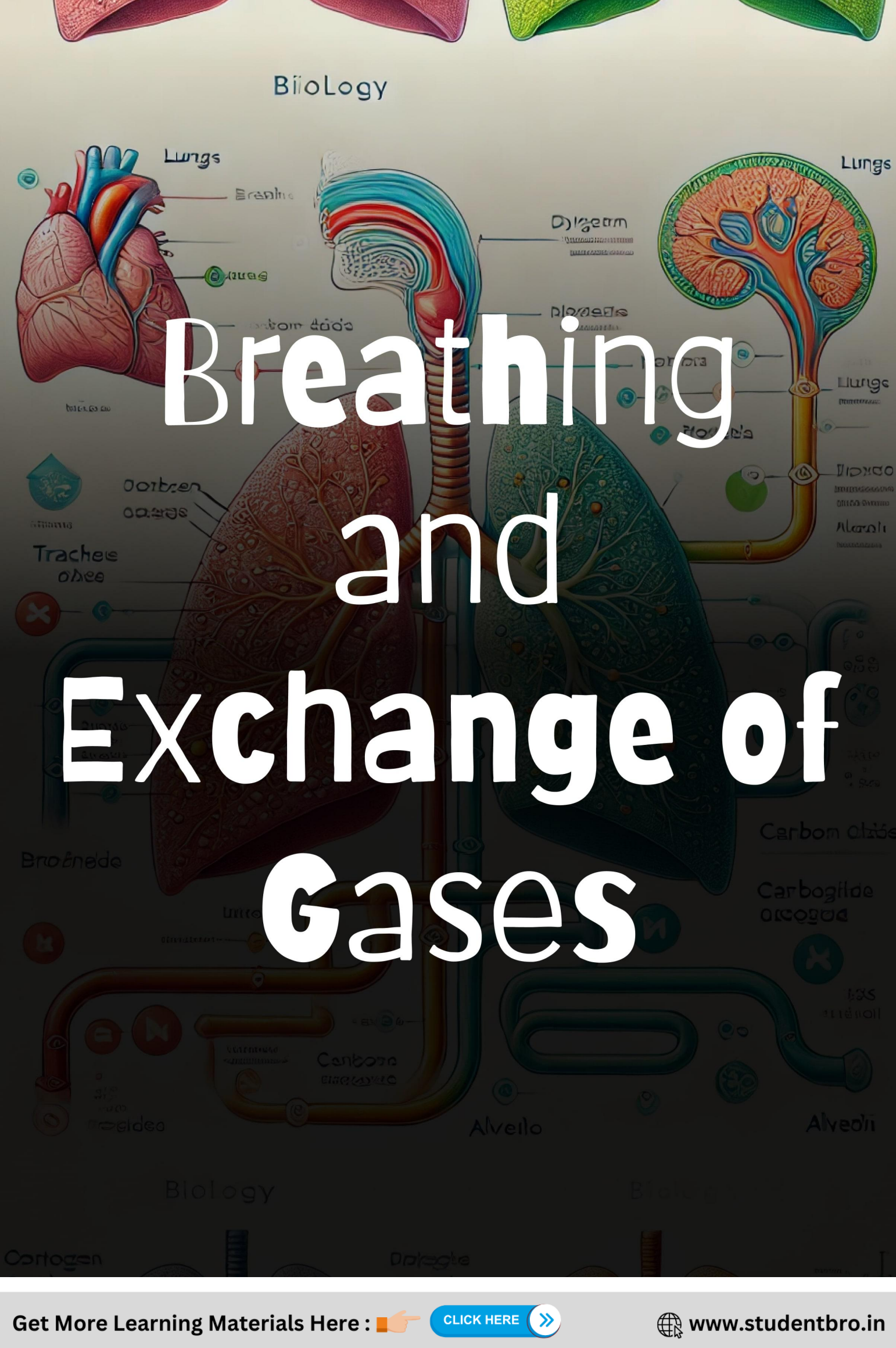


Breathing and Exchange of Gases

Breathing And Exchange of Gases

- PH of blood → 7.4 → slightly alkline
- PH of wine → 6 → acidic
- Hibernation → Winter sleep
- Aestivation → Summer sleep
- For diffusion and filtration membrane should be thin (Simple Squamous epithelium (SSE)
- Pseudo stratified ciliated columnar glandular epithelium
  unidirectional movement

Oxygenated Artery → Organ → deoxygenated vein

Pulmonary artery → Lungs / Respiratory system → Pulmonary vein
Max. deoxygenated blood Pulmonary / Max. oxygenated blood.

Hepatic, artery → Liver NH_3 → Urea → Hepatic, vein

Renal, artery → Kidney Urea eliminate → Renal, vein

Coronary artery → Heart → Coronary vein

Carotid artery → Brain Head → Jugular vein

- Arteries contains oxygenated blood except pulmonary artery
- Vein contains deoxygenated blood except pulmonary vein
- Max. deoxygenated blood → towards the respiratory organs.

Human → Pulmonary artery
Frog → Pulmocutaneous artery.

Max. oxygenated blood → away from respiratory organ (Pulmonary vein).

Maximum amount of urea

1) Hepatic artery
2) Hepatic vein ✓
3) Renal artery
4) Renal vein

As urea is synthesised in liver.

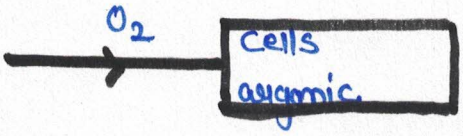
Maximum amount of urea.

1) Hepatic artery
2) Hepatic vein
3) Renal artery
4) Renal vein ✓

Of get excreated out.

If liver functionless → NH_3 ↑

If kidney functionless → urea ↑



Energy + CO_2 ↑

AEROBIC	ANAEROBIC
• Oxygen always required	• Oxygen not required
• More energy released	• Less energy released
• Most of the body cells.	• RBC (Erythrocytes) → due to absence of mitochondria.
	Ex → White Muscle fibres → during heavy exercise → deposition of lactic acid.

Human do respiration to produce energy.

Respiration is a catabolic process (amphibolic).

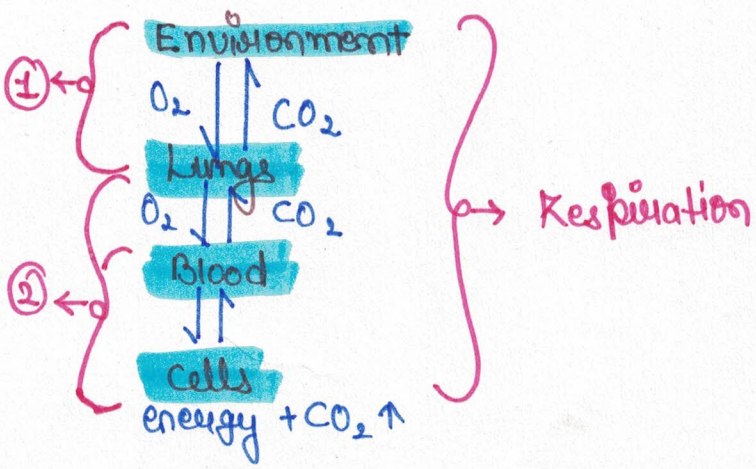
Human can't use oxygen directly.

Respiration involves the following steps :-

- Pulmonary ventilation (Breathing).
- Exchange of gases through alveoli membrane.
- Transport of gases by blood.
- Exchange of gases between blood and tissue.
- Utilisation of oxygen by catabolic rxn & release of CO_2.

Acc. to G.S Cautley

- External respiration / Breathing / ventilation.
- Internal respiration
- Cellular respiration



- Respiratory membrane should be thin, highly vascularised and should have large surface area.
- Surface area of human skin ⇒ 1 to 2 m^2
- Surface area of alveoli ⇒ 100 m^2

??? universal toxic substace.

1) Uric acid (2) CO_2 ✓ (3) Urea (4) NH_3

??? Most toxic N_2 substace.

1) Uric acid (2) CO_2 (3) Urea (4) NH_3 ✓

- Human blood → Red
- Blood plasma → Pale Yellow
- Human can't do cutaneous respiration.
- In Frog → Cutaneous (always)
  → Buccal cavity
  → Pulmonary
- Frog can't live without cutaneous respiration.
- Non-respiratory air sac, increase the efficiency in birds.
- The principle of counter current (opposite flow) mechanism facilitate the efficient system for gills in fishes.
- Respiratory organs in various organisms depends on their habitat and level of organisation.

1) Coelenterates, Sponges, Flat worm → General Body surfaces.
2) Earthworm → Moist cuticle.
3) Insect (cockroch) → Tracheal tube.
4) Aquatic → Gills.
5) Reptiles, Mammals → Lungs
6) Spider → Book lungs.

HUMAN RESPIRATORY SYSTEM

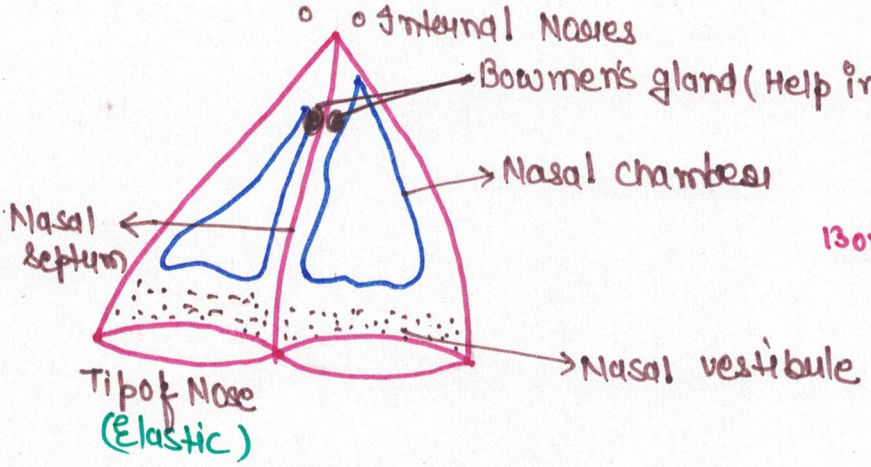
RESPIRATORY TRACK

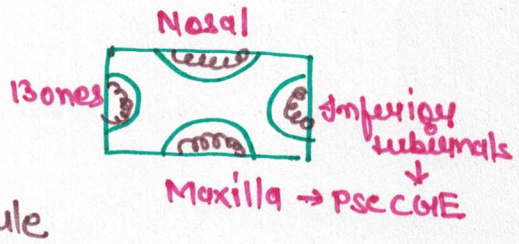
LUNGS

⇒ External Nostrils → Nasal Vestibule → Nasal chamber → Internal Nares → Nasopharynx → Pharynx → Glottis → Larynx → Trachea → Bronchial tree → Respiratory tree.

NOSE AND NASAL PASSAGE

- Nostrils
- Distinct conditions.
- Inflammation in Nasal track → Rhinites
- Spiracks of cockroach similar to nostrils.

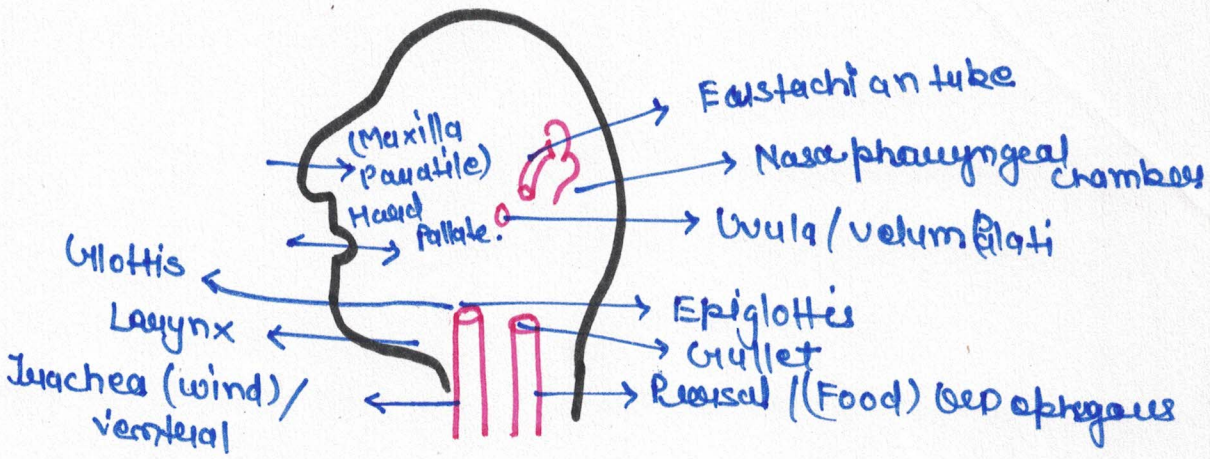




FUNCTION

- NOSAL VESTIBULE → Skin
- Respiratory Region → PSCCME
- Olfactory → Nerve → Sensory epithelium schneiderian membrane.

Buccopharyngeal Cavity



LARYNX

Modified Part of Trachea

- Sound box. Voice producing organ.
- Syrinx in birds does the same.

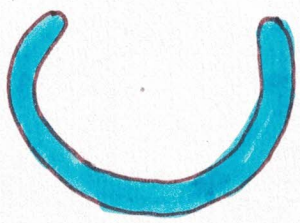
Cartilagenous box

THYROID (1)
Hyaline
- Ventrally blood and dorsally incomplete

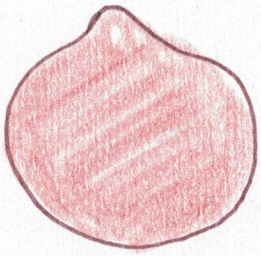
CRICOID (1)
Hyaline
Signet ring

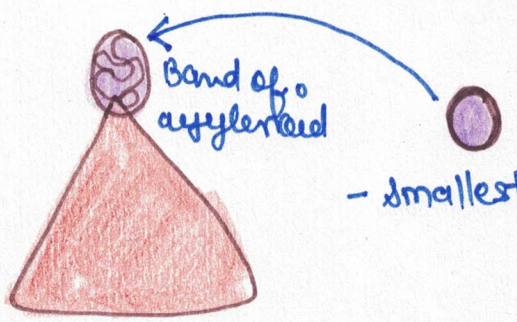
ARYTENOID (2)
Hyaline
Pyramidal shape

CARTILAGE OF SANTORINI (2)
Elastic
Rounded



Largest
(Adam's apple)





- Smallest

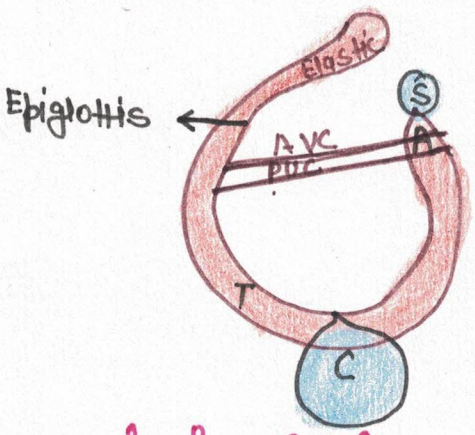
VOCAL CORDS

a. Anterior pair of vocal cords

- False vocal cords.
- Pink in colour
- Membranous
- Provides moisture to true vocal cords.

b. Posterior pair of vocal cords are

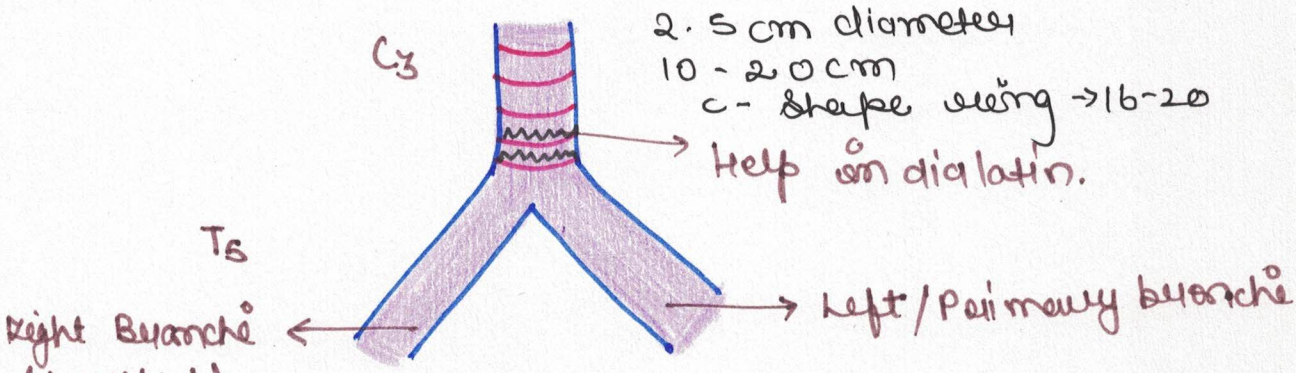
- True vocal cords
- Elastic (Yellow Fibrous connective tissue)
- Yellow in colour.
- Help in phonation



Vocal cords are situated below thyroid and Arytenoid cartilage.

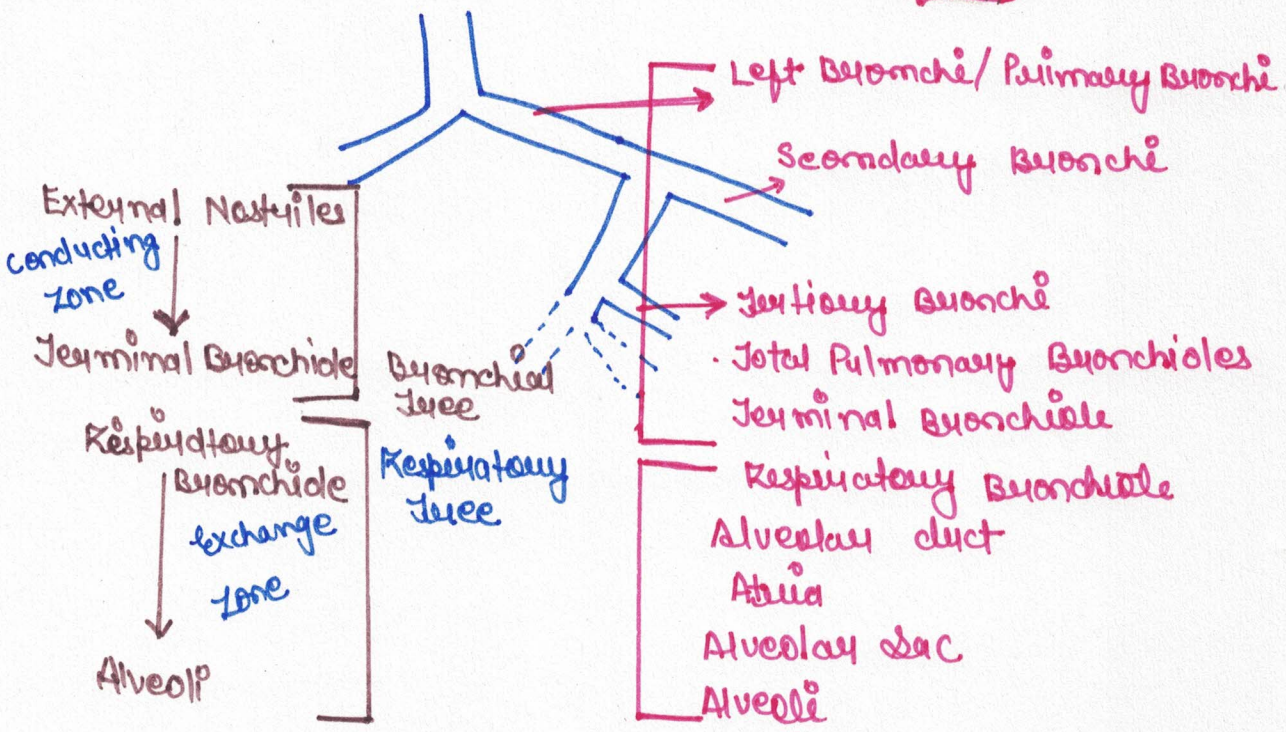
TRACHEA

- cilia present ⟶ Pass out mucus.



- whenever passage is short changes of injection is more.

Bronchial Tree and Respiratory Tree



BRONCHIAL TREE

Diameter is more

Rings present

No gaseous exchange

PSCCHE

Dead space vol or Anatomical Dead space = 150 ml.

RESPIRATORY TREE

Diameter is less

Rings absent

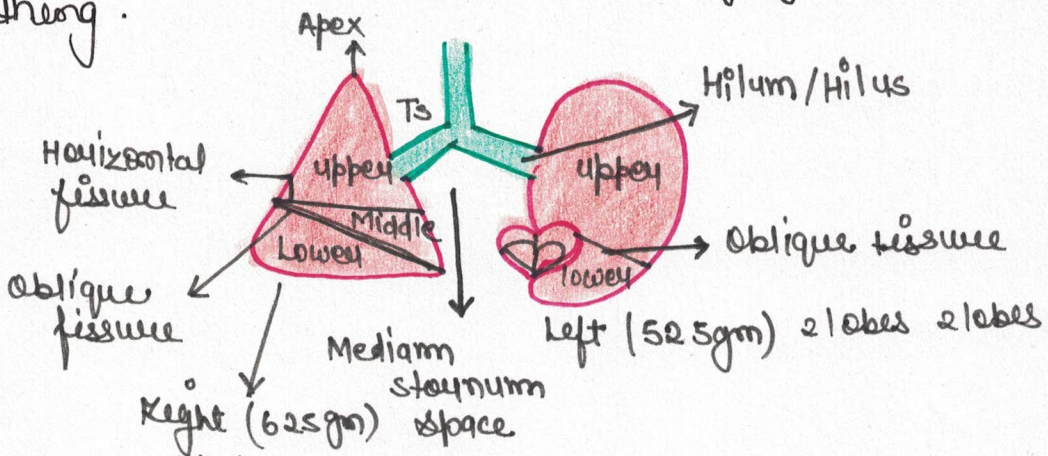
Gaseous exchange.

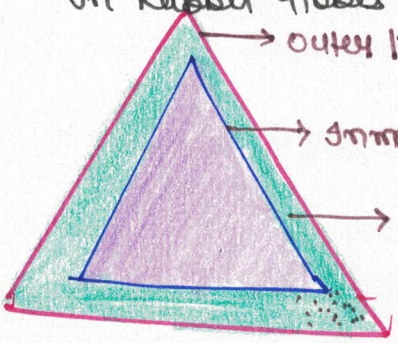
SSE

LUNGS

- A pair of lungs present in thoracic cavity.
- Central cavity absent.
- Soft and spongy.
- Lungs do not collapse → Negative intra pleural pressure (-4mm)
- Muscles are absent in lungs so power of self contractia and relaxation absent.
- Air tight chamber

- We can't change the pulmonary volume directly, it completely depends on thoracic cavity on the basis of arrangement.
- In human negative pressure breathing so we can eat and breath at the same time but in frog positive pressure breathing.





→ Outer Parietal Pleura → S.S.F (Mesodermal) (Towards thorax)

→ Inner Visceral Pleura → S.S.E (Mesodermal) (towards Lungs)

→ Pleural fluid → Shock absorption
→ reduce friction

Pleural fluid Increase → Pleurisy

Difficulty in excathing → Pleural effusion disease
(Dyspnea)

ALVEOLI

- Structural and functional unit of lungs.
- Endodermal
- 300 million in number
- 100 m^2 (High surface area)

V.F.C.T

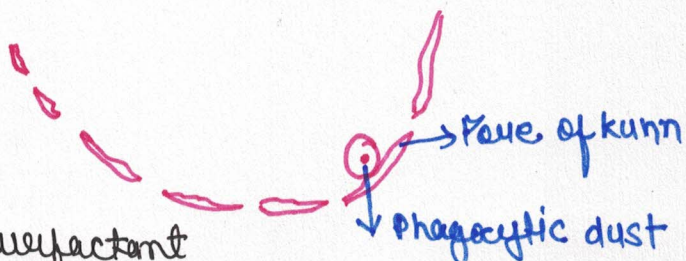
Pneumocyte

I — Cuboidal — II

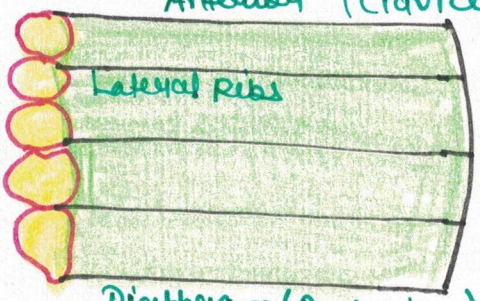
G.E

S.S.E

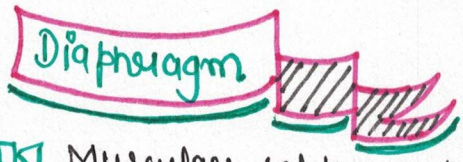
Lecithin Phospholipic surfactant
Reduces surface tension. Protect alveoli from collapsing.



THORACIC CAGE



Diaphragm



- Muscular septum present in mammals
- Normally dome shaped
- Radial / Phrenic Muscles (Primary muscle for breathing)
- If diaphragm puncture → Human will die (due to suffocation / asphyxia)

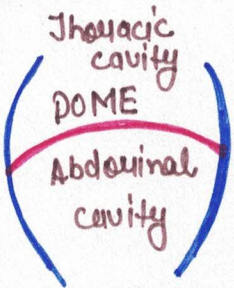
Function of diaphragm

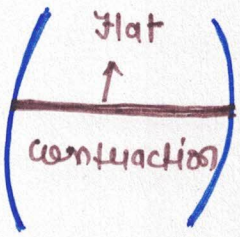
- Parturition, ejection and micturition.

Intercostal Muscles

EICM
Dorsal face of upper rib with ventral face of lower rib

IICM
dorsal face of lower rib with ventral face of upper rib.





"Impulse for voluntary muscles during forceful breathing
↓
Cerebrum

If EICM remove → Difficulty in normal breathing

If IICM remove → No effect on normal breathing

Mechanism of Breathing

Inspiration

It an active process

Take 2 sec

Diaphragm and external intercostal muscles contract

Antero-Posterior volume ↑

Dorso ventral volume ↑

Pulmonary volume ↑

Intra pulmonary pressure ↓

Air goes in → Inspiration takesplace.

Expiration

It's a passive process.

Takes 3 sec.

Diphragm and external intercostal muscles Relax.

Antero-posterior volume ↓

Dorso ventral volumn ↓

Pulmonary volume ↓

Intra Pulmonary pressure ↑

Air goes out → expiration take places.

Forceful Inspiration

It an active process

More contractions in diaphragm (Anterior-posterior volume ↑↑) and external Intercoastal muscles (Dorsa ventral volume ↑↑

Thoracic volume ↑↑

Pulmonary volume ↑↑

Intra-Pulmonary pressure ↓↓

Forceful Inspiration

Forceful Expiration

It's an active process.

Diaphragm and EICM relax but

Internal inter coastal muscles contracts (Antero-posterior and dorsa ventral volume ↓↓)

Thoracic volume ↓↓

Pulmonary volume ↓↓

Intra-pulmonary pressure ↑↑

Forceful expiration.

- Normal breathing → Abdominal breathing → Diaphragm +
- In pregnant female → Thoracic (other muscles) breathing + Diaphragm (60%)
- We have ability to increase the inspiration and expiration with the help of additional abdominal muscles (YOGA).

Pulmonary Volume and Capacity

Spirometer - Inert gas Helium used.

- Tidal volume = 500 ml
  Dead space volume = 150 ml

Pulmonary ventilation (500) > Alveolar Ventilation (500 - 150 = 350)

500 × 12 - 16 = 6000 - 8000 ml/min

- Inspiratory Reserve volume / complementary air
  I.R.V = 2500 - 3000 ml
- Expiratory Reserve volume / supplement air
  E.R.V = 1000 - 1100 ml
- Residual volume [R.V.] = 1200 ml
- Inspiratory capacity [I.C] = I.V + I.R.V
  500 + 3000 ⇒ 3500 ml
- Expiratory capacity [E.C.] = T.V. + E.R.V.
  500 + 1100 ⇒ 1600 ml
- Functional Residual capacity [F.R.V = R.V. + E.R.V
  F.R.V = 500 + 1100 = 1600 ml
- Vital capacity [V.C] = T.V + I.R.V + E.R.V
  V.C = 500 + 3000 + 1100 = V.C = 4600 ml

Total Lung capacity [T.L.C] = T.V + I.R + E.R.V + R.V

T.L.C = V.C + R.V

4600 + 1200

5800 ml

- Lung are non-functional in embryonic stage.
  Residual volume present in alveoli

Large number of alveoli ⟶ High percentage of Residual volume

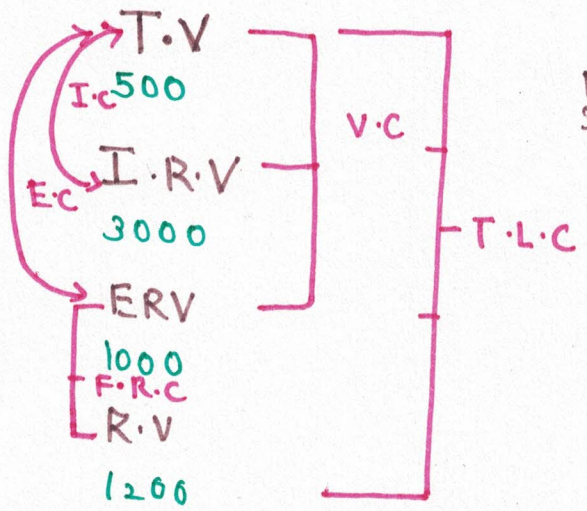
Efficiency decrease ⟵

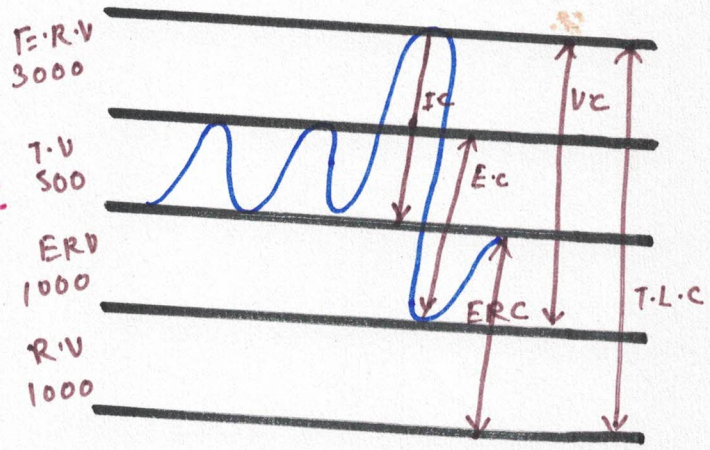
- Due to dead space volume and residual volume respiratory efficiency decreased (inefficient system).

Spirometer can't measure R.V, T.L.C, F.R.C.

T.V < E.R.V < RV < EC < FRC < IRV < IC < VC < TLC

500 1000 1200 1600 2300 3000 3500 1.5 6





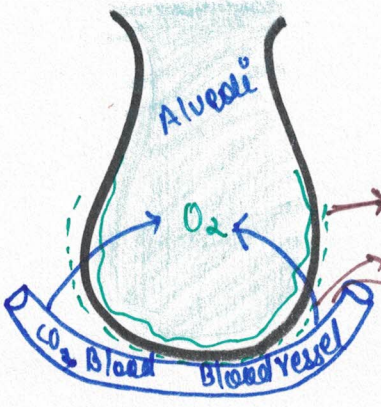
Gaseous Exchange

% = $\frac{\text{Partial Pressure}}{760} \times 100$

P_{O_2} = P.P of oxygen

- Gaseous exchange occurs at → alveoli, tissue
- Alveolis are the primary site for gaseous exchange
- Simple Diffusion (High → Low), without ATP.

Respiratory Membrane



① Alveolar epithelium

② Basement substance
- Basement membrane
- Interstitial space
- Basement membrane

③ endothelium

Respiratory membrane (less than a mm)

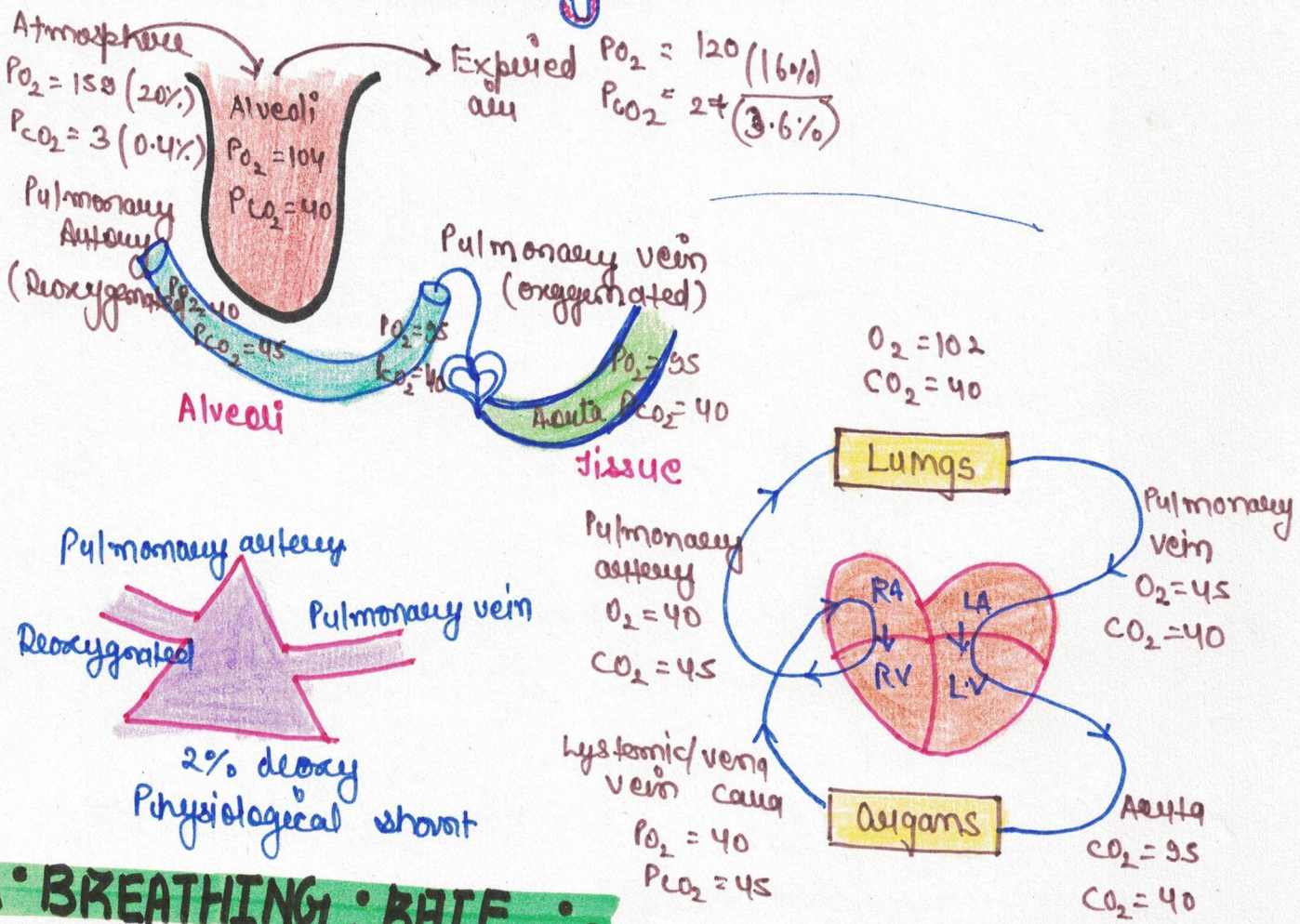
Diffusion capacity → $CO_2 > O_2 > N_2$

20 times 2 times

CO_2 = 420 ml

Factors :→ Solubility, Partial Pressure, Thickness of Respiratory membrance.

Gaseous Exchange



BREATHING RATE

- Adult = 12 - 160 / min
- Breathing rate ∝ Heart rate ∝ B.M.R
- child = 25 / min
- New born baby = 44 / min
- Embryo = 0 / min
- Rabbit = 38 / min

At high altitute heart rate, breathing rate, no. of R.B.C increases but binding affinity decreases but binding at low partial pressure (not % age.)

Transport of Gases

Oxygen

O_2 oxygenated Blood

- 3% O_2 dissolved with Plasma
- 97% RBC (Red → Hb)
  - Haem: Porphyrin, $4Fe^{+2}$
  - Globin: Polypeptide, α-141 AA
    - β, γ, δ → 146 AA

$2\alpha + 2\beta$ = Adult

$2\alpha + 2\gamma$ = Foetus (Affinity ↑)

One molecule of Haemoglobin carries 4 molecules of oxygen.

1g Haemoglobin ⟶ 1.34 ml oxygen

100 ml blood ⟶ 12-16 g Hb (exact 15)

$1.34 \times 15 \approx 20$ ml O_2

Dissociate: Normal condition

Tissue: 5 ml O_2 —75%→ veins, $PO_2 = 40$

During muscular exercise = 75% (3 times)

Hb_4 Fe^{+2} + $4O_2$ ⇌ HbO_2 Fe^{+2} (oxygenated Hb)

Alveoli (association) ⟶ ⟵ Tissue (Dissociation)

Reversible oxygenation, unstable.

Harmful Gases

CO, O_3, SO_3, NO_3

Hb (Fe^{+2}) + O_3 ⟶ Oxidised Hb (Methanoglobin) (Fe^{+3}) Stable

Hb + CO (300 times) ⟶ Carboxy Hb (cherry Red)

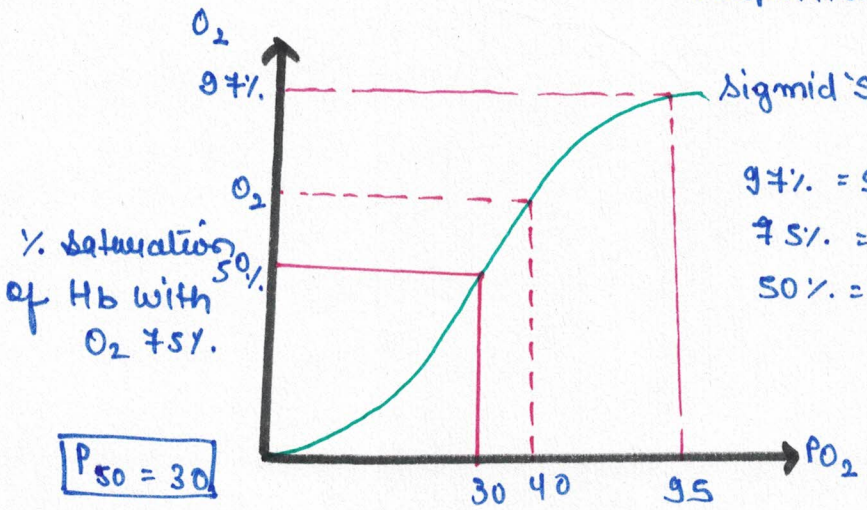
- Simple respiratory organ ⟶ Skin
- Due to Yawning ⟶ Due to lack of O_2
- Suddenly jerky movement of diaphragm ⟶ Hiccup/Hicough
- Residual volume present in alveoli
- Common salt ⟶ NaCl
- Carbonic anhydrase ⟶ Zn ⟶ Present in R.B.C and Plasma
- Donnan's Membrane = RBC membrane
  - Permeable for positive (Na^+, K^+)
  - Impermable for negative (Cl^-, HCO_3^-)

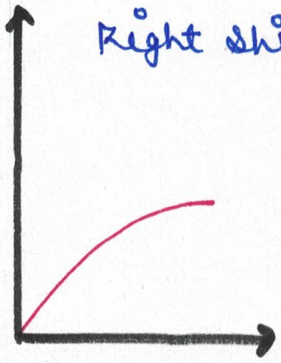
Oxygen dissociation Curve

- 100 ml oxygenated blood carry 20 ml oxygen but deliver 5 ml (25%) oxygen at tissue level during normal condition.

Respirato Distress Syndrome

Premature baby (7-8 months) ⟶ Lectin
⟶ Alveoli collapse
⟶ Respiratory distress syndrome.



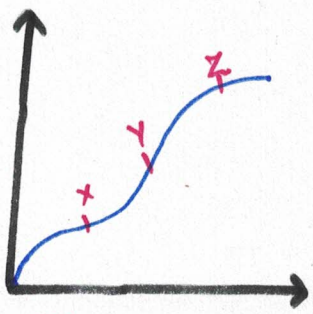


Right shift

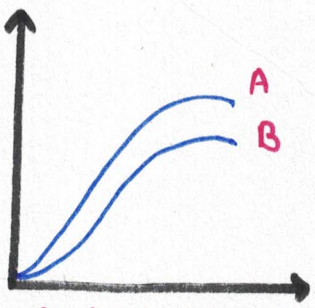
P_{O_2} ↓ (Bohr's effect's)
P_{CO_2} ↑
H^+ ↑ , PH ↓ (Roults effect)
Temp^{u} ↑
exercise → Glycolysis
3-Diphosphatyl glycerate

Left shift

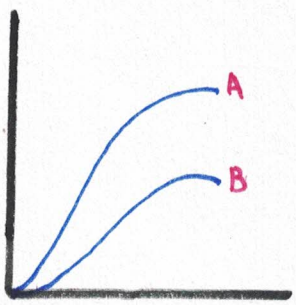
P_{O_2} ↑
P_{CO_2} ↓
H^+ ↓ , PH ↑
Temp ↓
D.P.G ↓



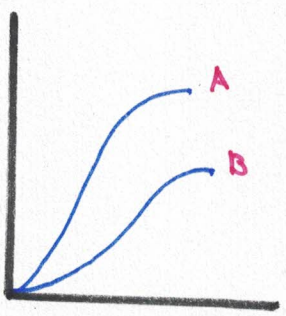
1) S.V y
2) P.V z
3) S.V (exercise) ↑



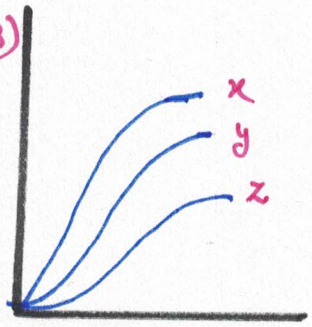
A ⇒ 1) Alveoli
2) Artery
B ⇒ 1) Tissue
2) vein



A = Foetal ($2\alpha + 2\alpha$)
B = Adult ($2\alpha + 2\beta$)



A = Myoglobin
B = Hb , $4Fe^{+2}$



Adult = z
Foetal = y
Myoglobin = x
(P_{50} 5-7 mm of Hg

Transport of CO_2

- 100 ml deoxygenated blood delivers 4ml CO_2 at alveoli level
- CO_2 transported by
  - (a) 5-7 % (0.3 ml) dissolved with plasma
  - (b) 70% (maximum) Bicarbonate → transported by plasma
  - (c) 20-25% (23%) as carbamino Hb → transported by Erythrocyte.
- Cl^- shift in response to HCO_3^-.

5-7% CO_2 dissolved with plasma

70% $CO_2 + H_2O$ ⇌ (5000 (zn), Carbonic anhydrase) $H^+ + HCO_3^-$ (Deoxygenated RBC) → $NaHCO_3$ Bicarbonate

$KHbO_2$ ⇌ $KHb + O_2$ (Buffer)

De oxy Hb

23% CO_2 + HHb + K + (α-shift) → Na^+Cl^- + KCl

$HHbNHCOOH$

Carbamine Hb

RBC $Cl^\ominus$ → Deoxy blood > oxy blood

PH → Deoxy > oxy

Regulation of Breathing

- Medulla oblongata
- Mainly three centres are present
- Dorsal Respiratory group (DRG)
- Dorsal portion of medulla oblongata
- Basic respiratory rythm centre
- Diaphragm + EICM contract

Ventral Respiratory System

- Upper dorsal part pons
- Switch off points of inspiration

- Fulfill the demand by regulating inspiration and expiration.

Pneumotaxic Centre

- Upper dorsal part pons
- Switch off point of inspiration
- When send strong signals (high frequency) → inspiration duration decrease so breathing rate increase.

Factors affecting Breathing Rate

1. PHYSICAL FACTOR

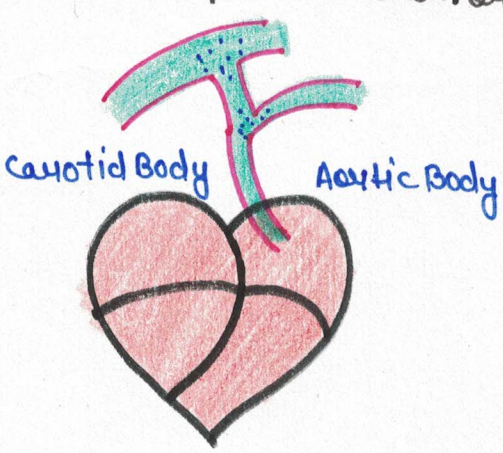
- High blood pressure and high temperature increase the breathing rate.

2. CHEMO-SENSITIVE AREA

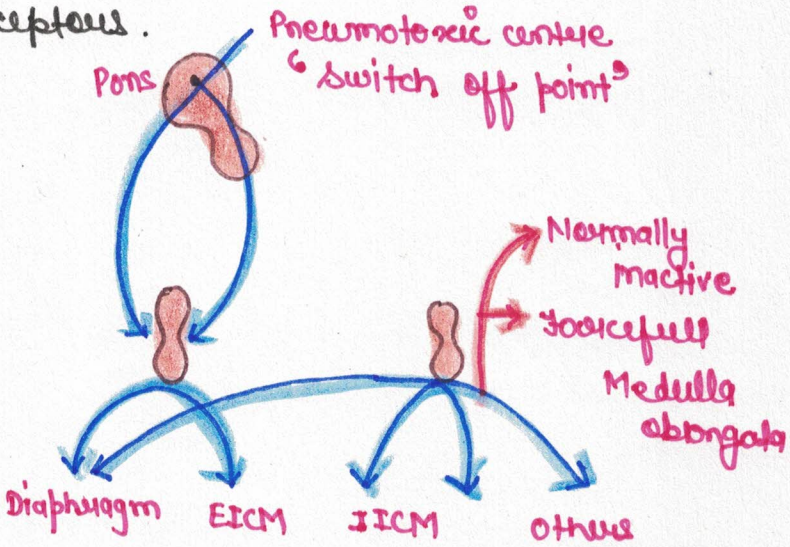
- Central chemo receptors
- Highly sensitive for $Pco_2 \uparrow, H^+ \uparrow, PH \downarrow$
- The role of oxygen in the regulation of respiratory rhythm is quite insignificant.

3. AORTIC BODY AND CAROTID BODY

- Peripheral chemoreceptors.

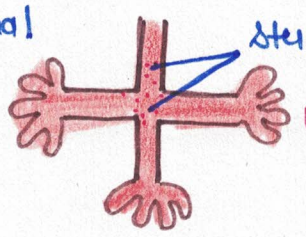


$Pco_2 \uparrow, H^+ \uparrow, PH \downarrow, Pco_2 \downarrow$

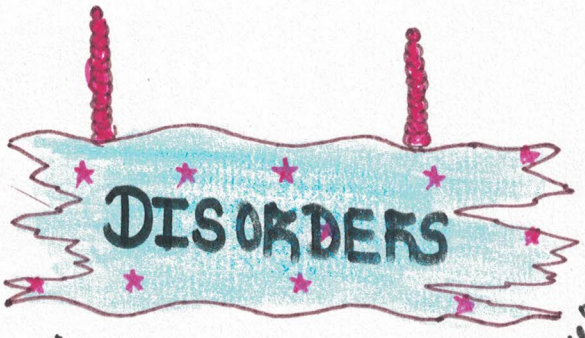


Hering Breuer Reflex arch

- Protective nervous action.
- Prevent the alveoli from over stretching.



Stretches receptors
↓
When alveoli filled with maximum air
↓
Receptor activate
↓
D.R.G. off
↓
Inspiration off.



- ASTHMA :→ Allergic disorder, mast cell, Histamine, vasodilator, spasm in bronchioles, difficulty in breathing, whistling sound, more difficulty in expiration (Passive)

TREATMENT :- Salbutamol (bronchodilator)

- BRONCHITIS :→ Inflammation, coughing and, itching.
- EMPHYSEMA :→ chronic disorder (Inflation of alveoli) :-

Major cause cigerate smoking
Surface area reduce

∿∿∿∿ → ∪ Inflatation of Alveoli surface area decrease

- OCCUPATIONAL RESPIRATORY DISORDER :→ Fibrosis (use mouth Mask)
- HYPOXIA :→ Oxygen Less
- ANOXIA :→ Oxygen Absent