Breathing vs Respiration

Includes inspiration & expiration

(inhalation) (exhalation)

- Active → O_2
- Exit
- Passive → CO_2

Utilisation of O_2 which enters our body inhalation

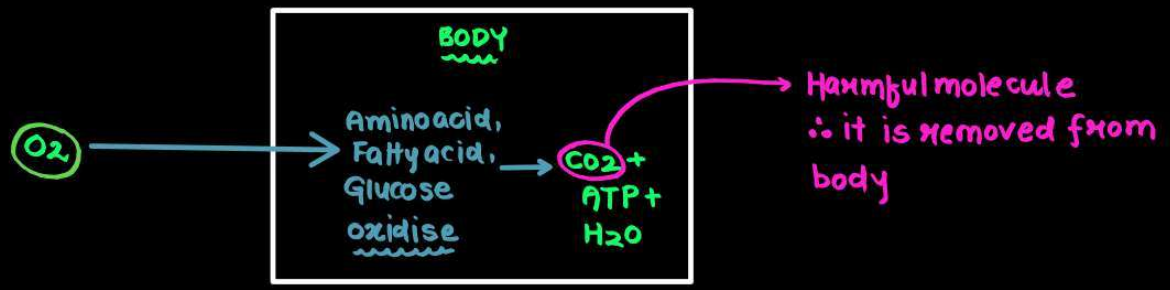
Aaloo ka Parantha → contains Starch → digest → Glucose → load in blood → it will reach to diff. cells

O_2 loaded in blood will also reach diff. cells → oxidise → $C_6H_{12}O_6$

$C_6H_{12}O_6 \rightarrow 6CO_2 + H_2O +$ ATP

Need of Breathing

- O_2 has to be continuously provided to the cells and CO_2 produced by the cells have to be released out.



Respiratory Organs

- **Mechanisms of breathing** vary among different groups of animals depending mainly on:

① Level of organisation of animal: e.g., Flatworm / Platyhelminthes
↳ goses diffuse 'in' and 'out' via general body surface

e.g., Humans: Lungs (pulmonary)

② Habitat: Fish (aquatic): Gills
Human: Lungs
↳ Terrestrial/land

Different Respiratory Organs

Organisms	Organs for Respiration
Unicellular Organisms like Amoeba, Paramecium	• Simple diffusion via cell
Porifera (sponges), Coelenterate, Ctenophora, Platyhelminthes	• Simple diffusion via general body surface
Earthworm	• Moist cuticle
Arthropoda	Land Insects: Tracheal tubes Crustaceans (like Prawn): In water → gill like str.
Mollusca	• Gill / Branchial respiration
Echinodermata	• TUBE-FEET
Fish	• GILL
Frog	Tadpole: Aquatic Adult frog: Buccopharyngeal, cutaneous, Pulmonary
Amphibians, Reptiles, Aves (birds), Mammals	Lungs

Human Respiratory System (Flow Chart)

External nostrils (2)
- upper part of upper lip

→ Nasal Passage → Nasal chamber → Pharynx (common passage for food & air)

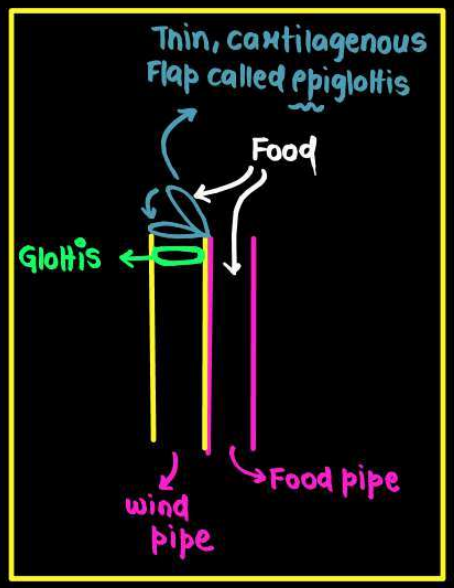
→ Larynx / Sound box (has a part called Glottis)
- formed of cartilage

→ TRACHEA (Windpipe)

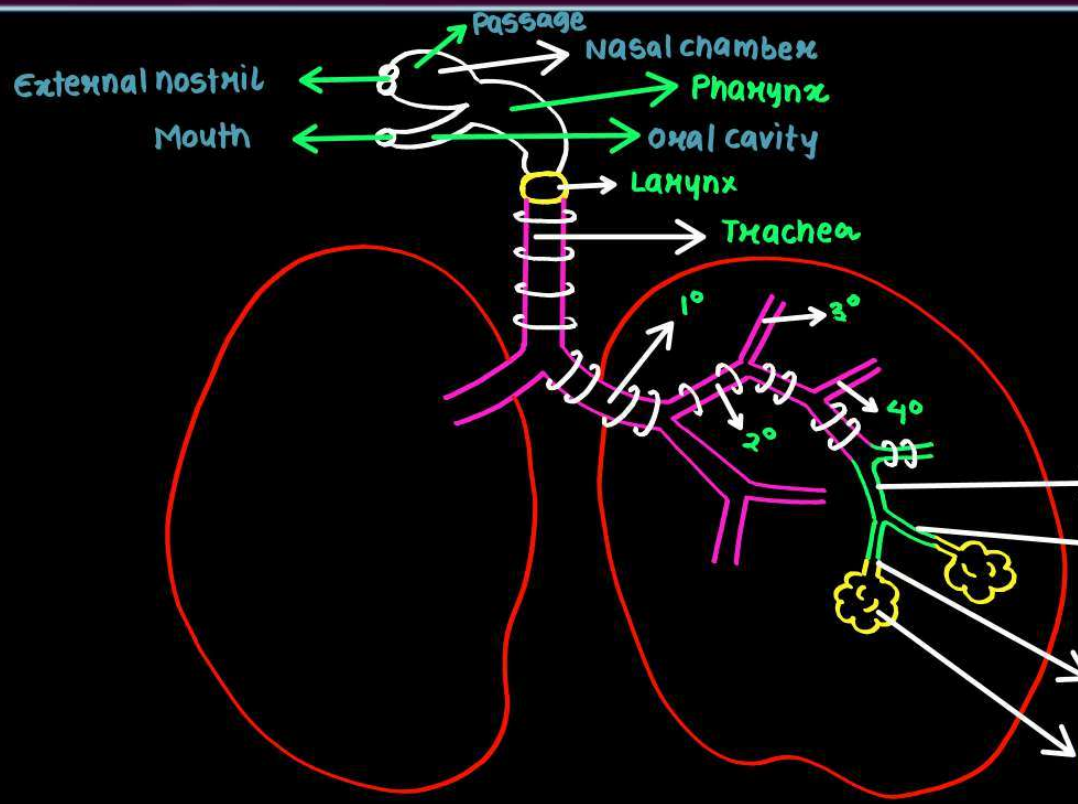
→ Divided into left & right Primary Bronchi at the level of 5th Thoracic vertebrae (T_5)

→ 2° bronchi → 3° bronchi → 4° bronchi → Initial bronchioles → Terminal bronchioles → Alveoli & alveolar duct (100 million alveoli / lung)

Irregular, bag like, vascular structure



Human Respiratory System (Diagram)



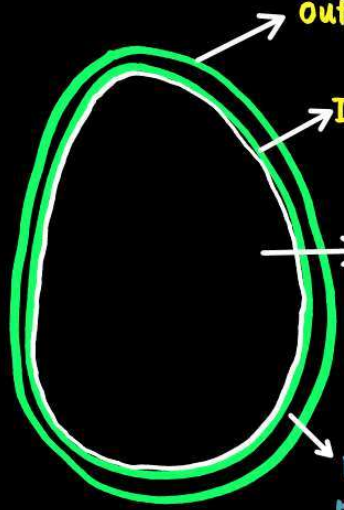
* 'C'-shaped incomplete cartilagenous rings are found from Trachea to initial bronchioles.
* Lungs = 1° bronchi + 2° + 3° + 4° + Initial bronchioles + term. bronchioles + alveoli

Respiratory System Details

- **Lungs** comprised of: 1° bronchi + 2° + 3° + 4° + Initial & Terminal bronchioles + Alveoli
- Trachea divides into left and right primary bronchi **at the level of:** T_5
- **What does** epiglottis **do:** covers the glottis when we engulf food so that it can't enter windpipe
- Incomplete cartilaginous rings **are present** ~~in~~ upto: Trachea to initial bronchioles

Structure of Lung: Cover and Air Tight Nature

- No. of lungs : 2
- Position : in thoracic cavity



Air Tight compartment

- Ventrally : Sternum
- Dorsal : Vertebral column
- Lateral : Rib-cage
- Below : Diaphragm

- we can't change the pulmonary volume directly ∴ we need to change the thoracic volume.

∴ Pulmonary volume depends on thoracic volume.

Lung

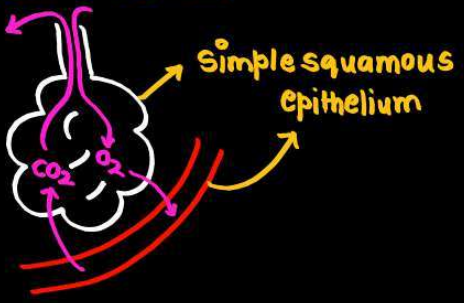
Conducting Part

- Conducts/transports air from atmosphere to exchange part
- From external nostril to terminal bronchioles

Functions:
1. conduct of air
2. Humidification of air
3. Cleaning/filteration of air
4. Maintenance of Temp.

Respiratory/ Exchange Part

- Gaseous exchange/diffusion occurs here
- Alveoli & its ducts



Mechanism of Breathing

LaO RADO

Respiration involves the following steps:

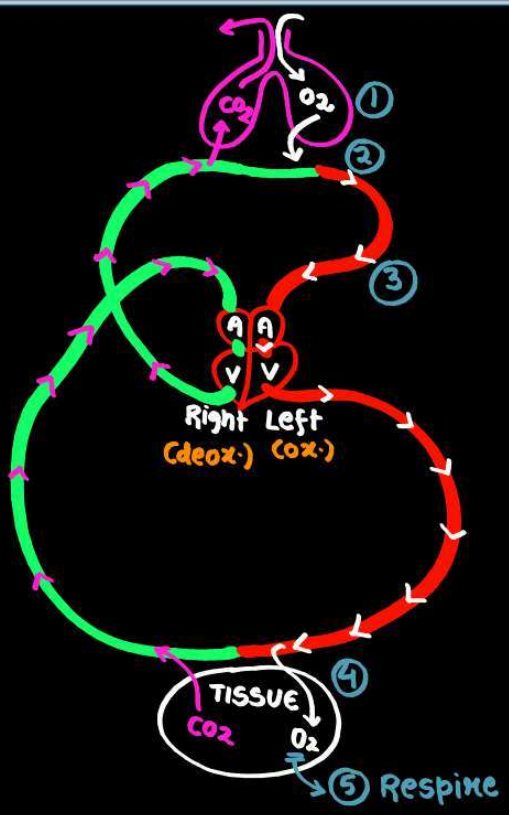
(i) Breathing or pulmonary ventilation by which atmospheric air is drawn in and CO2 rich alveolar air is released out.

(ii) Diffusion of gases (O2 and CO2) across alveolar membrane.

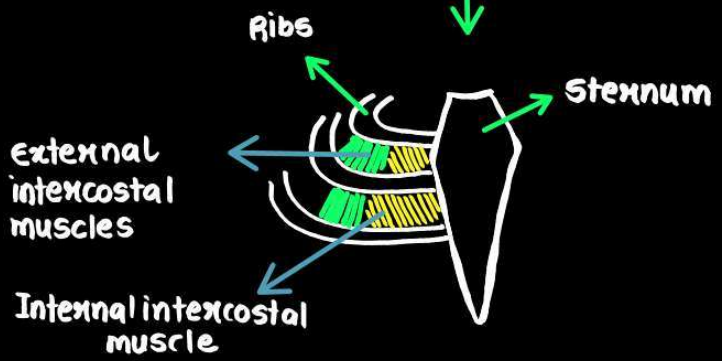
(iii) Transport of gases by the blood.

(iv) Diffusion of O2 and CO2 between blood and tissues.

(v) Utilization of O2 by the cells for catabolic reactions and resultant release of CO2 (cellular respiration).



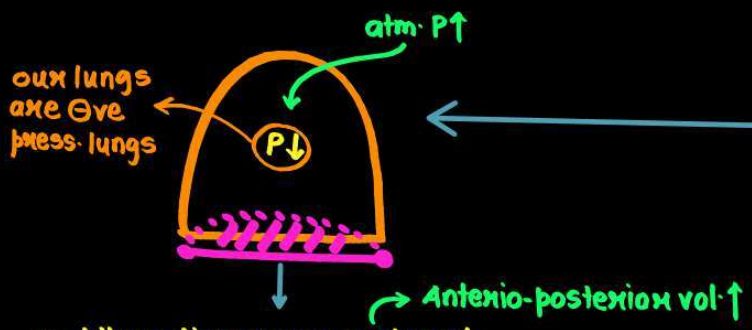
Muscles involved in Breathing



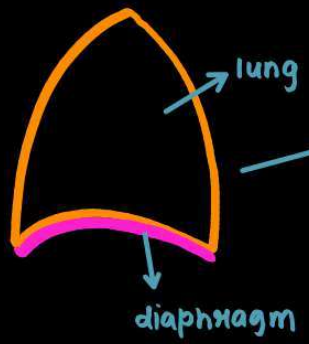
In case of forced breathing, some abdominal muscles also plays a role

Breathing

Inspiration

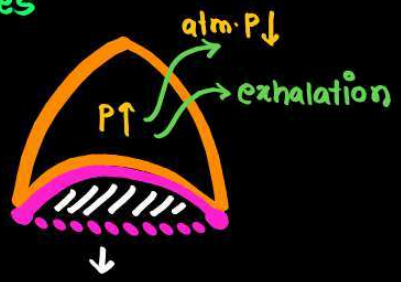


- When diaphragm contract
  Thoracic vol.↑ ; Pulmonary vol.↑
  Pulmonary pressure ↓
- Ext. intercostal muscles contract
  ∴ Pulmonary vol.↑ in dorsoventral side



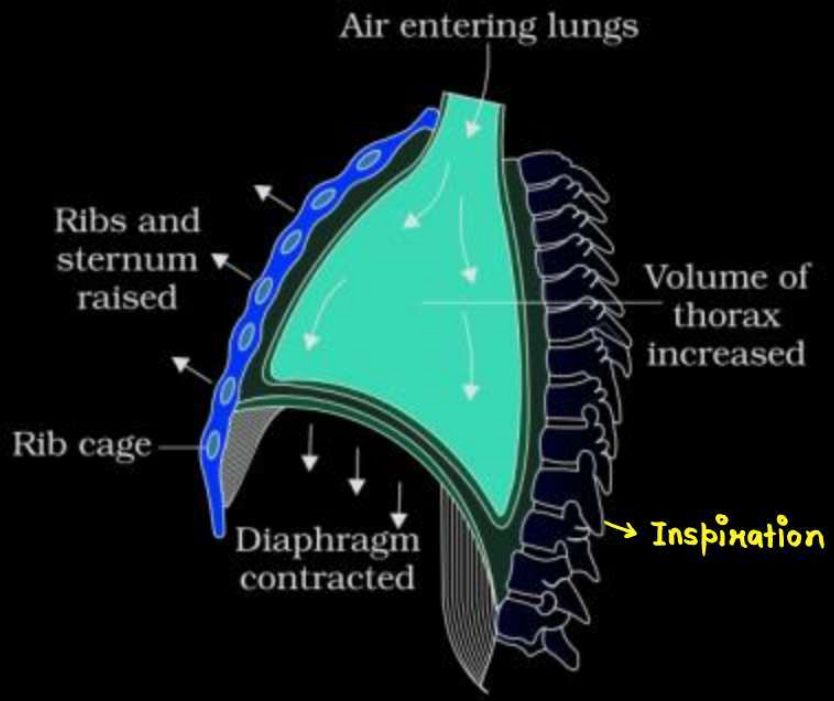
Expiration

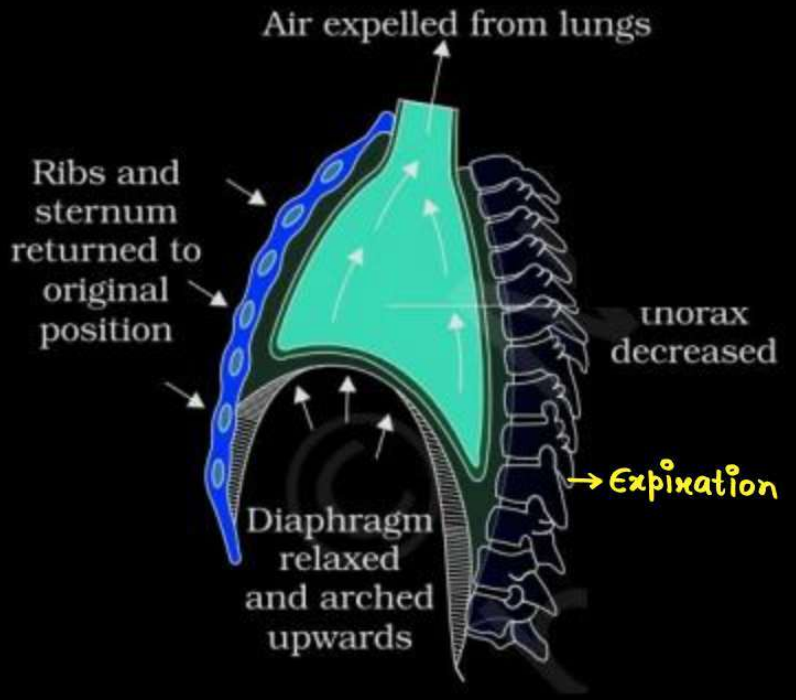
- Relax the diaphragm & Ext. intercostal muscles



Thoracic vol.↓ ; Pulmonary vol.↓ ;
Pulmonary Press.↑

Mechanism of Inspiration and Expiration





Facts Related to Breathing

- **Average breathing rate of Humans:** 12-16 times in a minute
  - 12 × 500 ml – 16 × 500 ml
  - 6 L – 8 L
- **Spirometer:** monitors the vol. of air inhaled or exhaled by a human

∴ It has clinical significance

Respiratory Volumes and Capacities

Basic Terms

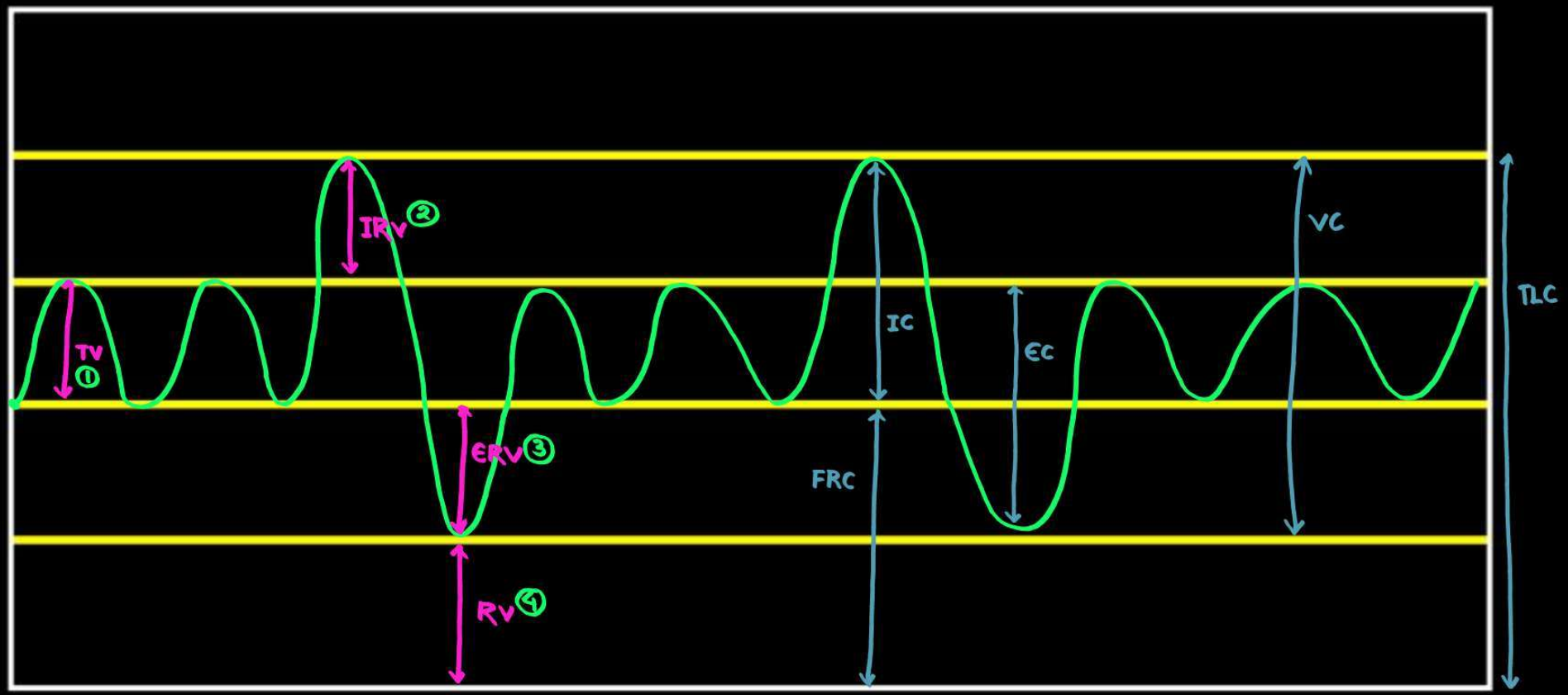
Derived from resp. volumes only

1. Tidal Volume (TV): Air taken in or sent out during normal inspiration & expiration
   → 500 mL
2. Inspiratory Reserve volume (IRV): Forceful inhalation after inhaling TV.
   → 2.5-3 L
3. Expiratory Reserve Volume (ERV): Forceful exhalation after exhaling TV.
   → 1-1.1 L (1000-1100 mL)
4. Residual volume (RV): Vol. of air remained in lungs even after forceful expiration
   → 1.1-1.2 L (1100-1200 ml)
   ⇓
   can't be measured by spirometer

Respiratory Capacities

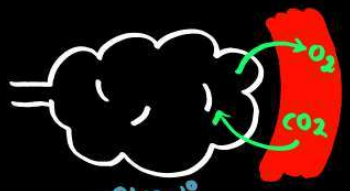
- **Inspiratory Capacity (IC):** TV + IRV ① + ② → Vol. of air inspired after normal expiration
  - TV → 500ml
  - IRV → 2500-3000mL
- **Expiratory Capacity (EC):** TV + ERV ① + ③ → Vol. of air expired after normal inspiration
  - TV → 500mL
  - ERV → 1000-1100mL
- **Functional Residual Capacity (FRC):** ③ + ④
  - ③ → ERV → 1000-1100mL
  - ④ → RV → 1100-1200ml
- **Vital Capacity (VC):** ① + ② + ③
  - ① → TV
  - ② → IRV
  - ③ → ERV
- **Total Lung Capacity (TLC):** ① + ② + ③ + ④
  - VC + RV
  - 1+2+FRC → TV, IRV, FRC
  - ① TV + ② IRV + ③ ERV → VC
  - ④ → RV

Respiratory Volumes and Capacities

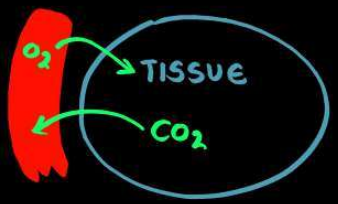


Exchange of Gases

- Diffusion occur at 2 places:

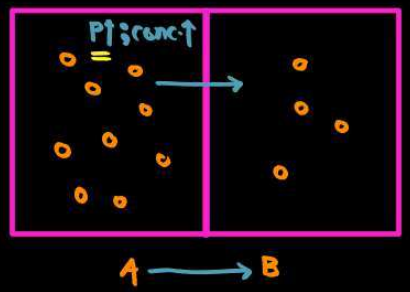


→ Primary site of diffusion



- Diffusion depends upon:

① Pressure/conc. gradient



② Solubility of gas → Solubility↑ ; diffusion↑

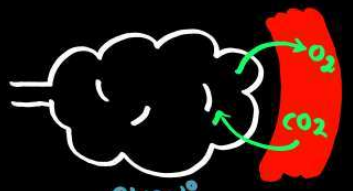
- CO_2 is 20-25X more soluble than O_2 in plasma

∴ O_2 : 3% transported in dissolved state

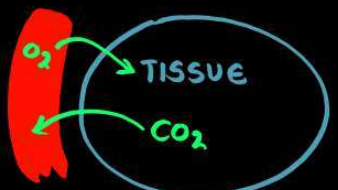
CO_2 : 7% transported in dissolved state

Exchange of Gases

- Diffusion occur at 2 places:



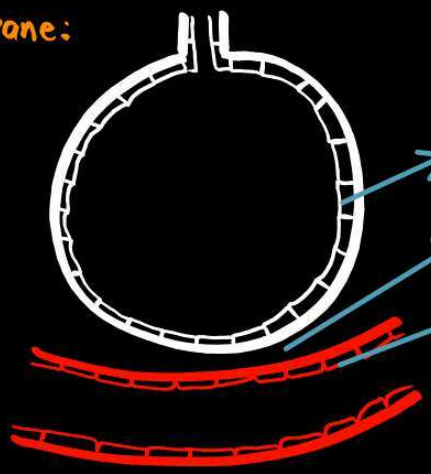
Primary site of diffusion



- Diffusion depends upon:

③ Thickness of membrane:

Thickness ↓ ; diffusion ↑

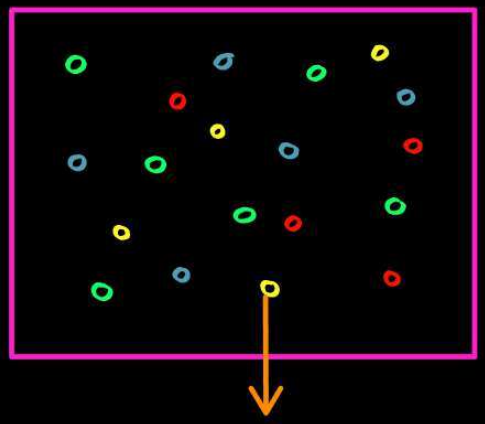


Alveolar epithelia
Basement subst.
Endothelium of Blood vessel

Thickness is less than 1mm
∴ can easily show diffusion

Partial Pressure of Gases

- **Definition:**



Partial pressure: pressure created by individual gas in a mixture of gases.

e.g.: pO_2 ; pCO_2

partial pressure of O_2

- Total pressure: 760 mmHg

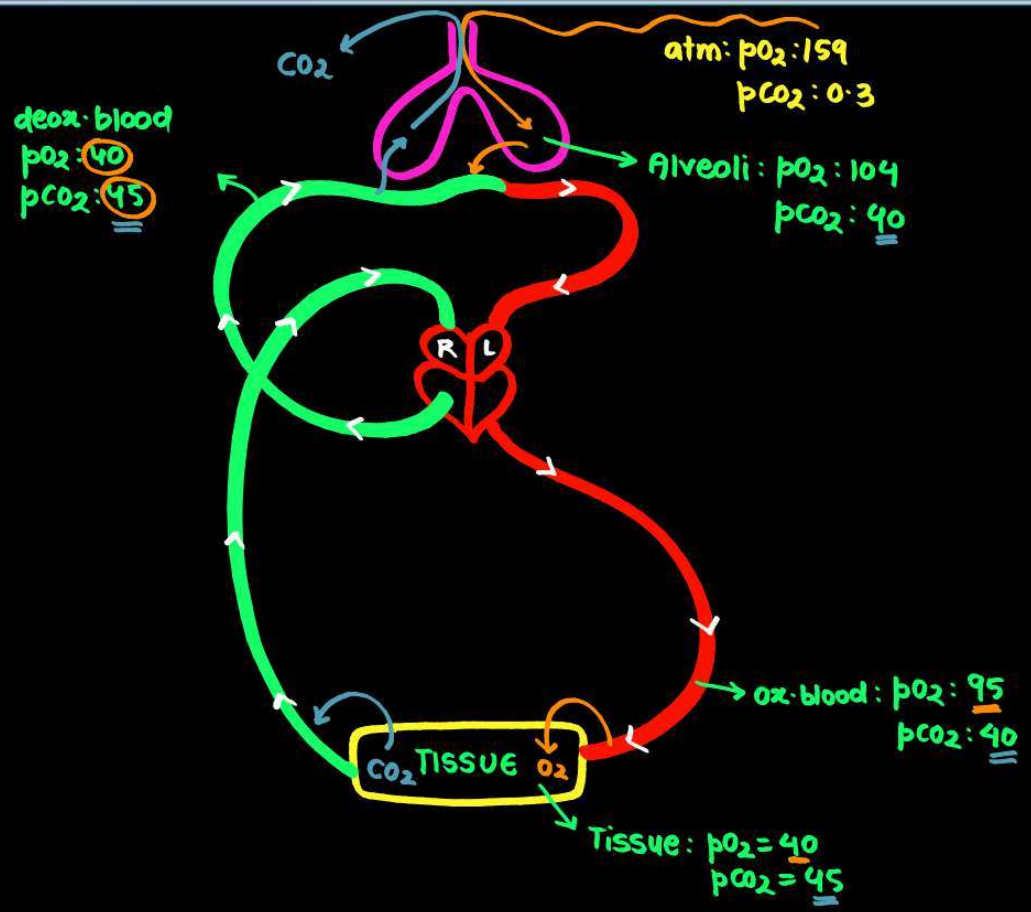
pO_2 : 159 mmHg
pCO_2 : 0.3 mmHg

Partial Pressure of O_2 and CO_2

Partial Pressures (in mm Hg) of Oxygen and Carbon dioxide at Different Parts Involved in Diffusion in Comparison to those in Atmosphere

Respiratory Gas	Atmospheric Air	Alveoli	Blood (Deoxygenated)	Blood (Oxygenated)	Tissues
O_2	159	104	40	95	40
CO_2	0.3	40	45	40	45

Mechanism


CO_2
atm: pO_2: 159
pCO_2: 0·3
deox·blood
pO_2: 40
pCO_2: 45
Alveoli: pO_2: 104
pCO_2: 40
R
L
ox·blood: pO_2: 95
pCO_2: 40
CO_2 TISSUE O_2
Tissue: pO_2 = 40
pCO_2 = 45

Transport of Gases

Oxygen Transport

- 97% as oxyhaemoglobin
  - ⇓
  - Red colour, Fe cont. pigment found in RBC
- 3% as plasma

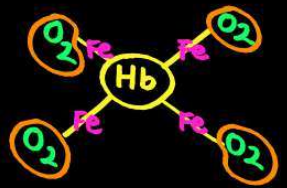
Carbon Dioxide Transport

- 70% in form of BICARBONATE
- 20-25% (~23%) as Carbamino-haemoglobin
- 7% in plasma

Transport of Oxygen

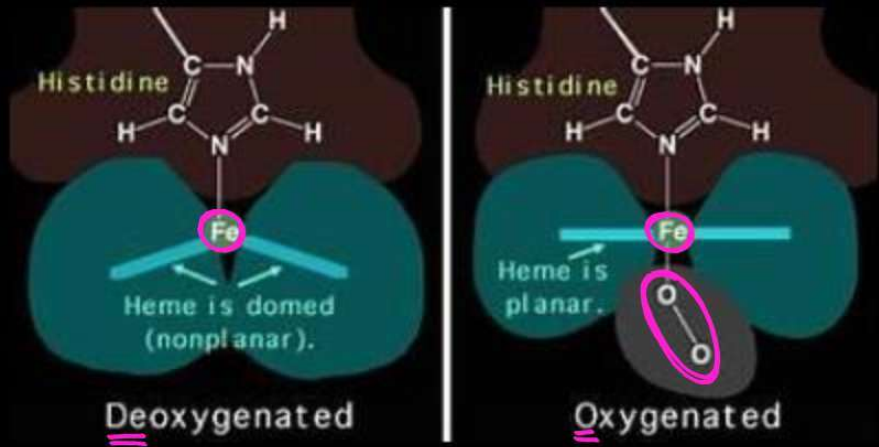
- **Hemoglobin:** Fe containing red coloured pigment in RBC

- **Binding is reversible and Cooperative**

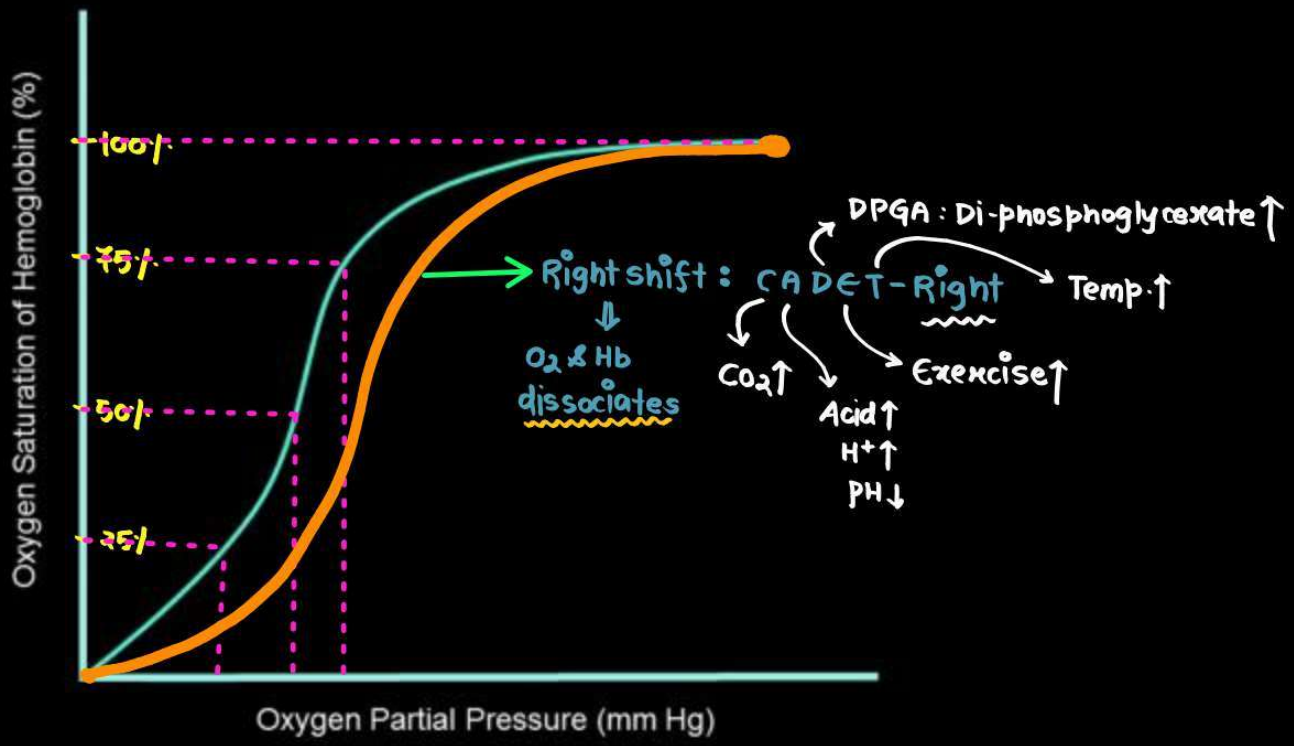


one 'O_2' molecule makes the loading of next 'O_2' molecules easy

- 1 'Hb' bind with 4 'O_2' molecules
- ——"—— 8 'oxygen' atoms



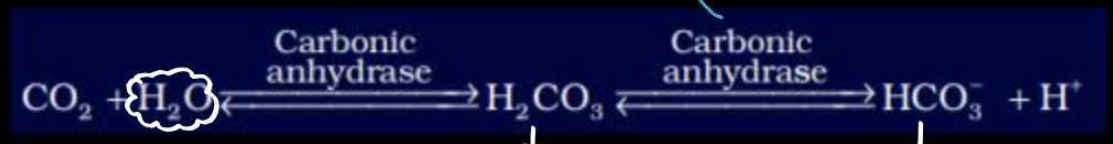
Oxygen Haemoglobin Dissociation Curve



* 100ml of ox. blood carry 5ml O_2.
* 100 mL of deox. blood carry 4ml CO_2

Transport of Carbon Dioxide

- 70% as bicarbonate
- ~23% → Carbamino Hb → CADET ↑ (CO_2 ↑, O_2 ↓)
- 7% in dissolved state

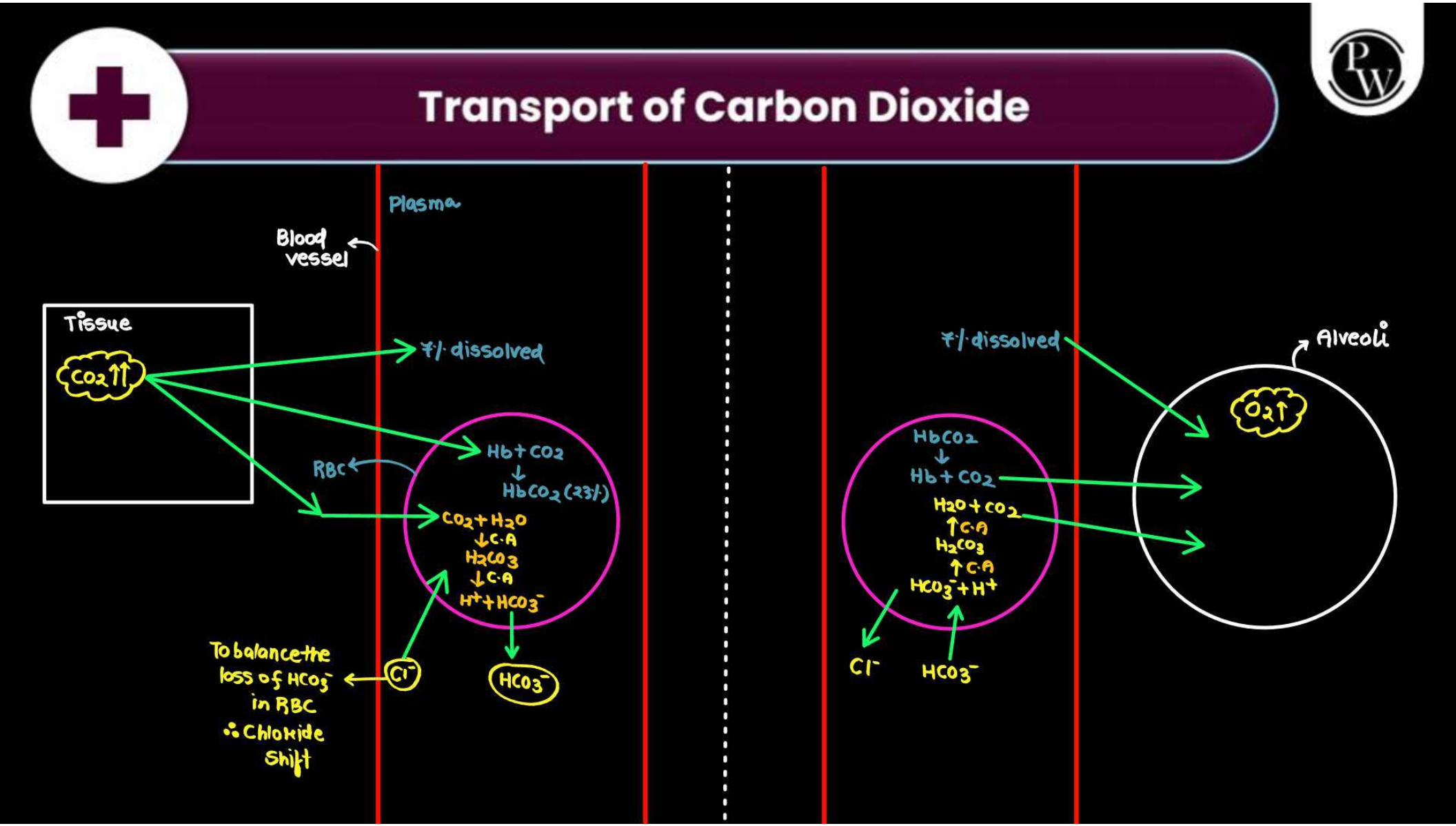


- H_2CO_3 → Carbonic acid
- HCO_3^- → Bicarbonate

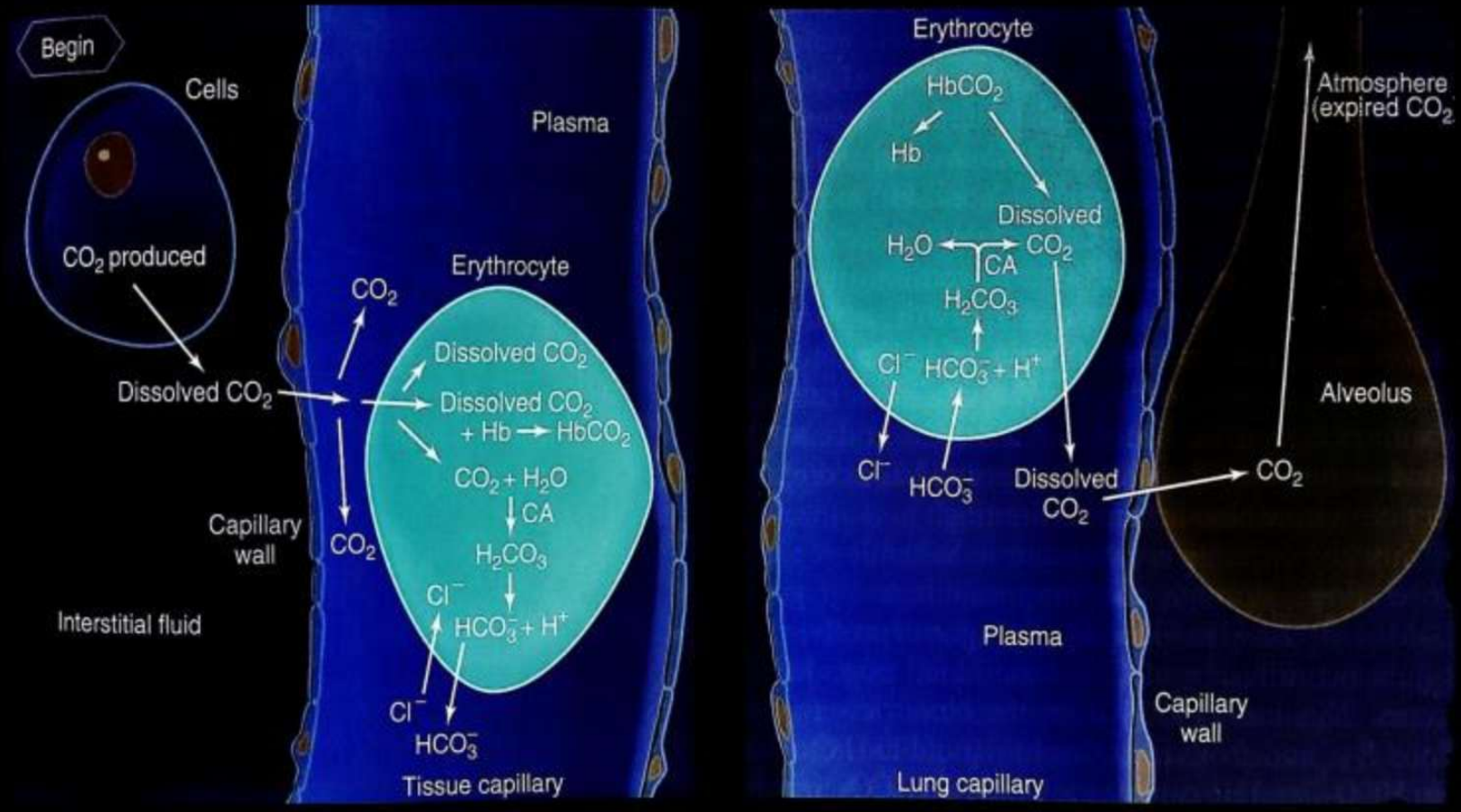
one of the most fastest acting enzyme

- Carbonic anhydrase is very abundant in RBC
- Some amount of this enzyme is also found in plasma

Transport of Carbon Dioxide



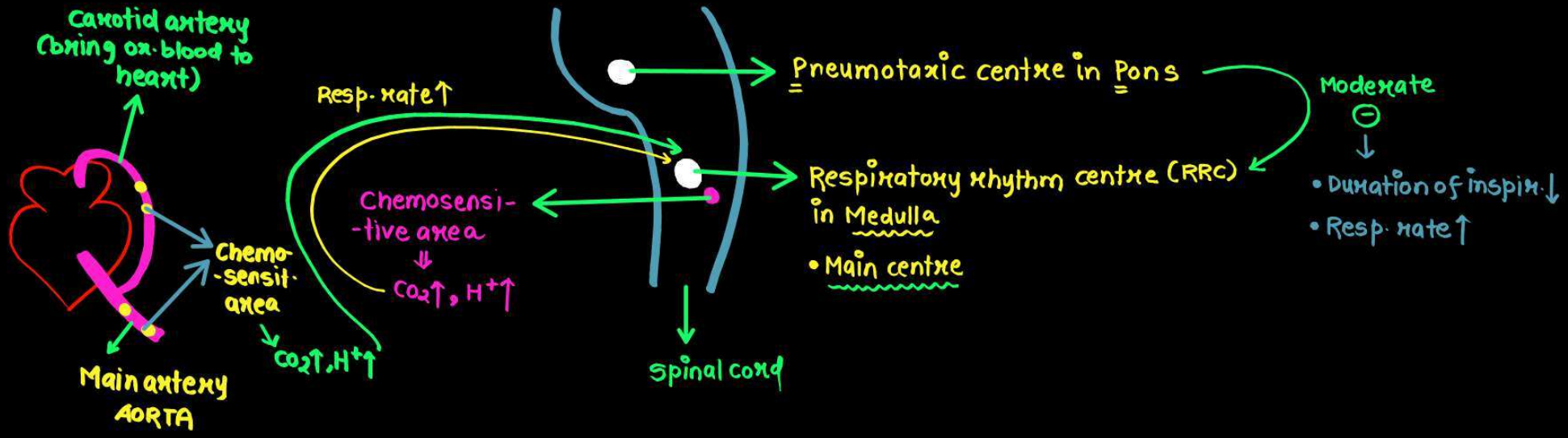
Transport of Carbon Dioxide



Regulation of Respiration

- Mainly regulated by nervous system → HINDBRAIN
- some chemoreceptors also helps in regulation

*O_2 levels are insignificant for this regulation



Disorders

S. No.	Disease	Features
1	Asthma	Difficulty in breathing causing wheezing due to inflammation of bronchi and bronchioles 
2	Emphysema	Chronic disorder (due to cigarette smoking) in which alveolar walls are damaged due to which respiratory surface is decreased. 

Disorders

3	Occupational Lung Disorders	In certain industries, especially those involving grinding or stone-breaking, so much dust is produced that the defense mechanism of the body cannot fully cope with the situation. Long exposure can give rise to inflammation leading to fibrosis (proliferation of fibrous tissues) and thus causing serious lung damage. Workers in such industries should wear protective masks.

Silicosis : silica
Asbestosis : Asbestos

Breathing and Exchange of Gases

- Breathing: inspire + expire (CO_2 → in) (CO_2 → out)
- Respiration: utilisation of O_2 to indirectly break molecules to make ATP / energy
- Mechanism of breathing in diff. animals: depends on 1. Habitat & 2. level of organisation of animals

Animals	Respiration Type
Sponges, Coelenterates, Flatworms	Simple diffusion through body surface
Earthworms	Moist cuticle
Insects Aquatic arthropods and Molluscs	Trachea Gills (branchial respiration)
Fishes	Gills
Amphibian, Reptiles, Aves and Mammals	Lungs (pulmonary)
Frog	Buccopharyngeal, Lungs and Cutaneous (skin)

HUMAN RESPIRATORY SYSTEM

NOTE: Glottis can be covered by epiglottis (cartilagenous flap) to prevent entry of food in larynx

Pair of external nostrils (above lips) → Nasal Passage → Nasal chamber → Pharynx (Food + air ∴ common) → Larynx (cartilage; sound box) → Trachea (windpipe)

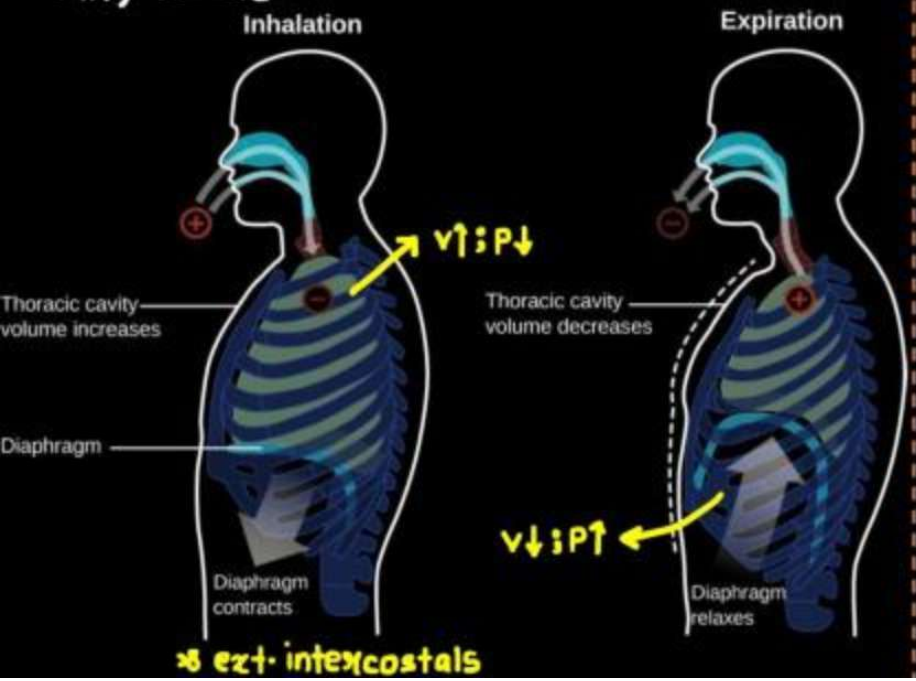
Trachea → (1) Divides into left and right bronchi at T5 (1°) → (2) 2° Bronchi → (3) 3° Bronchi → (4) Initial bronchioles → (5) Terminal bronchioles → (6) Alveoli (vascular bags)

- Lungs = 1+2+3+4+5+6
- Incomplete cart. rings = Trachea + 1+2+3+4
- From nostril to Terminal bronchioles = conducting part → transport air, clean it, humidify it, set temp.
- Alveoli & Alveolar duct = exchange / respiratory part : diffusion
- Lungs covered by double layered pleura & have pleural fluid b/w layers

Breathing and Exchange of Gases

- Lungs are present in air tight chamber:
  - Dorsally: vertebral column
  - Ventrally: Sternum
  - Sides: Rib cage
  - Below: Diaphragm
- ∴ change in thoracic volume will lead to change in pulmonary volume

- 12-16 times/min
- measured by SPIROMETER



& ext. intercostals

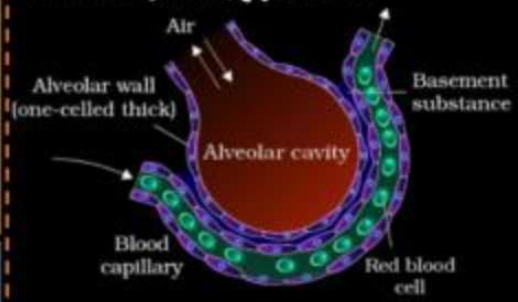
Respiratory volumes & capacities

Respiratory volumes	Feature
1. TV (Tidal Volume): 500mL	Normal air inspired and expired
2. IRV (Inspiratory Reserve Volume): 2.5-3L	Additional air inhaled by forceful inspiration
3. ERV (Expiratory Reserve Volume): 1-1.1L	Additional air exhaled by forceful expiration
4. RV (Residual Volume): 1.1-1.2L	Air in lungs even after forceful expiration

Respiratory Capacity	Sum of
IC (Inspiratory Capacity)	1 + 2
EC (Expiratory Capacity)	1 + 3
FRC (Functional Residual Capacity)	3 + 4
VC (Vital Capacity)	1 + 2 + 3
TLC (Total Lung Capacity)	1 + 2 + 3 + 4

Gaseous Exchange

- Primary site: Alveoli
- Factors affecting diffusion
1. Pressure/conc. gradient
∴ Gradient ↑; diffusion ↑
2. Thickness of membrane
∴ Thin; ↑ diffusion

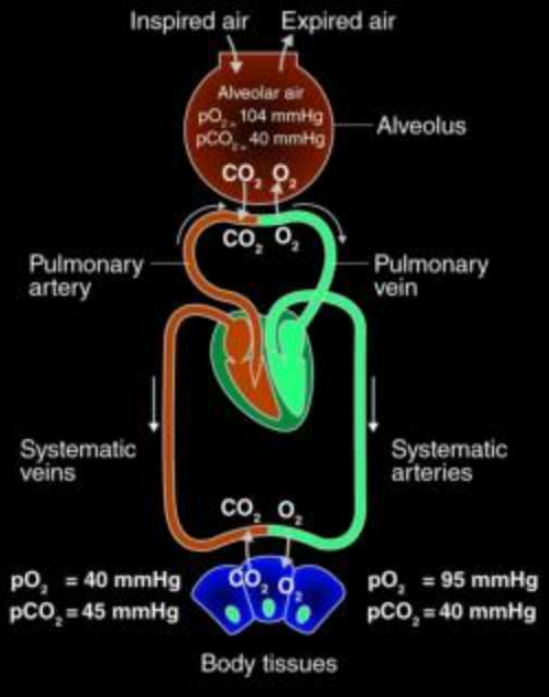


3 layer total thickness <1mm
3. Solubility of gases
∴ Solubility ↑; diffusion ↑
- CO_2 is 20-25 X more soluble than O_2

Exchange of Gases

Respiratory Gas	Atmospheric Air	Alveoli	Blood (Deoxygenated)	Blood (Oxygenated)	Tissues
O_2	159	104	40	95	40
CO_2	0.3	40	45	40	45

Steps: 1. Pulmonary ventilation; 2. Diffusion across alveoli; 3. Transport of gases by blood; 4. Diffusion b/w blood and tissue 5. Respiration in Tissues

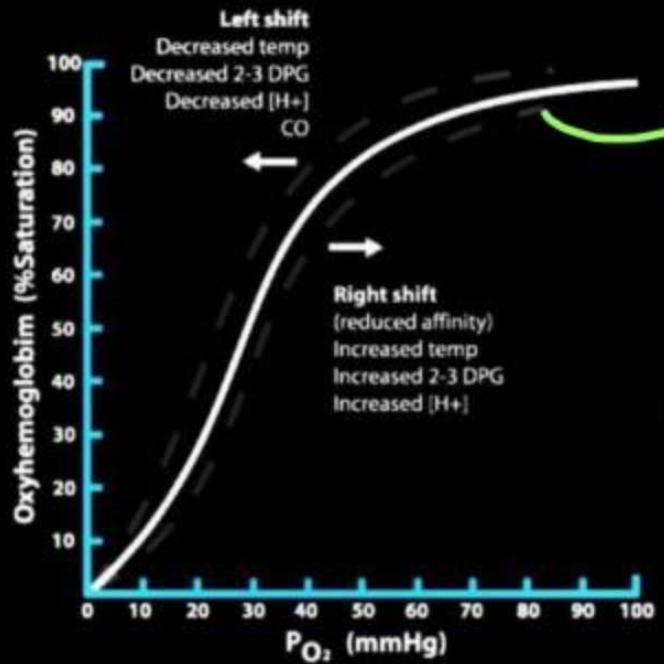


Transport of Gases

O_2: 97% through RBC, 3% through Plasma

CO_2: 70% bicarbonate, 20-25% → RBC, 7% through plasma

O_2-TRANSPORT: Hb can bind with 4 O_2 molecules reversibly.



DISSOCIATION

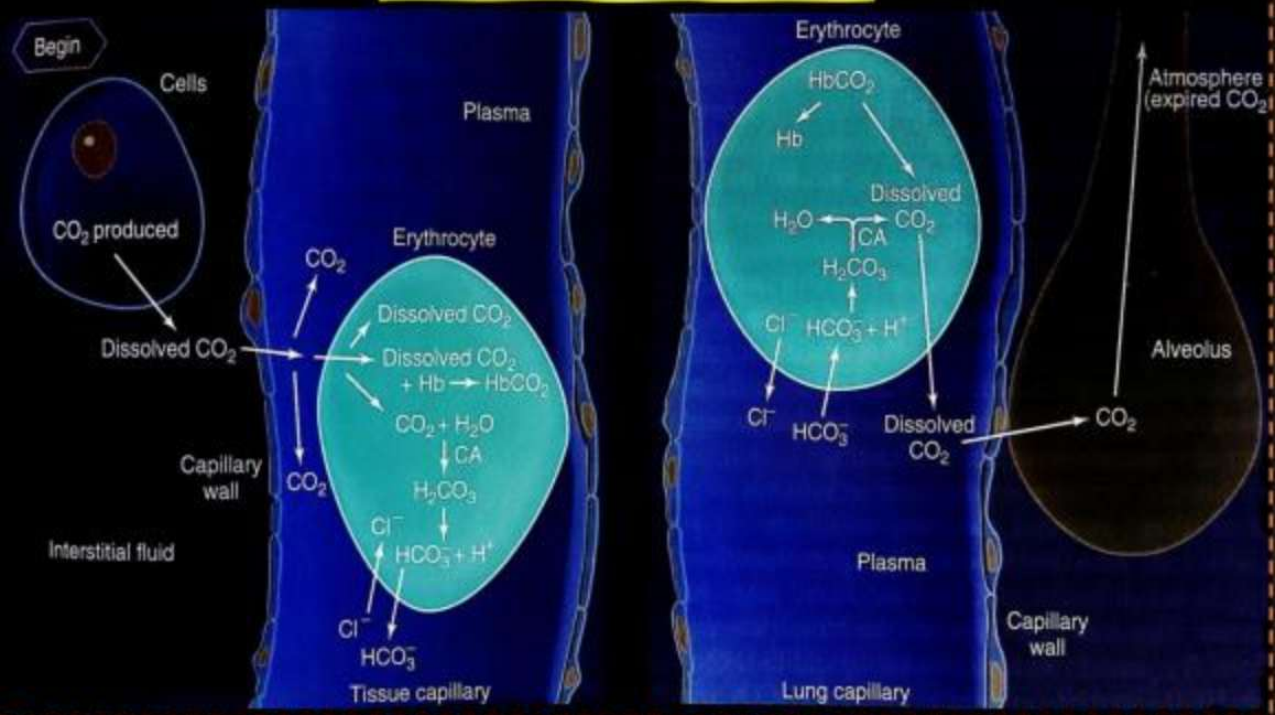
CADET-Right

CO_2↑ → Acidity↑; pH↓ H^+↑

- DPGA↑
- Exercise↑
- Temp.↑

100 ml of oz. blood carry 5 ml O_2 & deoz. blood carry 4 ml CO_2

Transport of CO_2

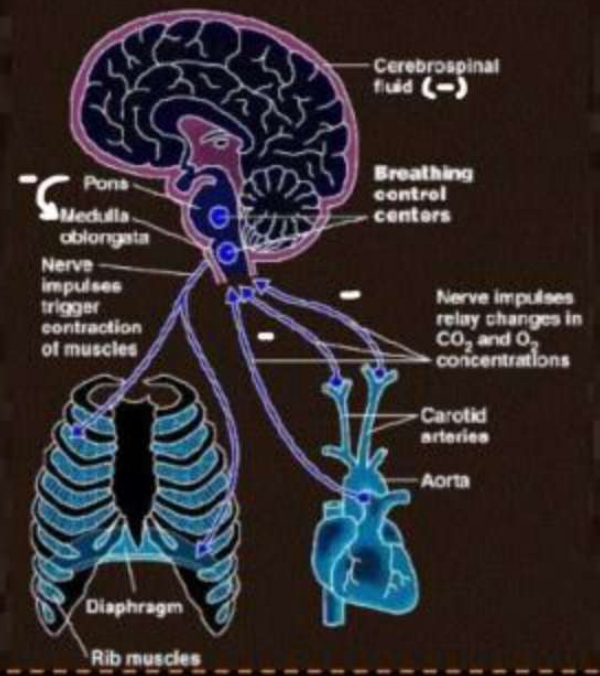


Disorders

- **Asthma**: wheezing due to inflammation of bronchi & bronchioles; difficulty in breathing
- **Emphysema**: Alveolar walls damaged ∴ surface ↓; chronic due to cigarette smoking

Regulation of Respiration

- Medulla: Respiratory rhythm center (main)
- Pons: Pneumotaxic center



- **Occupational disorders**: Fibrosis
  - **Silicosis**: Silica
  - **Asbestosis**: Asbestos

QUESTION (NEET PYQ EXAM 2024)

Match List I with List II :

	List I		List II
A.	Expiratory capacity	I.	Expiratory reserve volume + Tidal volume + Inspiratory reserve volume
B.	Functional residual capacity	II.	Tidal volume + Expiratory reserve volume
C.	Vital capacity	III.	Tidal volume + Inspiratory reserve volume
D.	Inspiratory capacity	IV.	Expiratory reserve volume + Residual volume

Choose the correct answer from the options given below :

(1) A-II, B-IV, C-I, D-III

(2) A-III, B-II, C-IV, D-I

(3) A-II, B-I, C-IV, D-III

(4) A-I, B-III, C-II, D-IV

QUESTION (NEET PYQ EXAM 2024)

Which of the following factors are favourable for the formation of oxyhaemoglobin in alveoli?

(1) High pO_2 and ~~High~~ pCO_2

(2) High pO_2 and Lesser H^+ concentration

(3) Low pCO_2 and ~~High~~ H^+ concentration

(4) Low pCO_2 and High ~~temperature~~

QUESTION (NEET PYQ EXAM 2024)

Match **List-I** with **List-II**:

	List-I		List-II
A.	Residual Volume	I.	Maximum volume of air that can be breathed in after forced expiration (ERV+TV+IRV)
B.	Vital Capacity	II.	Volume of air inspired or expired during normal respiration (TV)
C.	Expiratory Capacity	III.	Volume of air remaining in lungs after forcible expiration (RV)
D.	Tidal Volume	IV.	Total volume of air expired after normal inspiration (TV+ERV)

Choose the **correct** answer from the options given below:

(1) A-IV, B-III, C-II, D-I

(2) A-II, B-IV, C-I, D-III

(3) A-III, B-I, C-IV, D-II ✓

(4) A-I, B-II, C-III, D-IV

QUESTION (NEET PYQ EXAM 2024)

Given below are two statements: One is labelled as Assertion A and the other is labelled as Reason R.

Assertion A: During the transportation of gases, about 20-25 percent of CO_2 is carried by Haemoglobin as carbamino-haemoglobin.

Reason R: This binding is related to high p CO_2 and low p O_2 in tissues.

In the light of the above statements, choose the correct answer from the options given below.

(1) A is true but R is false.

(2) A is false but R is true.

(3) Both A and R are true and R is the correct explanation of A.

(4) Both A and R are true but R is NOT the correct explanation of A.

QUESTION (NEET PYQ EXAM 2023)

Select the sequence of steps in respiration.

(Manipur 2023)

(A) Diffusion of gases (O_2 and CO_2) across alveolar membrane. (2)

(B) Diffusion of O_2 and CO_2 between blood and tissues. (4)

(C) Transport of gases by the blood (3)

(D) Pulmonary ventilation by which atmospheric air is drawn in and CO_2 rich alveolar air is released out. (1)

(E) Utilisation of O_2 by the cells for catabolic reactions are resultant release of CO_2 (5)

Choose the **correct** answer from the options given below.

(1) (D), (A), (C), (B), (E) (2) (C), (B), (A), (E), (D)

(3) (B), (C), (E), (D), (A) (4) (A), (C), (B), (E), (D)

QUESTION (NEET PYQ EXAM 2023)

Vital capacity of lung is;

(1) IRV + ERV + TV

(2) IRV + ERV

(3) IRV + ERV + TV + RV

(4) IRV + ERV + TV − RV

FOR NOTES & DPP CHECK DESCRIPTION

QUESTION (NEET PYQ EXAM 2022)

Identify the region of human brain which has pneumotaxic centre that alters respiratory rate by reducing the duration of inspiration. **(2022 II)**

(1) Cerebrum
(2) Medulla
(3) Pons
(4) Thalamus

QUESTION (NEET PYQ EXAM 2022)

Under normal physiological conditions in human being every 100 ml of oxygenated blood can deliver 5ml ml of O_2 to the tissues. (2022)

(1) 10 ml
(2) 2 ml
(3) 5 ml
(4) 4 ml

QUESTION (NEET PYQ EXAM 2022)

Which of the following is **not** the function of conducting part of respiratory system? **(2022)**

(1) Provides surface for diffusion of O_2 and CO_2.

(2) It clears inhaled air from foreign particles.

(3) Inhaled air is humidified.

(4) Temperature of inhaled air is brought to body temperature.

QUESTION (NEET PYQ EXAM 2021)

The partial pressures (in mm Hg) of oxygen (O_2) and carbon dioxide (CO_2) at alveoli (the site of diffusion) are; **(2021)**

(1) $pO_2 = 40$ and $pCO_2 = 45$

(2) $pO_2 = 95$ and $pCO_2 = 40$

(3) $pO_2 = 159$ and $pCO_2 = 0.3$

(4) $pO_2 = 104$ and $pCO_2 = 40$

QUESTION (NEET PYQ EXAM 2021)

Select the favourable conditions required for the formation of oxyhaemoglobin at the alveoli. **(2021)**

(1) Low pO_2, high pCO_2, more H^+, higher temperature

(2) High pO_2, high pCO_2, less H^+, higher temperature

(3) Low pO_2, low pCO_2, more H^+, higher temperature

(4) High pO_2, low pCO_2, less H^+, lower temperature

CADET ↓↓

QUESTION (NEET PYQ EXAM 2020)

Identify the **incorrect** statement with reference to transport of oxygen; **(2020)**

(1) Partial pressure of CO_2 can interfere with O_2 binding with haemoglobin.

(2) Higher H^+ conc. in alveoli favours the formation of oxyhaemoglobin.

(3) Low pCO_2 in alveoli favours the formation of oxyhaemoglobin.

(4) Binding of oxygen with haemoglobin is mainly related to partial pressure of O_2.

QUESTION (NEET PYQ EXAM 2020)

Select the **correct** events that occur during inspiration; **(2020)**

1. Contraction of diaphragm
2. Contraction of external inter-costal muscles
3. Pulmonary volume decreases
4. Intra pulmonary pressure increases

(1) 3 and 4
(2) 1, 2 and 4
(3) Only 4
(4) 1 and 2

QUESTION (NEET PYQ EXAM 2020)

Match the following **List-I** and **List-II** select the **correct** option. **(2020 Covid)**

	List-I		List-II
A.	Pneumotaxic Centre	P.	Alveoli
B.	O_2 dissociation curve	Q.	Pons region of brain
C.	Carbonic anhydrase	R.	Haemoglobin
D.	Primary site of exchange of gases	S.	R.B.C

(1) A-(Q); B-(R); C-(S); D-(P)
(2) A-(R); B-(Q); C-(S); D-(P)
(3) A-(S); B-(P); C-(R); D-(Q)
(4) A-(P); B-(R); C-(S); D-(Q)

QUESTION (NEET PYQ EXAM 2020)

Total lung capacity (TLC) is the total volume of air accommodated in the lungs at the end of a forced inspiration. This includes; **(2020 Covid)**

(1) RV, ERV, IC and EC (2) RV, ERV, VC and FRC

(3) RV, ERV, TV and IRV (4) RV, IC, EC and ERV