✱ 11 Breathing & Exchange OF Gases

→ Exchange of O_2 & CO_2 b/w atm & cells → Breathing / Respiration. (commonly called as)

✱ Respiratory Organs

✱ Mech. of breathing ∝ Habitats & L.O.O.

1. Lower Invertebrates :→ Sponges, Coelentrates & flatworms → Simple diffusion
2. Cutaneous → Earthworms → Moist Cuticle [cutaneous respⁿ]
3. Insect → Tracheal system

(F) [1 → Aquatic arthropods + Molluscs → Gills (+ hemichordata) → Branchial respirat⁴ (vascularized str.)
2 → Terrestrial arthropods + 11 → Lungs [~~Bronchial~~ pulmonary respirat⁴]

5. Vertebrates

- Fishes → Gills
- Amphibians → Frog → Moist skin + lungs → Lungs → ~~Gills~~ lungs; → Gills.
- Reptiles → Lungs
- Birds → Lungs
- Mammals → Lungs (well developed Resp. sys.)

✱ Human Respiratory System

Nostrils → Nasal passage → N. Chamber → Nasopharynx → Glottis (In Larynx region) → Trachea → 1° Bronchus / Brochi

1° Bronchi & 2° & 3° Bronchi → Initial Bronchioles → Terminal Bronchioles → Alveoli [Bag like, irregular walled (thin)].

✱ Cartilaginous Incomplete C-shaped rings → Trachea (F) → Initial Bronchioles
↳ supporting

✱ Voice Box → Larynx → Cartilaginous.

Division of Trachea → 1° Bronchus → 5th Thoracic vertebrae. (F) ✱✱

Pleural Membrane → Double layered → pleural fluid in b/w.
↳ Reduce frictⁿ on lung surface.
Outer → touch thoracic lining.
Inner → lung surface touch

Epiglottis → Elastic cartilage ✱✱ [prevent food → trachea]
Uvula → soft palate [11 11 → Nasopharynx]

* Respiratory System

Conducting part
* Nostrils → terminal Bronchioles
→ Transport atm. air to alveoli
→ Humidify it, bring to body temp.
→ Clarify foreign particles.

Respiratory / Exchange part
* Alveolic & their ducts.
→ Site of diffusion of O_2 & CO_2 b/w blood & atm. air.

Lungs → fit in Thoracic chamber → anatomically air tight.

- **Dorsally** → Vertebral column
- **Ventrally** → Sternum
- **laterally** → Ribs
- **on Lower side** → Diaphragm (main resp. muscle)

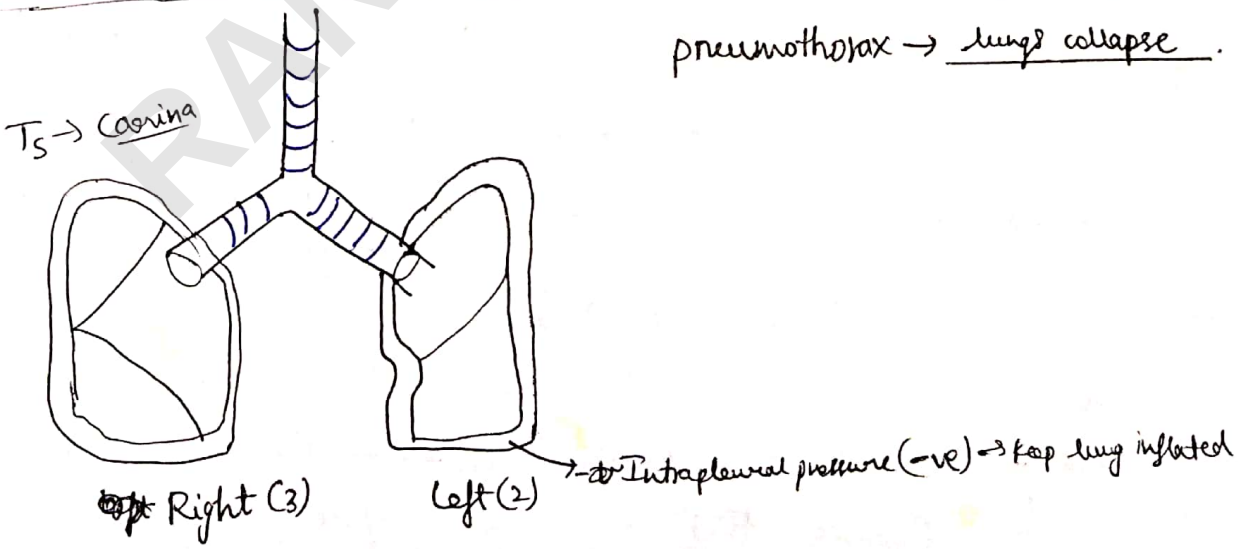
Anatomical setup ⇒ Δ Vol^m of T.C. → Δ in (Vol^m of Pulmonary Cavity (lung))

Can't be altered directly.

* Steps of Respiration

(1) Breathing / Pulmonary ventilat^n → atm air in, CO_2 rich air out.
(2) Diffusion of gases (O_2 & CO_2) across alveolar membrane.
(3) Transport of gases by blood.
(4) Diffusion of O_2 & CO_2 b/w blood & tissues.
(5) Utilisat^n of O_2 [catabolic rxn] & release of CO_2.

pneumothorax → lungs collapse.



03

1+2 = IC [T.V = 500 ml ; IRV = 2500–3000 ml] → I.V.C.

1+3 = EC

3+4 = FRC [ERV = 1000–1100 ml ; RV = 11–1200 ml] → T.L.C.

(F) TLC – V.C. = R.V.

T.V. = 500 × (12–16) (→ Rf.) = 6000 – 8000 ml/min

(T.V. – D.S.A) × RR = 4200 ml/min

(alveolar ventilation ← ; D.S.A ↓ ISO)

✱ Mechanism of Breathing

✱ Insp. & Expirat^{n} → By creating press. gradient b/w atm & lungs.

1. Inspirat^{n} → Intra-pulmonary pressure :- –ve wrt. atm pressure
2. Expirat^{n} → Intra-pulmonary pressure :- +ve wrt. " "

✱ Gradients → Generated by → Diaphragm → Muscular

→ (Ext. & Internal Intercostals) → Specialised set of muscles b/w ribs.

	Inspirat^{n}	Expirat^{n}
Diaphragm	Contract → Initiat^{n} of inspirat^{n}. Thoracic Vol^{m} (pulmonary) ↑ in antero-posterior axis (almost all at rest)	Relax. → Normal posit^{n} ↓ T.V., ↑ pressure → air expelled out.
Internal Interco.	Relax.	Contract
External Interco.	Contract → ↑ vol^{m} of T.C. in dorso-ventral axis. → Lifts up ribs & Sternum → pressure ↓es → air comes in	Relax.

✱ Our ability to ↑ Strength of Expi./Inspirat^{n} due to :- Help of additional muscles in abdomen (Rectus abdominus).

Healthy Human → Breathes (F) 12–16 times/min.

(F) Spirometer → ** For measuring vol^{m} of air involved in breathing movements.

→ Clinical assessments.**

Respiratory Volm & capacities :→

1. Tidal Volm (TV) :→ Volm of air inspired/expired during Normal respirat^{n}. TV = 500 ml per breathe TV = 6000-8000/min

2. ERV :→ Addn volm expired by forcible expirat^{n}.
ERV → 1000-1100 ml

3. IRV :→ Add volm inspired by forcible inspirat^{n}.
IRV → 2500-3000 ml

4. R.V :→ Volm of air remained in lungs after forcible expirat^{n}.
RV = 1100-1200 ml → No spirometer measure..

5. I.C :→ **T.V. + I.R.V.** (after normal expirat^{n}).

6. E.C :→ **T.V. + E.R.V.** (after normal inspirat^{n}).

7. Functional Residual Capacity :→ Remain in lung after normal expirat^{n}. → No spirom.
(FRC) = R.V. + E.R.V.

8. Vital Capacity (V.C) :→ Max. volm breathed after forcible expn.
V.C. = IRV + T.V. + ERV.

9. → Total lung capacity :→ No spirometer. → Volm but after forcible inspirat^{n}.
T.L.C. = IRV + T.V + ERV. + R.V.

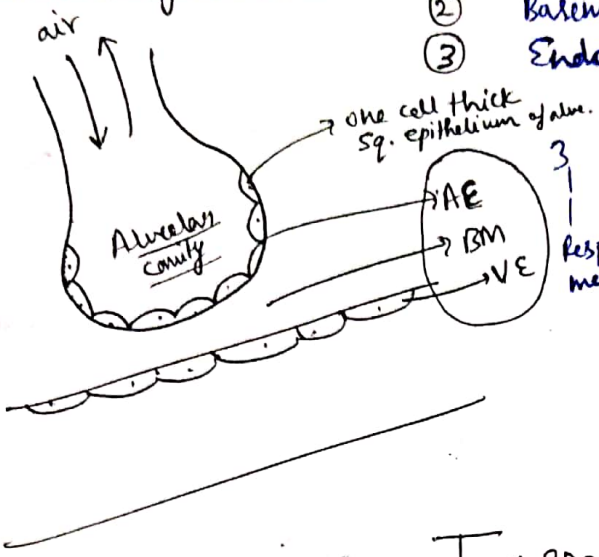
Exchange of gases

* Exchange of gases → By pressure/conc^{n} gradient → Simple diffusion
↳ Solubility of gas + thickness of membr. → Imp. Factors. for Rate of Diffusion.

Solubility: $CO_2 > O_2$ 20-25 times.

Gas	Atm air	Alveoli	Deoxyg. Blood	Oxygen. Blood	Tissue
O_2	159	104	40	95	40
CO_2	0.3	40	45	40	45

* Membranes of Respirat^{n} :→ ① Squamous epithelium of alveoli
② Basement subst.
③ Endothelium of ~~alveolar~~ Blood capillary.



< 0.1mm thick
≈ 0.2mm

Transport OF GASES

a) OF oxygen :→

O_2 → (E) 97% HbO_2 (oxygenated Hb) — Hb → Red coloured pigment having iron.
→ (F) 3% Dissolved (plasma).

* 1 Hb → 4 molecules of O_2 (max.) [cooperativity. → sigmoid curve]

#	Alveoli	tissue
pO_2	High	Low
pCO_2	Low	High
temp.	Low	High
H^+ conc	Low	High
pH	More	Less

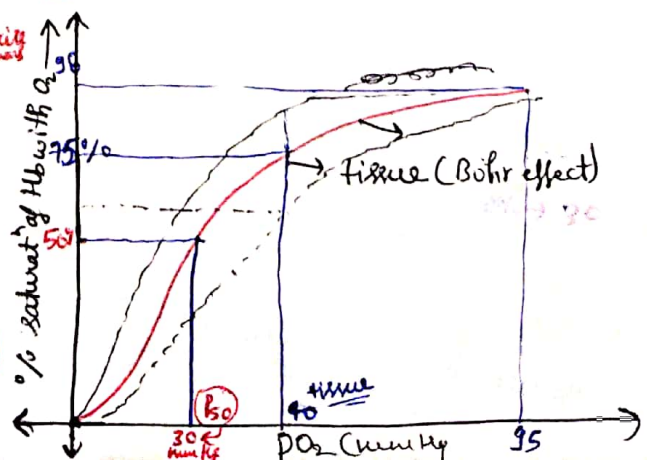
$O_2 + Hb \rightleftharpoons HbO_2 \rightleftharpoons O_2 + Hb$

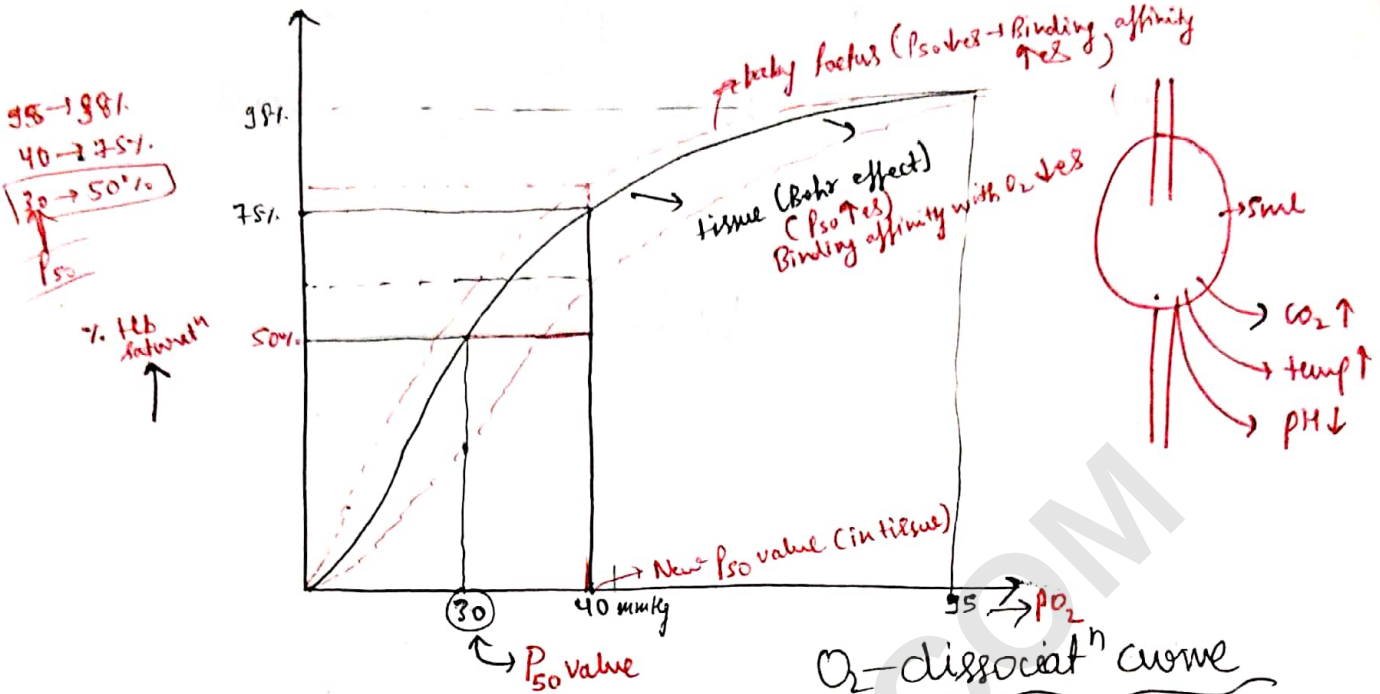
Oxyhaemoglobin.

(E) 100ml blood → deliver 5 ml O_2 to tissue (Normal cond^{n}).
↳ 12-16 gm Hb → deliver 15ml during exercise

Graph ~~pO_2~~ % saturat^{n} of Hb with O_2 v/s pO_2 → Sigmoid.

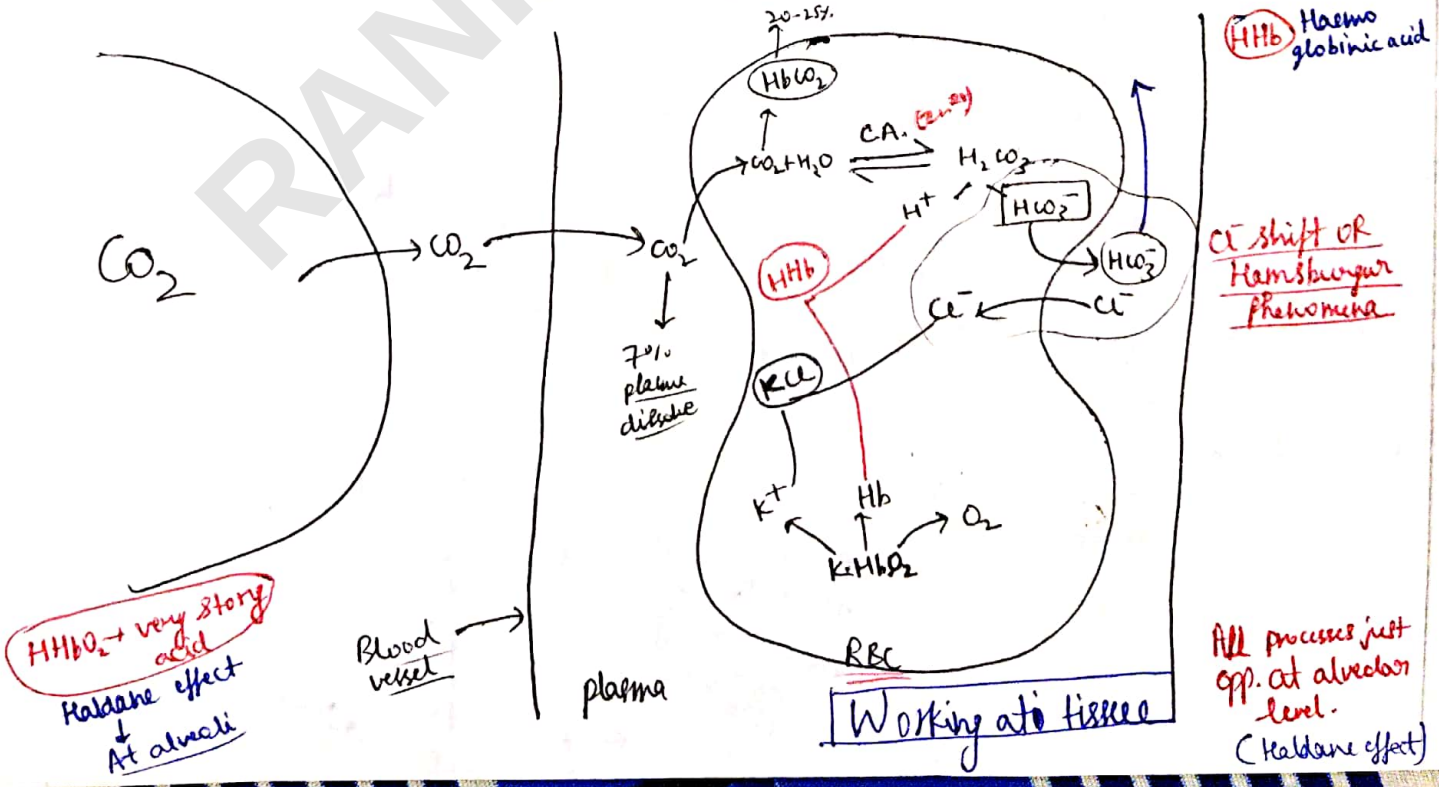
95-98% → 90 (tissue) mmHg
75% → 40 mmHg
50% → 30 mmHg
↓
P_{50} value





Transport of CO_2

- Carbamino-Hb (F) — 20–25%
  - Binding related to pCO_2
  - PO_2 → major factor affecting binding
- as HCO_3^- ion (F) — ~70%
  - CO_2 → diffuse into blood [plasma & RBC]
  - at tissue $H_2O + CO_2 \xrightleftharpoons{CA} H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$
  - HCO_3^- → transported to alveoli
  - at alveoli: $HCO_3^- + H^+ \xrightleftharpoons{CA} H_2O + CO_2 \uparrow$
- Dissolved state in plasma (F) (~7%)



Every 100ml blood → Delivers (4 ml CO_2) at alveoli.

Regulat^n of Respirat^n

Neural

Chemical

O_2 → ↓ role, insignificant in R.R

CO_2, H^+

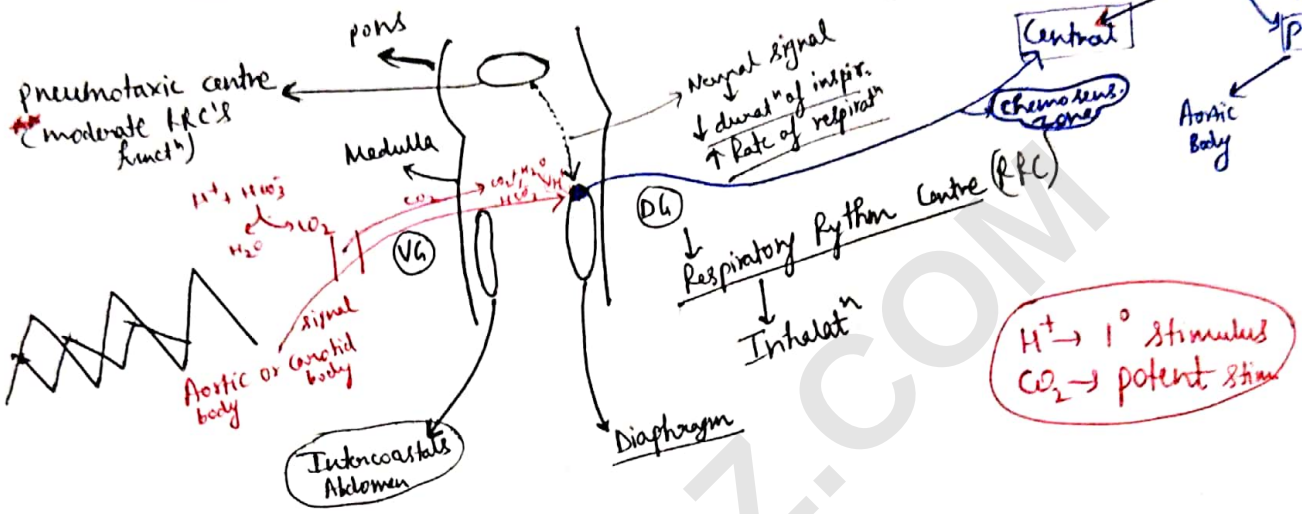
Chemoreceptors

Central

Peripheral

Aortic Body

Carotid Body



H^+ → 1° Stimulus

CO_2 → potent Stim

Disorders of Respiratory System :→

1. **Asthma** :→ Difficulty in breathing causing wheezing
   Cause → Inflammat^n of Bronchi & Bronchioles.

2. **Emphysema** :→ Chronic disease → Alveolar walls are damaged → Respi. surface ↓es
   → Cigarette Smoking.. → treatment ∝-1-antitrypsin

3. Occupational Respiratory Disorder :→ Defense system can't cope with dust of stone breaking industry.
   (1) Fibrosis → proliferat^n of fibrous tissue (due to inflammat^n)
   (2) Silicosis (TB).
   (3) Asbestosis (Lung cancer)

   } Injury in lung tissue → Heal by Fibrosis

pneumoconiosis