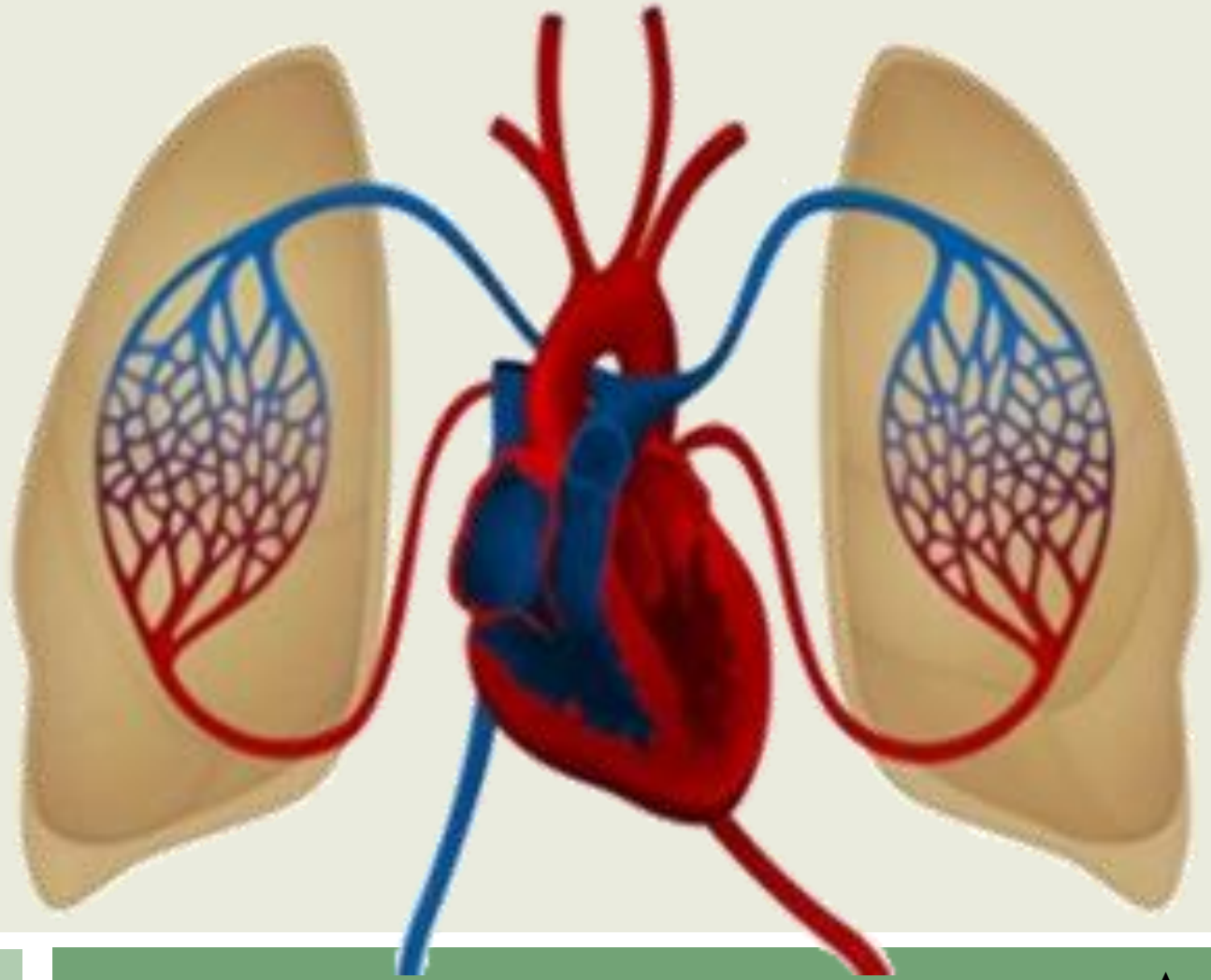
CHAPTER 8 RESPIRATION AND CIRCULATION

Mithibai Junior College



Arati G Raut

WHAT IS RESPIRATION?

Respiration : It is a biochemical process of oxidation of food , release of chemical energy (ATP)

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + 38\ ATP$$

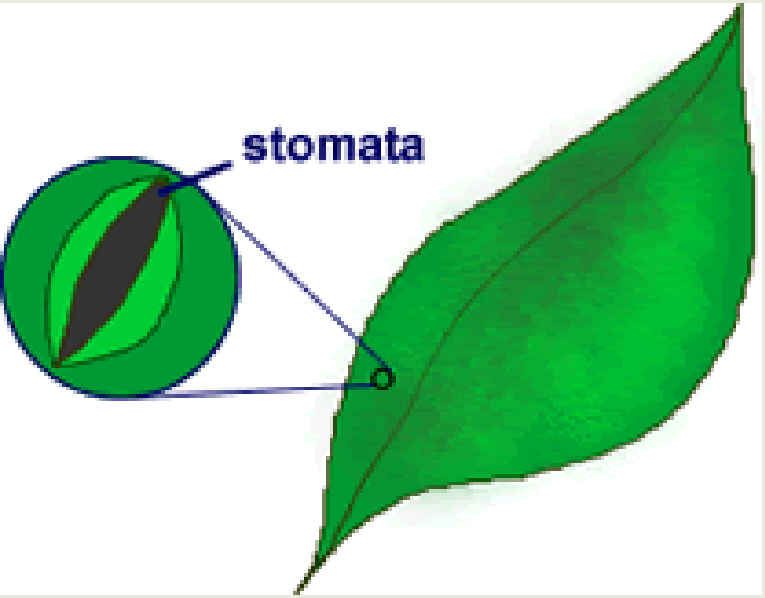
RESPIRATION IS GASEOUS EXCHANGE BETWEEN THE ORGANISM AND THE ENVIRONMENT"

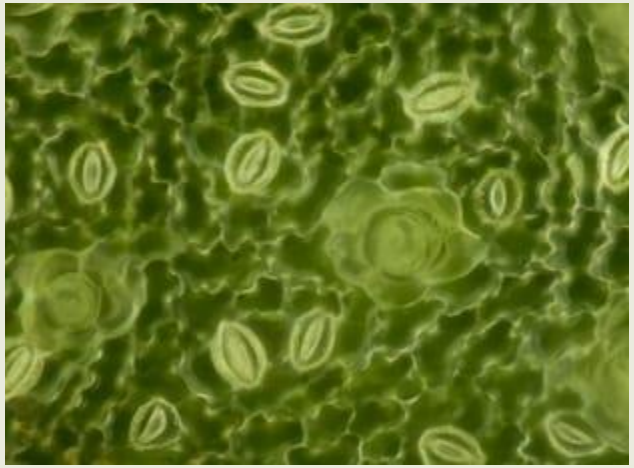
RESPIRATORY SURFACE - SITE OF RESPIRATORY EXCHANGE

CHARACTERISTICS OF RESPIRATORY ORGANS/SURFACES

- large surface area.
- thin, highly vascular and permeable
- moist

GASEOUS EXCHANGE IN PLANTS

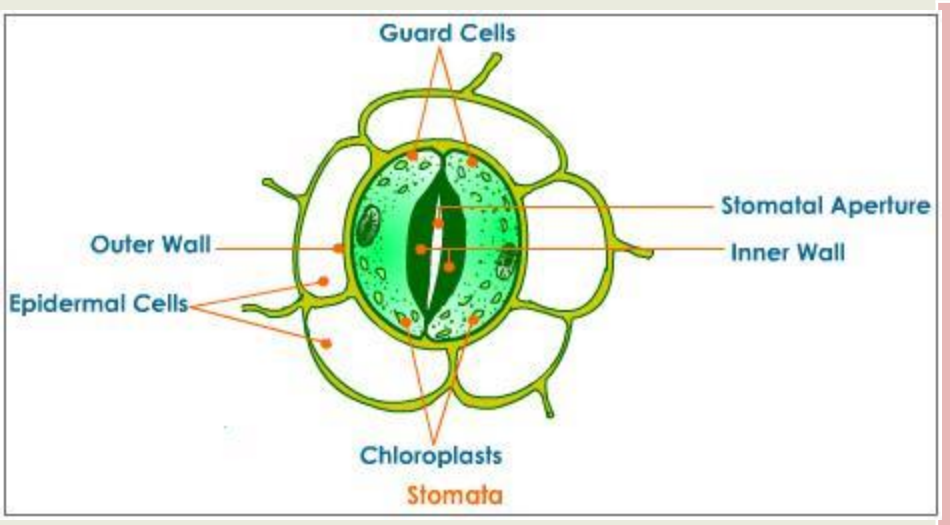




STOMATA
ON
STEM, LEAF

LENTICELS
ON
SECONDARY GROWTH TISSUE
LIKE THE WOODY BARK

GASEOUS EXCHANGE IN PLANTS

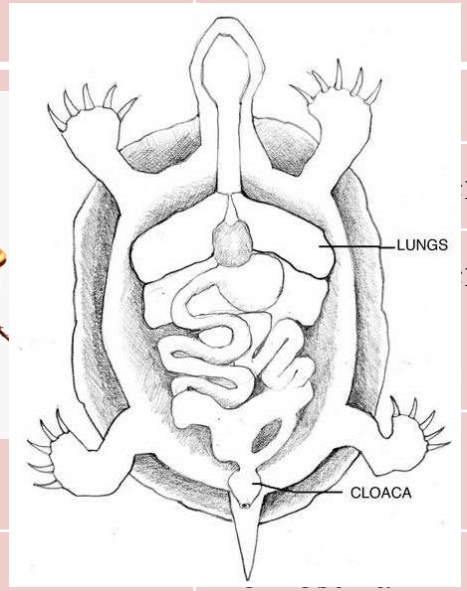


- OXYGEN DIFFUSES INTO THE CELLS

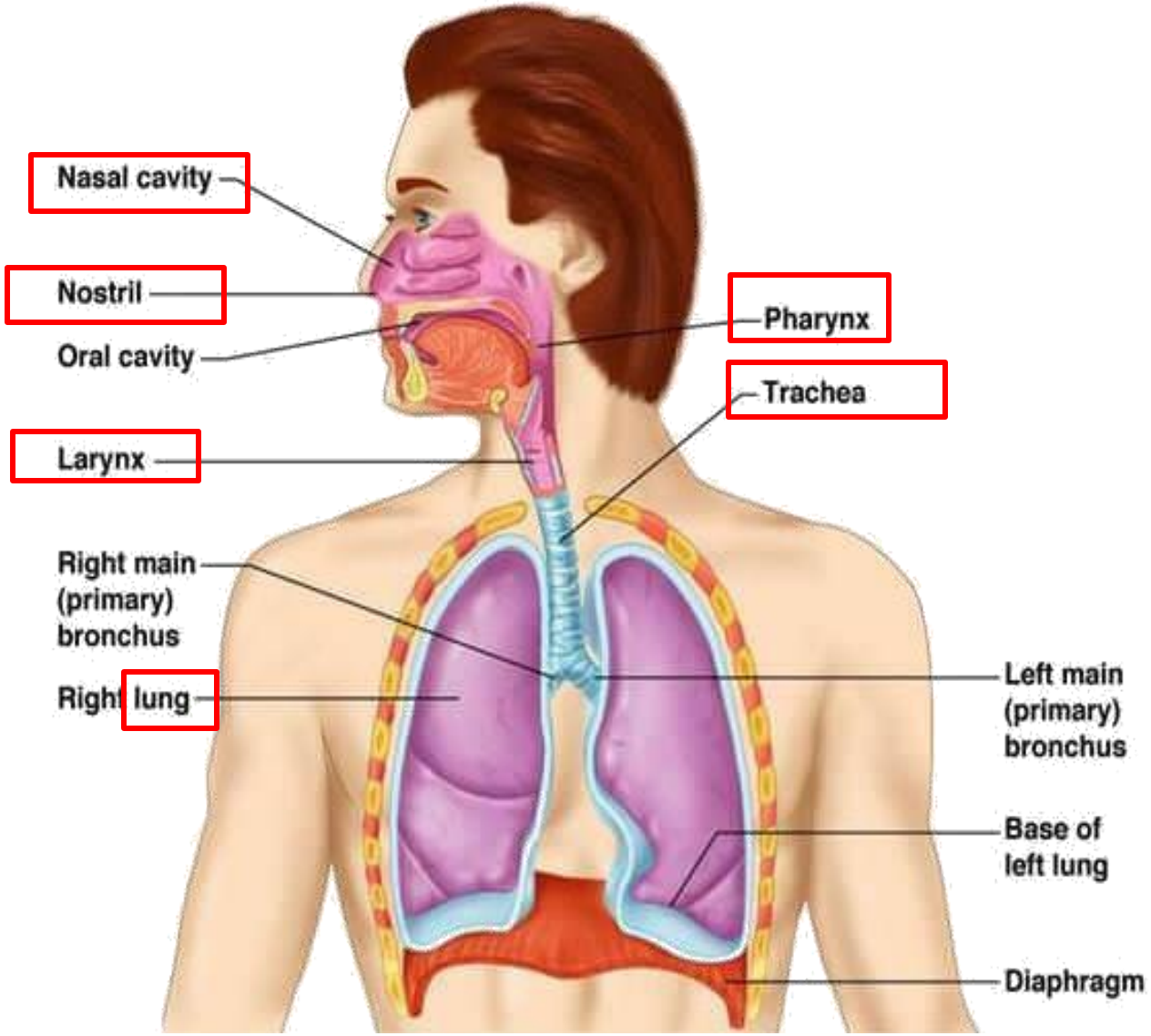
CARBON DIOXIDE AND WATER VAPOUR DIFFUSE OUT

TERESTRIAL PLANTS HAVE MANY AIR SPACES BETWEENTHE CELLS OF STEM, LEAF AND ROOT	WOODY FLOWERING PLANTS (TREES AND SHRUBS) HAVE AN EXTERNAL IMPERVIOUS BARK. HERE, GASEOUS EXCHANGE OCCURS THROUGH SMALL PORES IN THE STEM
FILM OF MOISTURE OR WATER AROUND THE ROOT TISSUE	
STOMATA	LENTICELS.

Organism	Habitat	Respiratory surface/ organ
Protists, Spo		
Fl		
An		
fro		
Insects		
Arachnids lik		Book lungs
Limulus (Arthropod)	Aquatic	Book gills
Amphibian tadpoles of frog, salamanders and Newts	Aquatic	External gills
Fish	Aquatic	Internal gills
Reptiles, Birds and Mammals	Terrestrial	Lungs
Turtles	Underwater	cloaca



Human Respiratory system:



Nose :

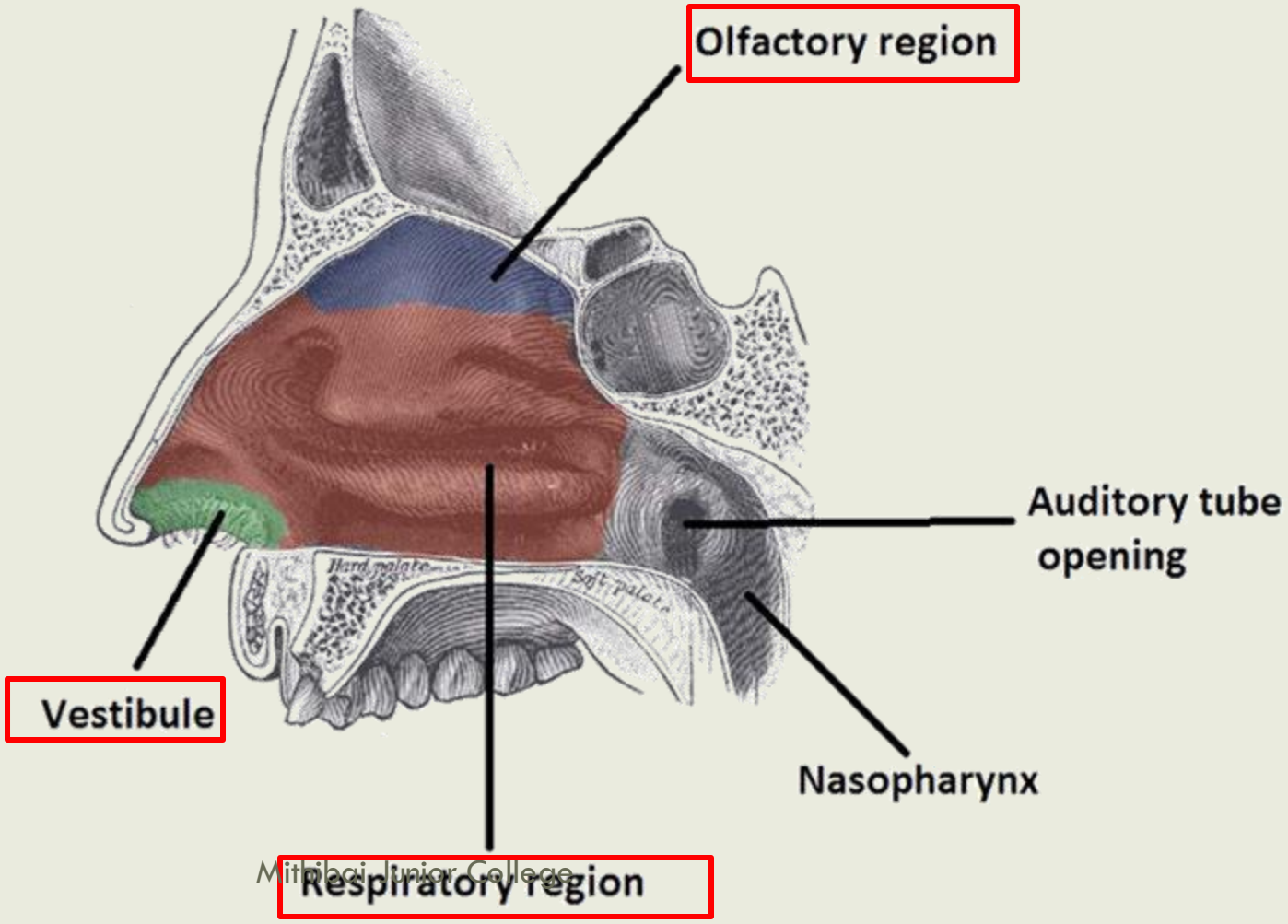
The nose has a pair of slit like openings called external nares or nostrils for entry of air into the nasal cavity. The nasal cavity is divisible into right and left nasal chambers by a **mesethmoid cartilage**.

NASAL CHAMBERS: 3 Chambers

1) Vestibule

2) Respiratory part (conditioner)

3) Olfactory or sensory chamber



NASAL CHAMBERS

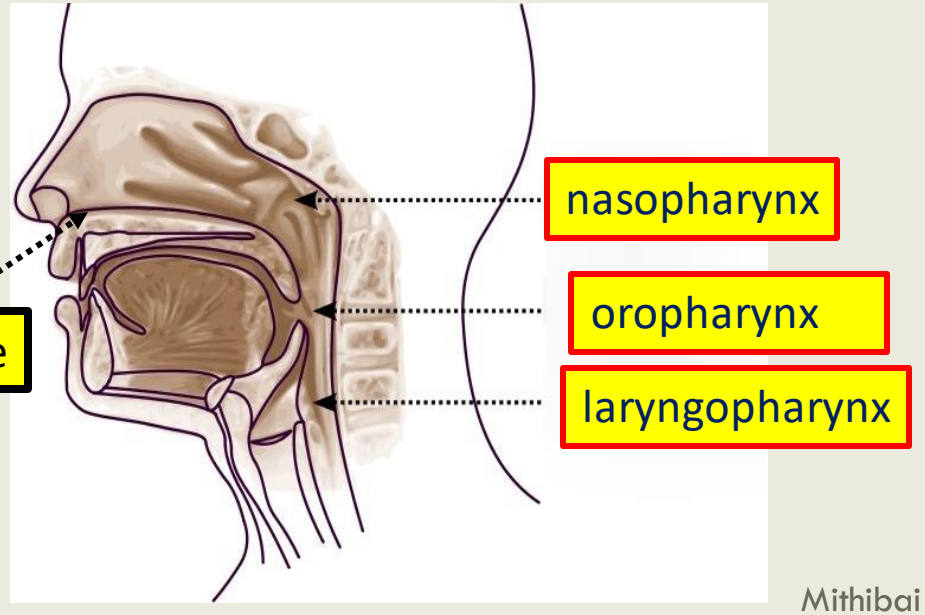
Pharynx:

uppermost part - The **nasopharynx**

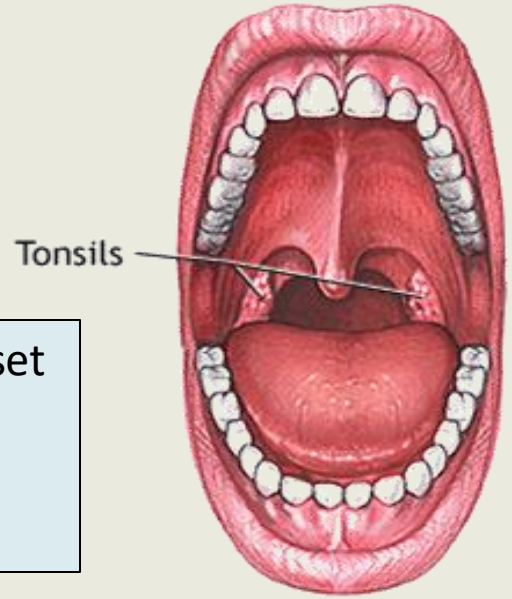
Between the nasopharynx and oropharynx is the palate bone

common passage for food and air – The **oropharynx**

Laryngopharynx - That leads into the Larynx

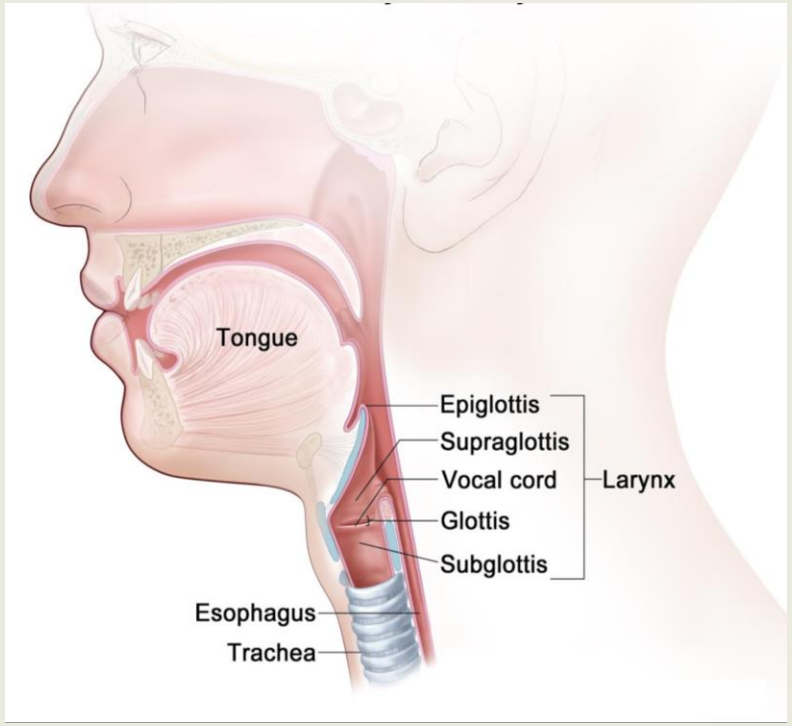


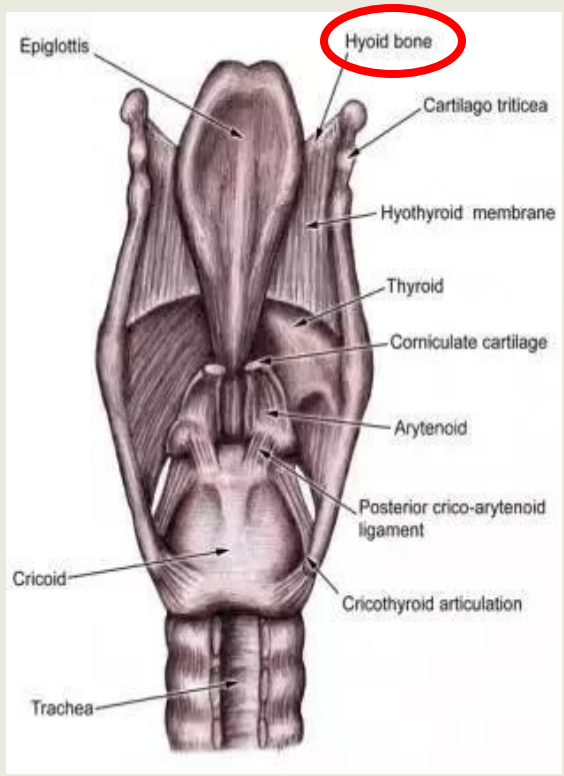
pharynx has a set of lymphoid organs called **tonsils**.

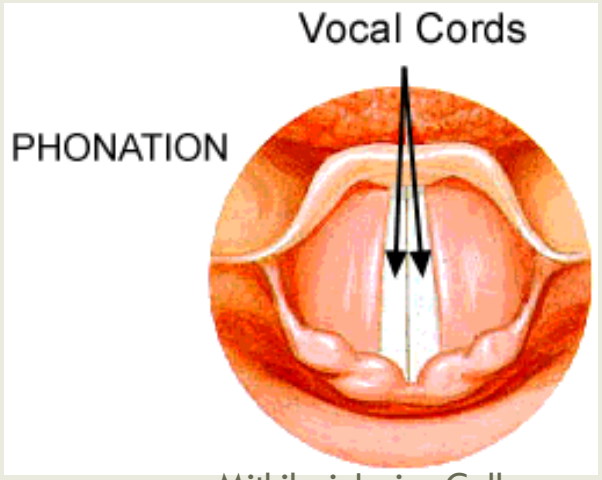


LARYNX (Voice box)

- It is a hollow, tubular structure.
- It extends from the laryngopharynx and the **hyoid bone** to the trachea
- The connection is through an opening called **GLOTTIS**
- Opening gaurded by **Epiglottis**
- Its wall is made up of cartilage plates held by membranes and muscles
- Internally, it is lined by a pair of folds of elastic **vocal cords** (true vocal cords).





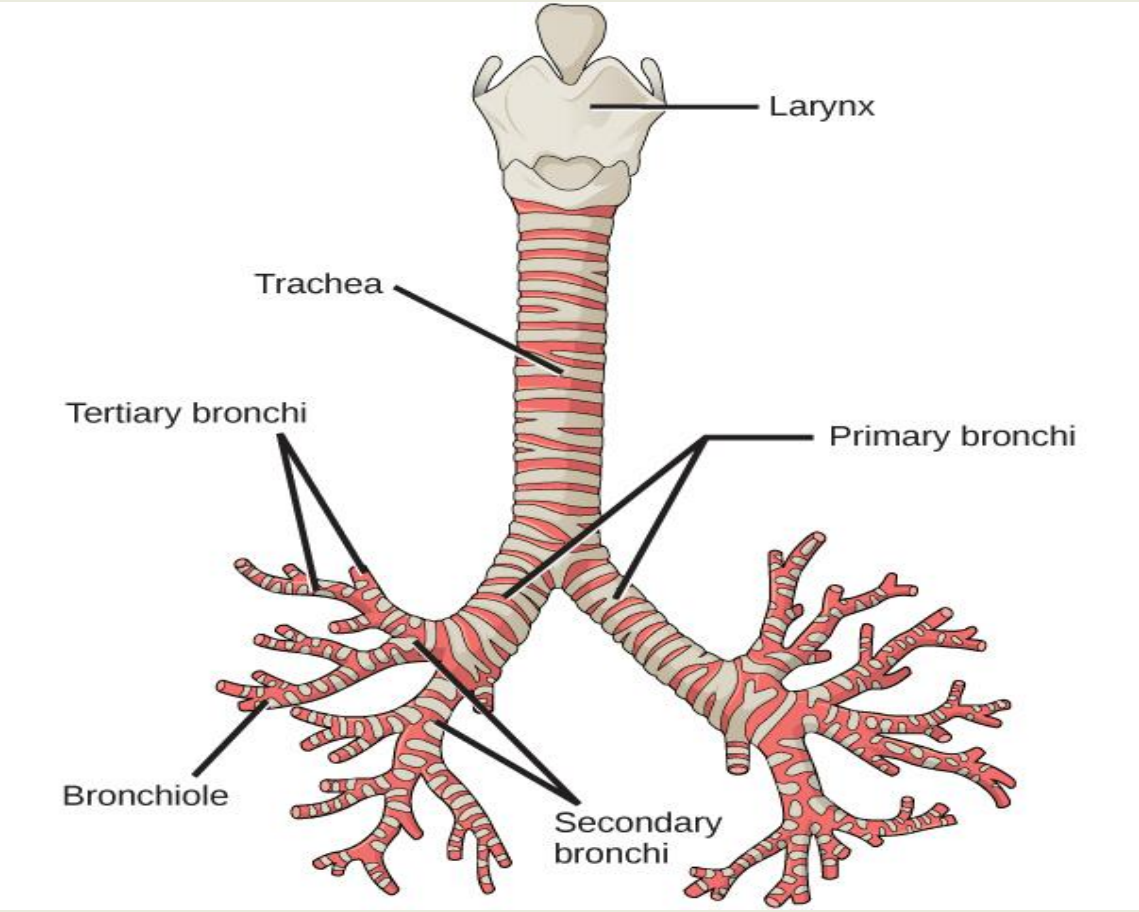


TRACHEA (WIND PIPE) :

It is a long tube 10 to 12 cm in length.

It is supported by **'C' shaped cartilages**.

It is lined internally with ciliated, pseudostratified epithelium and mucous glands



TRACHEA reaches the middle of the thoracic cavity.

BRONCHI

are internally supported by 'C' shaped incomplete rings of cartilage.

RIGHT ← PRIMARY → LEFT

SECONDARY

TERTIARY

terminal BRONCHIOLES

ALVEOLI (ending into)

Upper respiratory tract

Nasal cavity

Pharynx

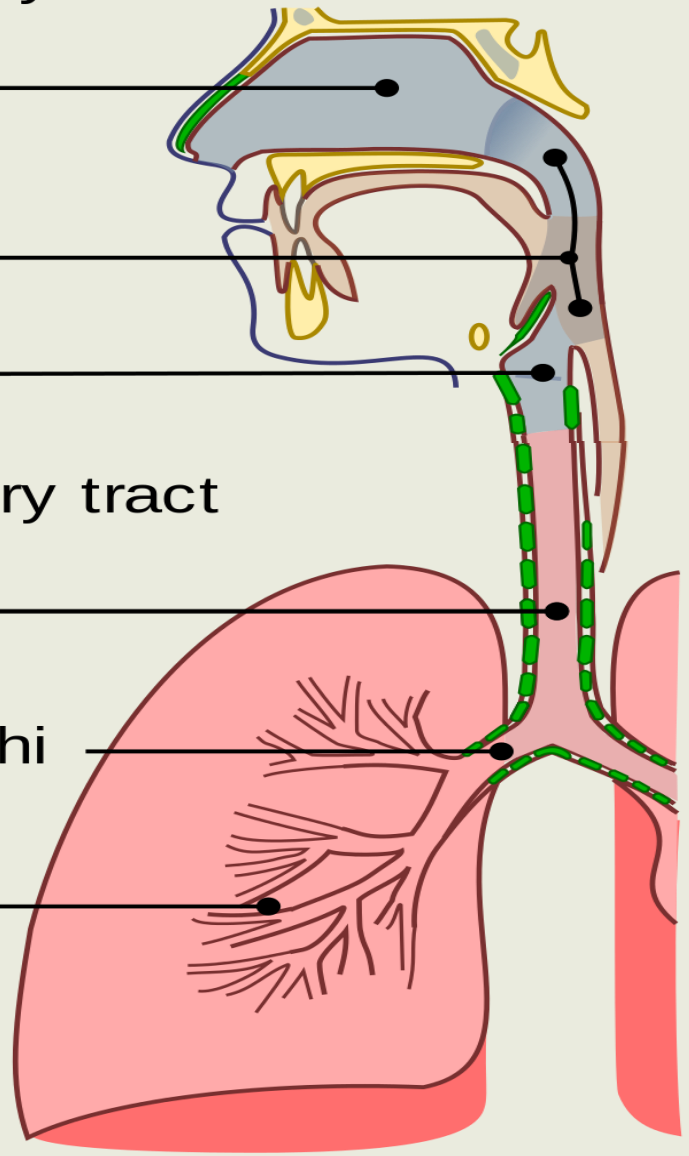
Larynx

Lower respiratory tract

Trachea

Primary bronchi

Lungs

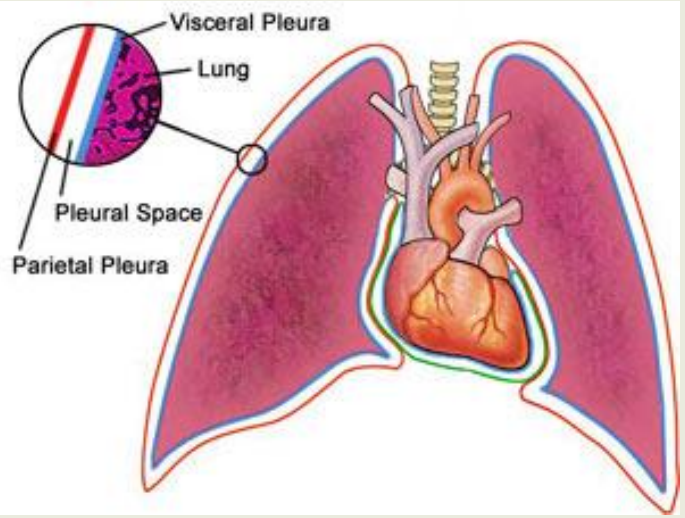


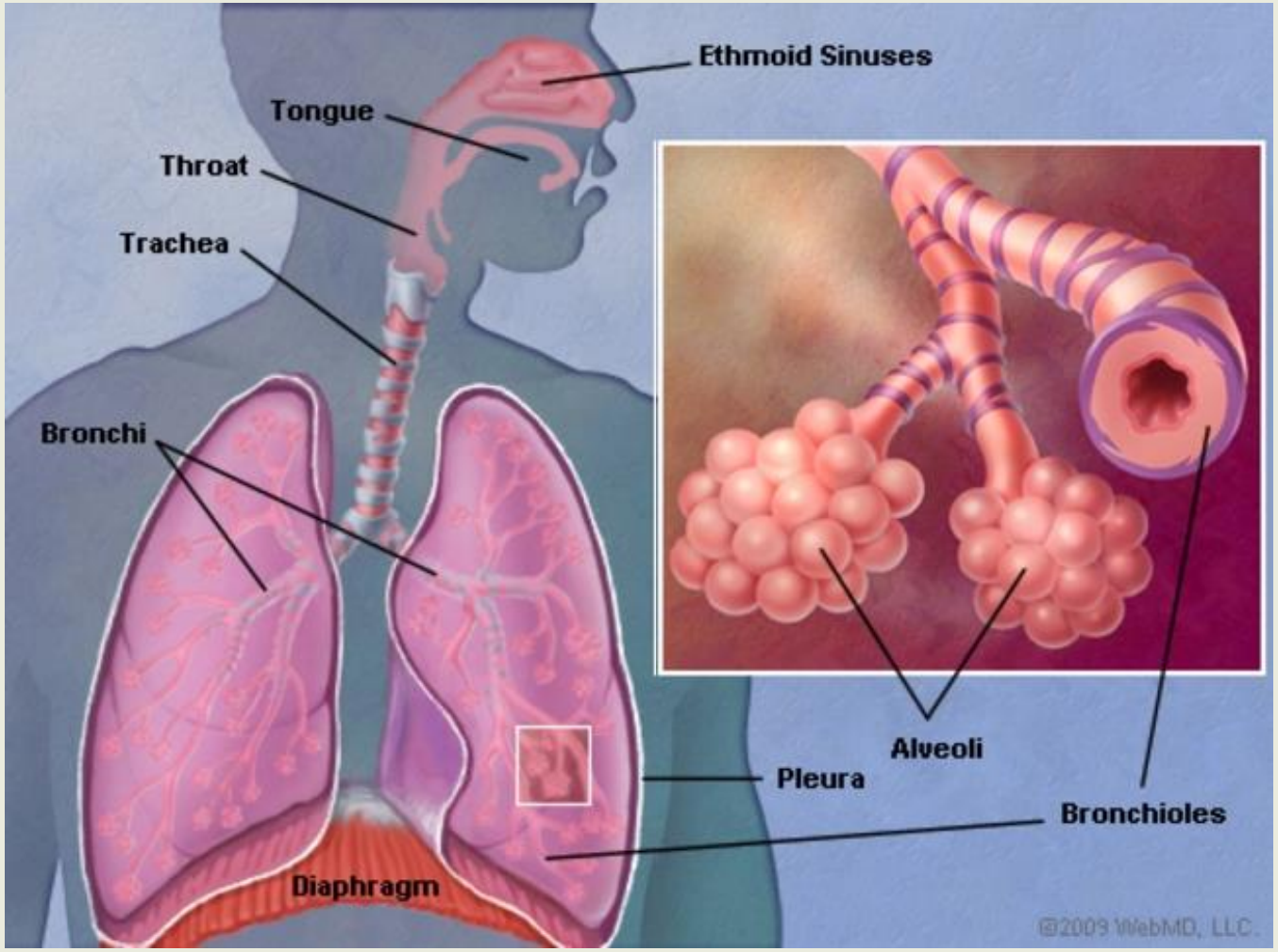
LUNGS :

These are the **main respiratory organs** of humans.

A pair of lungs

Each lung - **double pleural membrane,**
outer parietal and inner visceral membrane.
Pleural cavity – **pleural fluid**





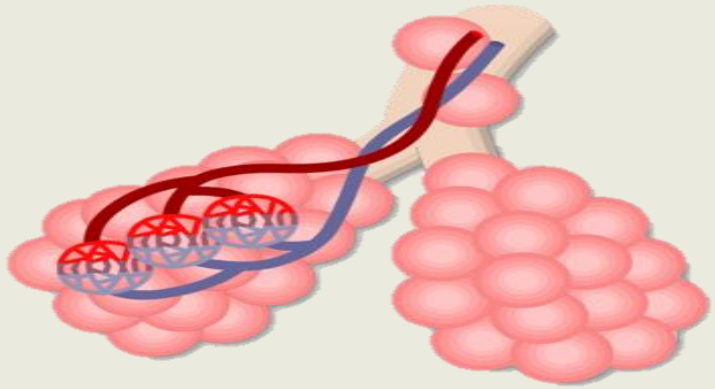
The right lung - **3 lobes**

The left lung - **2 lobes**

Terminal bronchioles ending in a bunch of air sacs, each with **10 to 12 alveoli.**

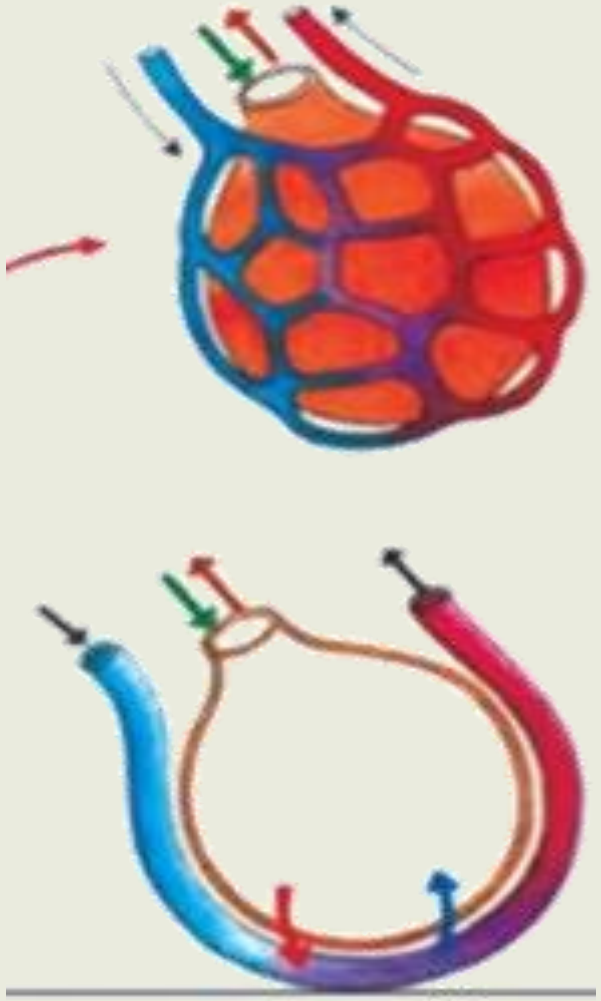
ALVEOLI:

Are thin walled lobulated structures, like a bunch of grapes.



About 700 million alveoli are present in the lungs and they provide the surface area for exchange of gases.

Each alveolus is surrounded by a **network of capillaries of pulmonary arteries and veins** having highly elastic walls made up of a single layer of **squamous epithelium resting on a basement membrane**



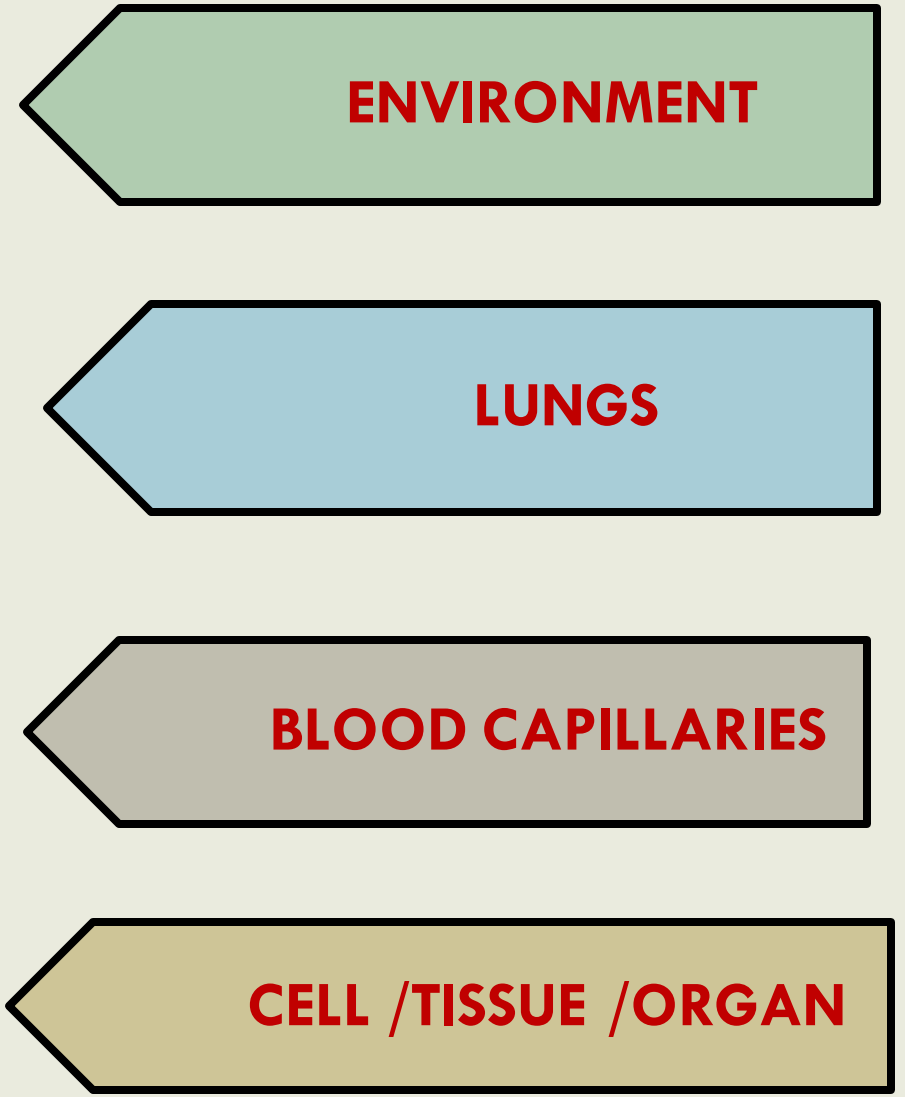
Mechanism of respiration:

A.Breathing

B. External respiration

C. Internal respiration

D. Cellular respiration

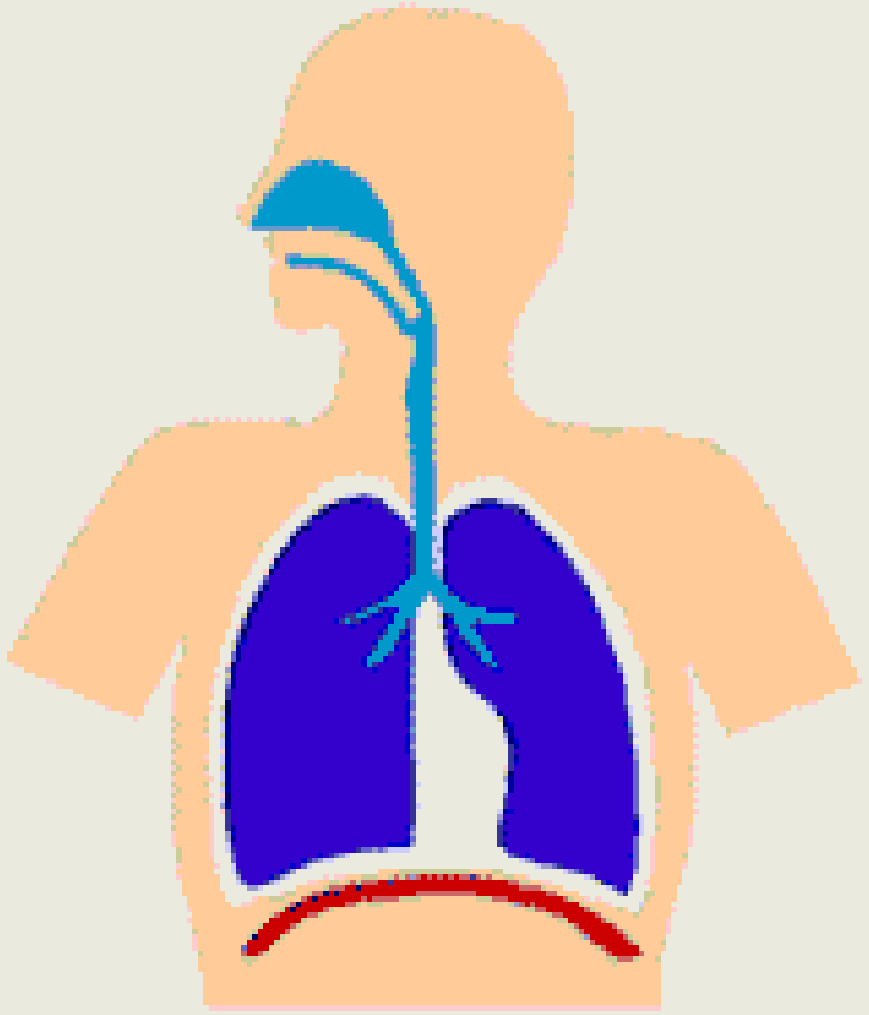


A. Breathing

Involves two mechanical processes:

1) **Inspiration**
   (take in oxygen)

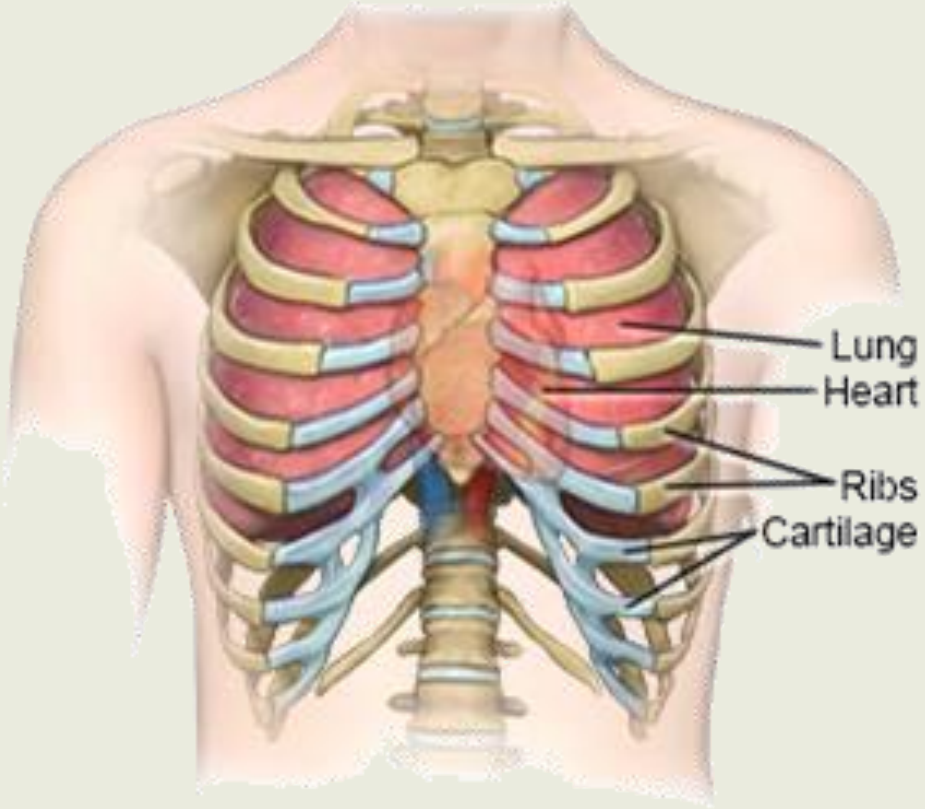
2) **Expiration**
   (Give out carbondioxide)

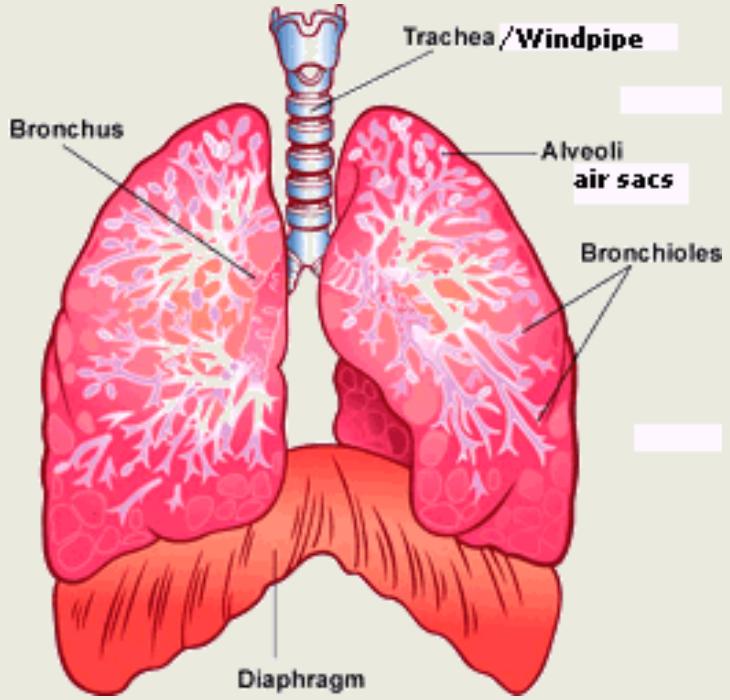


Involves:

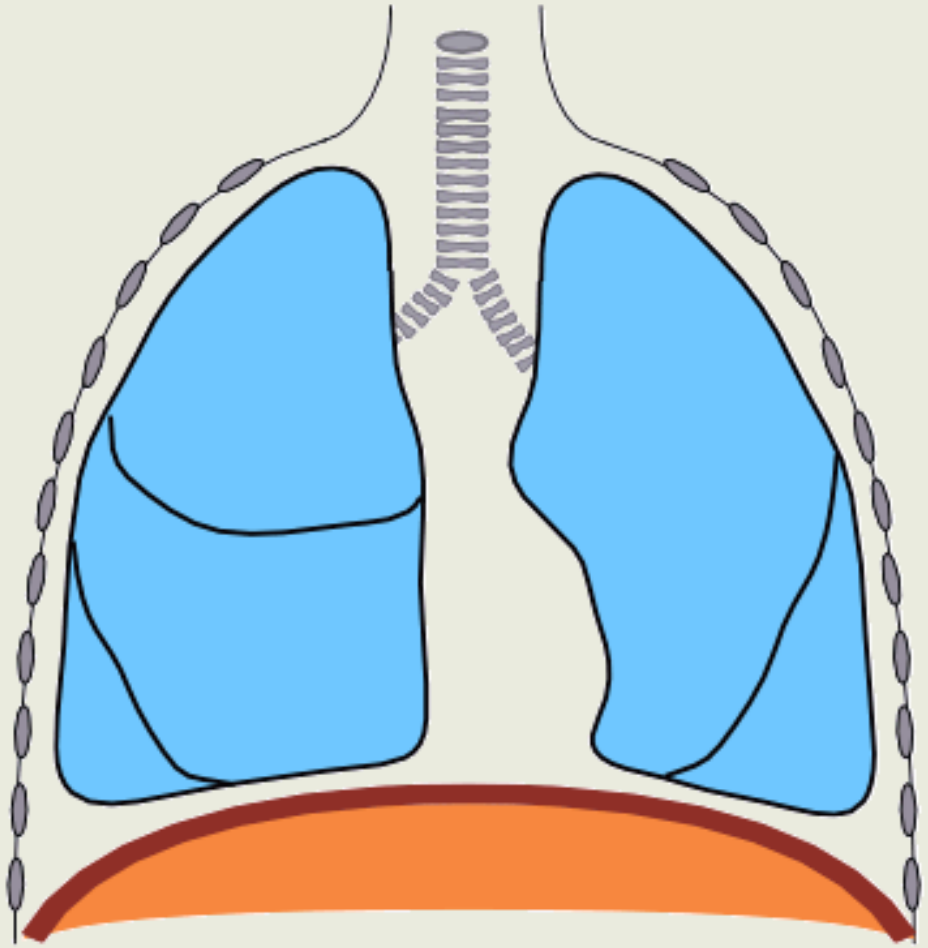
(Parts of thoracic cage)

- **Ribs**
- **Sternum**
- **Intercostal muscles**
- **Diaphragm**





Inspiration



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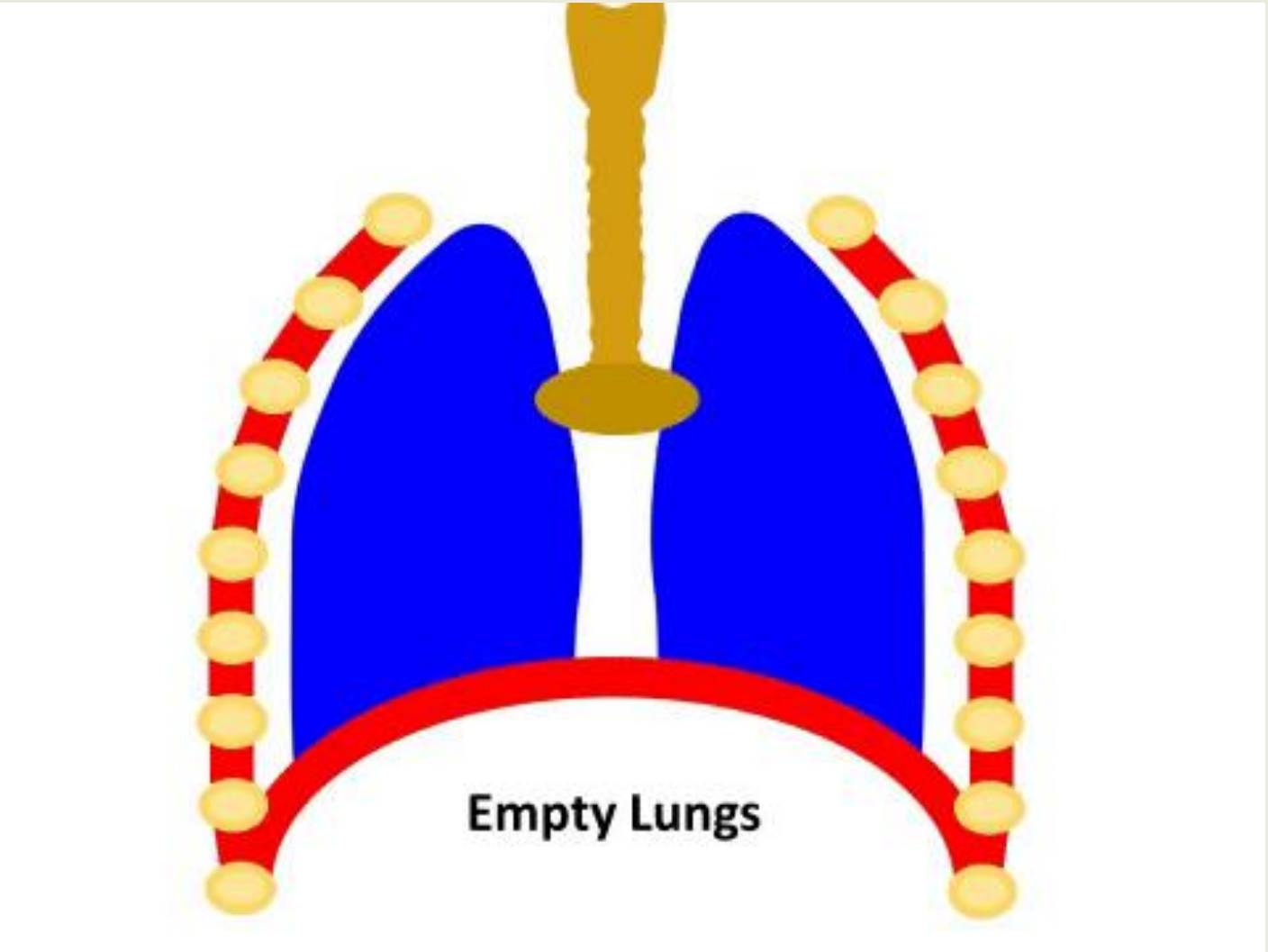
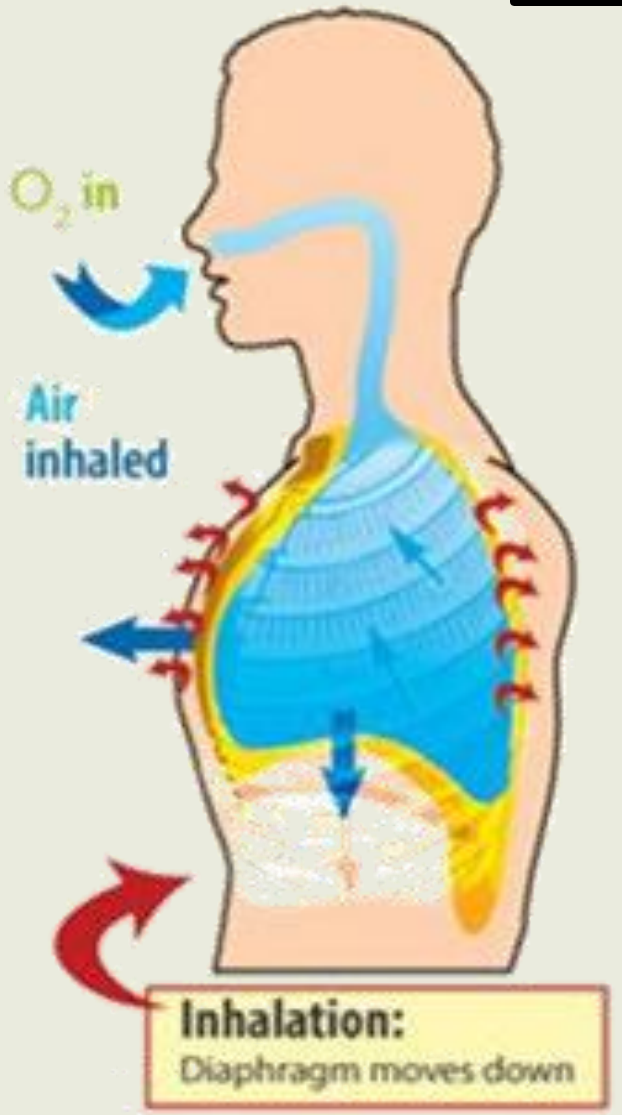
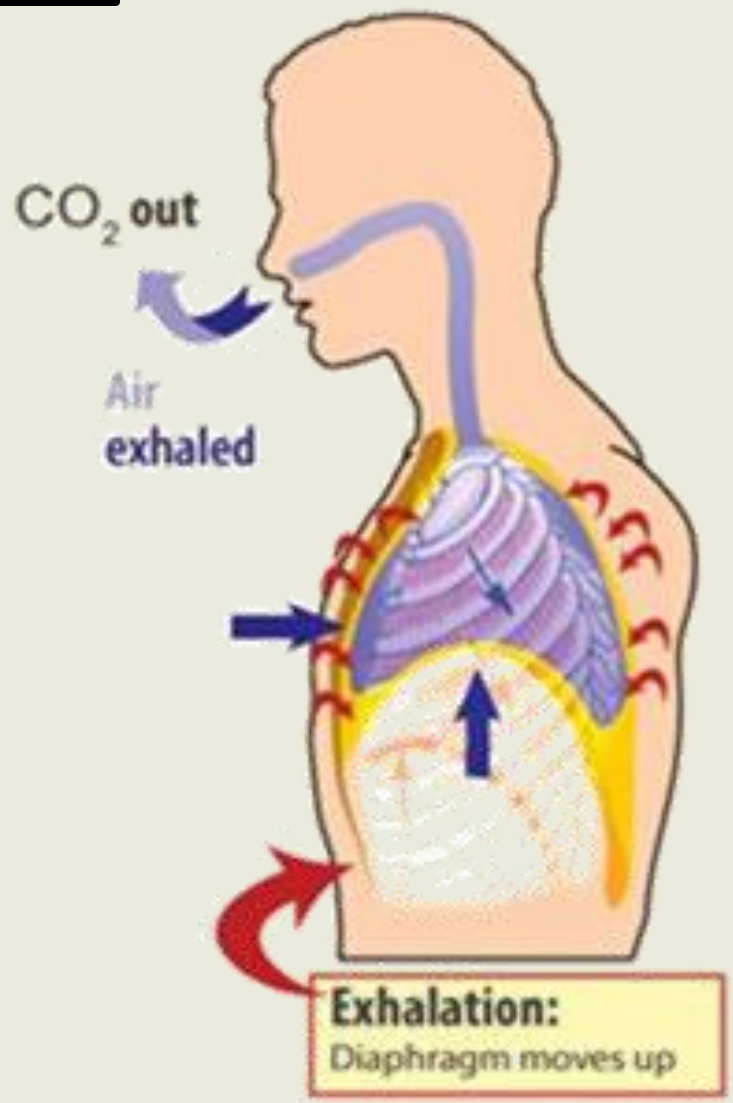
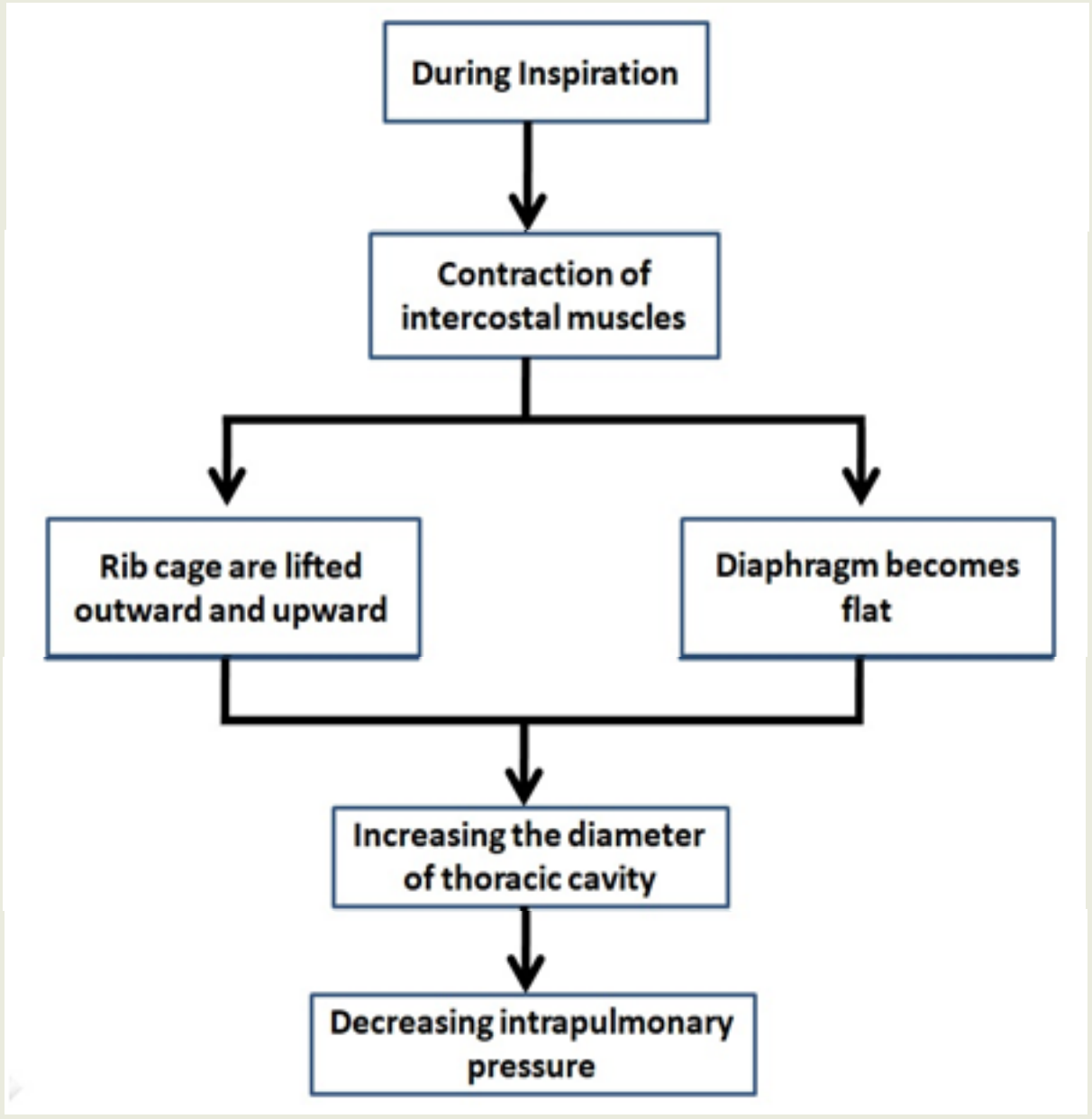
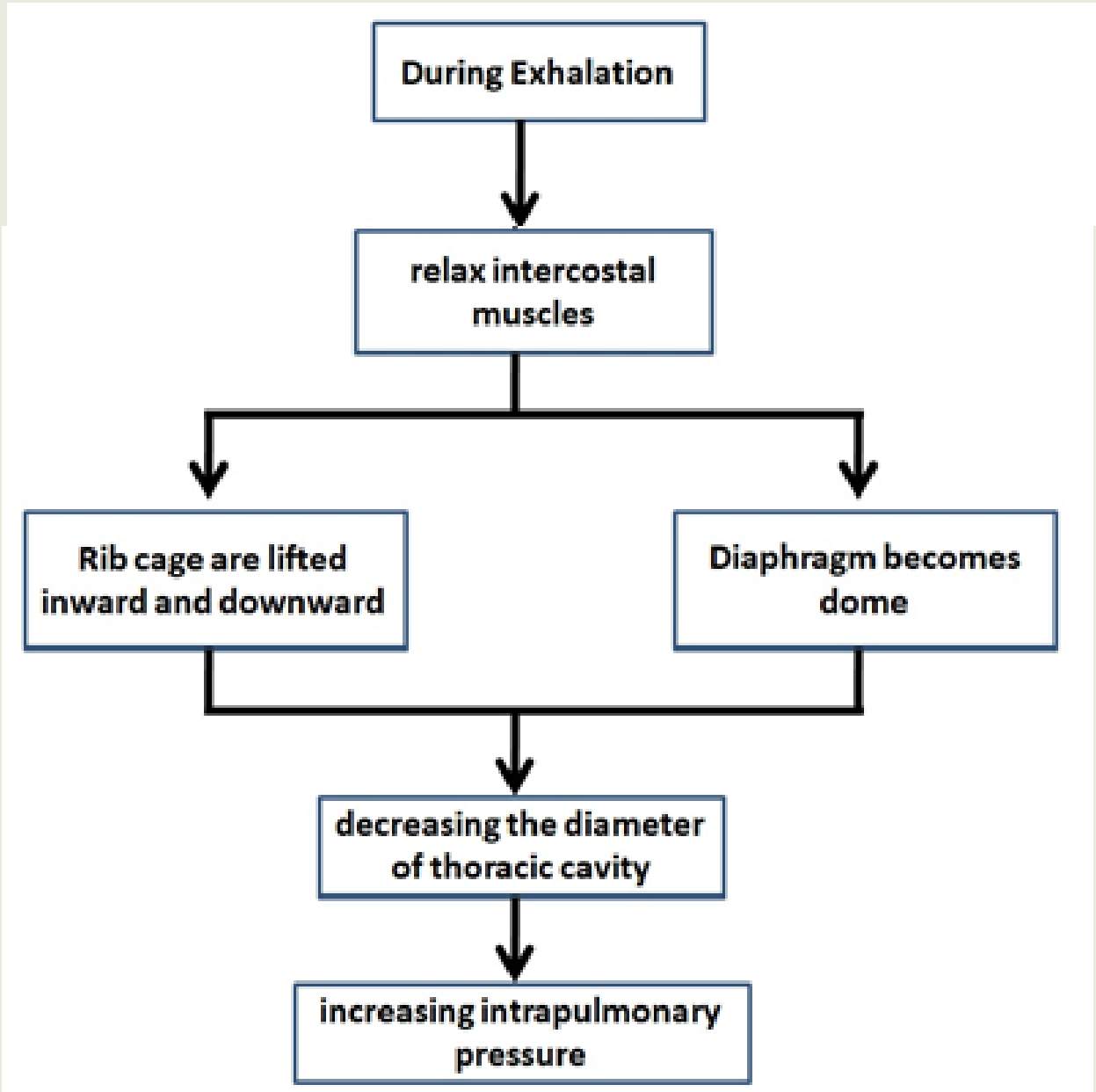

Empty Lungs

BREATHING

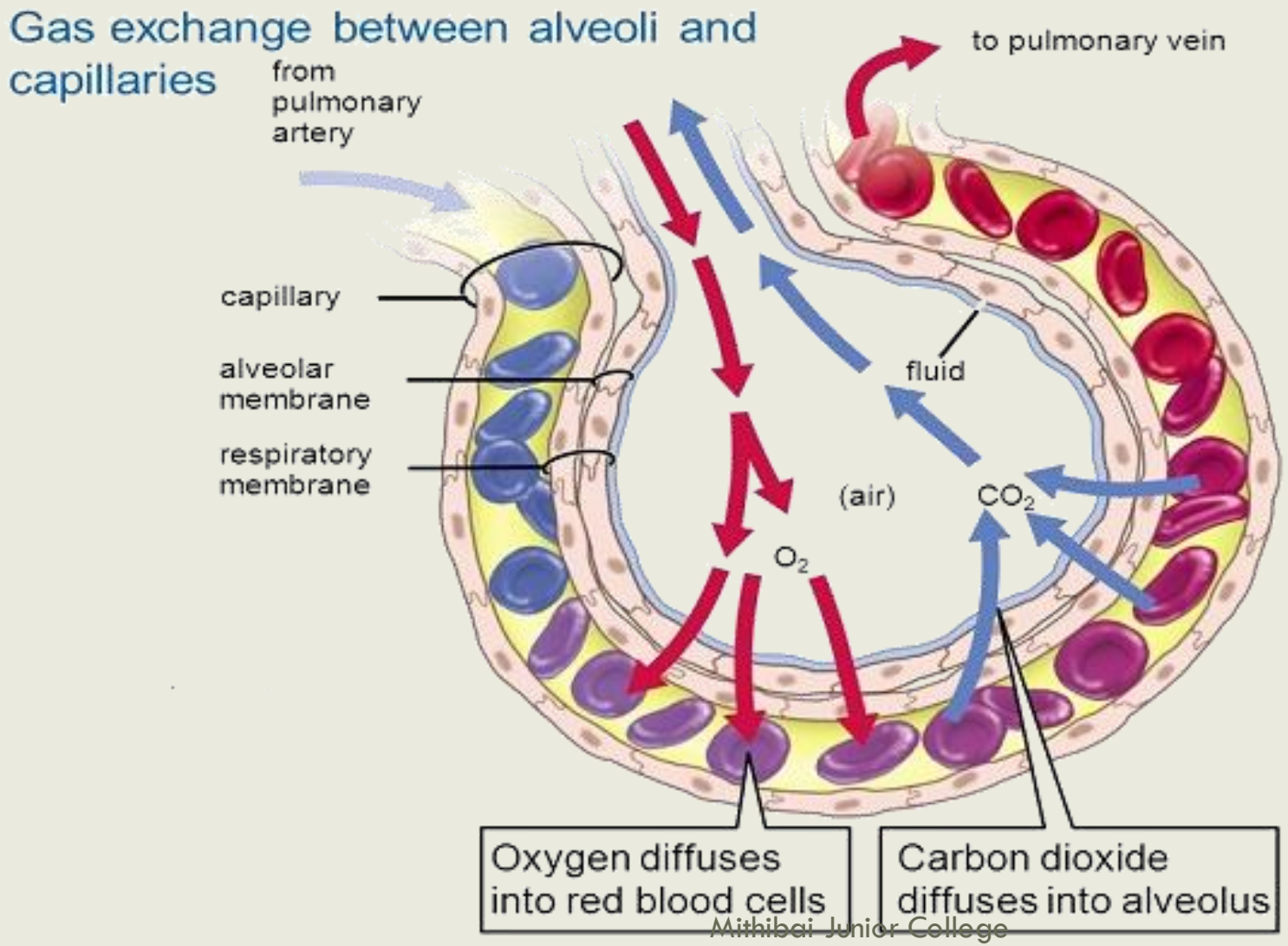

O_2 in
Air
inhaled
Inhalation:
Diaphragm moves down


CO_2 out
Air
exhaled
Exhalation:
Diaphragm moves up


During Inspiration
Contraction of intercostal muscles
Rib cage are lifted outward and upward
Diaphragm becomes flat
Increasing the diameter of thoracic cavity
Decreasing intrapulmonary pressure


During Exhalation
relax intercostal muscles
Rib cage are lifted inward and downward
Diaphragm becomes dome
decreasing the diameter of thoracic cavity
increasing intrapulmonary pressure

B. EXTERNAL RESPIRATION/ EXCHANGE OF GASES AT THE ALVEOLAR LEVEL :

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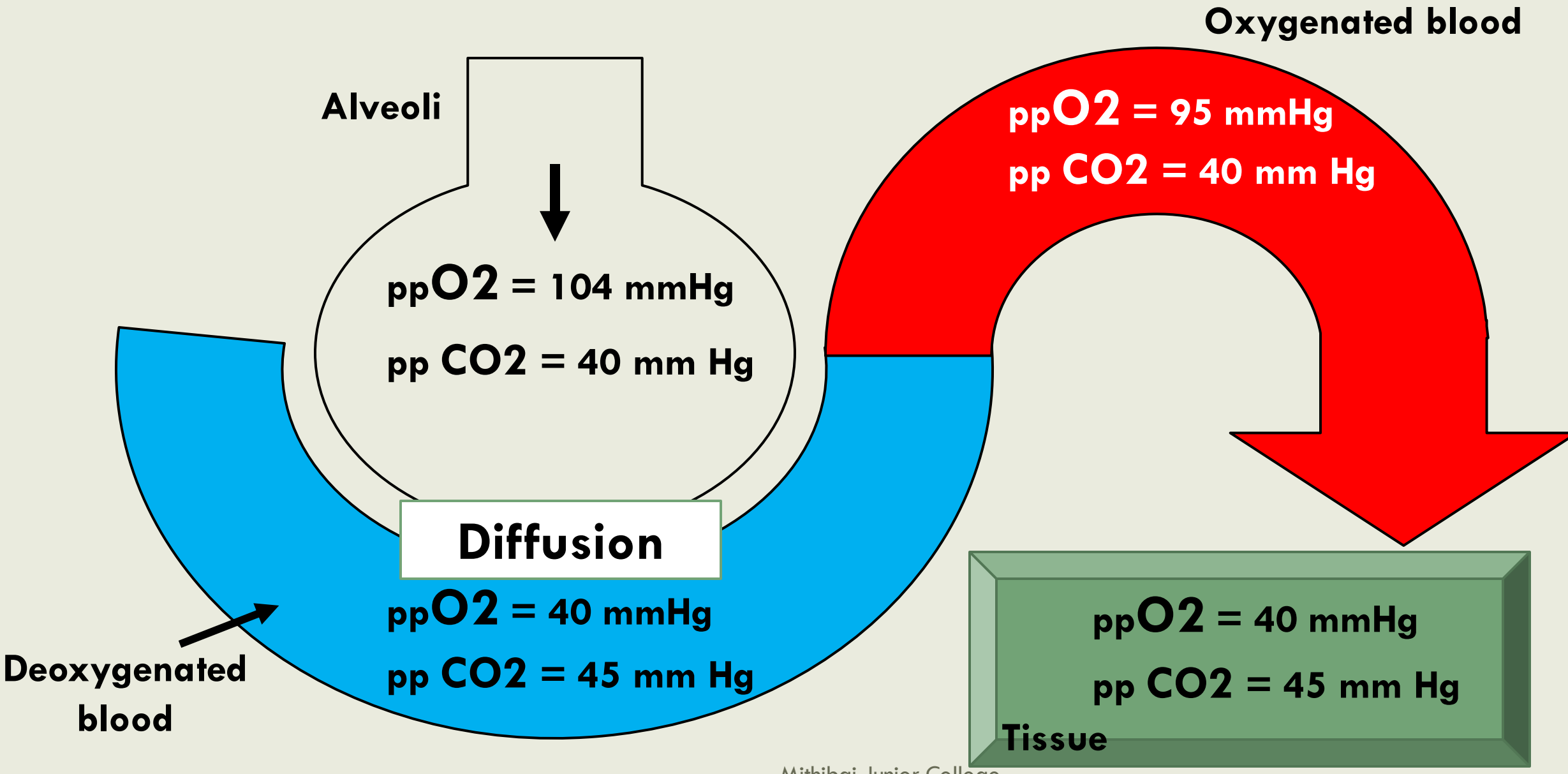
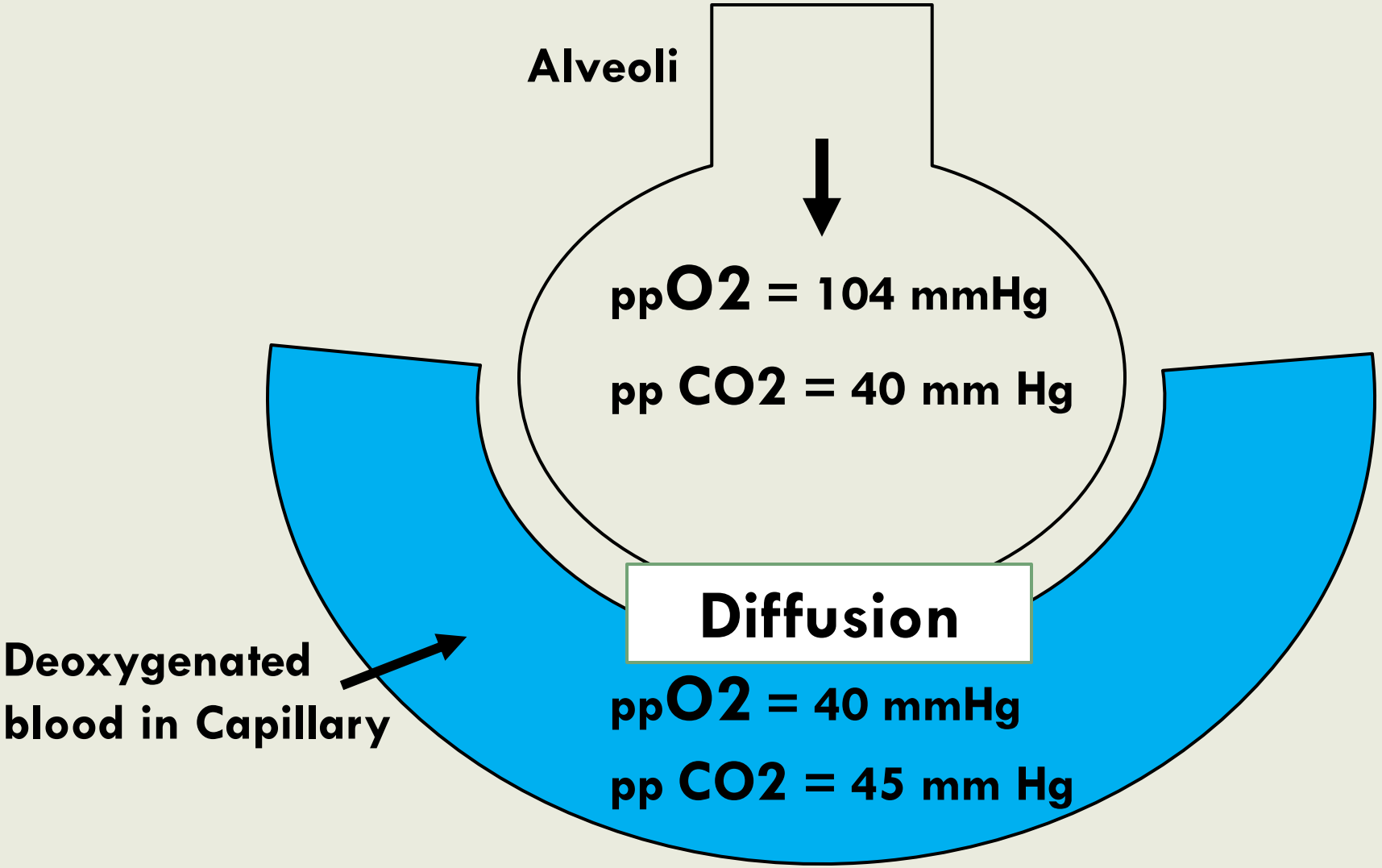
B. EXTERNAL RESPIRATION/ EXCHANGE OF GASES AT THE ALVEOLAR LEVEL :



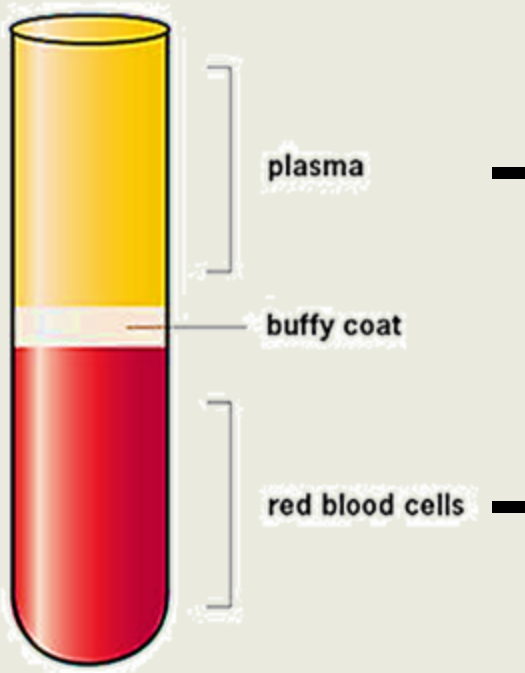
B. EXTERNAL RESPIRATION/ EXCHANGE OF GASES AT THE ALVEOLAR LEVEL :



Due to this difference **oxygen diffuses from alveoli to the capillaries**.

C. INTERNAL RESPIRATION :

1. OXYGEN TRANSPORT

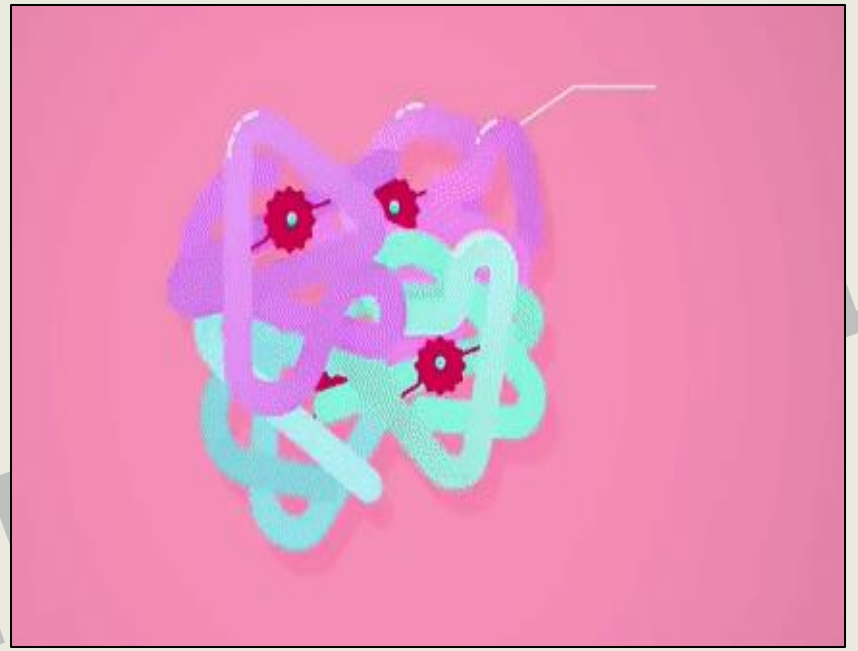


3 % - In dissolved state

97 % - As Oxyhaemoglobin

As Oxyhaemoglobin by RBCs – 97%

RBC



Haemoglobin

- Made up of
  - Haeme (4 Fe) and
  - Globin (2 α and β protein chains)
- Respiratory Carrier
- Has high affinity for O_2
- Undergoes Oxygenation.
- Haeme + O_2 = Oxyhaemoglobin

1 Hemoglobin molecule

4 Fe in Hb + 4 O_2 $\longleftrightarrow$ Hb (4 O_2)

In Lungs

Saturation of Hb (Binding of Hb and O2)

Hb + 4 O_2 $\longrightarrow$ Hb (4 O_2)

In tissues

Dissociation of O2 (Separation of Hb and O2)

Hb (4 O_2) $\longrightarrow$ Hb + 4O2

In Lungs

Saturation of Hb (Binding of Hb and O2)

$$Hb + 4\ O_2 \longrightarrow Hb\ (4\ O_2)$$

Hb saturation in different conditions

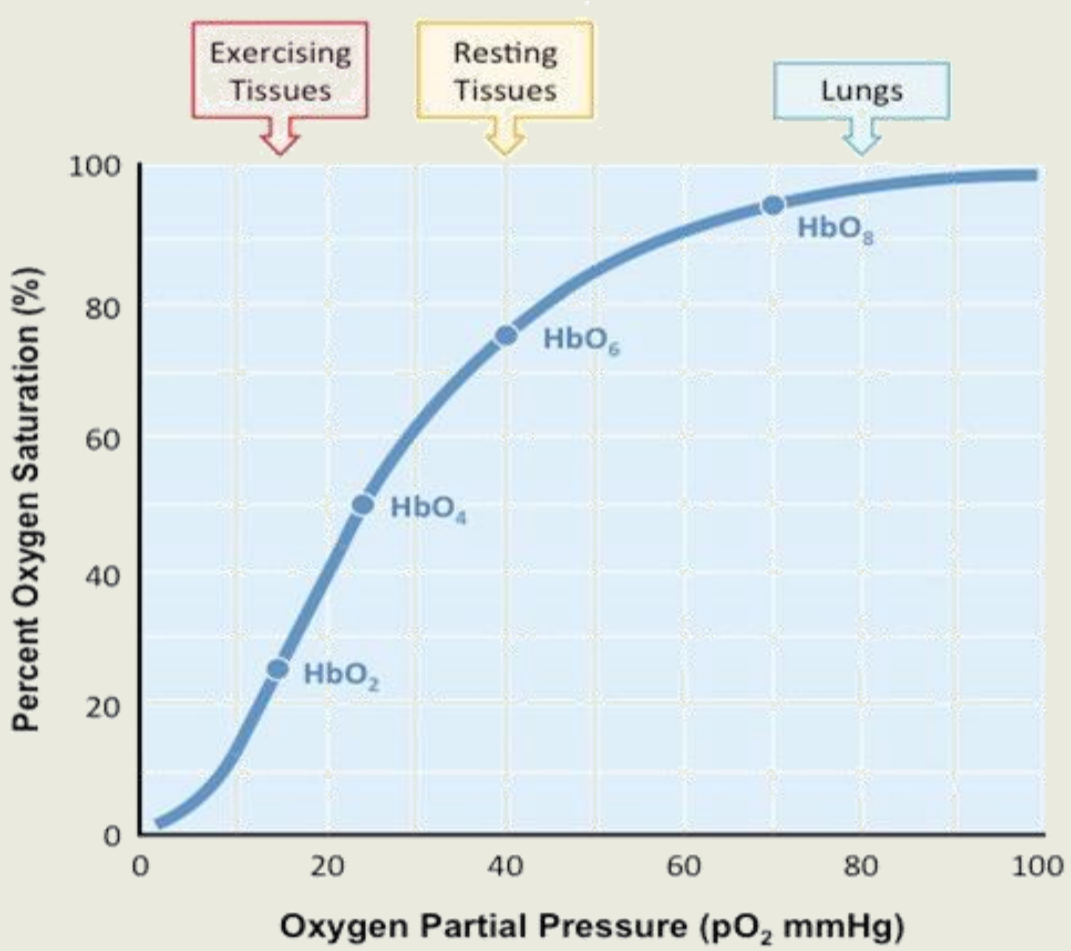
Saturation rate	ppO2
100 %	Rare (should be more than 104 mm Hg)
95 to 97 %	100 mm Hg
50 %	30 mmHg

As ppO2 decreases, rate of Hb saturation also decreases.

As ppO2 increases, rate of Hb saturation also increases.

OXYGEN DISSOCIATION CURVE

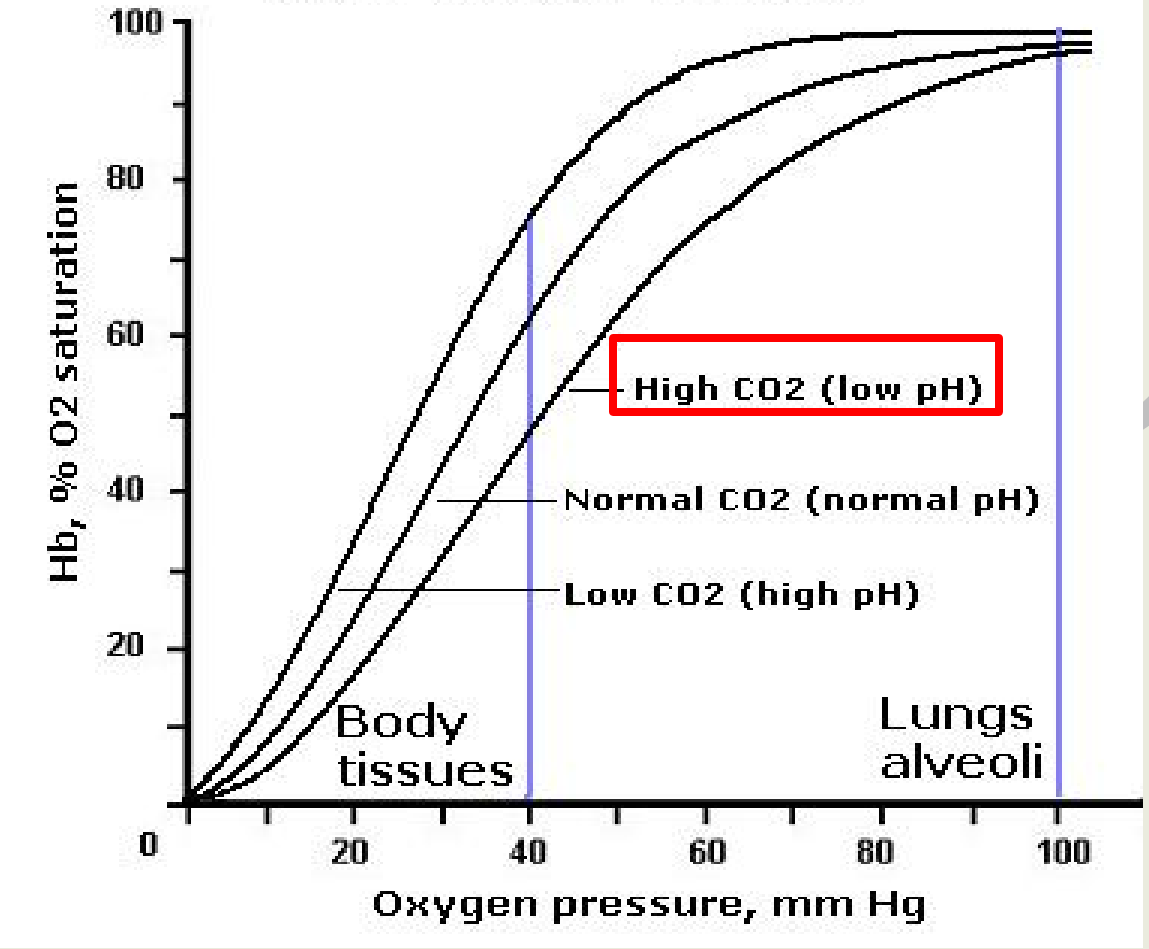
Relationship between HbO_2 saturation and oxygen tension (ppO_2)



- % of Hb in its saturated form is plotted against partial pressure of O2.
- A **Sigmoid curve** is obtained
- Represents : as the ppO2 increases , Hb saturation also increases until an equilibrium is reached.
- **Factors affecting oxygen dissociation curve :**
  - **H^+ conc (pH).**
  - **Temperature (increase)**
  - **Rise in DPG (2,3 diphosphoglycerate)**
  - **$ppCO_2$ (increase)**

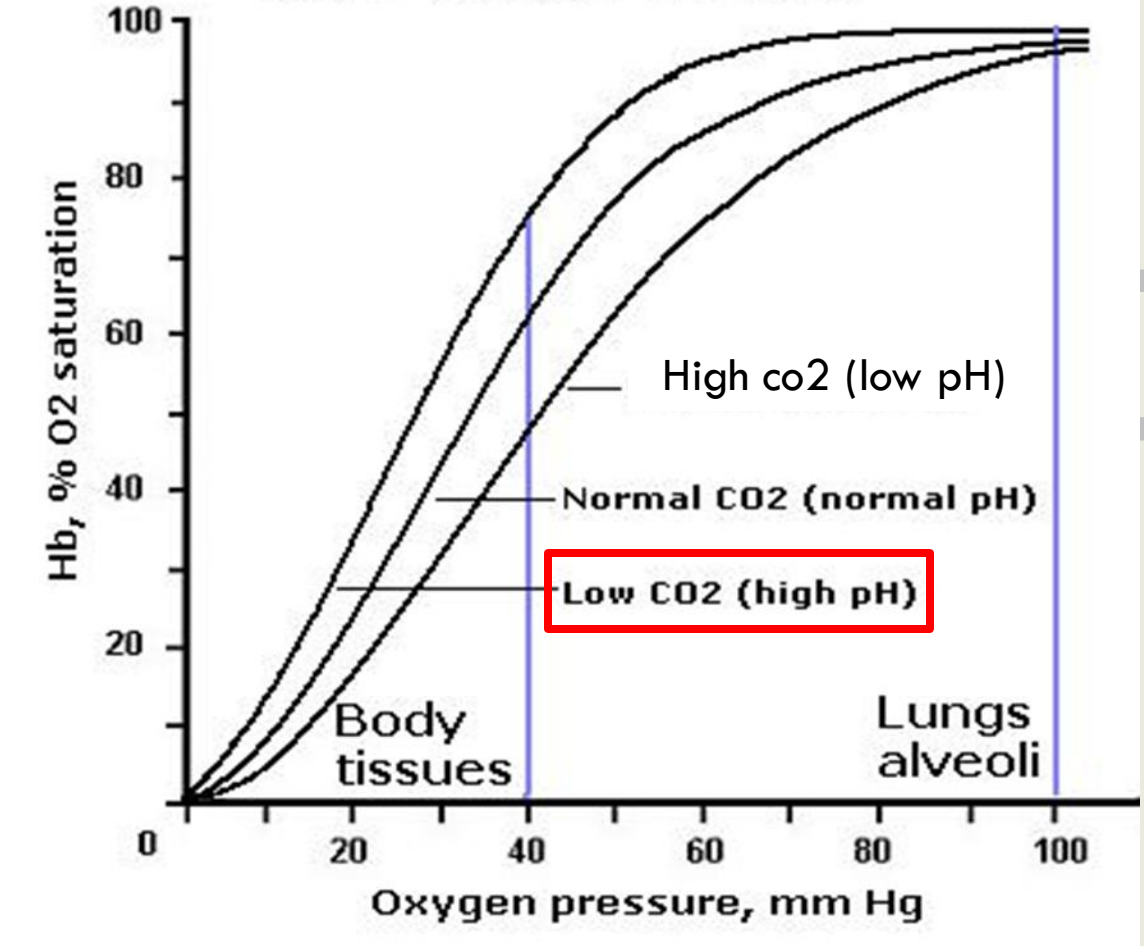
  (It reduces affinity of haemoglobin to oxygen)

Bohr Effect by Christian Bohr



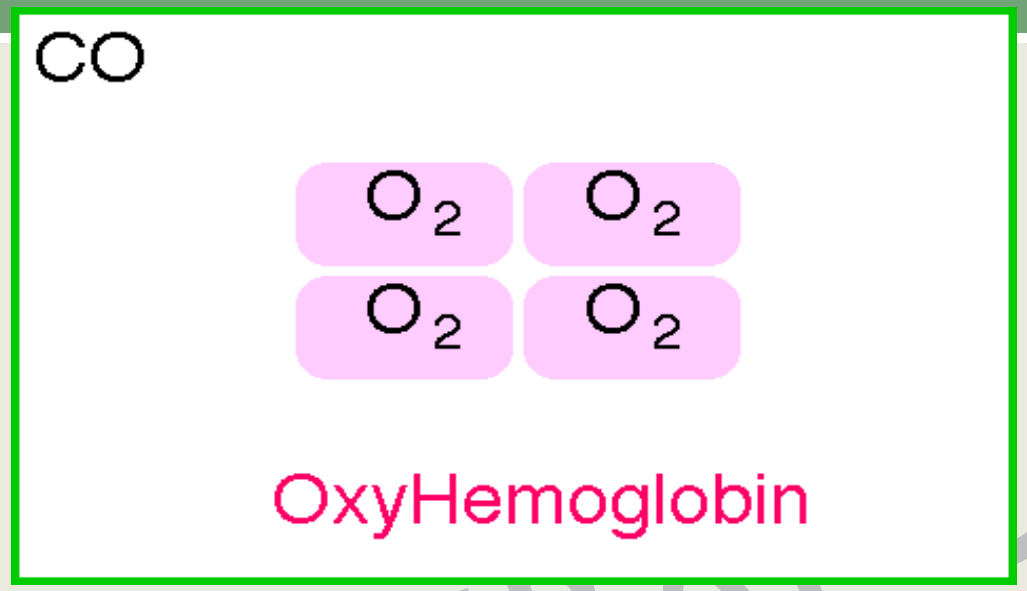
- **Rightward shift of curve**
- Due to :
  - Change in pp CO2
  - **pp CO2 is higher** in tissues due to metabolism.
  - Later changes to carbonic acid
  - Leads to decrease in pH.
- **Conclusion : more oxygen dissociation**

Haldane Effect by John Scott Haldane



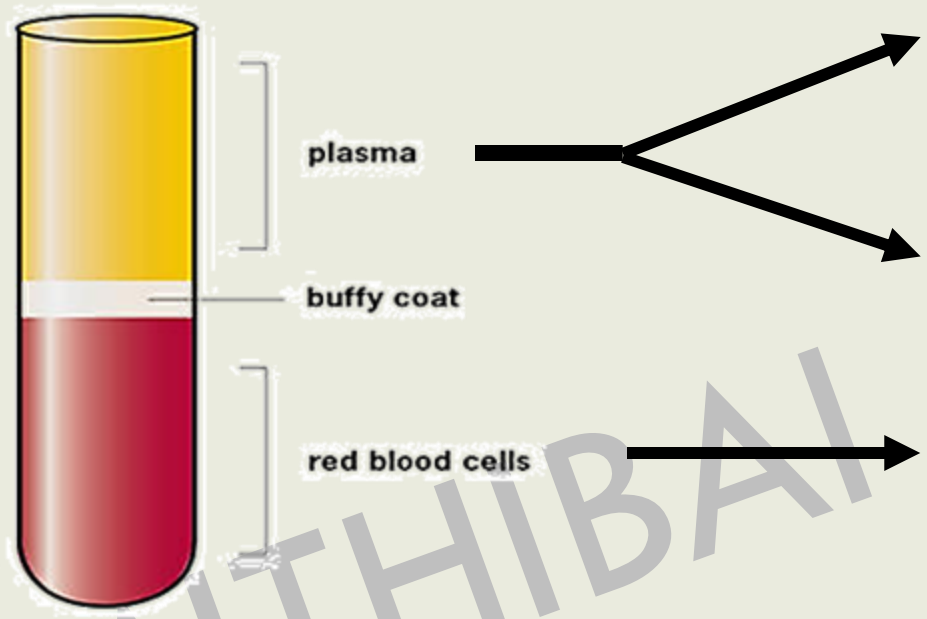
- **Leftward shift of curve**
- Due to :
  - **pp CO2 is lower** in alveoli due to inhalation.
  - OxyHb in alveoli acts as an acid and releases H^+ which is accepted by $HCO3^-$ to form H2O and CO2.
  - Leads to increase in pH.
- **Conclusion : More Hb saturation**

Carbon monoxide Poisoning



- Hb has 250 times more affinity towards CO.
- Readily forms Carboxyhemoglobin.
- Less Hb available for O2 transport.
- Tissue deprived of O2.

2. CARBON DIOXIDE TRANSPORT



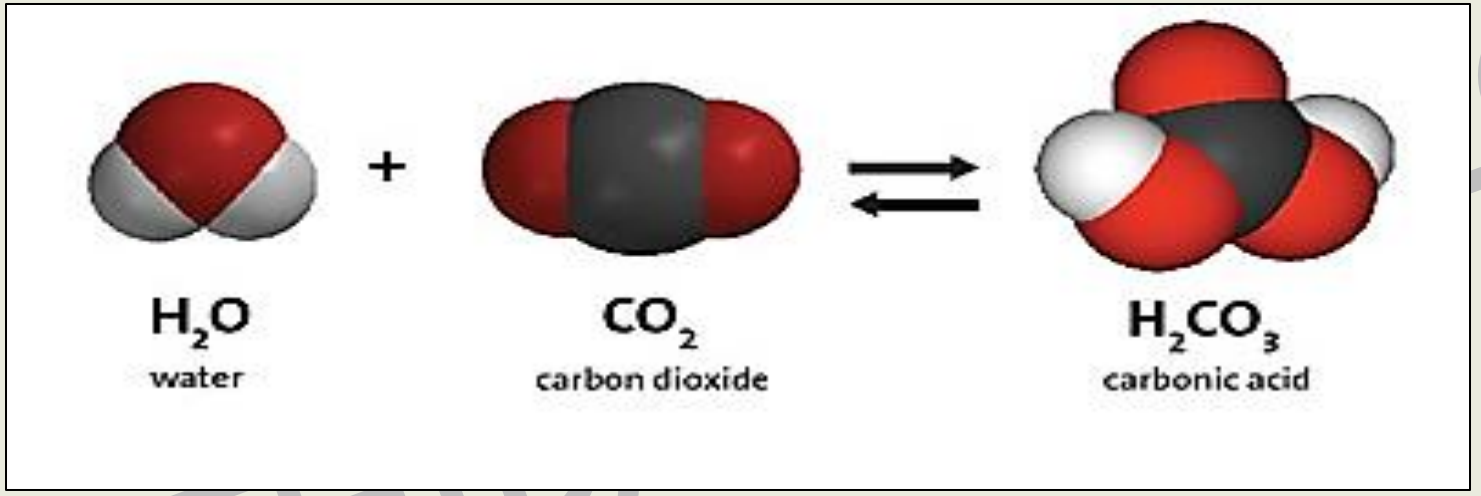
7 % - In dissolved state

70 % - as bicarbonate ions

23 % - as Carbaminohaemoglobin

a) In solution (dissolved) form

- 7 % Co2 transported in dissolved form in plasma.

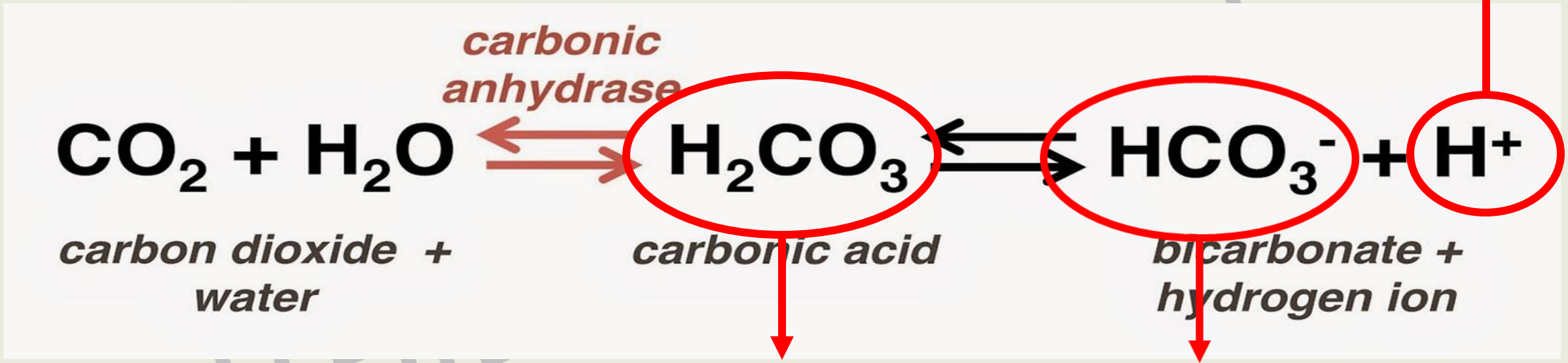


- But the reaction is very slow and reversible.

b) As bicarbonate ions – 70%

Binds to Hb

- Reaction takes place in RBCs and later bicarbonate ions are



Highly unstable

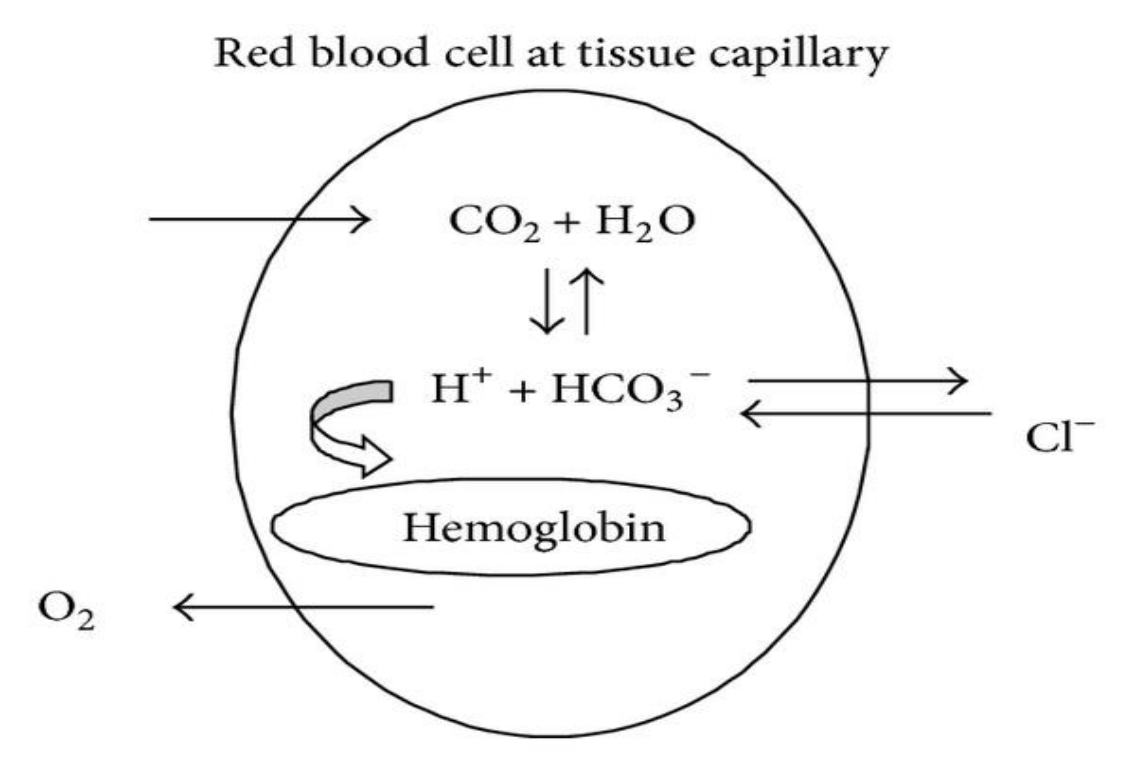
Moves out of RBC, in plasma

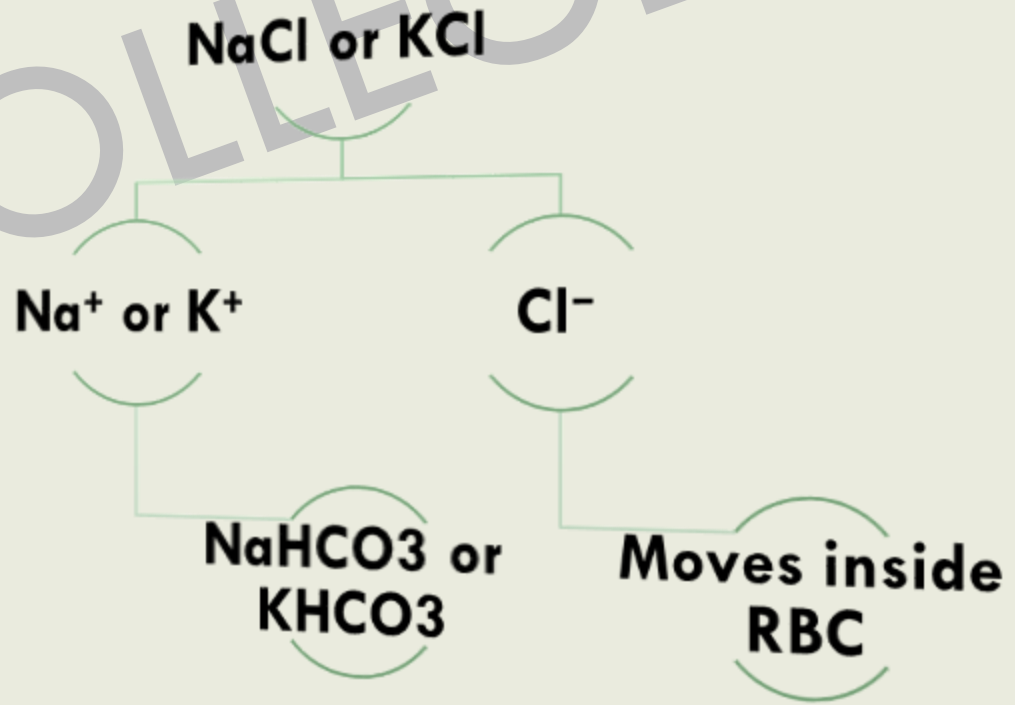
Leads to imbalance of charge inside RBCs

Hamburger's Phenomenon – Chloride Shift by Hartog Jacob Hamburger.

Exchange of Negative Ions which maintains electrical balance between Plasma and RBC cytosol

- Diffusion of $HCO3^-$ (Bicarbonate) ions from RBCs to plasma, Develops charge imbalance in RBCs
- To maintain the charge neutrality, Cl ions enters the RBCs





At the level of tissues

$$CO_2 + H_2O \xleftrightarrow{CA} H_2CO_3 \xleftrightarrow{CA} HCO_3^- + H^+$$

$HCO_3^- + Na^+ \longrightarrow NaHCO_3$ (Sodium Bicarbonate)

$HCO_3^- + K^+ \longrightarrow KHCO_3$ (Potassium Bicarbonate)

$Hb + H^+ \longrightarrow HHb$ (Reduced Hb/ Deoxyhaemoglobin)

H^+ can lower the blood ph.
Hence, they are buffered by Hb, by formation of deoxyhaemoglobin.

At the level of lungs

Because of low ppCO2

$$HHb \longrightarrow Hb + H^+$$

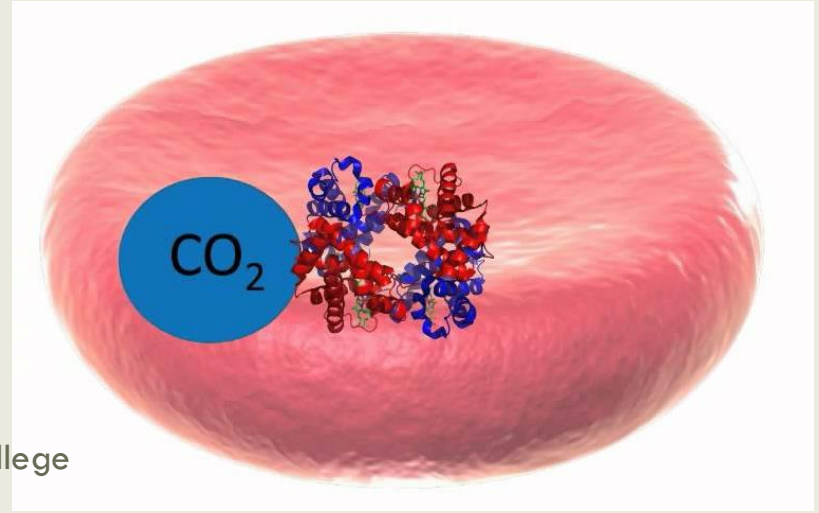
$$HCO_3^- + H^+ \xleftrightarrow{CA} H_2CO_3 \xleftrightarrow{CA} CO_2 + H_2O$$

c) As Carbaminohaemoglobin – by RBCs

- **23%** Carbon dioxide binds with the **amino group of the haemoglobin** and form a loosely bound compound **carbaminohaemoglobin.**

- This molecule readily decomposes in region where the partial pressure of carbon dioxide ($ppCO_2$) is low (alveolar region), releasing the carbon dioxide.

$$Hb + CO_2 \leftrightarrows HbCO_2$$



D) CELLULAR RESPIRATION :

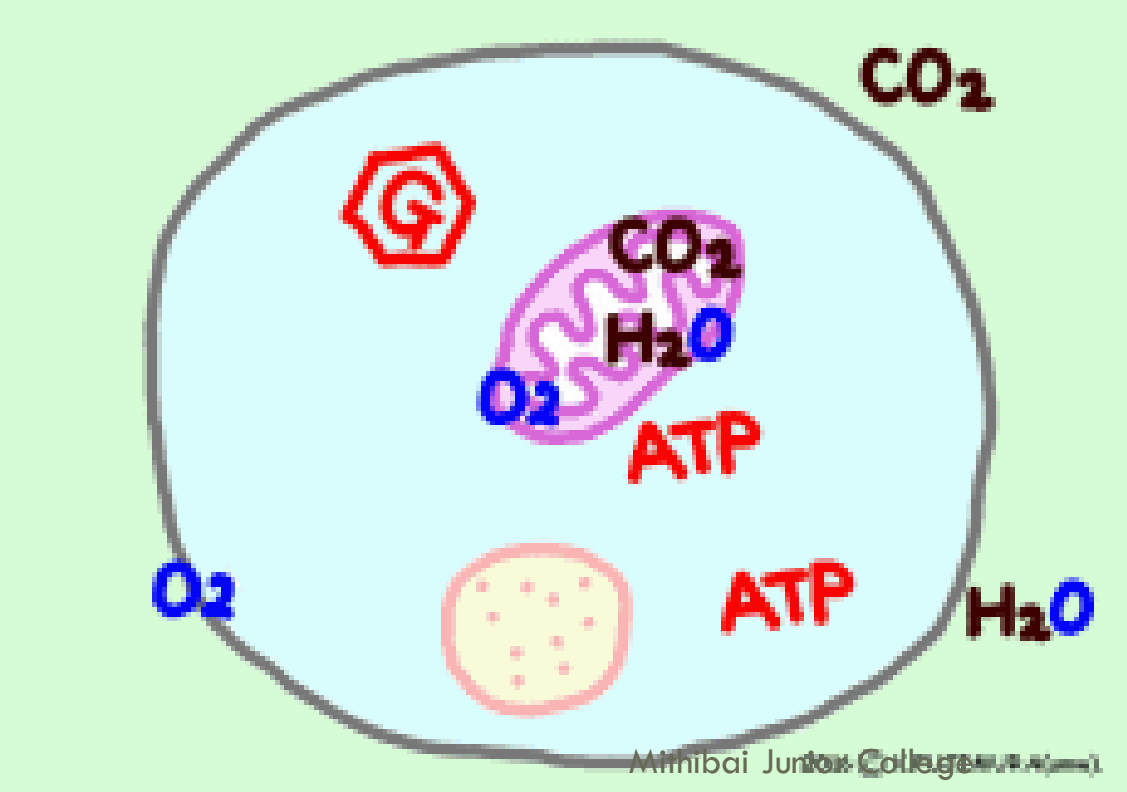
Food is oxidized and ATP is generated. It can be shown by two steps:

Oxidation

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + 686$ kcal

Phosphorylation

ADP + iP + 7.3 Kcal → ATP



Regulation of respiration

Normal breathing: Involuntary control but we can voluntary change the pattern of breathing.

Steady rate of Respiration- controlled by:

Neurons (Respiratory centres)

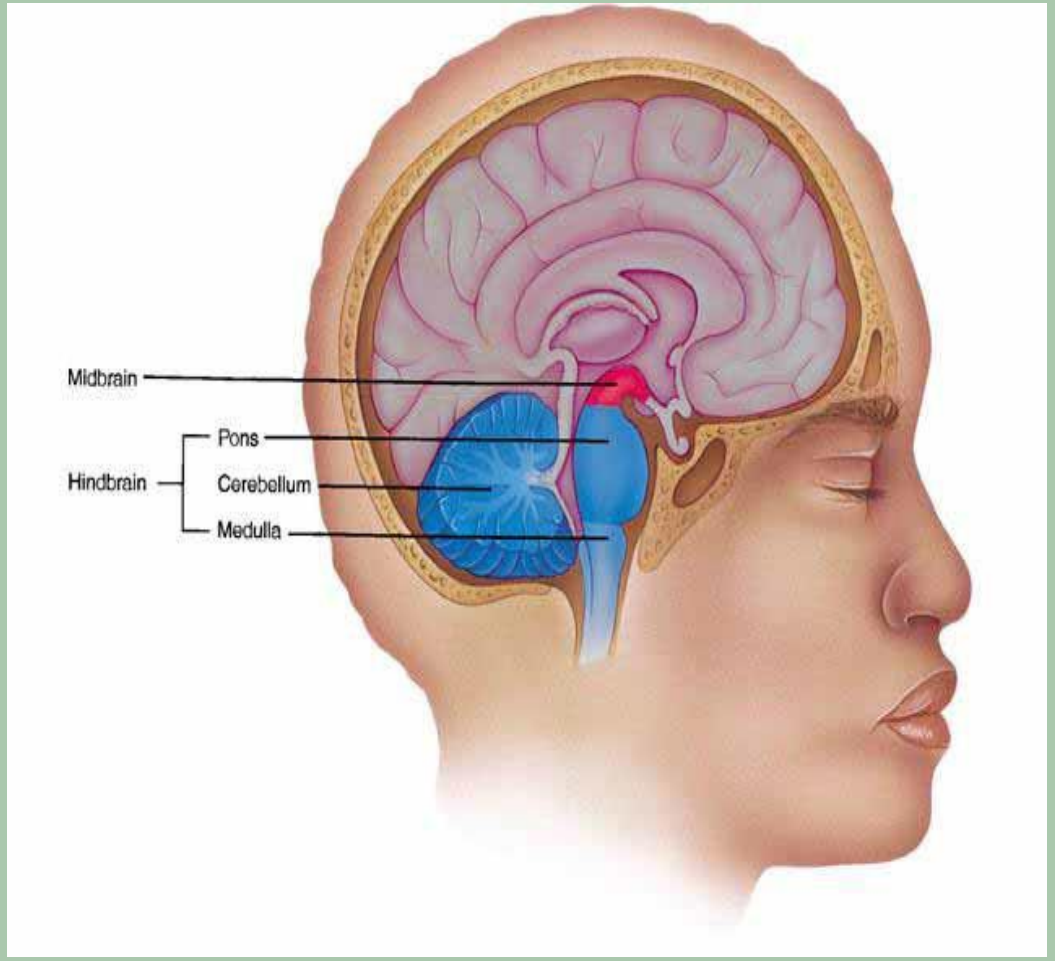
Neural regulation of respiration

Autonomic (involuntary) breathing center

1)Medulla
2) Pons

Regulates rate and depth of breathing

Adults: 12 times/min
Newborns: 44times/min

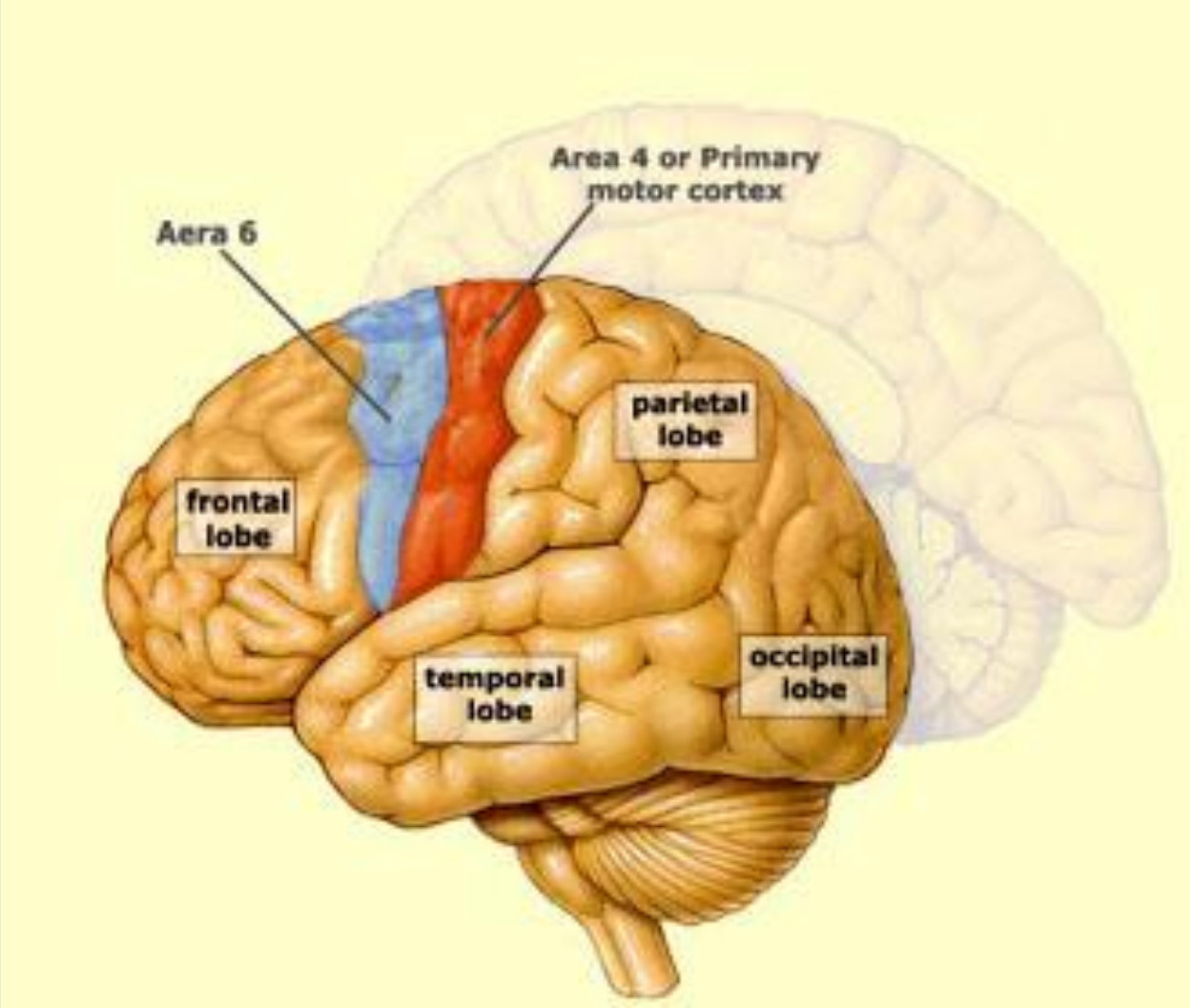


Respiratory centres have connection with

-**Cerebral cortex**

- voluntarily change pattern of breathing

-it is protective



Respiratory centre: a collection of functionally similar neurons that help to regulate the respiratory movement

Basic respiratory centre: produce and control the respiratory rhythm

Medulla -dorsal group ***inspiratory center*** (normal inhalation) &
ventro lateral ***inspiratory and expiratory*** **center (forcefull exhalation)**

Pons - Pneumotaxic center primarily ***limits inspiration. (during exercise breathing increase but vol reduce))***

(slow wave sleep {deep sleep} and rapid eye movement {dreaming stage/bizarre content)

Apneustic center in the medulla is ***antagonistic*** to the **Pneumotaxic center.** It promotes inspiration.

(controls nonrapid eye movement {dreaming is rare} and wakefullness {sleepwalk})

Higher Respiratory Centre:

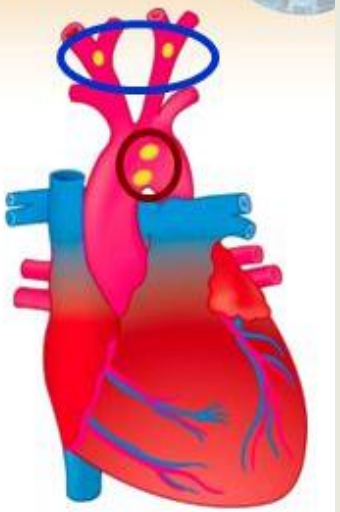
cerebral cortex, hypothalamus & limbic system

Spinal cord: respiratory motor neurons

chemoreceptors in:

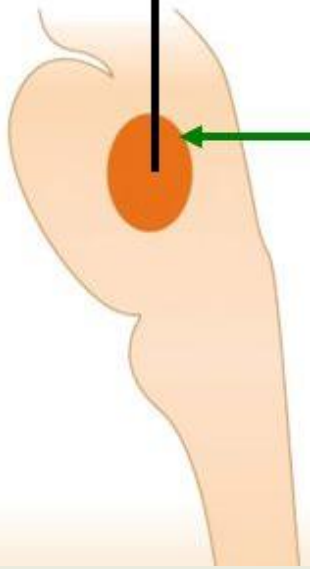
- carotid bodies
- aortic bodies

(sensitive to PO2 and PCo2)

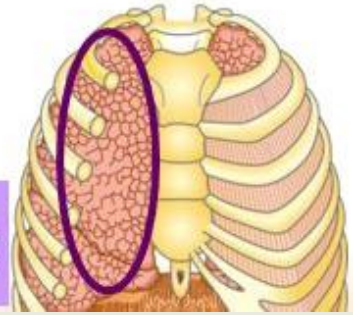


respiratory centre

nerve impulses



stretch receptors



During inspiration

Lungs expand to critical point

Stretch receptors stimulated

Impulses via vagus nerve

To expiratory centre

Sends inhibitory impulses

To inspiratory centre

Inspiratory muscles relax

Stretch receptors not stimulated

Lungs deflate

During expiration

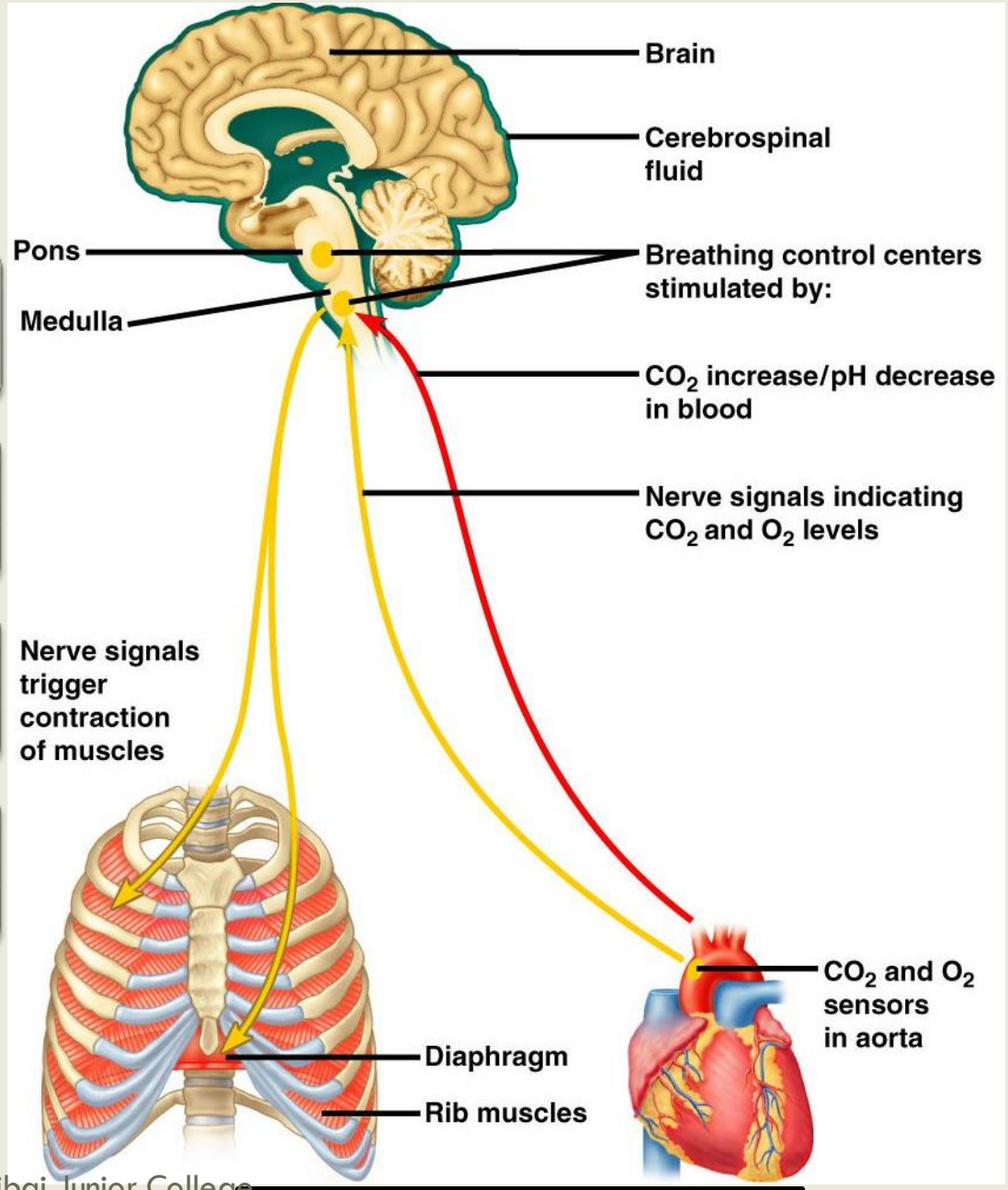
Expiration follows

So inspiratory centre no longer inhibited

New cycle begins

Events called Hering –breuer reflex

Controls depth and rhythm of breathing



Regulation of breathing

Modified Respiratory Movements :

Different from the normal respiratory movements and help express emotion or clear the air passage.

Of these movements some may be reflexes, but others can be initiated voluntarily e.g. coughing and yawning.

Artificial ventilation :

- Artificial respiration

- **Method** of inducing breathing in a person
  - natural respiration has ceased or is faltered (choking /drowning/suffocation)

- **Involves two main steps**

1) establishing and maintaining an open air passage from the upper respiratory tract to the lungs

2) force inspiration and expiration (mouth to mouth or mechanical means

Ventilator : a machine that supports breathing (surgery/treatment)
Used in hospitals

Common disorders of respiratory system
(symptoms/cause/treatment)

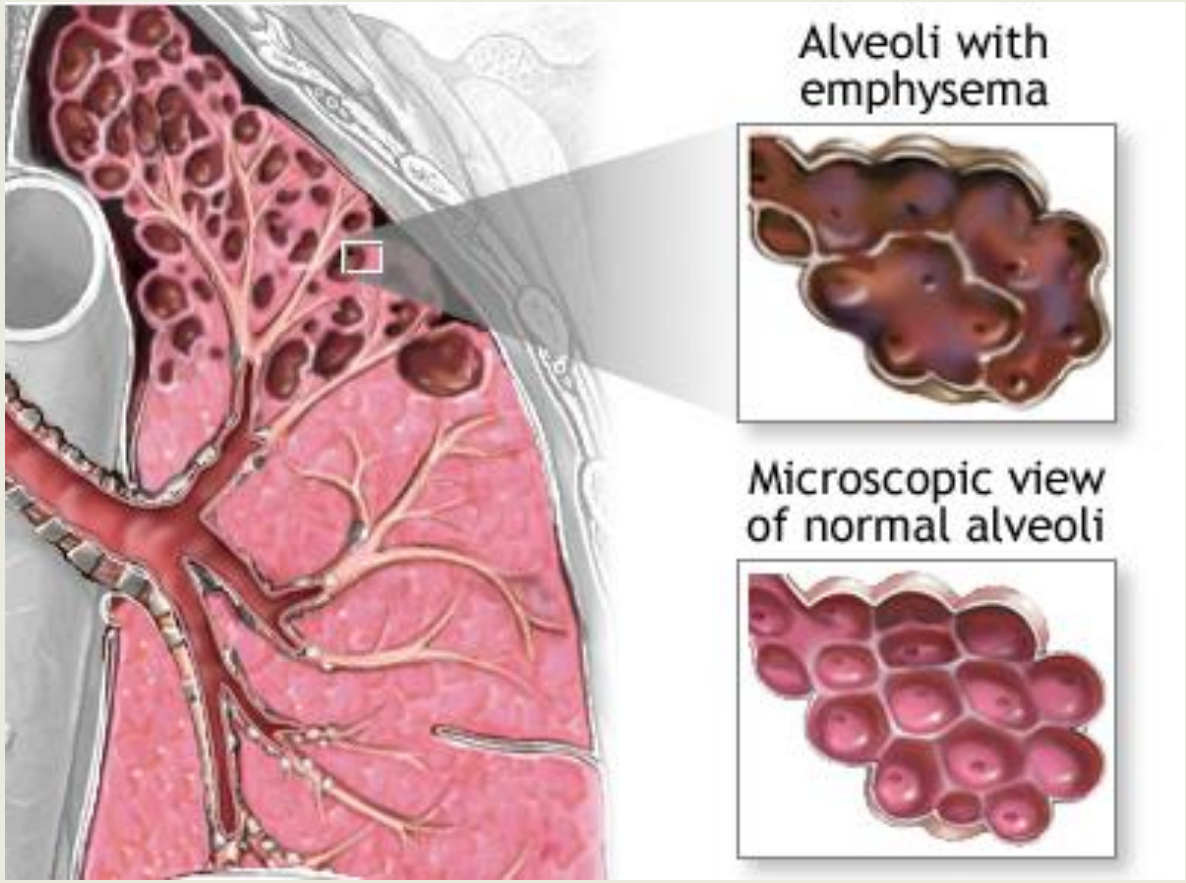
EMPHYSEMA:

Symptoms:

- Shortness of breath
- Alveoli breakdown

Cause: smoking ,air pollution

Treatment: avoid above



CHRONIC BRONCHITIS:

Symptoms:

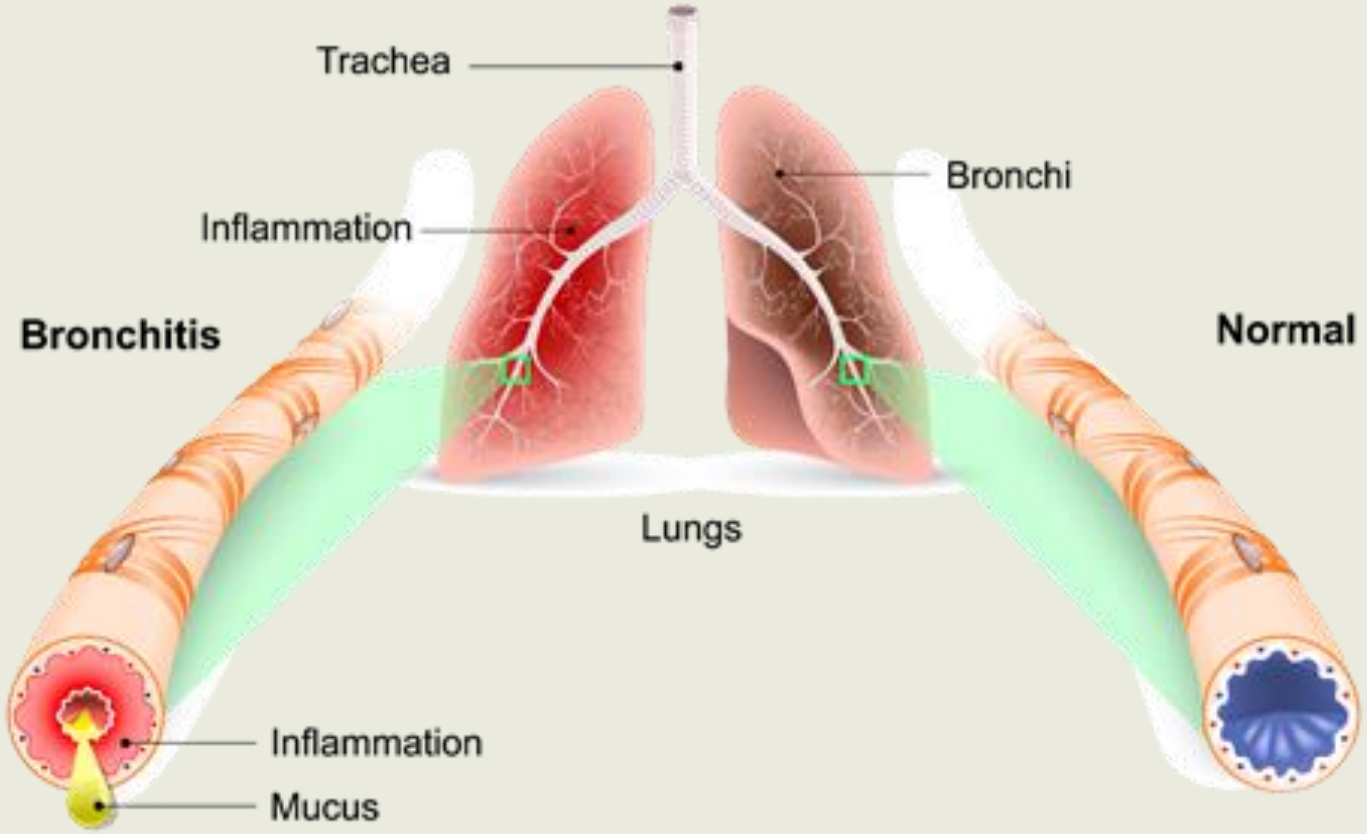
- Coughing
- Shorthness of breath

Cause:

Smoking , air pollution

Treatment:

Avoid above



ACUTE BRONCHITIS:

Symptoms:

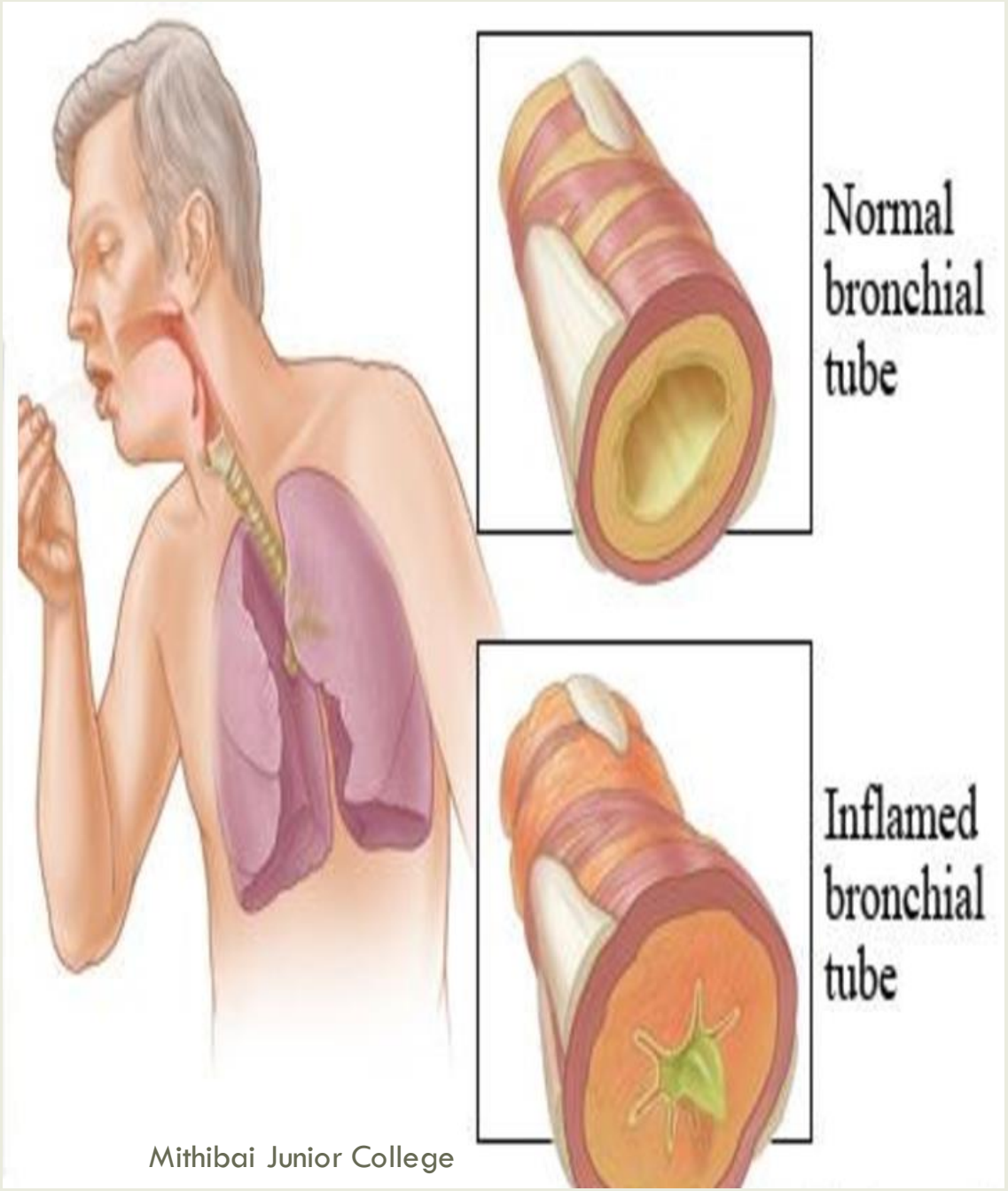
- Inflammation of bronchi
- Yellow mucus
- Shortness of breath

Cause:

Viruses, bacteria

Treatment:

Antibiotics (bacterial), cough medicine , vaporizer



SINUSITIS:

Symptoms:

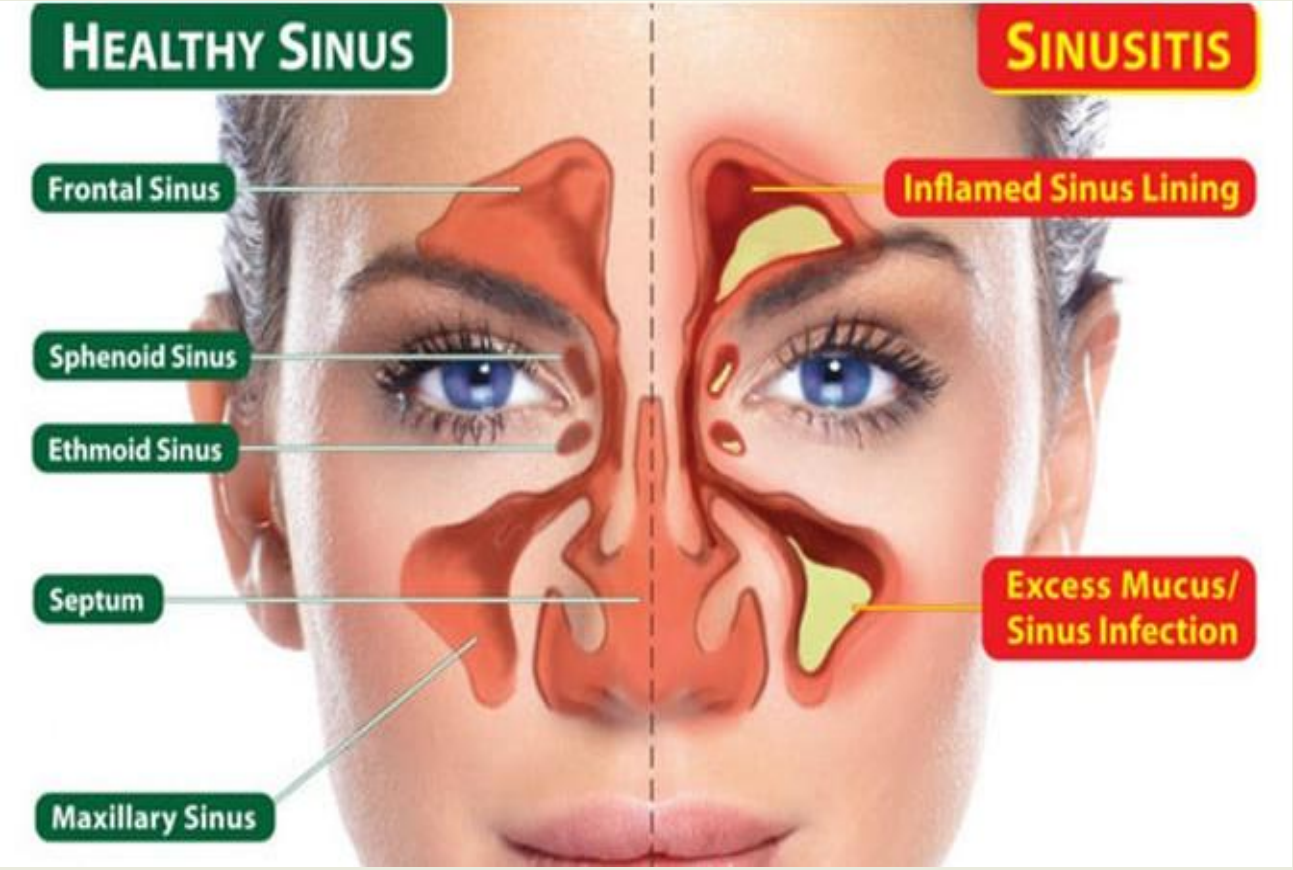
- Inflammation of sinuses
- Mucous discharge

Cause:

Viruses , bacteria

Treatment:

Antibiootics(bacterial), vaporizer, decongestants



LARYNGITIS:

Symptoms:

- Inflammation of larynx (vocal cords)
- Mucus build up

Cause:

Viruses, bacteria

Treatment:

Antibiotics(bacterial), cough medicines, voice rest,
Avoid irritants

PNEUMONIA:

Symptoms:

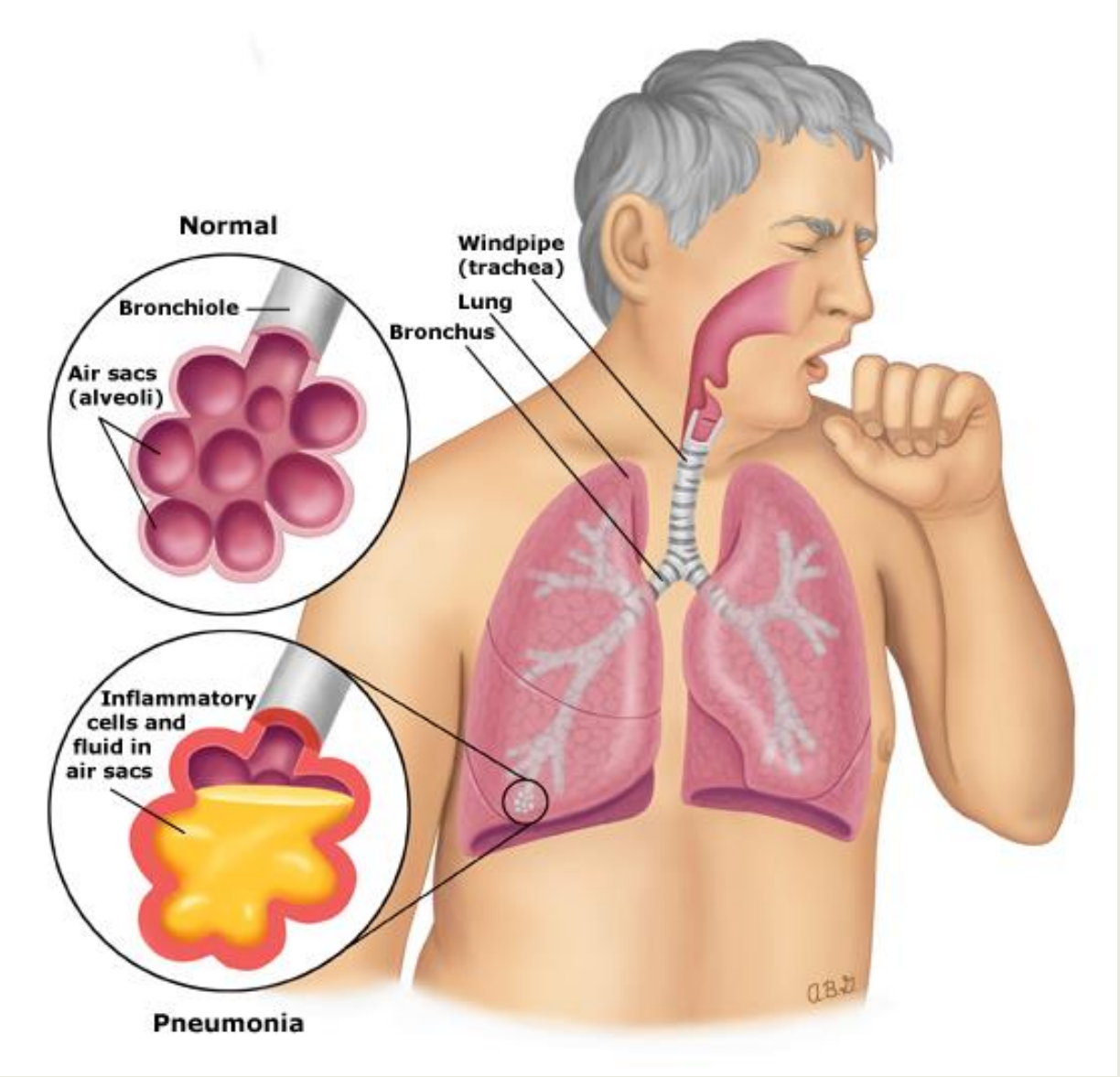
- Inflammation of lungs
- Cough, fever
- Shortness of breath
- Sweating
- Chest pain
- Blood in mucus

Cause:

Viruses and bacteria

Treatment:

Antibiotics, stay warm



ASTHMA:

Symptoms:

- Constriction of bronchioles
- Mucus
- Difficulty in breathing
- Periodic wheezing

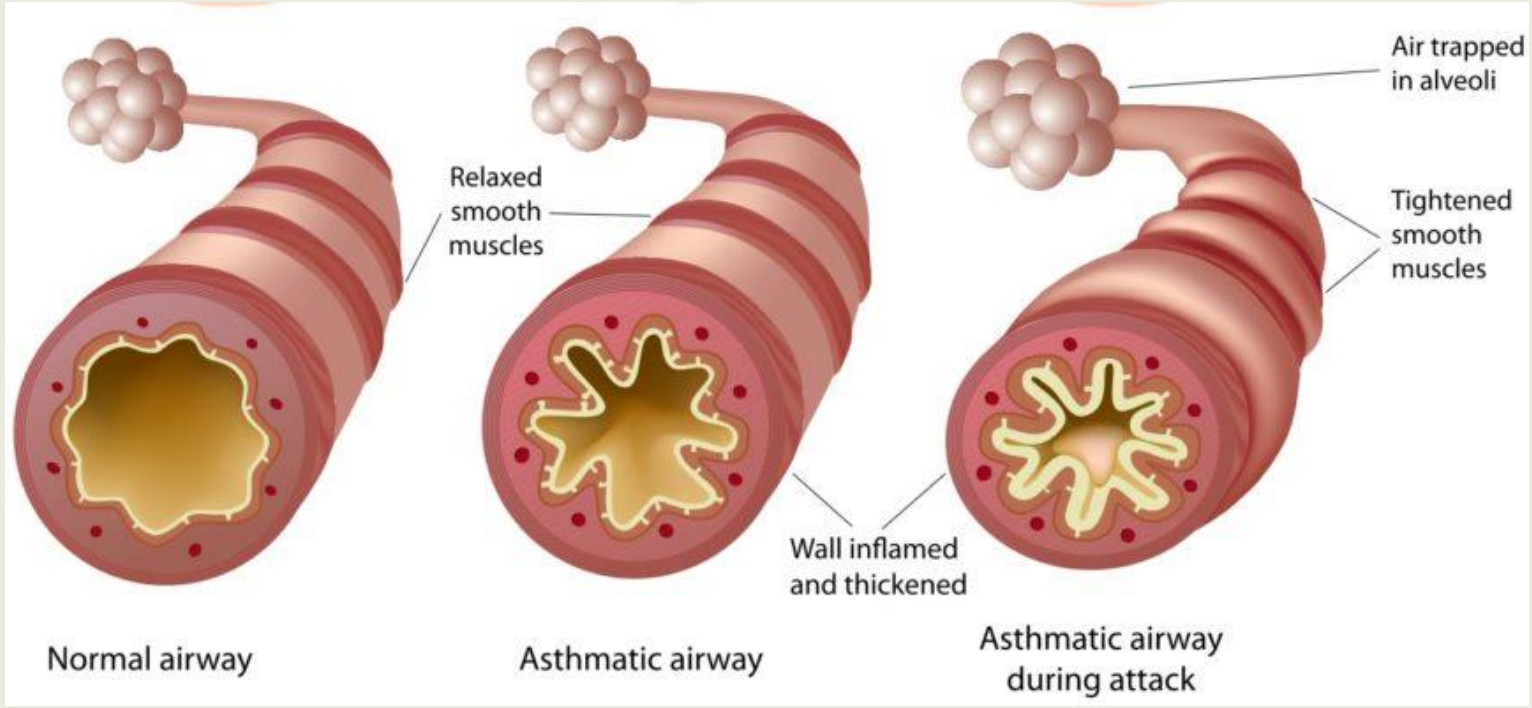
Cause:

Allergy – pollen, food, pet hair

Treatment:

Avoid irritants

Use of inhalants

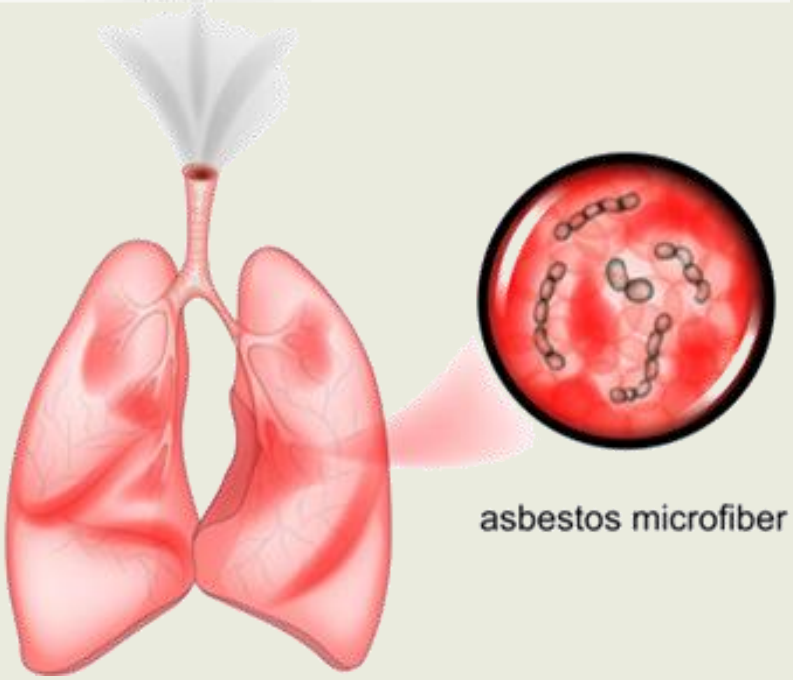


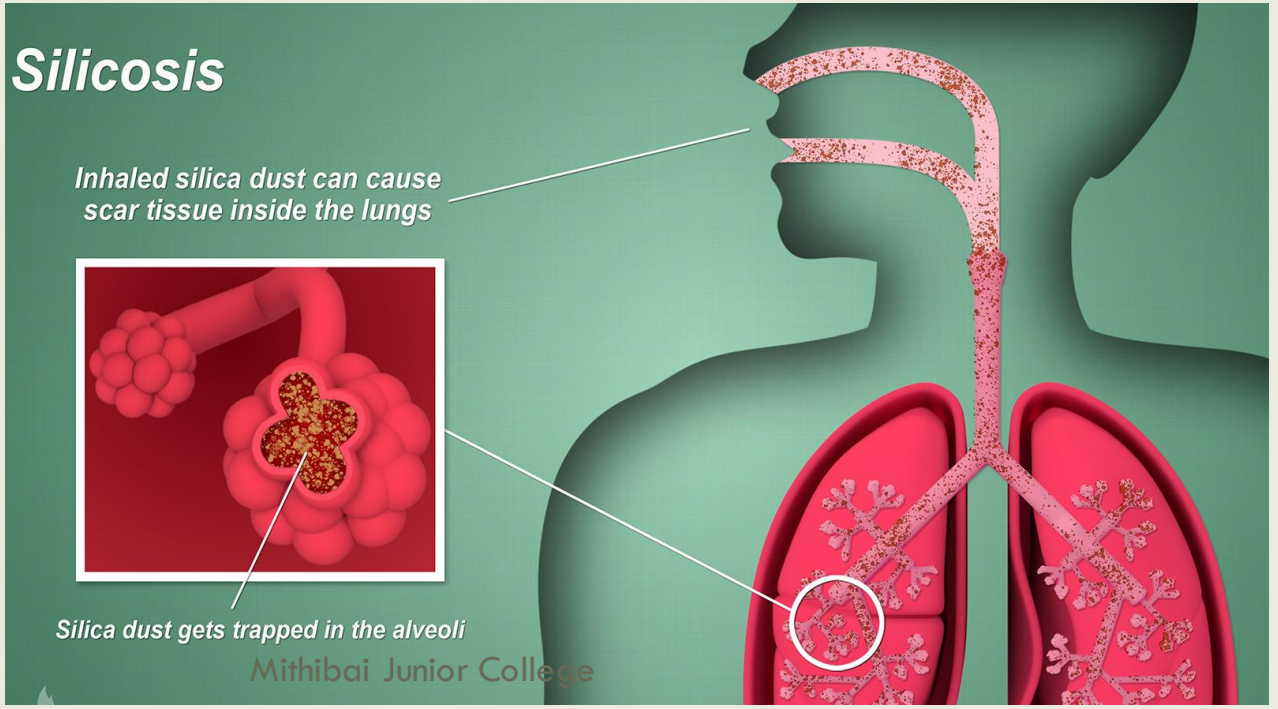
OCCUPATIONAL RESPIRATORY DISORDERS:

1) **SILICOSIS**
2) **ASBESTOSIS**

- Inflammation,fibrosis
- Lung damage

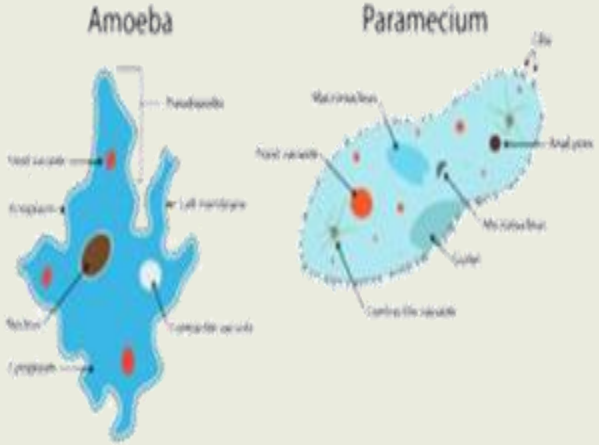
Cause: Long term exposure
(Use of protective mask and gear)





8.7 Transportation in living organisms :

Cyclosis **intracellular transport**.



Significance:

Circulation of nutrients and oxygen, for metabolic activities.

Waste generated is given out of the body.

MODE: DiFFUSION AND ACTIVE /PASSIVE TRANSPORT

extracellular transport:

Coelenterates-water circulation through body cavities

Flatworms: parenchymal tissues

Round worms: contraction of body wall/muscles