RESPIRATORY VENTILATION

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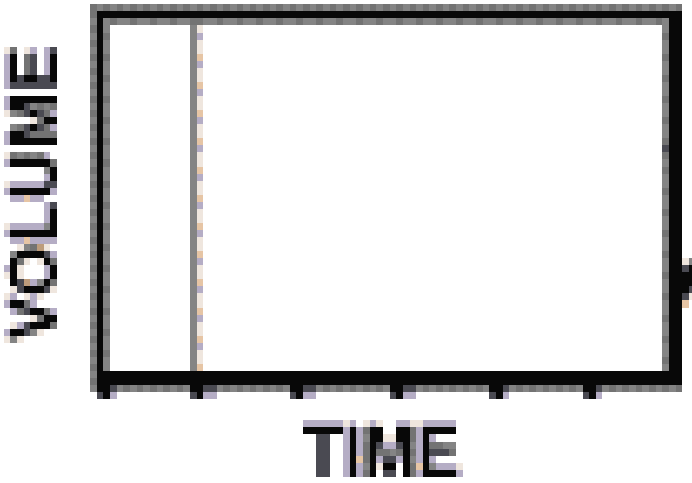
LECTURE OUTLI NES / OBJECTIVES

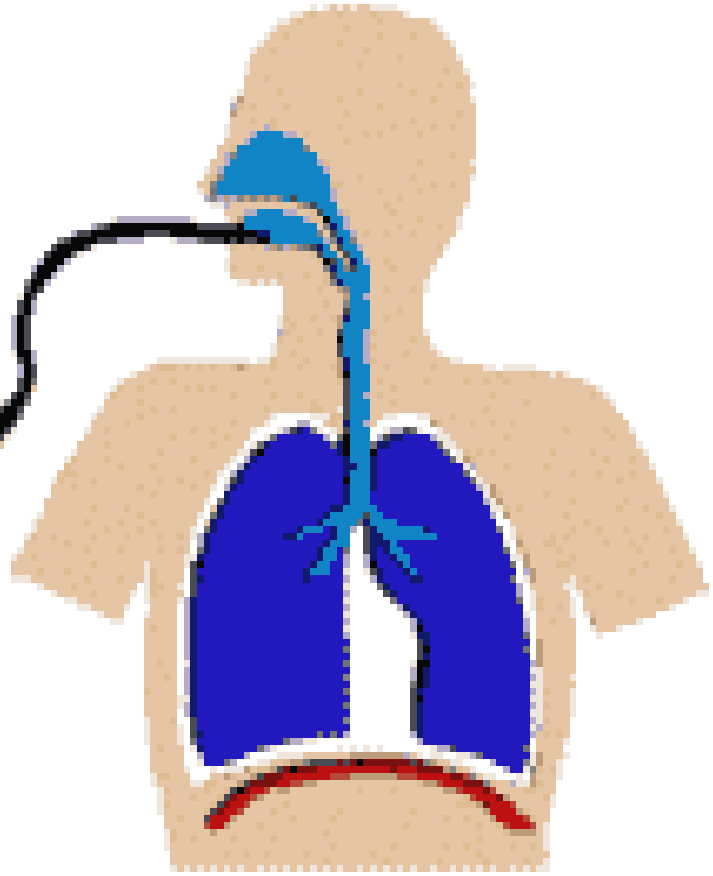
STUDENTS ABLE TO UNDERSTAND:

- Define the various lung volumes and capacities and provide values for each.
- Define Minute and Alveolar ventilation rate, their typical values and their measurement.
- Describe lung volume and capacities and their role in differentiating obstructive and restrictive lung diseases

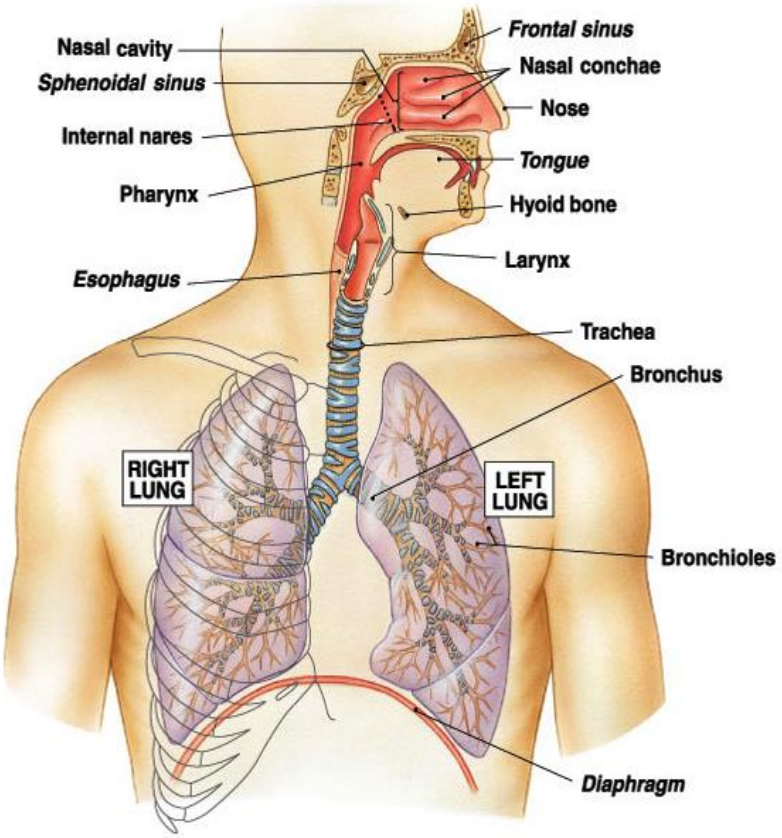
PULMONARY / LUNG VOLUMES AND CAPACITIES

Tidal volume: = 500 ml





RESPIRATORY SYSTEM



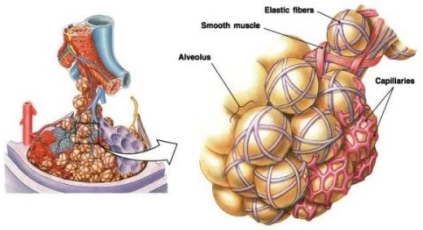
Upper respiratory tract

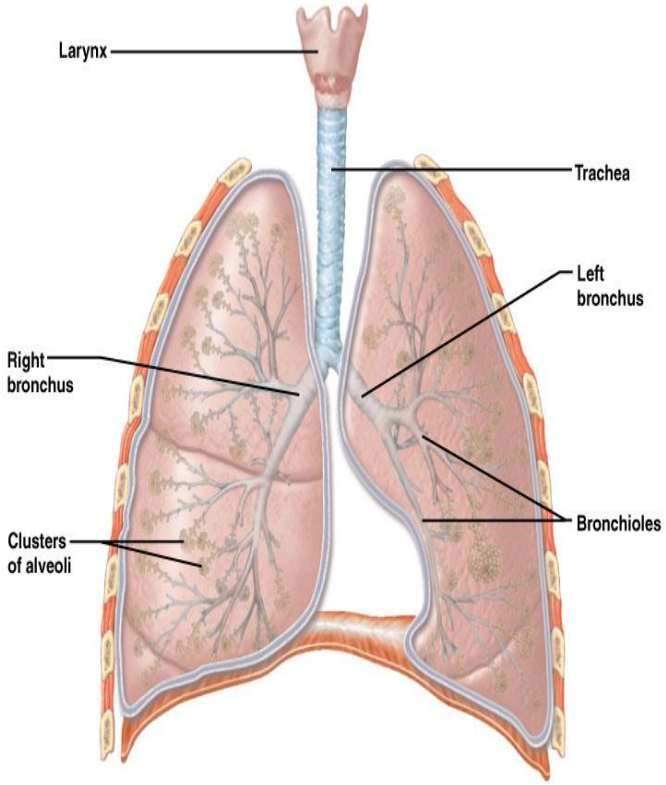
- Nose
- Pharynx and associated structures

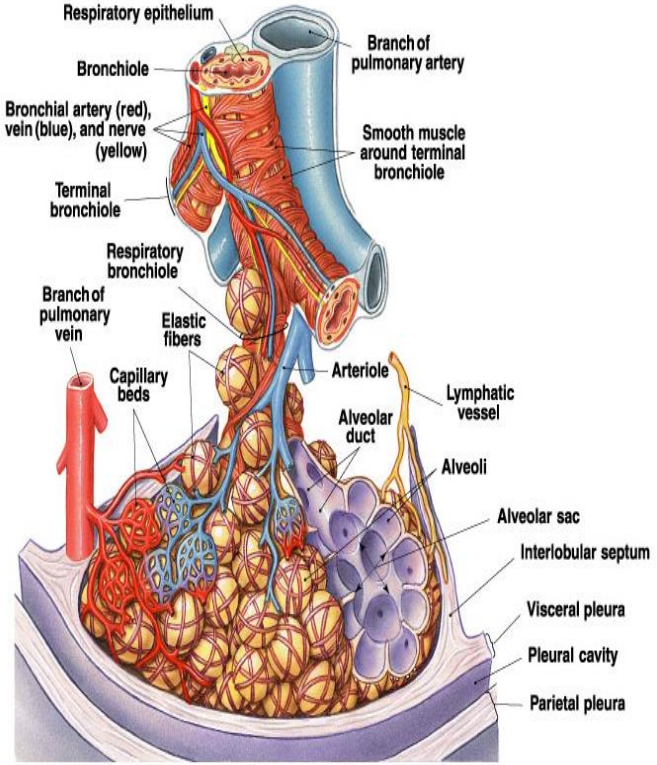
Lower respiratory tract

- Larynx
- Trachea
- Bronchi
- Lungs

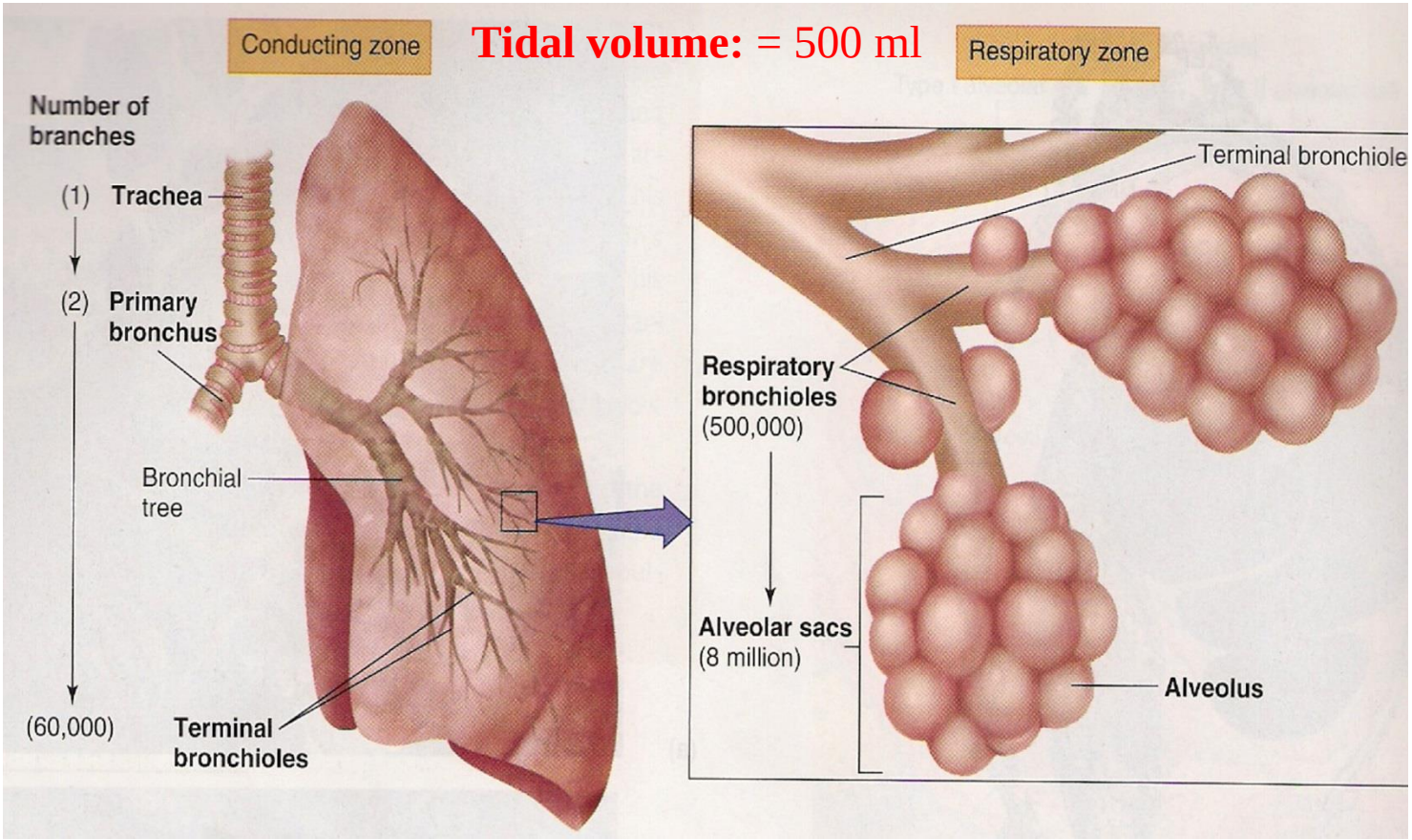
COMPONENTS OF LOWER RESPIRATORY TRACT







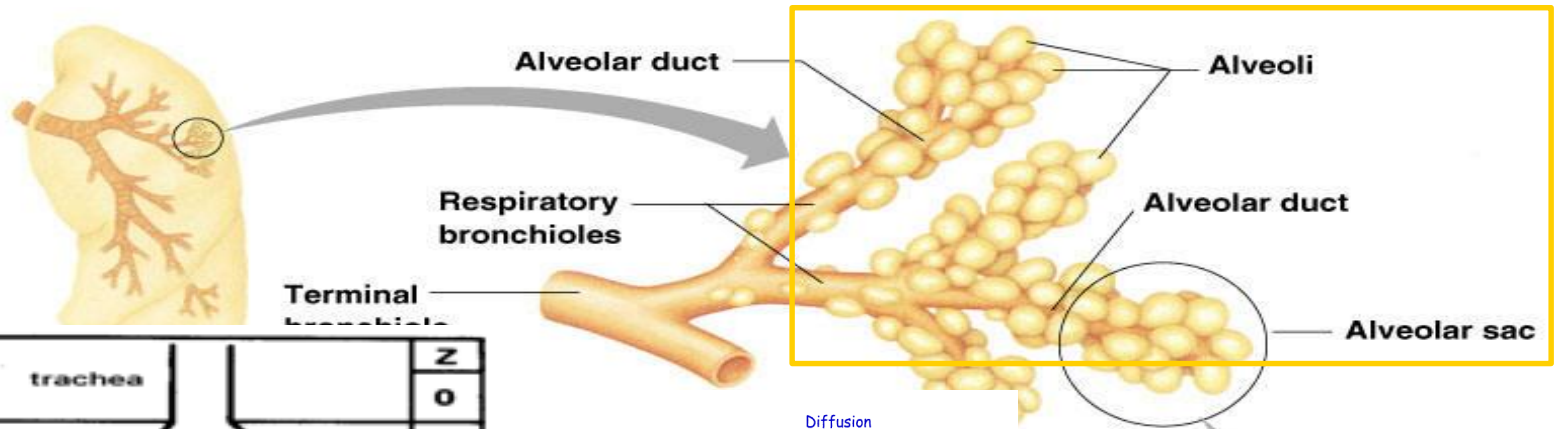
ZONES OF THE RESPIRATORY TRACT

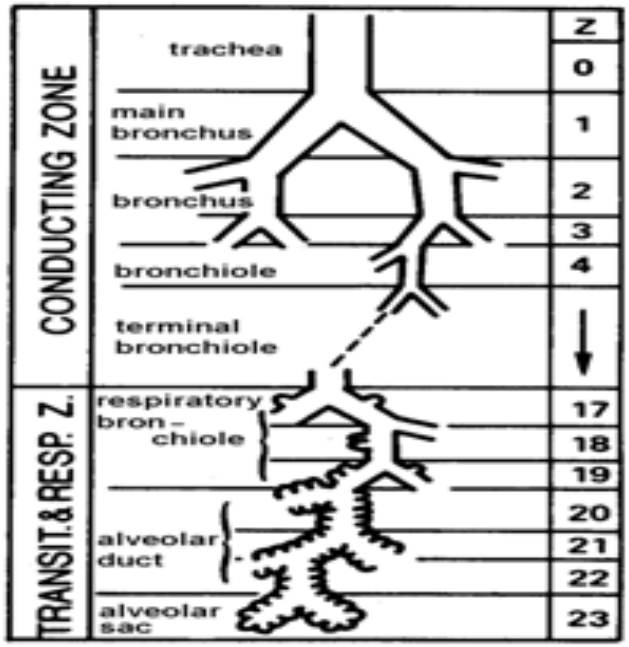


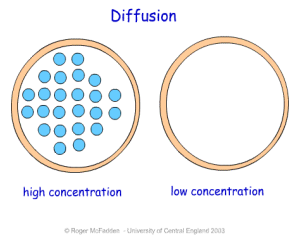
Conduction Zone= 150 ml

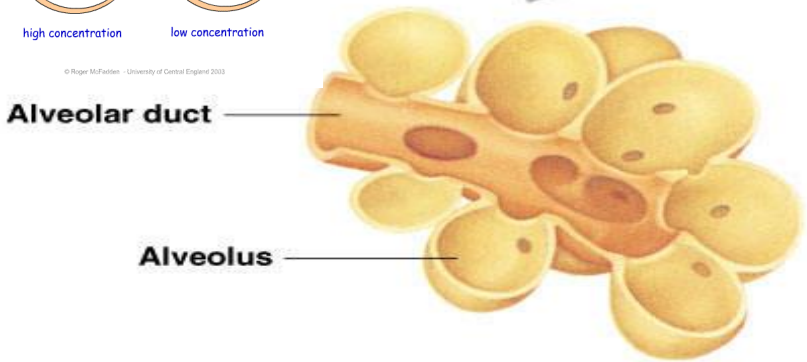
Respiratory Zone= 350 ml

ZONES OF THE RESPIRATORY TRACT



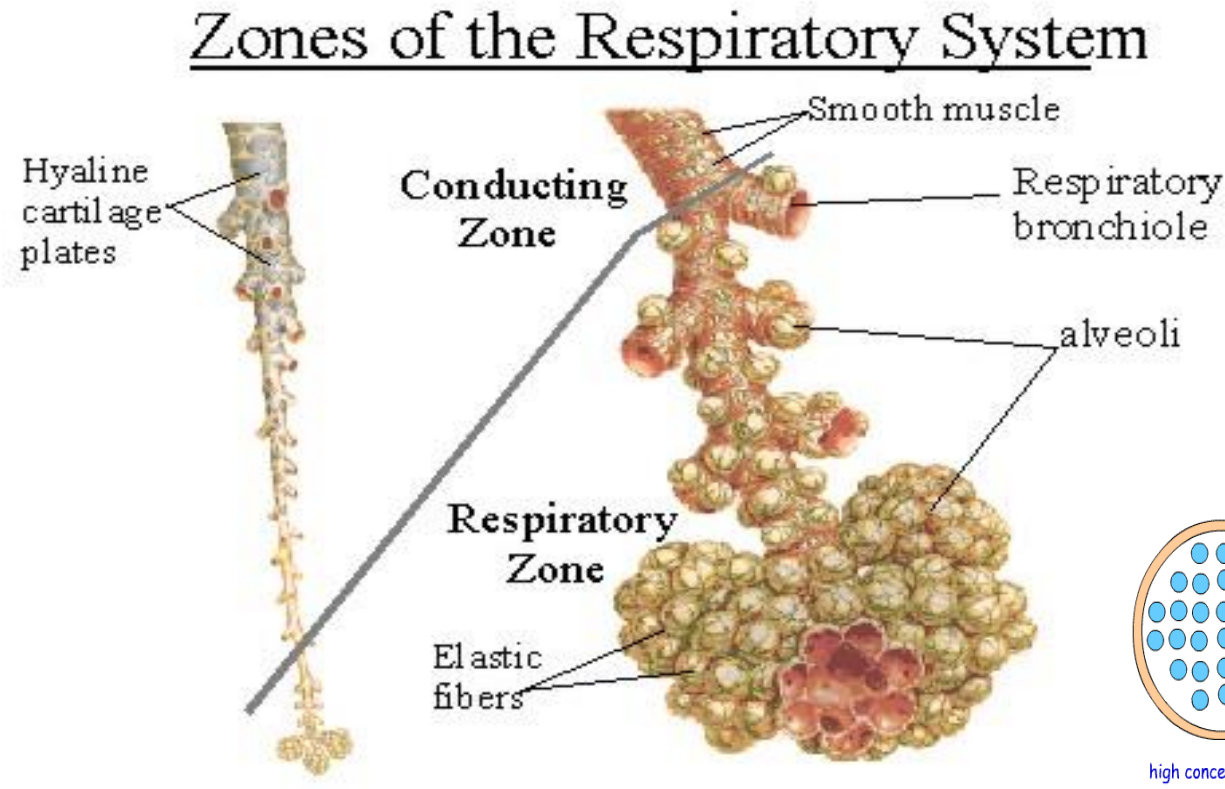


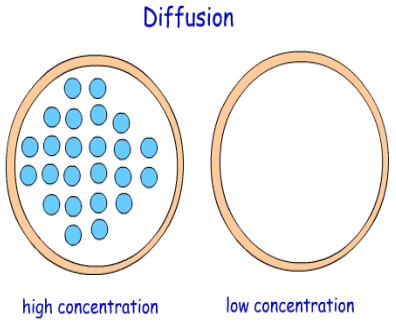




as Benjamin Cummings.

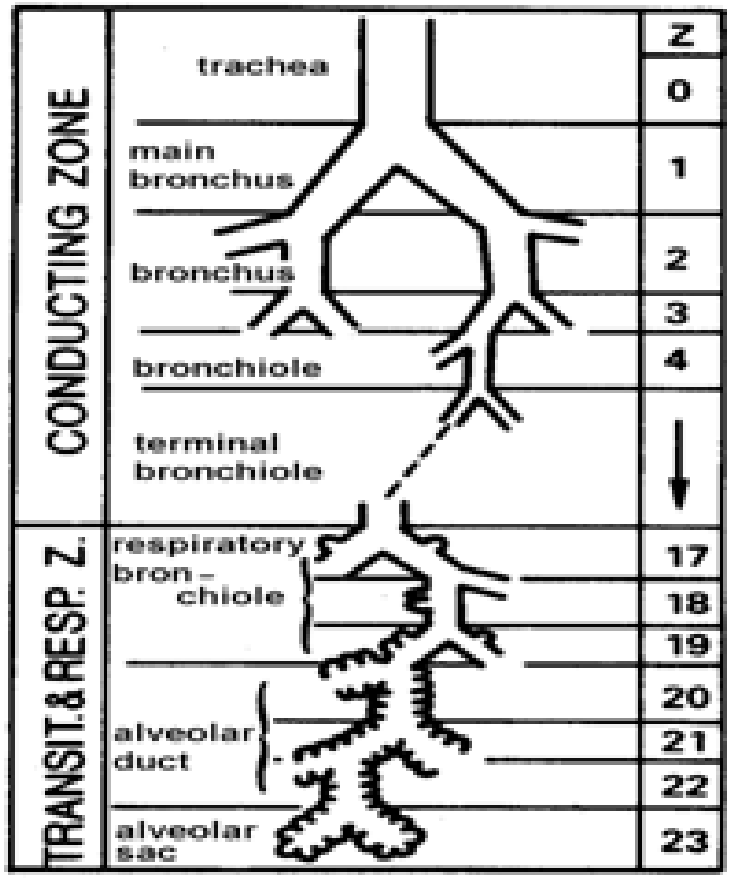
ZONES OF THE RESPIRATORY TRACT

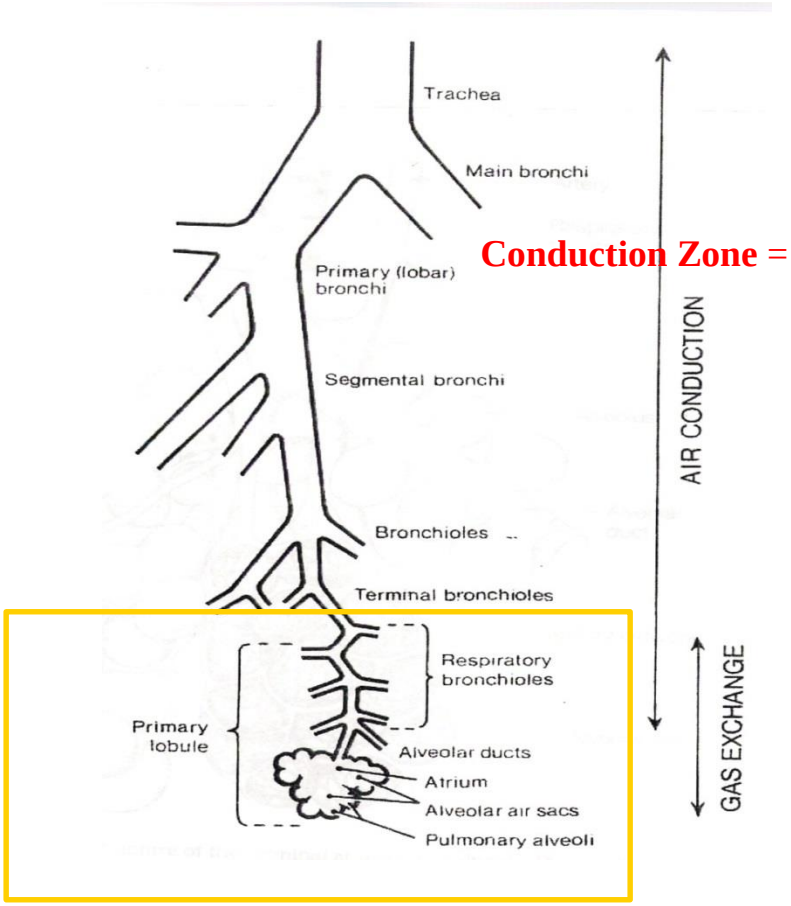




ZONES OF THE RESPIRATORY TRACT

Tidal volume: = 500 ml

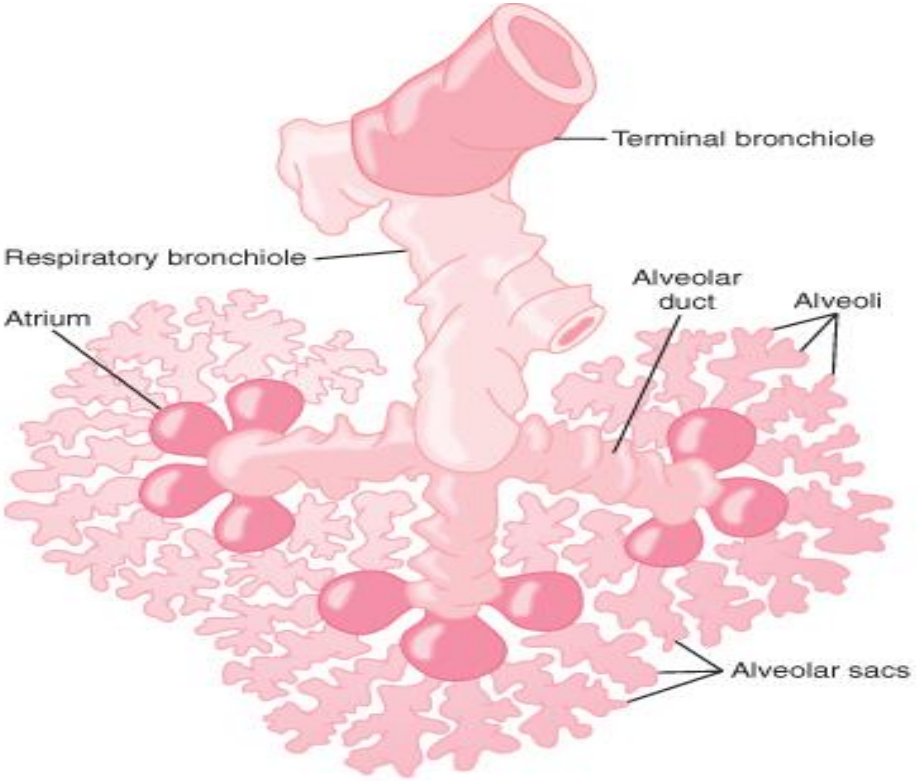




Conduction Zone = 150 ml

Respiratory Zone= 350 ml

RESPIRATORY UNIT



DEAD SPACE

Part s of the respiratory tract not participating in gas exchange

- **Anatomical dead-space:**
- Tracheo-bronchial: Oropharynx, trachea, and airways
- Normally 2ml/kg or 150ml in an adult, roughly a third of the tidal volume.
- **Alveolar Dead Space:** Alveoli ventilated but not perfused (Non-perfused alveoli)
- **Physiologic Dead Space:** Anatomical + Alveolar

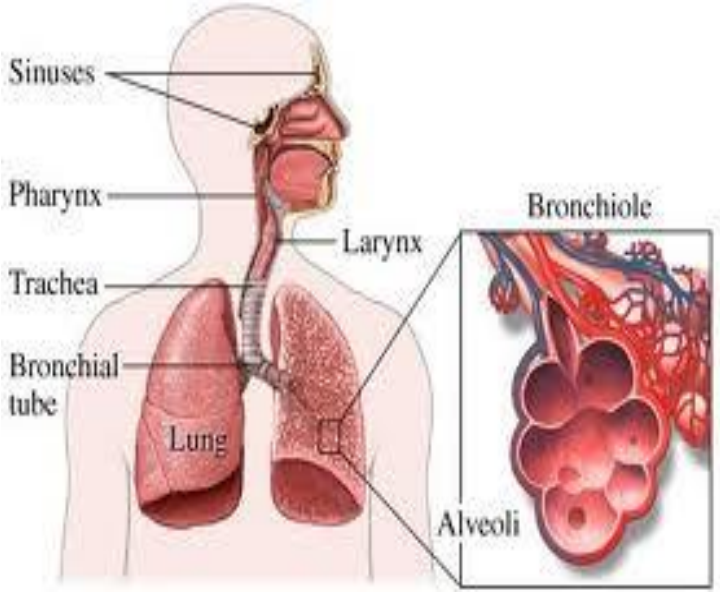
POLLUTION AND DISEASE PATTERN

Dust particles with an aerodynamic diameter of

10μm= nose and pharynx.

2-10μm=tracheo-bronchial tree

0.1-2μm within the alveoli.

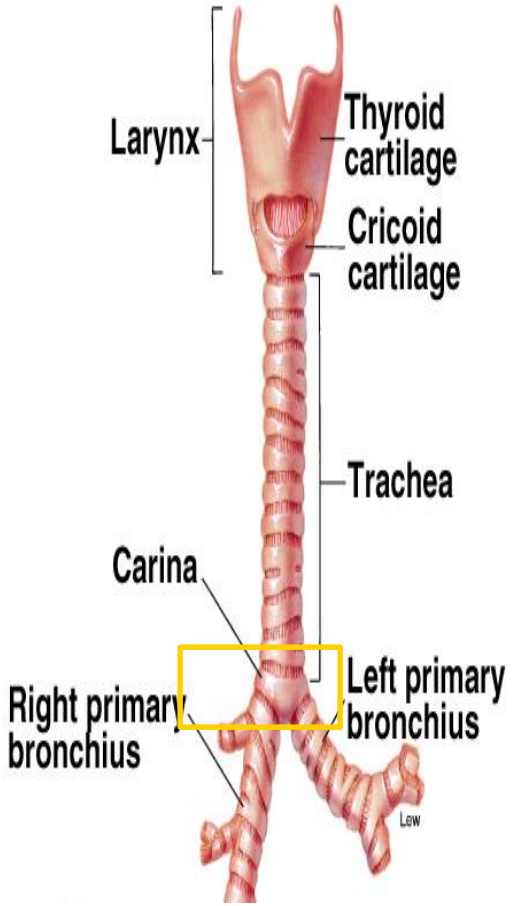


Particles smaller then 0.1μm remain in the air stream and are exhaled.

Sheppard et al., 1999 Occup Med, 1991

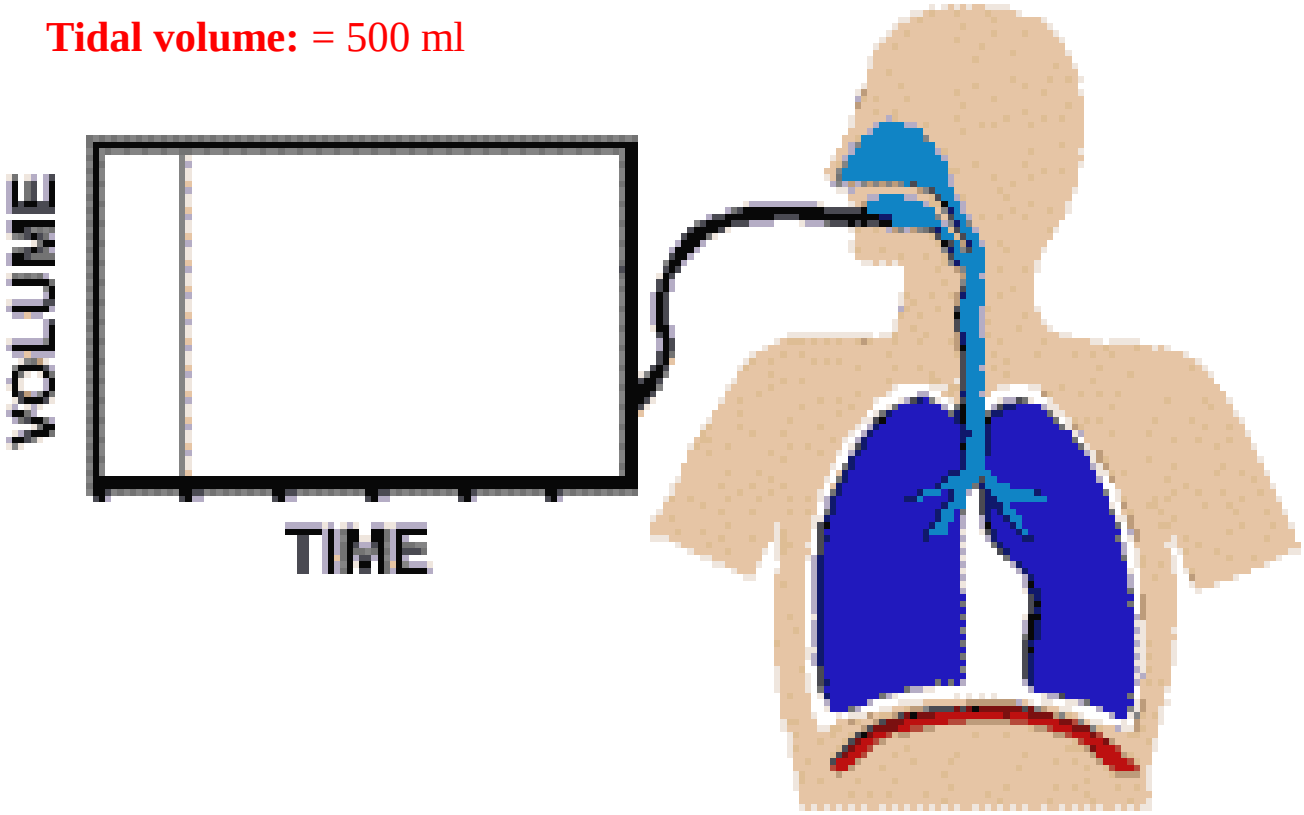
POLLUTION AND DISEASE PATTERN

- The larynx and carina are very sensitive to dust particles
- Terminal bronchioles and even the alveoli are also sensitive to chemical such as sulfur dioxide or chlorine gas.
- Air expelled at velocities ranging from 75 to 100 miles / hour [Guyton]
- 965 Km (600 miles / hour [Ganong]

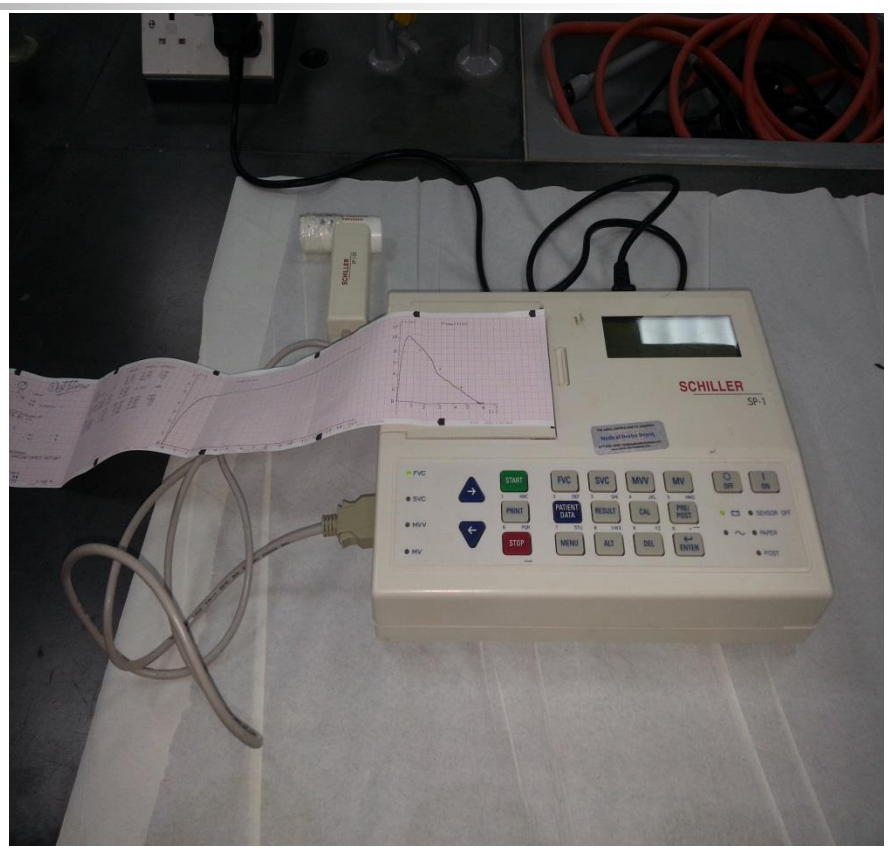


PULMONARY / LUNG VOLUMES AND CAPACITIES

Tidal volume: = 500 ml



Spirometers



PHYSIOLOGICAL CONDITIONS AND PULMONARY VOLUMES / CAPACITIES

Physiology conditions:

- Age, Sex, Height, Weight
- Ethnic group
- Exercise
- Posture
- Pregnancy
- Diurnal variation, seasonal, climate
- Customary activity
- Geographical location

All pulmonary volumes and capacities are about 20 to 25 % less in women than in men, and they are greater in large and athletic people than in small and asthenic people

PULMONARY VOLUMES AND CAPACITIES

Lung Volumes

- Tidal volume: [VT]
- Inspiratory reserve volume [IRV]:
- Expiratory reserve volume [ERV]:
- Residual volume [RV]:

Lung Capacities

- Vital Capacity [FVC]:
- Inspiratory capacity (IC),
- Functional Residual Capacity [FRC]
- Total lung capacity [TLC]:

Physiological variations in lung volumes

Lung volumes	Male	Female
Tidal volume	500	500
IRV	3000	2000
ERV	1100	700
Residual volume	1200	1100
TLC	5800	4300

PULMONARY VOLUMES

- **Tidal volume: [VT]** Volume of air inspired or expired in each normal breath; value= 500 ml.
- **Inspiratory reserve volume [IRV]:** It is the extra volume of air, that can be inspired forcefully, beyond the normal tidal volume value= 3000 ml

PULMONARY VOLUMES

- **Expiratory reserve volume [ERV]:** It is the extra volume of air that can be expired forcefully beyond the normal tidal volume. Value= 1100 ml
- **Residual volume [RV]:** It is the volume of air still remaining in the lungs after a forceful expiration. Value= 1200 ml

PULMONARY CAPACITIES

- **Functional Residual Capacity [FRC]** This is the amount of air that remains in the lungs at the end of normal expiration. Equals the expiratory reserve volume plus the residual volume. 2300 milliliters.

PULMONARY CAPACITIES

Forced Vital Capacity [FVC]: This is the maximum amount of air that a person can expel forcefully from the lungs after taking a deep inspiration. The vital capacity is the sum of the tidal volume + inspiratory reserve volume + expiratory reserve volume = 500 + 3000 + 1100= 4600 ml

PULMONARY CAPACITIES

Total lung capacity [TLC]: This is the maximum volume to which the lungs can be expanded with the greatest possible inspiratory effort. It is the sum of all pulmonary volumes. Tidal volume + Inspiratory + Expiratory reserved volume + Residual volume = 500+3000+1100+1200=5800 ml

PULMONARY CAPACITIES

Forced expiratory volume in one second (FEV_1): This is the volume of air expelled during the first second of a forced expulsion after a maximum inspiration.

This is a very useful volume to test for the diagnosis of obstructive lung diseases, such as emphysema and asthma in which FEV_1 is significantly reduced.

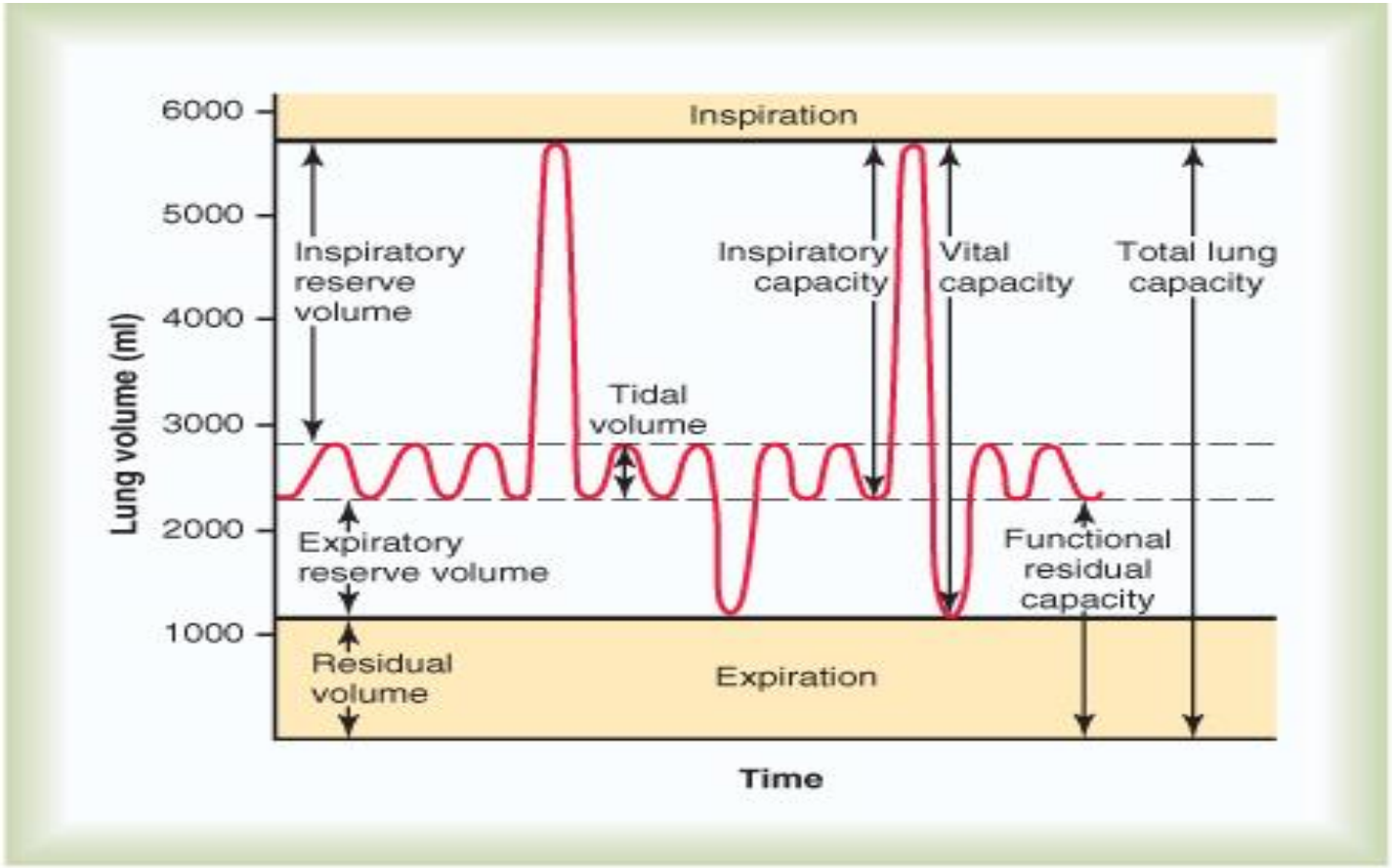
It is 80%-90% of the vital capacity. FEV_1 =3680 ml.

PULMONARY CAPACITIES

Forced Expiratory Ratio (FEV_1/FVC): The forced expiratory ratio is a sensitive index in differentiating obstructive from restrictive pulmonary disease.

It is decreased in obstruction and is normal or increased in restriction (Enright, 1997).

SPIROGRAM



MINUTE VENTILATION RATE AND VOLUME

Respiratory rate: Number of breaths taken per minute

Minute ventilation: Total amount of air moved into and out of respiratory system per minute

Minute respiratory volume: MRV: The total amount of new air that moves into the respiratory passages in each minute is called the minute respiratory volume. The normal rate of respiration in one minute is 12 [Approximately 12-18 / min]. The minute respiratory volume is equal to: MRV = tidal volume x respiratory rate = 500 x 12 = 6000 ml /minutes

MINUTE ALVEOLAR VENTILATION RATE AND VOLUME

Rate of Alveolar Ventilation:

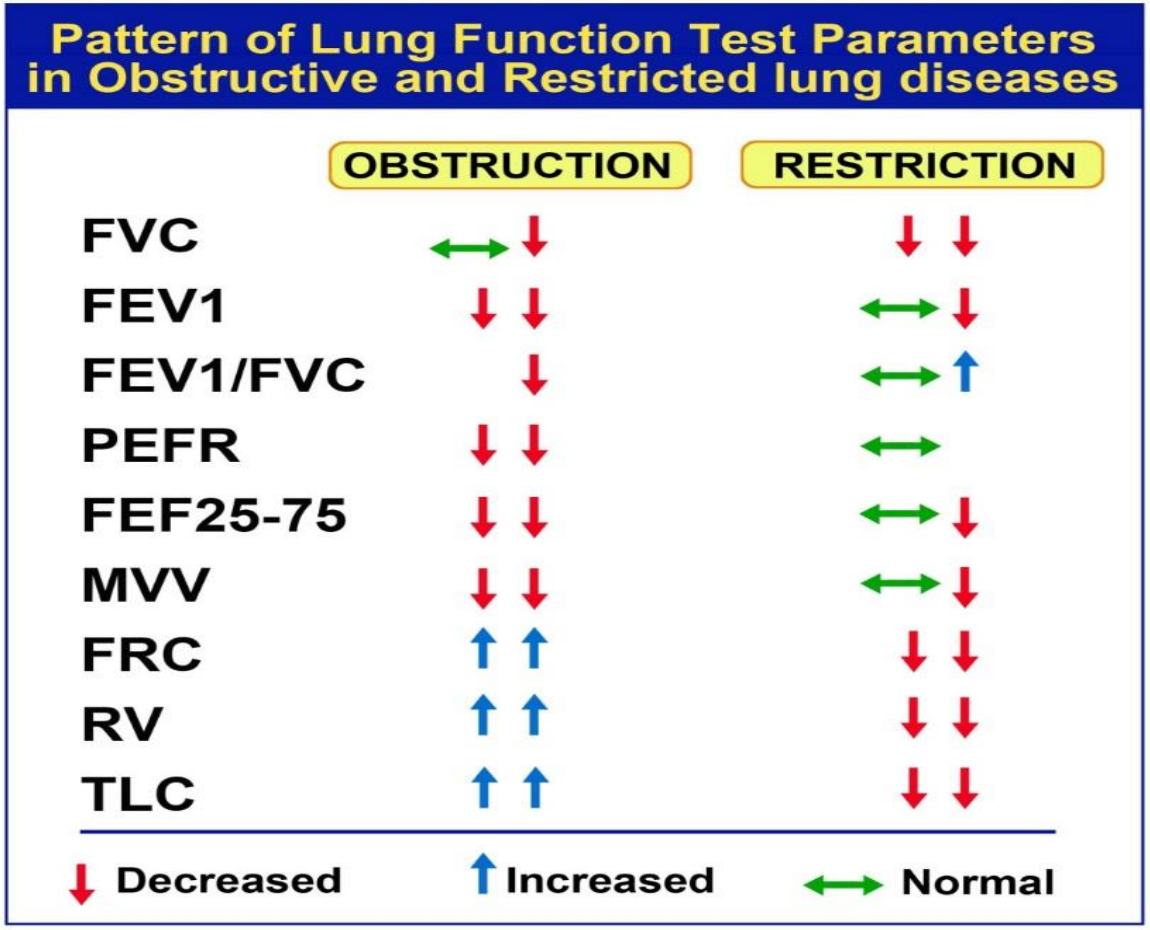
Normal tidal volume of 500 milliliters

Normal dead space of 150 milliliters

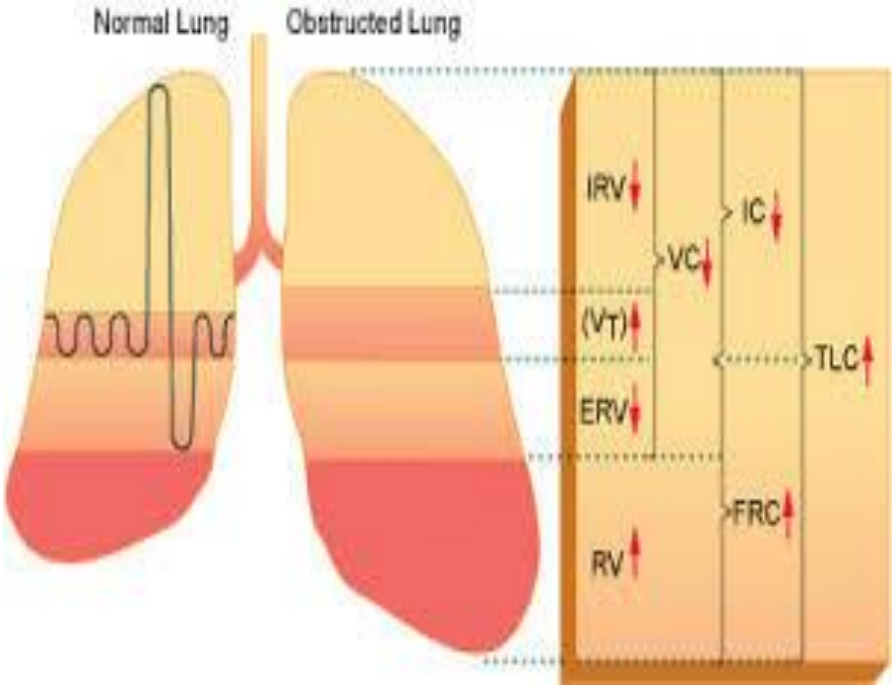
Respiratory rate of 12 breaths per minute

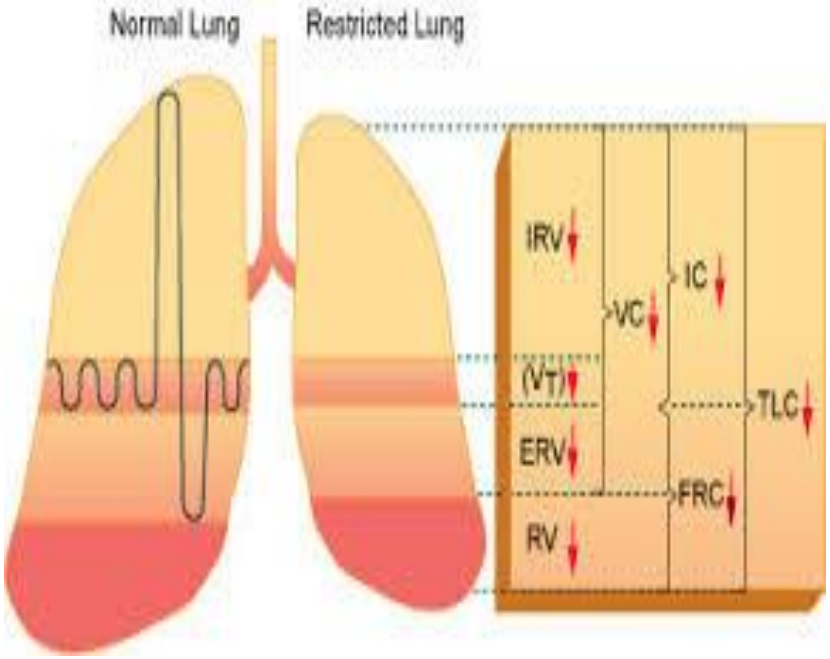
Alveolar ventilation: 12 ¥ (500–150) 4200 ml/min

LUNG VOLUMES IN OBSTRUCTIVE AND RESTRICTIVE LUNG CONDITIONS



LUNG VOLUMES IN OBSTRUCTIVE AND RESTRICTIVE LUNG CONDITIONS





THANK YOU