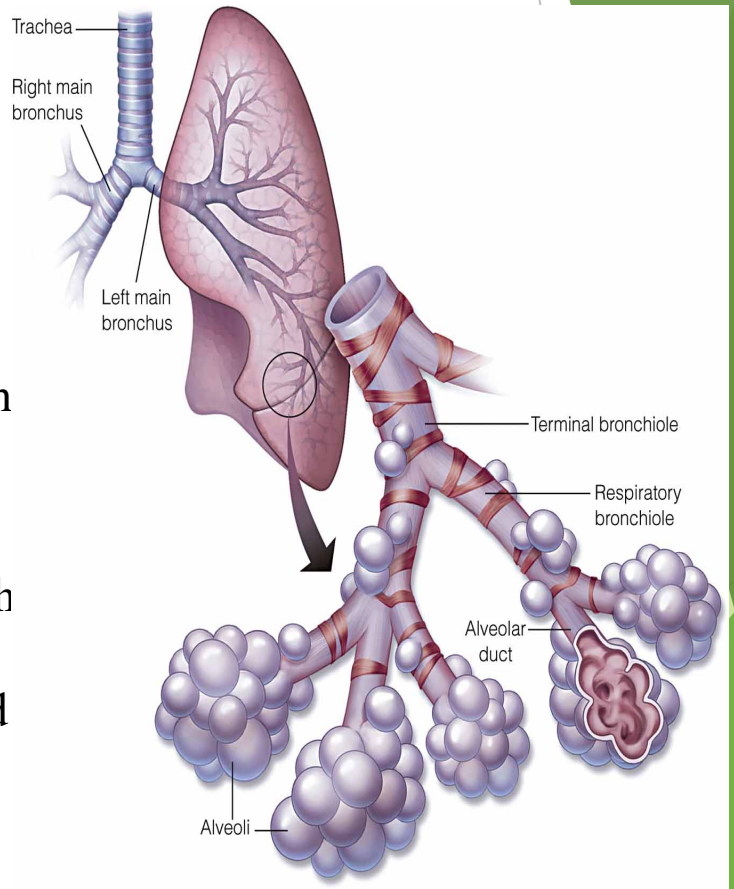
Lung Diseases...three families

- **Prevalence of lung disease depends on the population, but in general we have three families:**
- **1. obstructive is 70%,**
- **2. restrictive is 20-25% and**
- **3. vascular the rest 5-10%**
- Obstructive Diseases: Increased resistance to flow
- Restrictive Diseases: Decreased expansion of the lungs

Introduction

- Bronchial asthma and COPD (chronic obstructive pulmonary disease) are obstructive pulmonary diseases that affected millions of people all over the world
- Asthma is a serious global health problem with an estimated 300 million affected individuals
- COPD is the fourth leading cause of death in the world and further increases in its prevalence and mortality can be predicted



COPD

1. Emphysema 2. Chronic bronchitis ±3. Bronchial asthma…only when it becomes chronic

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

Chronic bronchitis….excessive mucous production

Asthma….constriction of bronchioles

Chronic Obstructive Pulmonary Disease

- **Chronic pulmonary emphysema**
  - infection (secretions)
  - Obstruction→ turbulence → wheezes
  - loss of parenchyma…loss of surface area available for diffusion …hypoxemia…hypoxia
  - **Consequences**

    - high airway resistance

    - decreased diffusing capacity

    - pulmonary hypertension…increase pulmonary vascular resistance

logy

Resistance to airflow

- Lumen
- excessive secretions
- obstruction due to aspiration

– Airway

- contraction of smooth muscle
- hypertrophy of bronchial wall

– outside of airway

- destruction of the elastin fibersparenchyma

The work of Breathing:

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

Normally 0.5 L X 5 cm H_2O = 0.25 J……*One Joule is equal to = 10 L X cm H_2O = 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 (during inspiration and during expiration)

B) 80% is due to air way resistance:

$T_{Total} = P_{Elastic} + P_{Nonelastic}$

$P_{Elastic}$: elastic recoil P

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

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

Always remember Ohm's law: Flow is directly proportional to the driving force and inversely proportional to the resistance
Flow = pressure difference / resistance = ΔP/R….
What is the ΔP? It is the pressure difference between the two opposite ends of the airways: ($P_{alv} - P_{atm}$)
If R is large then ΔP 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 inversly proportional to $1/ r^4$

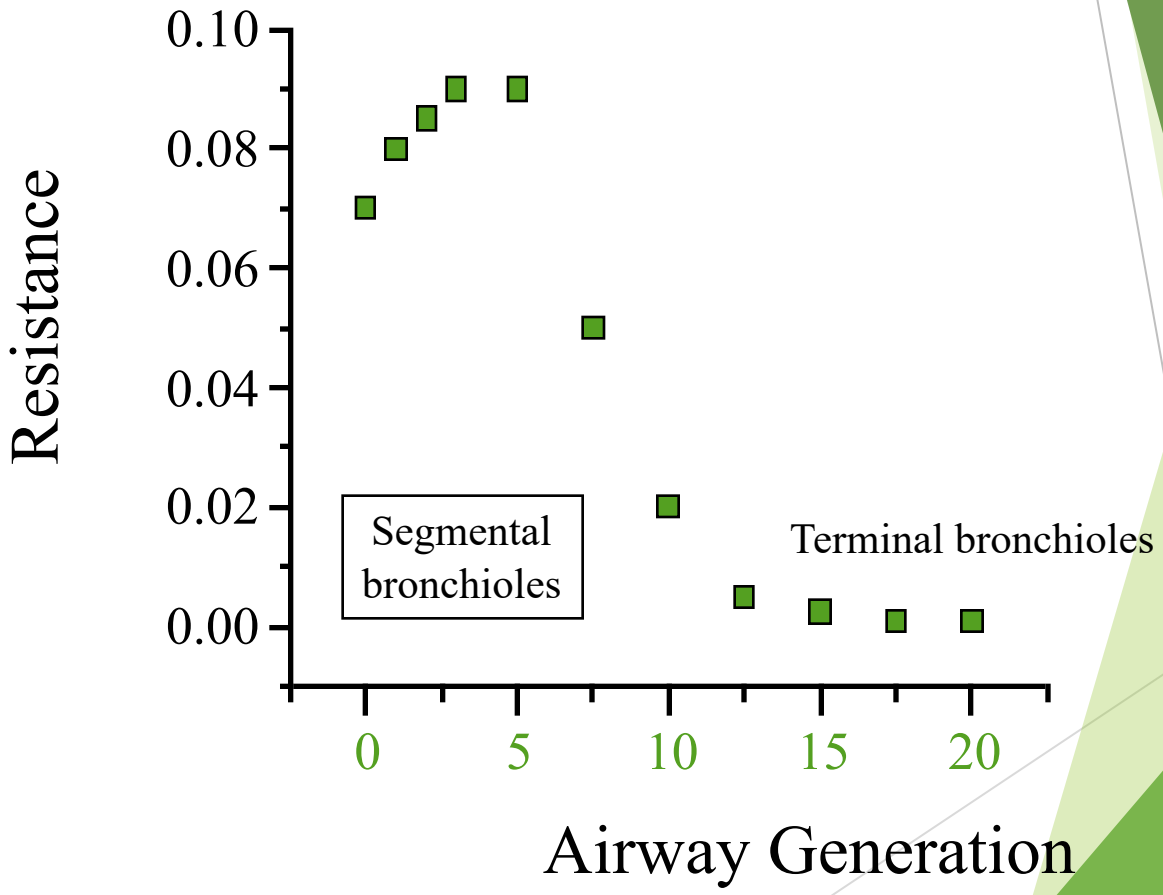
Small change in "r" results in huge change in R.

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

Remember the four Take home messages: Discussed In the lecture

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.

Airway Resistance



Ventilation

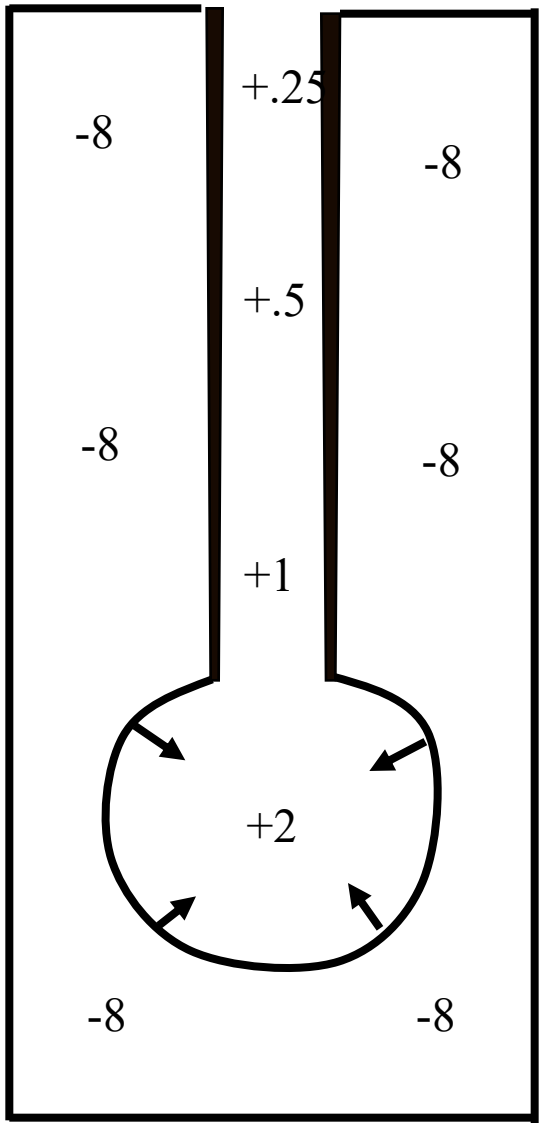
Airway diameter & other factors that affect airway resistance?

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 (β_2-receptors)

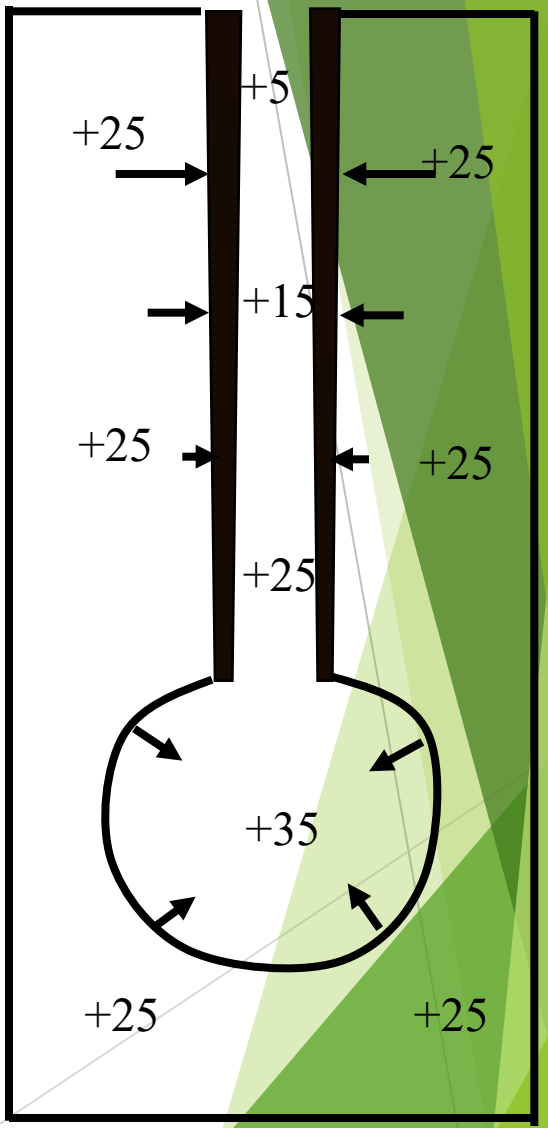
Pulmonary Disorders (continued)

- **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,,,obstruction comes from ouside**
    - **Cigarette smoking stimulates macrophages and leukocytes to secrete protein digesting enzymes that destroy tissue.**

ed Exhalation



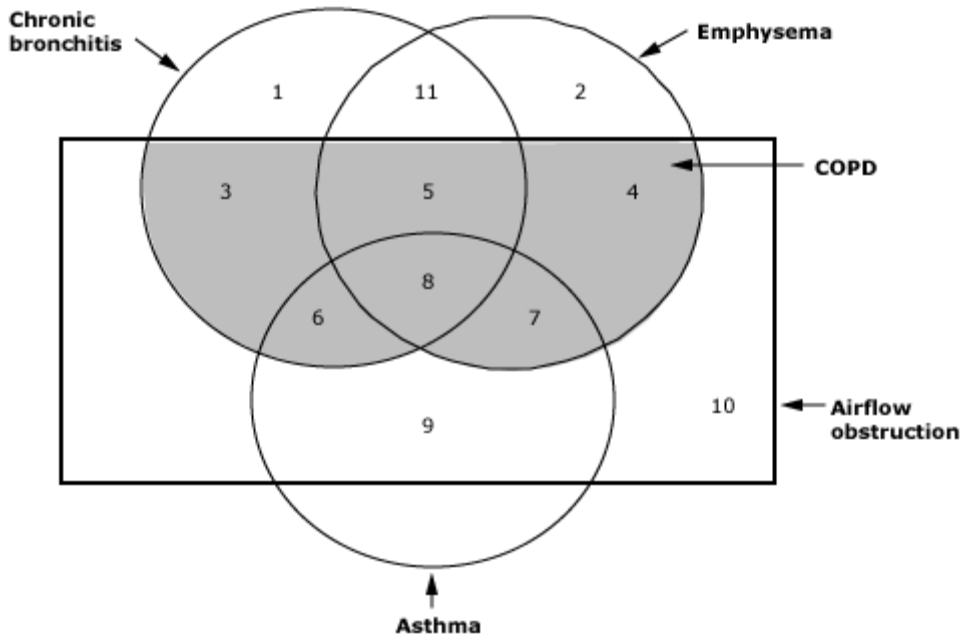
Passive Expiration



Forced Expiration

Control of Bronchiolar Diameter

- Nervous
  - Sympathetics
    - β_2 receptors dilate (salbutamol, dobutamine, albuterol, fenoterol, terbutaline).
  - Parasympathetics
    - Acetylcholine constrict bronchioles
- Humoral
  - Histamine, acetylcholine >> Constrict
  - Adrenergic (β agonists) >> Relax


Chronic bronchitis
Emphysema
1
11
2
COPD
3
5
4
8
6
7
10
Airflow obstruction
9
Asthma

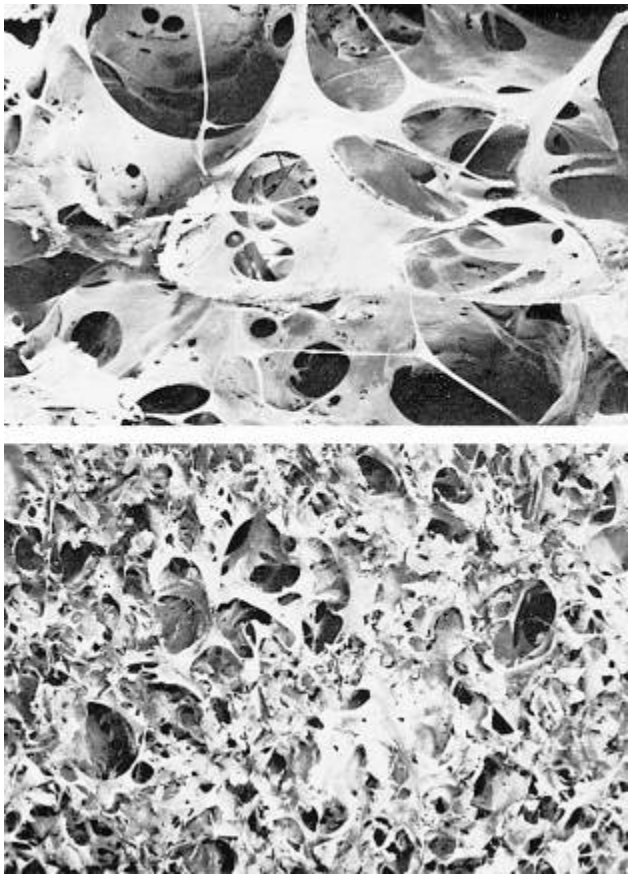
Pursed Lip Breathing in COPD patients

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, RV and normal airway resistance
- Diffuse Interstitial Pulmonary Fibrosis
  - thick collagen deposits
- Pneumothorax



Emphysematous Lung

Normal Lung

Figure 42-4

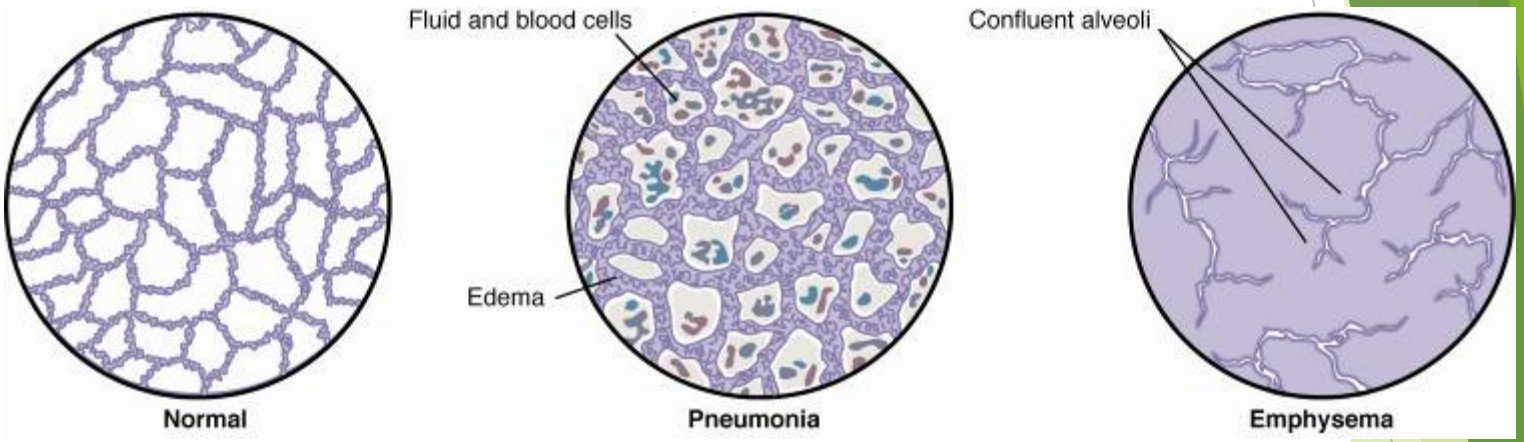

Fluid and blood cells
Edema
Confluent alveoli
Normal
Pneumonia
Emphysema

Figure 42-5

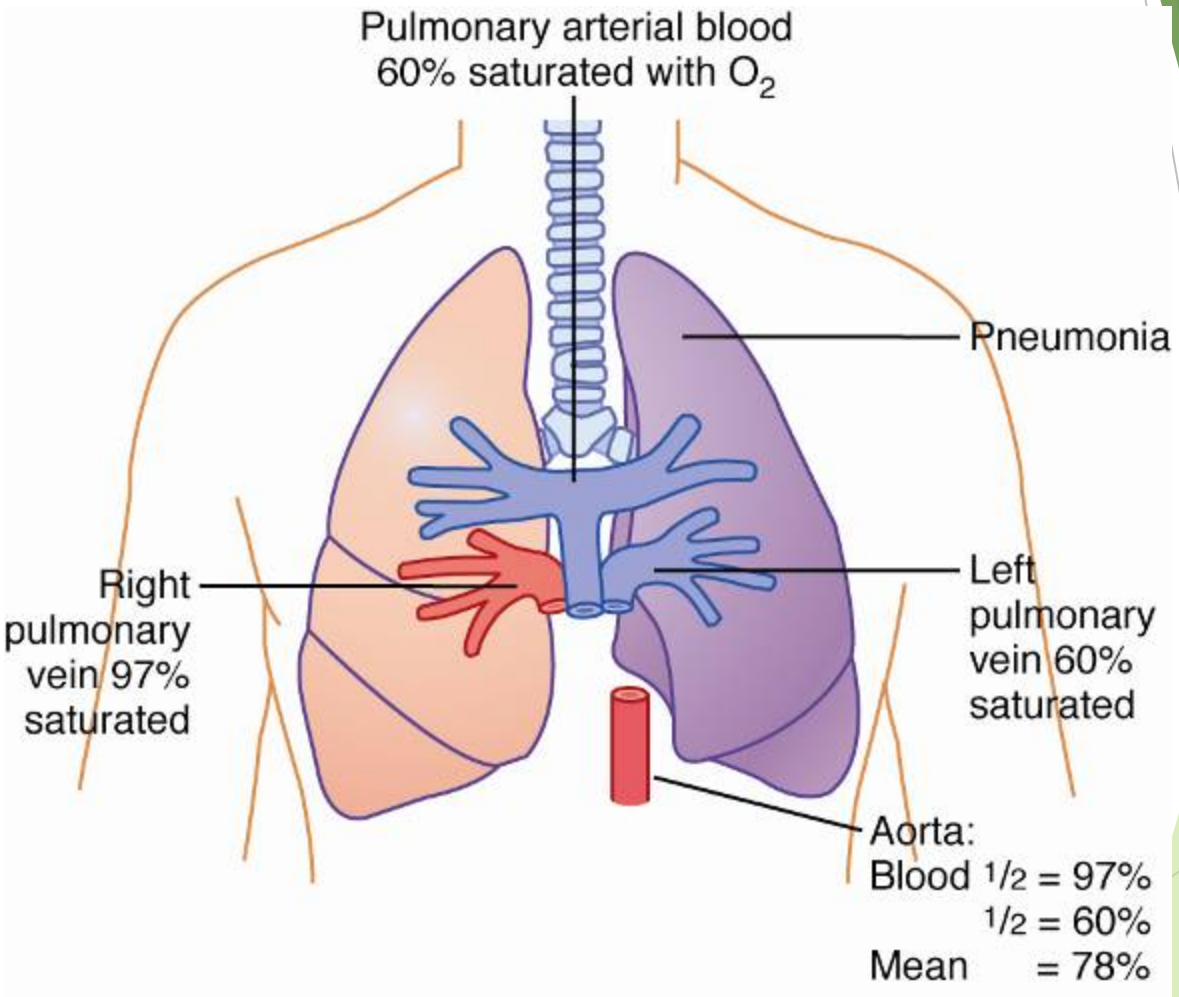

Pulmonary arterial blood
60% saturated with O_2
Pneumonia
Right
pulmonary
vein 97%
saturated
Left
pulmonary
vein 60%
saturated
Aorta:
Blood 1/2 = 97%
1/2 = 60%
Mean = 78%

Figure 42-6

ology

- Atelectasis
  - collapse of alveoli
    - airway obstruction
    - lack of surfactant

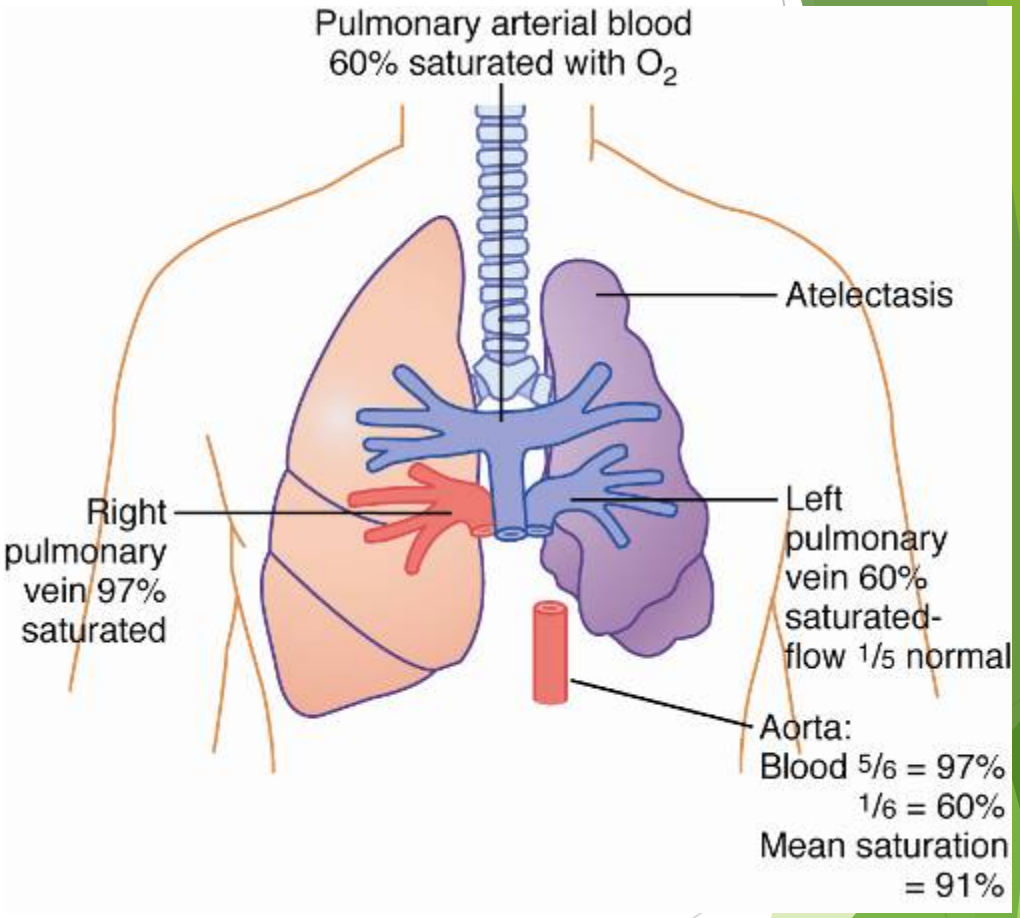


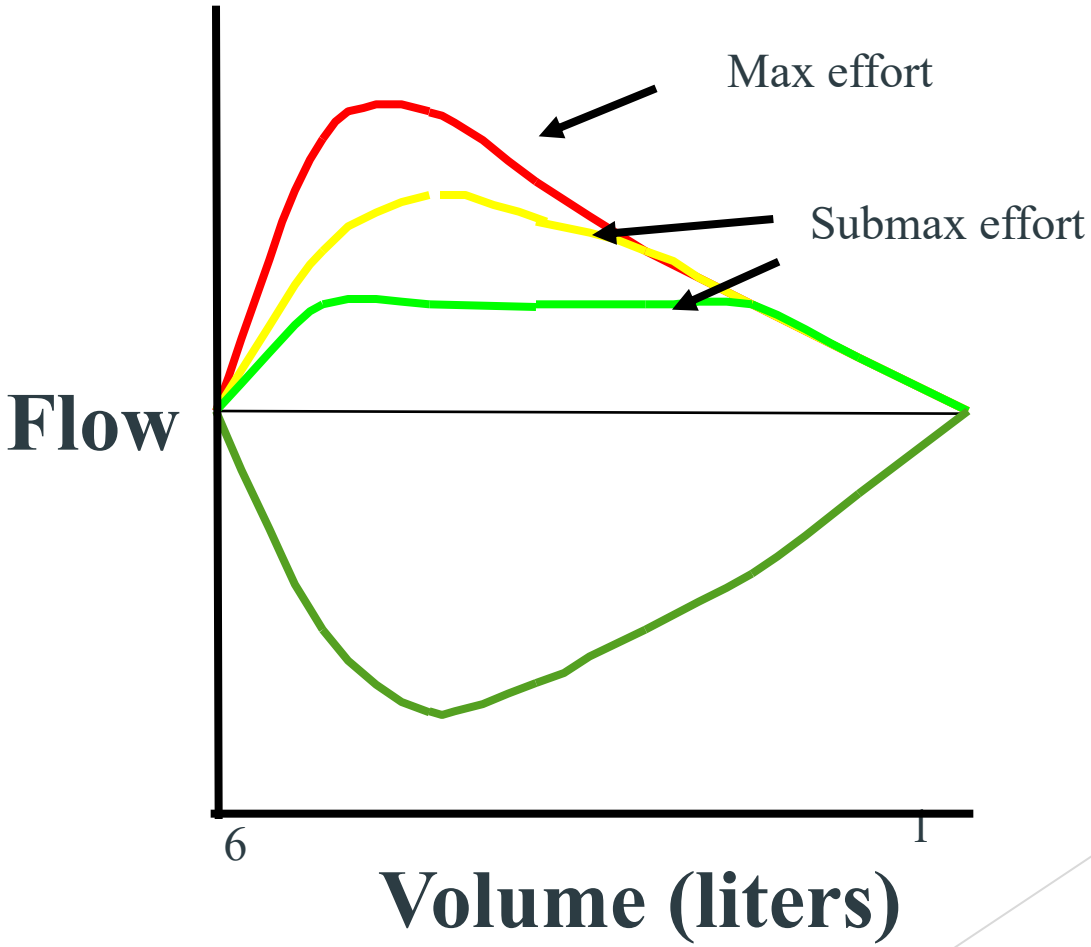
Figure 42-7

y Function Tests in Obstruction: Go to the e-learning videos

des an objective assessment of airflow obstruction and is important in staging asthm
l diagnosis of asthma, after treatment is started and symptoms have stabilized, and
netry is used to measure the rate of airflow during maximal expiratory effort after m
n differentiating between obstructive and restrictive lung disorders. In asthma (an ob
ced expiratory volume in 1 second (FEV1) is usually decreased, **the forced vital capa**
atio FEV1/FVC is decreased. In restrictive disorders the FEV1 and FVC are both decre
.
urements are usually done before and after administration of a β_2 agonists (salbutam
rol, terbutaline).. Reversibility with the use of a bronchodilator is defined as an incr
ts with severe asthma may need a short course of oral steroid therapy before the

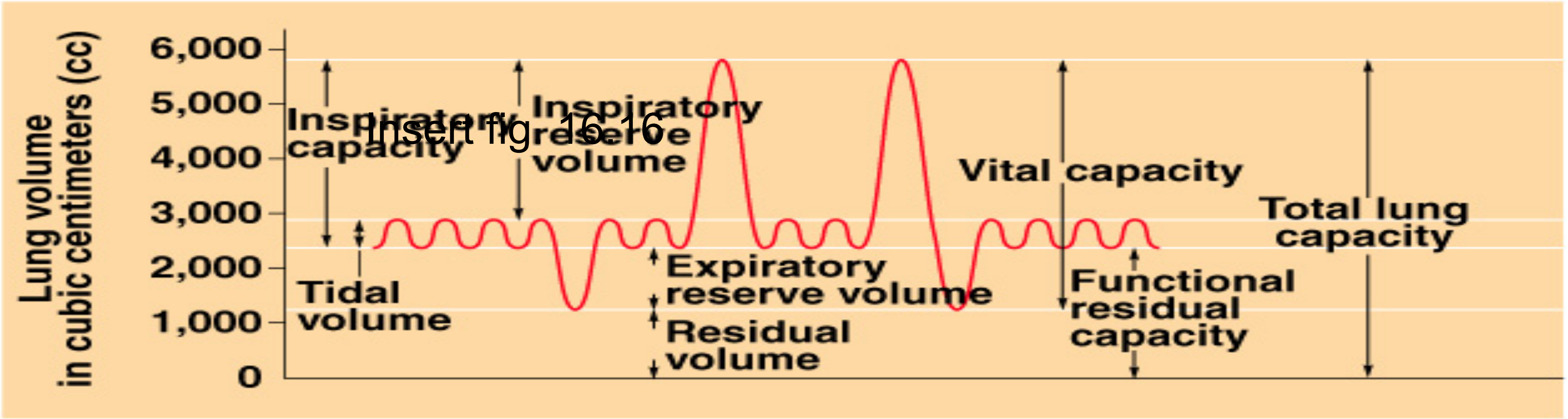
n Spirometry

is an example of a volume-time curve. It shows the amount of air expired from the l


Max effort
Submax effort
Flow
6
1
Volume (liters)

Pulmonary Function Tests

- Assessed by spirometry.
- Subject breathes into a closed system in which air is trapped within a bell floating in H_20.
- The bell moves up when the subject exhales and down when the subject inhales.



Terms Used to Describe Lung Volumes and Capacities

Table 16.3 Terms Used to Describe Lung Volumes and Capacities

Term	Definition
Lung Volumes	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
Lung Capacities	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

nses

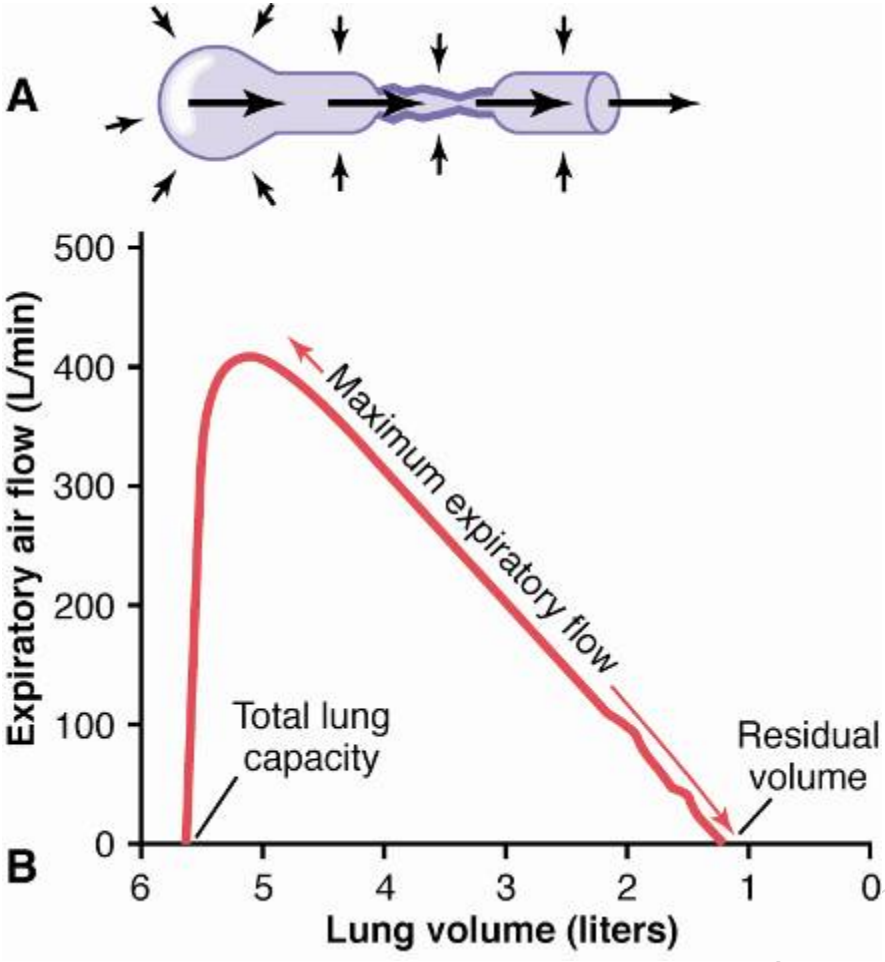


Figure 42-1

Dynamic Flow - Volume Loops

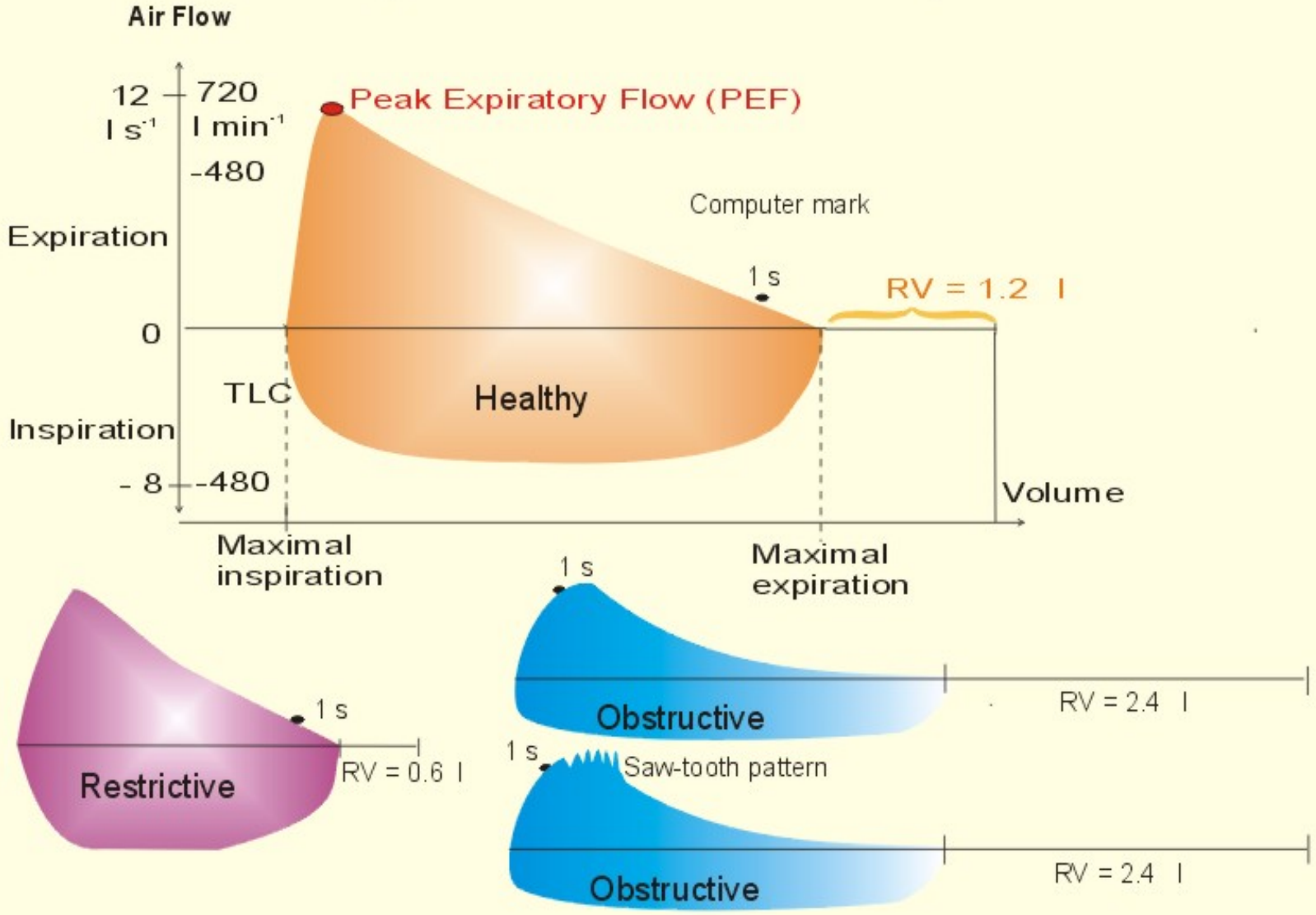


Fig. 13-6

KMc

onses

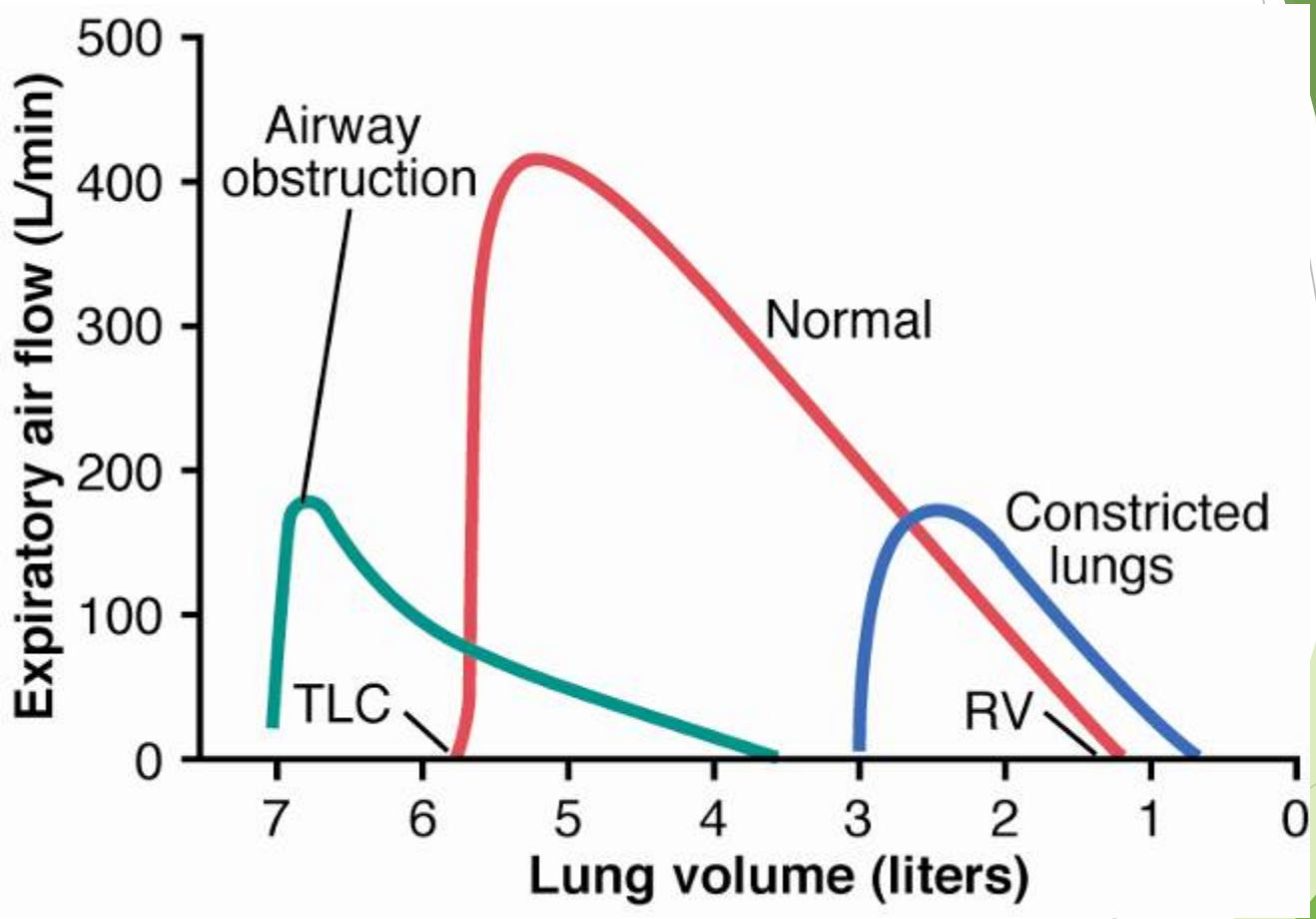


Figure 42-2

city

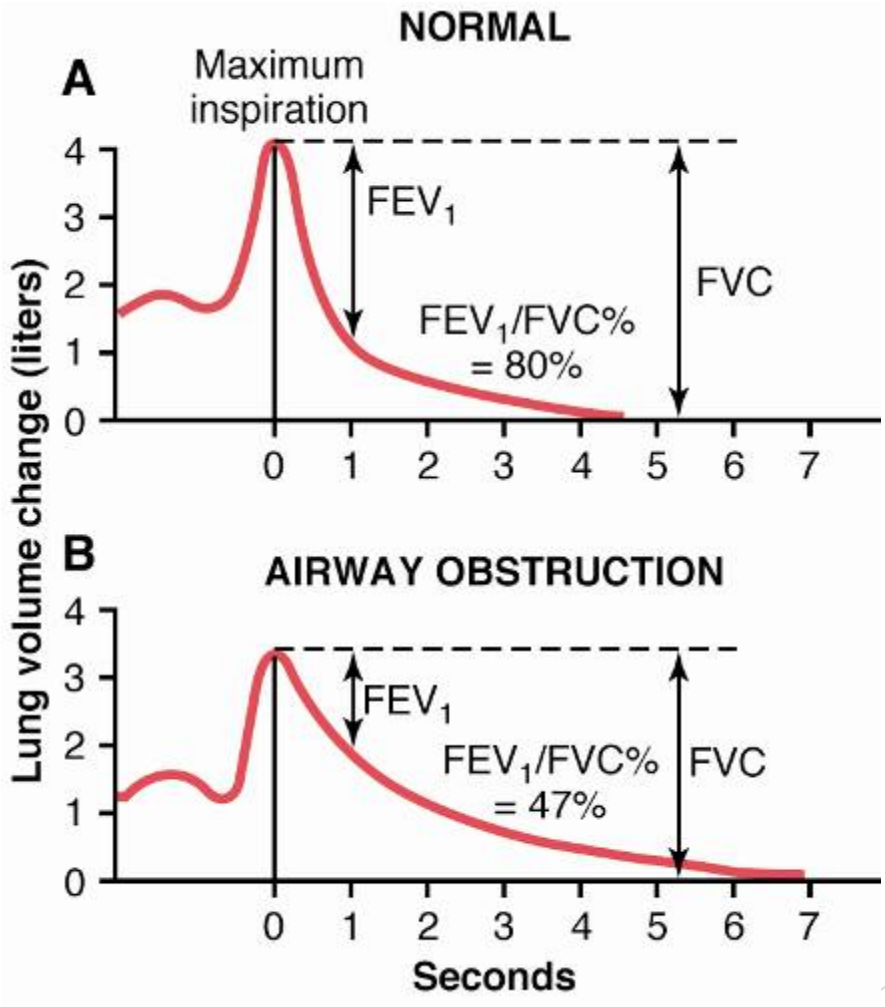


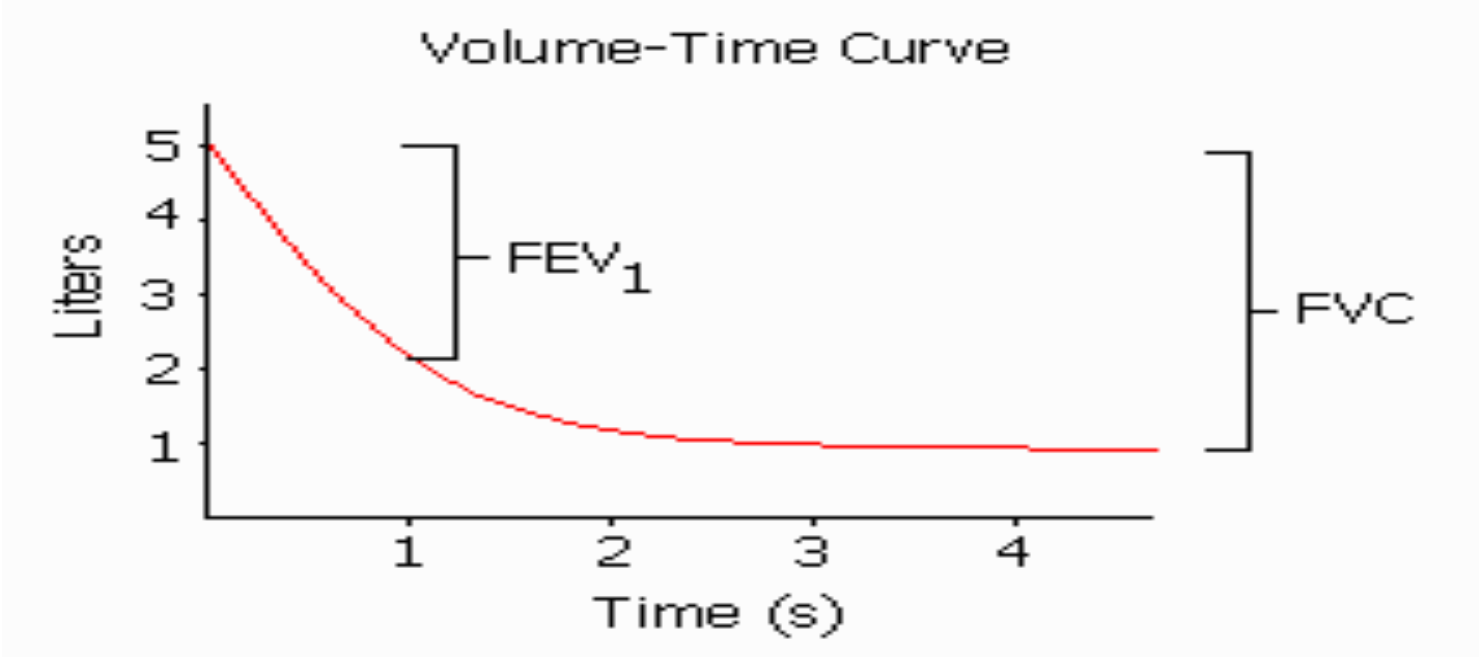
Figure 42-3

Staging of COPD based on FEV_1

GOLD: **G**lobal **I**nitiative of chronic obstructive **L**ung **D**isease

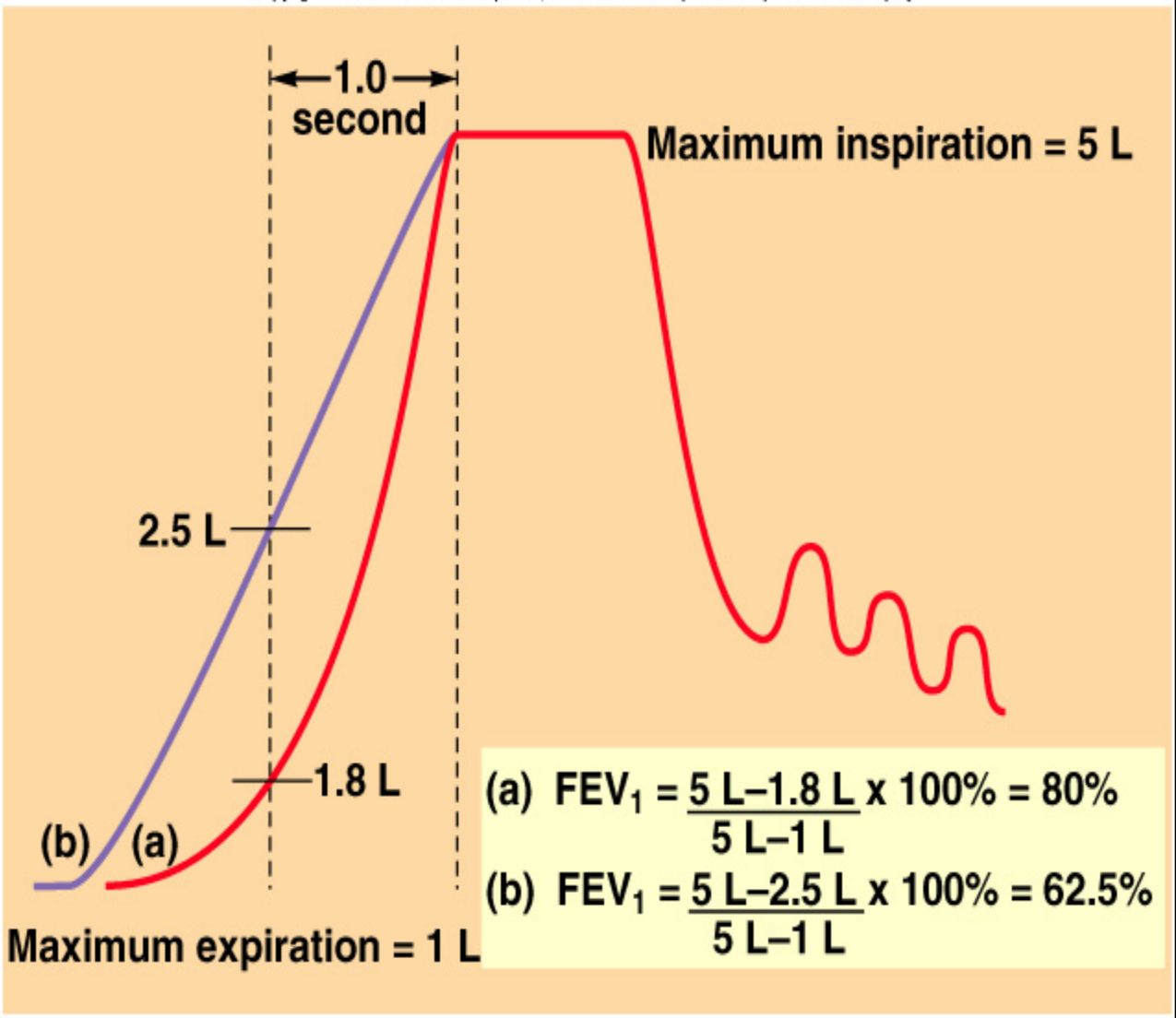
FEV_1 values (expressed as a percentage of **predicted**) may classify the severity of the COPD

	FEV_1 compared to predicted for age/ gender/ height
GOLD Stage I	$FEV_1 \geq 80\%$
GOLD Stage II	$50\% \leq FEV_1 < 80\%$
GOLD Stage III	$30\% \leq FEV_1 < 50\%$
GOLD Stage IV	$FEV_1 < 30\%$



Restrictive and Obstructive Disorders

- Restrictive disorder:
  - Vital capacity is reduced.
  - FVC is normal.
- Obstructive disorder:
  - Diagnosed by tests that measure the rate of expiration.
    - VC is normal.
    - FEV_1 is < 80%.



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+) ions present.

The normal range is 7.35 to 7.45

PaO_2

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

The normal range is 80 to 100 mm Hg.

SaO_2

The arterial oxygen saturation.

The normal range is 95% to 100%.

$PaCO_2$

The amount of carbon dioxide dissolved in arterial blood.

The normal range is 35 to 45 mm Hg.

HCO_3^-

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 tissue use

erapy

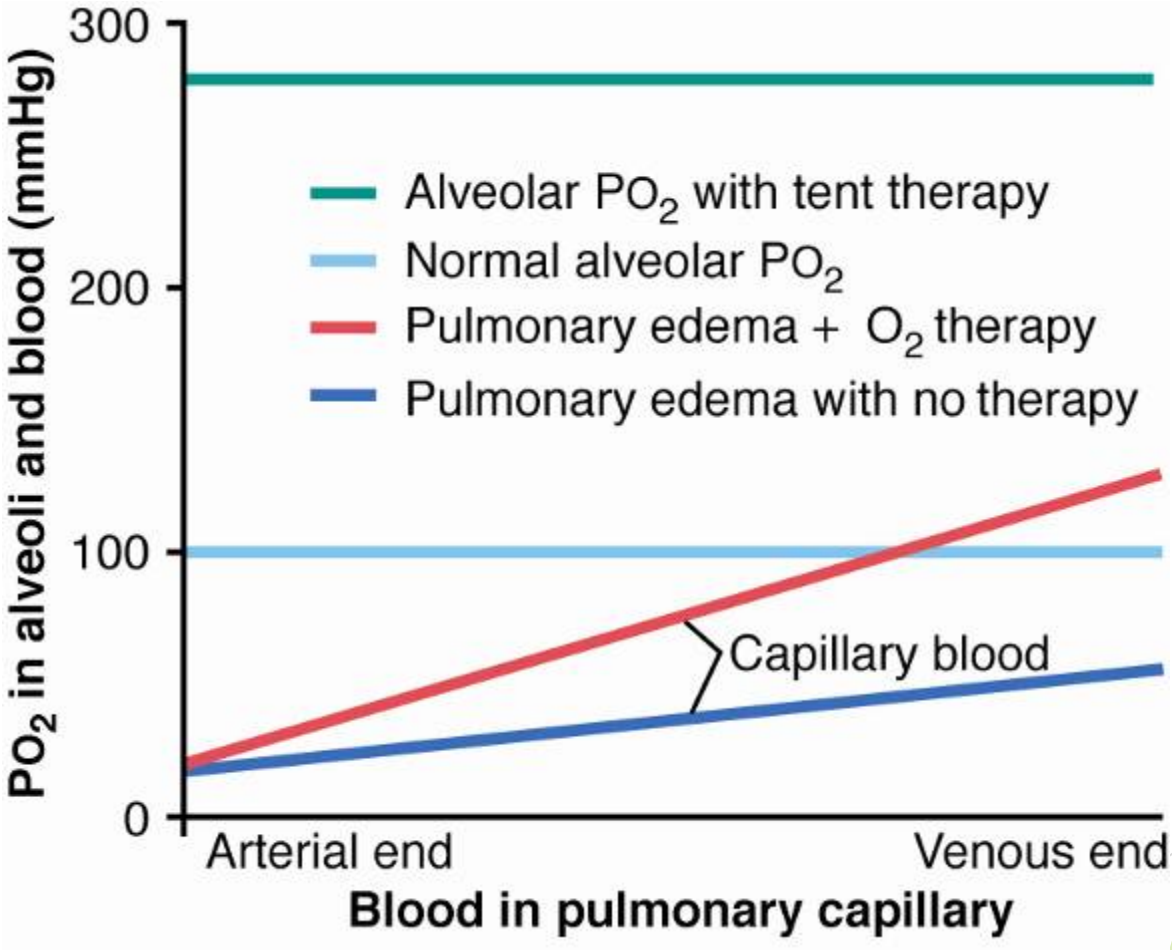


Figure 42-8

THANK YOU

Next Time…

- Compliance