factors affecting bronchial tone(airway radius) :

a) smooth muscle: smooth m. contract →↓airway radius →↑resistance
   Smooth m is controlled by :
   - autonomic control:
     - parasympathetic control: parasympathetic nerve fiber by vagus nerve → release acetylcholine(Ach) →binds to M3 muscarinic receptors →bronchoconstriction→↓airflow
     - sympathetic system : norepinephrine (sympathetic fiber terminal) and epinephrine (adrenal medulla) →bind β2 adrenergic receptors →brnonchodilation →↑ air flow
   - local factors :→airway smooth muscle contraction →bronchoconstriction
     - local irritants and allergens
     - histamine and inflammatory mediators

b) lung volume
   - high volume : radial traction : because airways are tethered to surrounding alveoli , when alveoli inflate→ force airways to dilate→↑airway radius→↓resistance→↑airflow
   - low volumes : ↓radial traction →↓airway radius→↑resistance→↓airflow

c) Airways cooling : inhalation of cold air →bronchoconstriction

d) circadian rhythm :
   - maximum constriction of bronchial muscle occurs at 6 am maximum dilation occurs at 6 pm .

Work of breathing :

- is the work done by respiratory muscles during breathing to overcome the resistance in thorax and respiratory tract
- At rest : it accounts for 5% of total energy .
- During exercise: energy required ↑ as much as 50 folds .
- Work of breathing is Insignificant in healthy persons but in some patient with respiratory diseases →lung expansion is difficult→ ↑ work

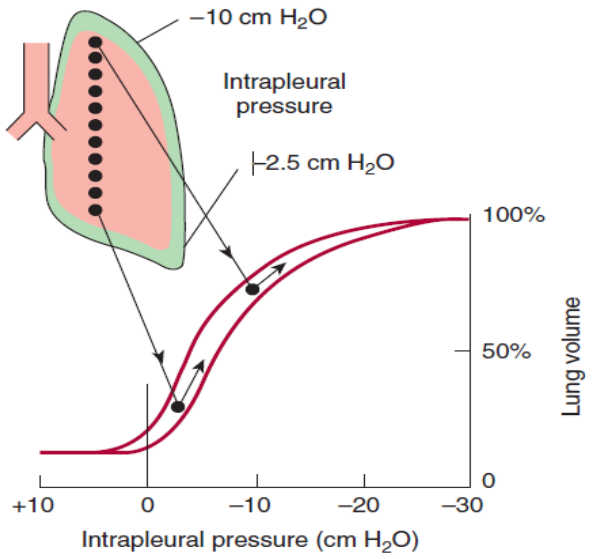
- work of breathing can be divided into three fractions :
  1. compliance or Elastic work : 65 % required to counter lung recoil
  2. tissue or Viscous resistance work :moving inelastic tissue 7%
  3. Airways resistance work : 28%

- Work of breathing ↑in :
  - COPD : high airway resistance.(↑resistance work).
  - Pulmonary fibrosis : stiff lung (↑elastic work).

Effects of gravity :

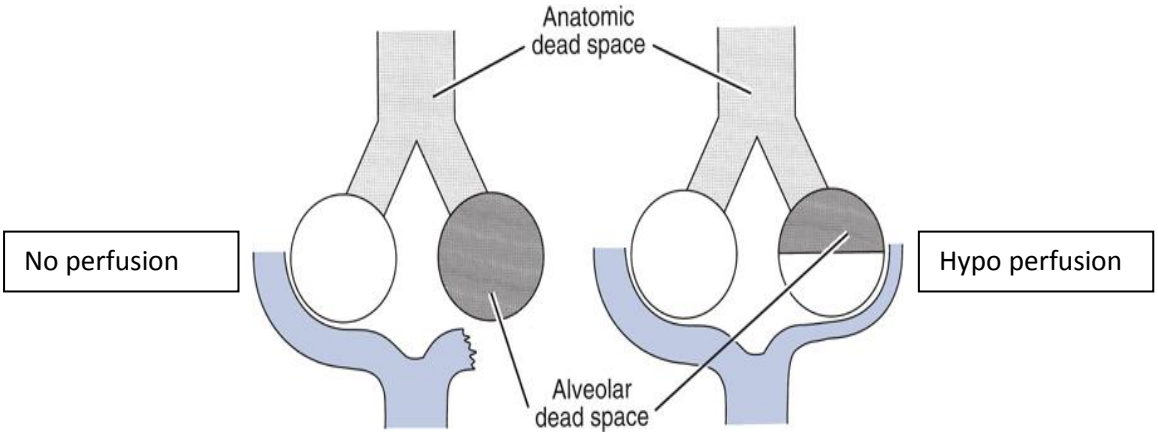
Lungs has a mass →regional differences(apex Vs base) in intrapleural pressure and alveolar volume . When the lung positioned vertically it is like a coil .

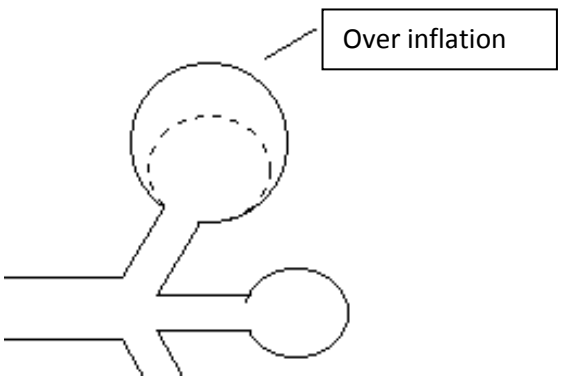
- Apex : Alveoli are forced to inflate by the pulling effect of underlying lung tissue weight (coil is widely spaced at the top)and intrapulmonary pressure is more negative (- 10 cmH2O) . lungs at the apex are functioning near the top of pressure –volume curve (further inflation is limited) .
- Base: alveoli are compressed by overlying lung tissue weight ,intrapleural pressure = -2 cm H2O.Lungs at the base are functioning near the base of the pressure-volume curve (further expansion is favored) .



dead space : two types

1. **Anatomic dead space** : volume of air in the respiratory tree that does not participate in gas exchange process during respiration (conducting zone) it approximately equals to the body weight in pounds
2. **Physiological (Total) dead space** :
   - is the total volume of air that does not participated by gas exchange . it equals to anatomic dead space + alveolar dead space (dead space generated by non functional alveoli) due to
     a) over inflation
     b) blood gas interface is damaged
     c) blood flow to these alveoli is poor(hypoperfusion) or absent.
   - In healthy person it equals to anatomic dead space.
   - In diseased lung the physiological dead space could be 1-1.5 L> anatomic dead space





Respiratory Minute volume RMV: is the total volume of air inhaled or exhaled per minute during quite breathing

MRV = TV X breaths /min = 500 x 12 = 6 L/min

Alveolar ventilation V_A: is the volume of air that reaches the gas exchange area (respiratory zone) per min.

V_A = (tidal volume – dead space volume)X breath /min

= (500 ml – 150 ml) X 12

= 350 X12 = 4200 ml /min

- Rapid shallow breathing produces less alveolar ventilation than slow deep breathing at the same minute respiratory volume (RMV) :

	Rapid shallow breathing	**Slow deep breathing**
RR	30/min	10/min
Tidal volume	200mL	600mL
RMV	6L	6L
Alveolar ventilation	(200-150)×30 = 50 ×30 = 1500mL	(600-150)×10= 450 ×10= 4500mL

Maximum voluntary ventilation (MVV) :largest volume of air that can be expired with effort per min: 120-180 L/min (measured for 15 S).