximum amount of gas that can be expired after a maximum inspiration
Inspiratory capacity	The maximum amount of gas that can be inspired after a normal tidal expiration
Functional residual capacity	The amount of gas remaining in the lungs after a normal tidal expiration

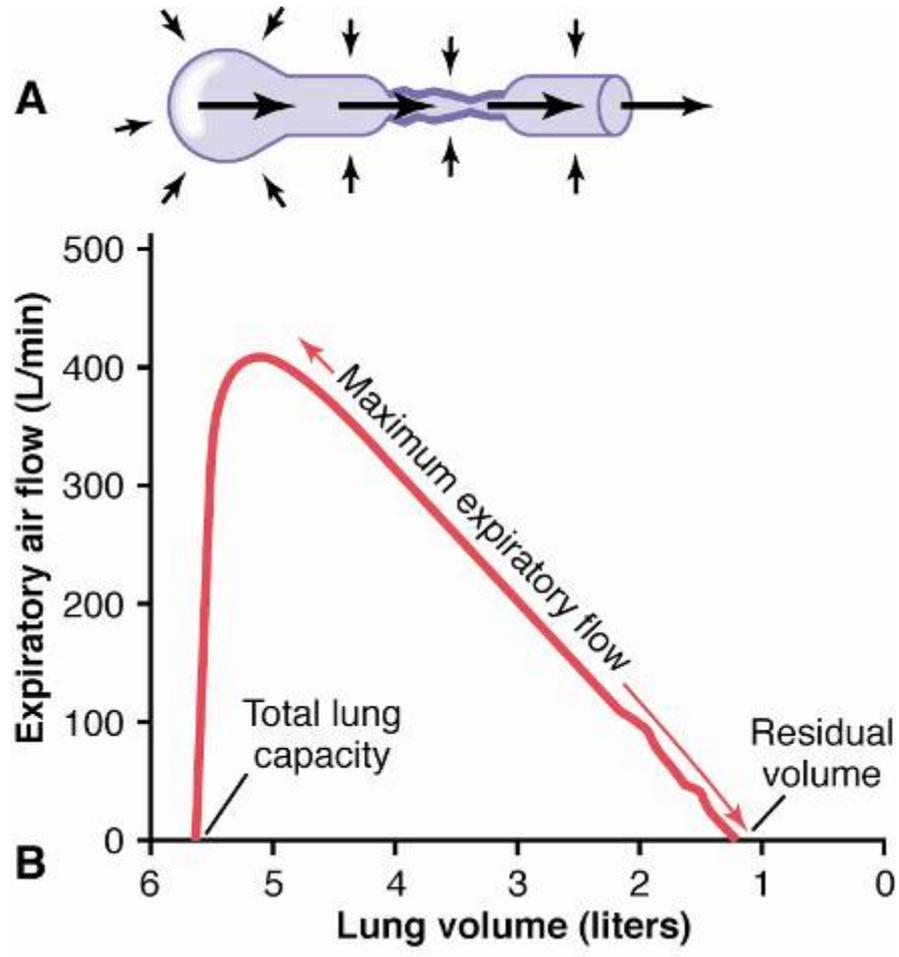


Figure 42-1

# Dynamic Flow - Volume Loops

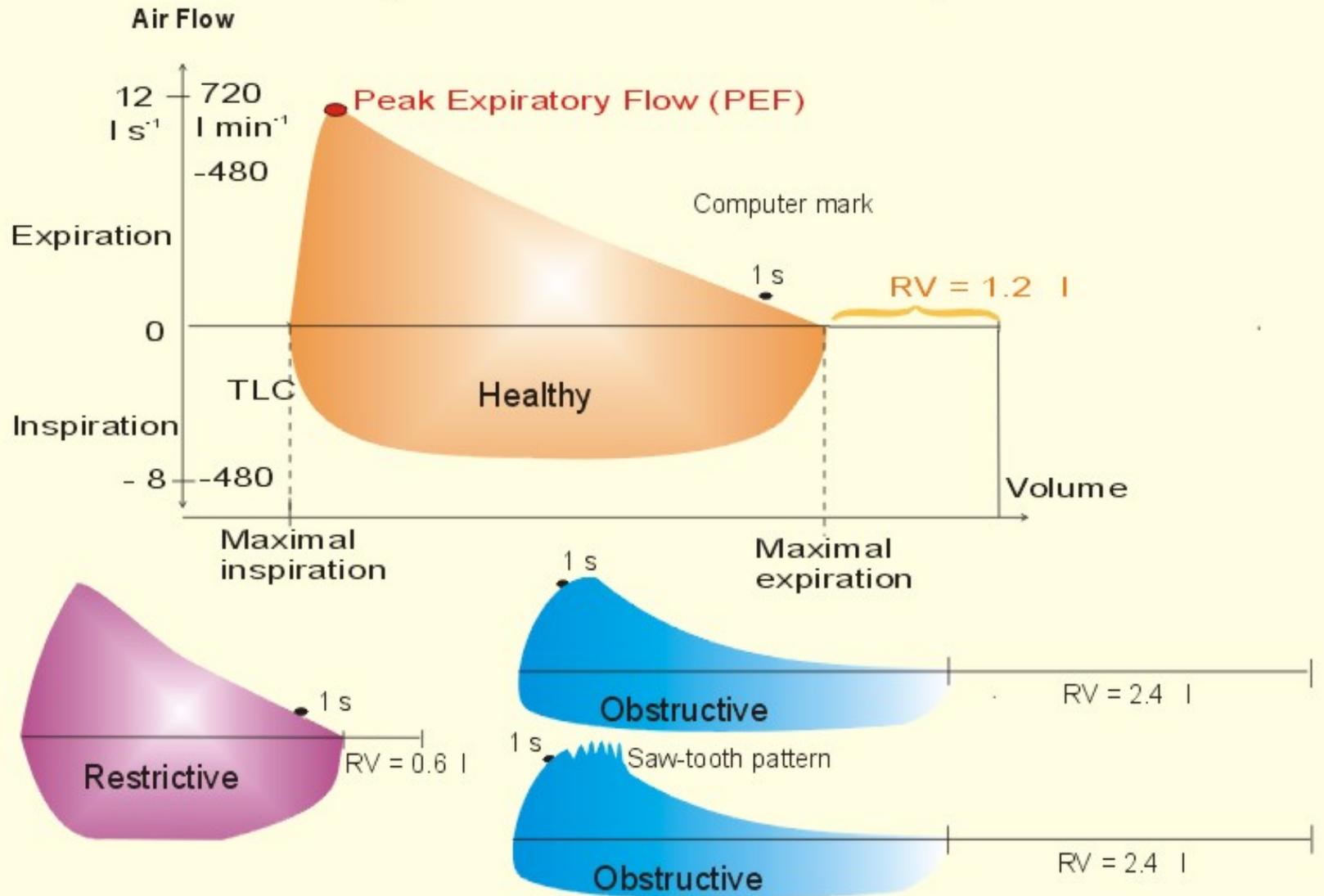


Fig. 13-6

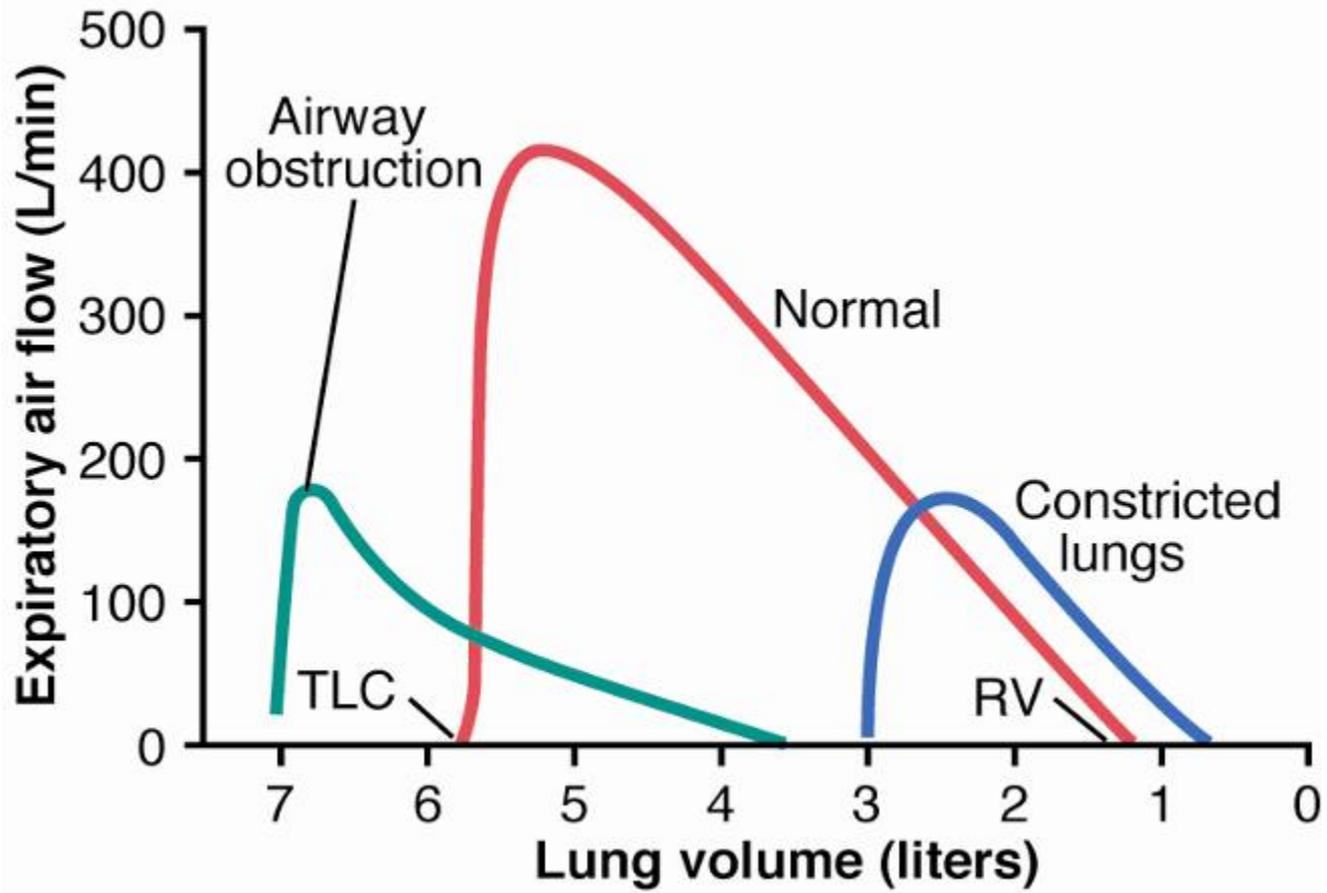


Figure 42-2

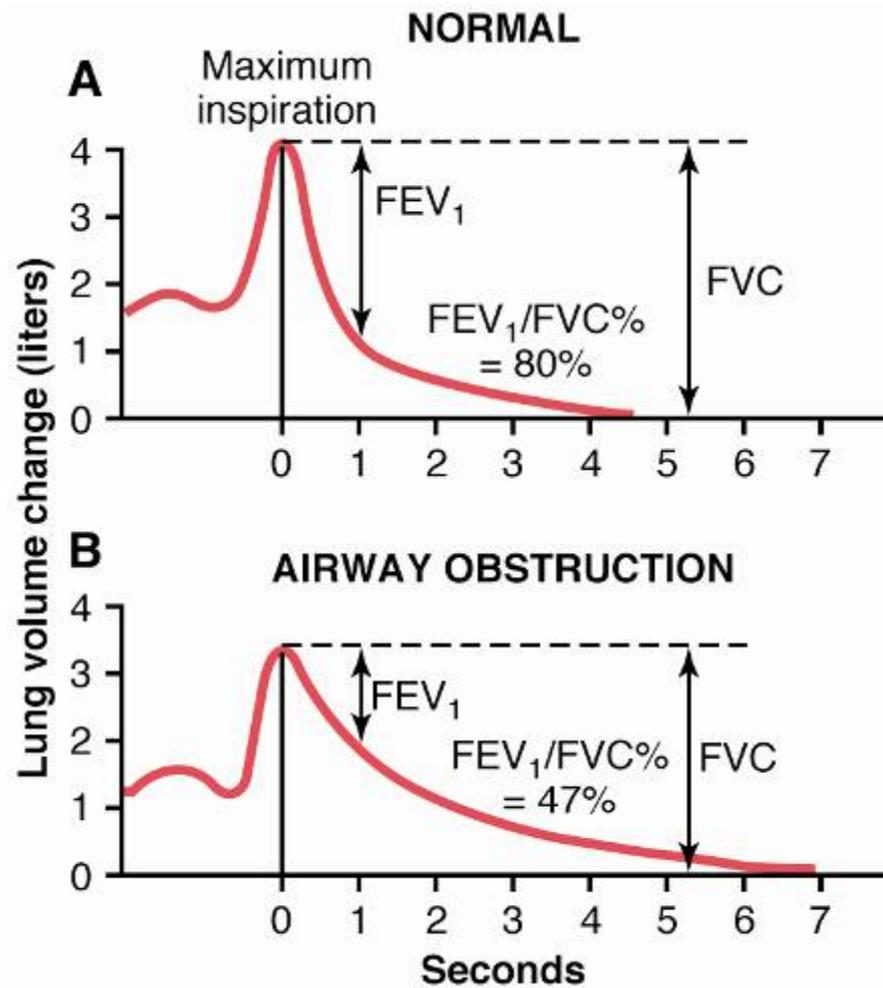


Figure 42-3

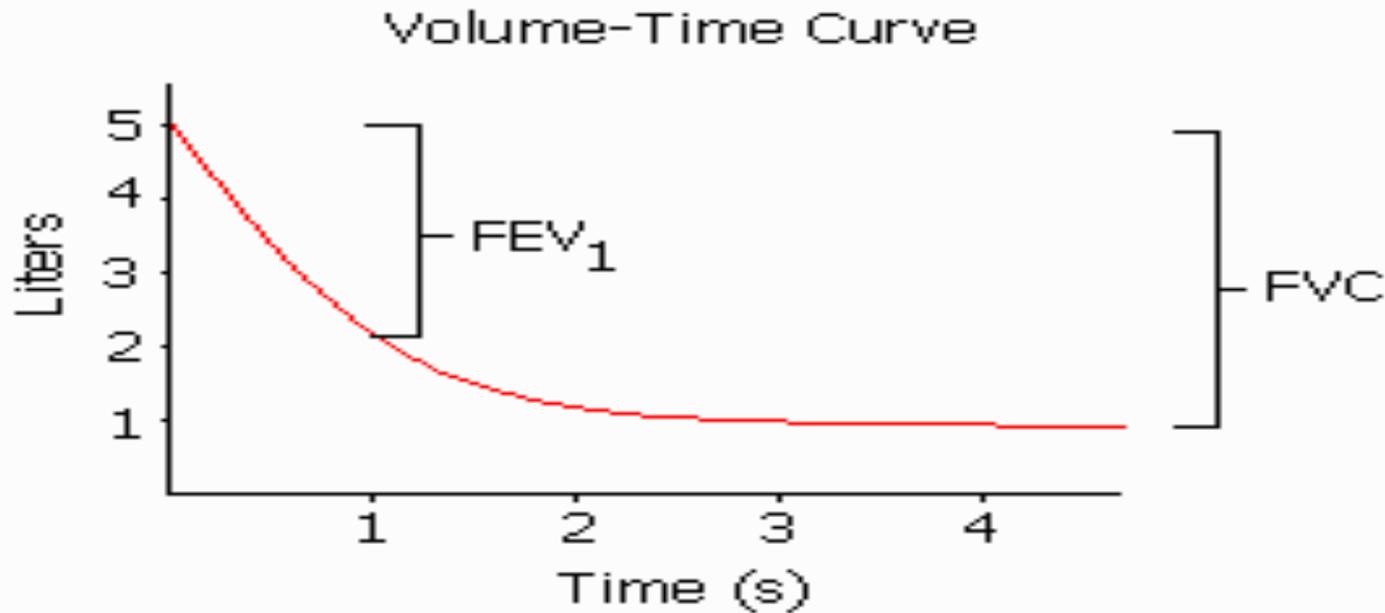
# Chronic Obstructive Pulmonary Disease

FEV<sub>1</sub> values (expressed as a percentage of **predicted**) may classify the severity of the COPD

60% - 79% of the predicted: MILD COPD

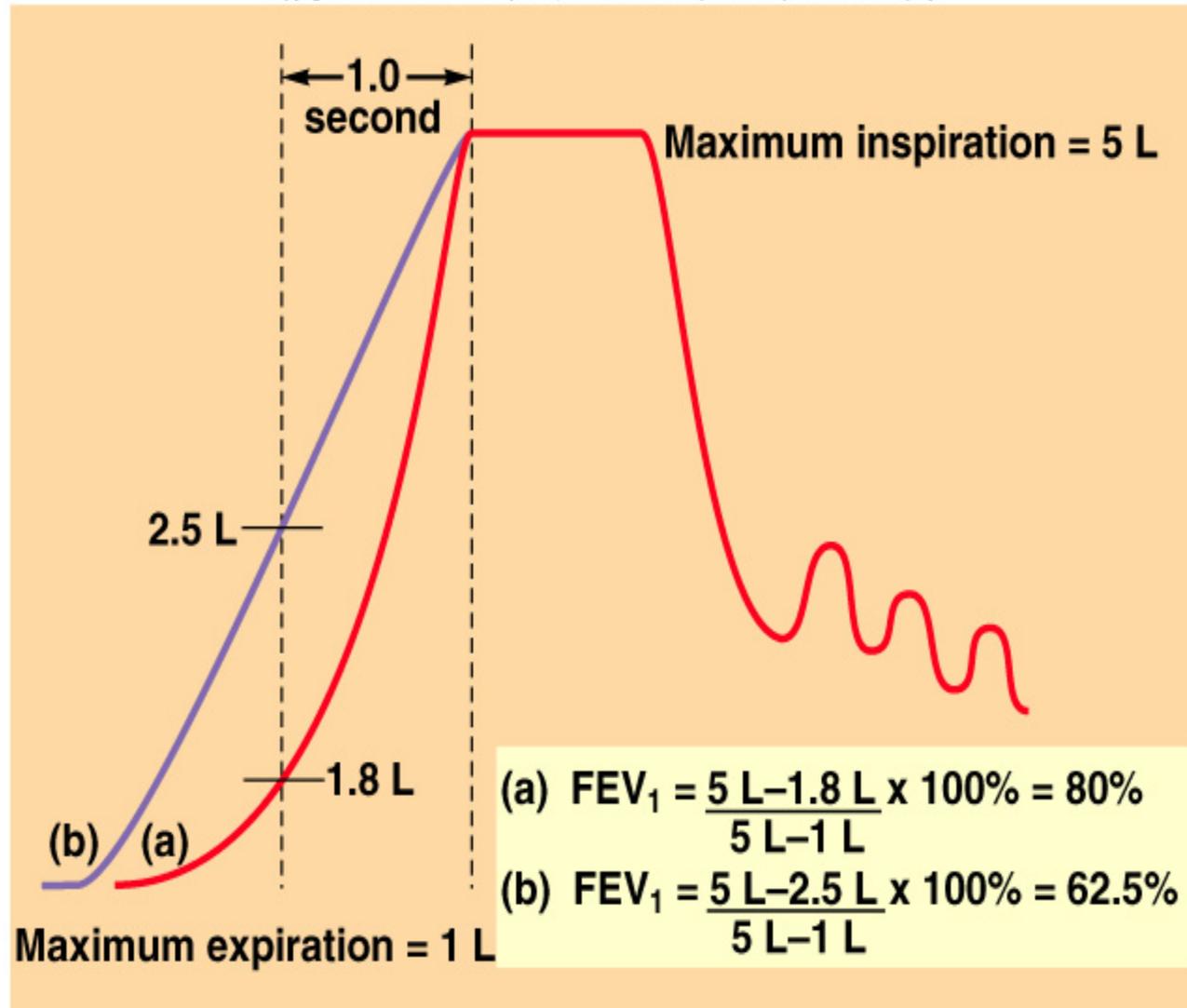
40% - 59% **predicted**: MODERATE COPD

Less than 40% predicted: SEVERE COPD



# Restrictive and Obstructive Disorders

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**Closing volume (CV)** is the volume of air that can be exhaled after the gravitationally dependent airways have closed down. The point at which the closure begins during expiration is called the closing point which is normally reached near to residual volume. If its reached before the end of normal  $V_T$ , then the V/Q ratio falls sharply. By the mid-forties, CV equals FRC in the lying position and by the mid-sixties it equals FRC in the erect position. It increases in smokers, pulmonary congestion, pulmonary edema, chronic bronchitis, and excessive bronchial secretions. Any condition which interfere with diaphragmatic movement such as, tight clothing, obesity, pregnancy, ascites, phrenic paralysis, obesity, pneumothorax

# ABG

- An **arterial blood gas (ABG)** is a blood test that is primarily performed using blood from an artery. It involves puncturing an artery with a thin needle and syringe and drawing a small volume of blood. The most common puncture site is the radial artery at the wrist, but sometimes the femoral artery or other sites are used. The blood can also be drawn from an arterial catheter

- The test is used to determine the pH of the blood, the partial pressure of carbon dioxide and oxygen, and the bicarbonate level. Many blood gas analyzers will also report concentrations of lactate, hemoglobin, several electrolytes, oxyhemoglobin, carboxyhemoglobin

# Components of the Arterial Blood Gas

The arterial blood gas provides the following values:

## **pH**

Measurement of acidity or alkalinity, based on the hydrogen (H<sup>+</sup>) ions present.

The normal range is 7.35 to 7.45

## **PaO<sub>2</sub>**

The partial pressure of oxygen that is dissolved in arterial blood.

The normal range is 80 to 100 mm Hg.

## **SaO<sub>2</sub>**

The arterial oxygen saturation.

The normal range is 95% to 100%.

## **PaCO<sub>2</sub>**

The amount of carbon dioxide dissolved in arterial blood.  
The normal range is 35 to 45 mm Hg.

## **HCO<sub>3</sub><sup>-</sup>**

The calculated value of the amount of bicarbonate in the bloodstream.

The normal range is 22 to 26 mEq/liter

## **B.E.**

The base excess indicates the amount of excess or insufficient level of bicarbonate in the system.

The normal range is -2 to +2 mEq/liter.

(A negative base excess indicates a base deficit in the blood.)

# Oxygen Therapy

- Atmospheric
- Hypoventilation
- impaired alveolar membrane
- anemia, abnormal hemoglobin
- inadequate

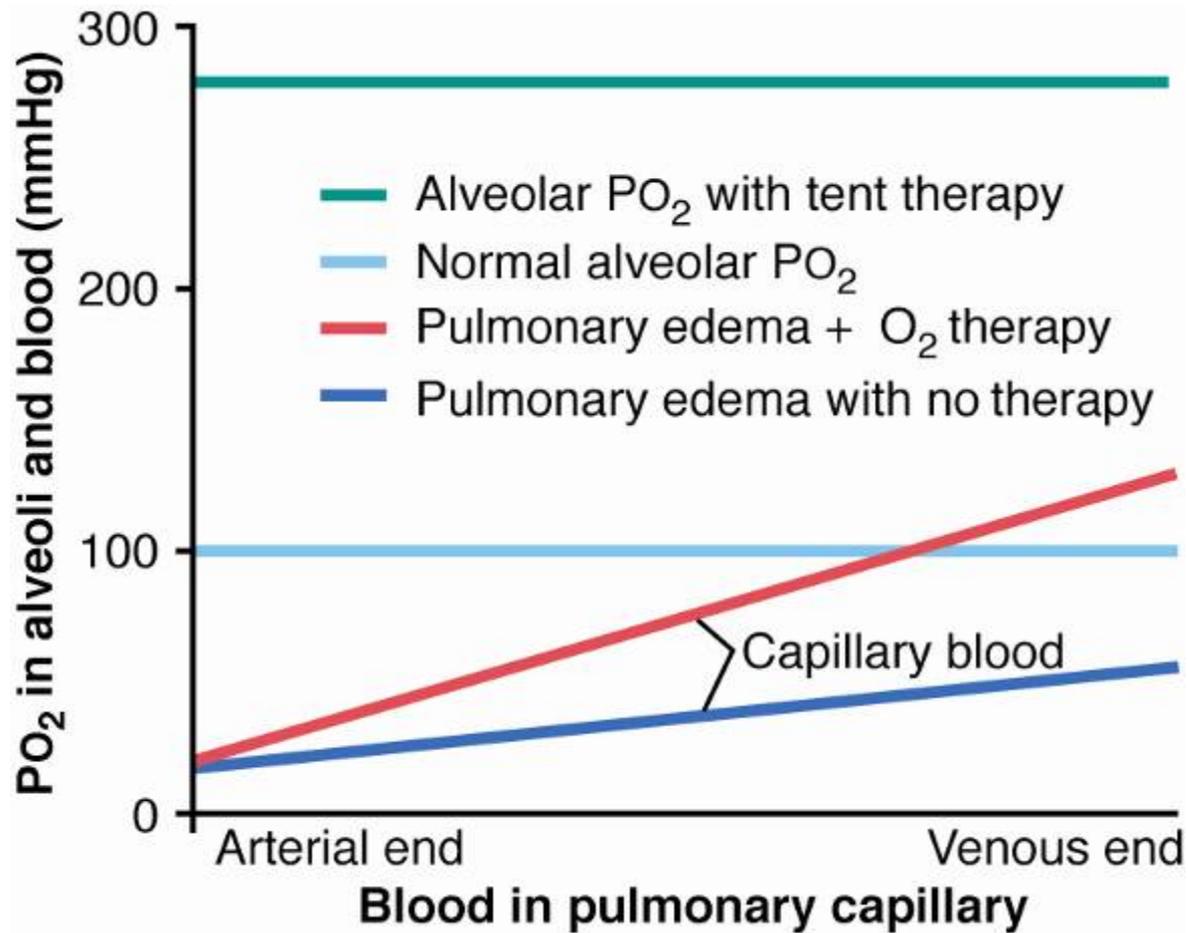


Figure 42-8

**THANK YOU**

# Next Time...

- Compliance