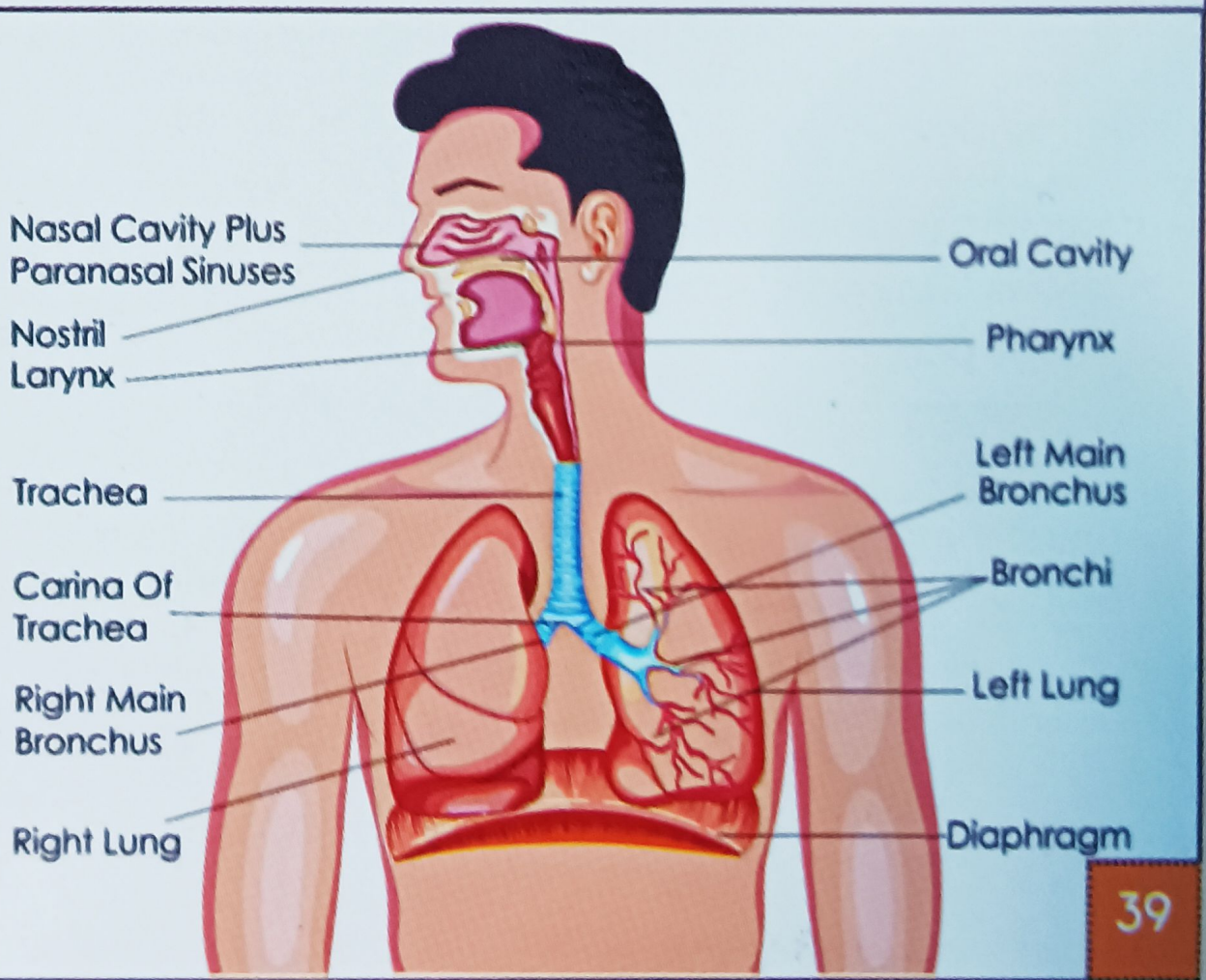
BREATHING & EXCHANGE OF GAS

Various organs	
Body surface-lower Invertebrates (sponges, coelenterates, flatworms)	**Skin (most cuticle)** Earthworms, Leech
Gills (Branchial Respiration) Aquatic arthropods, molluscs	**Tracheal Tubes** Insect
Lungs (Pulmonary Respiration) Most vertebrates (amphibians, reptile, birds, mammals)	



Human Respiratory System

External nostrils → Nasal chamber → Pharynx → Larynx (Sound box) → Trachea

Trachea —(divides at 5th Thoracic vertebra)→ Bronchi —(divides)→ 2° & 3° bronchi → Bronchioles → Alveoli (thin, irregular walled, vascular bag-like)

Trachea → Support incomplete cartilage rings

Note-Alveoli- Structural and Functional unit

Lungs-Formed by network of bronchi, bronchioles, Alveoli

↘ covered by **pleura** (2 layered - pleural fluid within them)

outer pleural membrane	contact with thoracic lining
inner pleural membrane	contact with lung surface

Conducting part- nostrils to bronchioles (transports, humidifies & maintains temp. of air)

Exchange part - Alveoli and its ducts (actual diffusion)

Location of Lungs - Thoracic chamber

Dorsal - vertebral column	Ventral - sternum
Lateral - ribs	Lower side - diaphragm

Steps of Respiration

1. Pulmonary ventilation (Breathing)
2. Gaseous exchange - B/W blood and alveoli and B/W Tissue and Blood.
3. Cellular/Tissue Respiration

Normal respiration rate 12-16 times/min Spirometer - used to measure respiration rate	NOTE

STAGES of Breathing = Inspiration + Expiration	
INSPIRATION	**EXPIRATION**
Active process	Passive process
Intake of air from the atmosphere to the lungs	Expelling air from lungs into atmosphere
Diaphragm contracts; inc. volume of the thoracic cavity (anteroposterior axis)	Inter-coastal muscles & diaphragm relaxes; dec. thoracic volume
External intercoastal muscles contract (dorsiventral axis)	Abdominal muscle & internal intercoastal muscles contract
Intra pulmonary pressure < atmospheric	Intra pulmonary pressure > atmospheric pressure (+ve pressure in

Respiratory volumes and capacities
Tidal volume (TV) : volume inspired/expired during normal respiration = 500mL
Residual Volume (RV) - the residual amount of air that remains in lungs even after forceful expiration = 1100-1200 mL
Inspiratory Reserve volume (IRV) Additional volume of air that can be inspired by forceful inspiration = 2500-3000 mL
Expiratory Reserve volume (ERV) Additional volume expired on forceful expiration = 1000-1100mL

Inspiratory capacity Volume inspired after normal expiration, TV+IRV = 3000-3500 mL
Expiratory capacity Volume Expired after normal inspiration, TV+ERV = 1500-1600 mL
Functional Residual capacity Volume remaining in lungs after normal expiration, **ERV + RV = 2100-2300 mL**
Vital capacity Volume that can be taken in after forced expiration, ERV+TV+IRV = 3500-4500mL
Total lung capacity Volume of air in lungs after max inspiration, RV + ERV + TV +IRV + RV = 5000-6000 mL

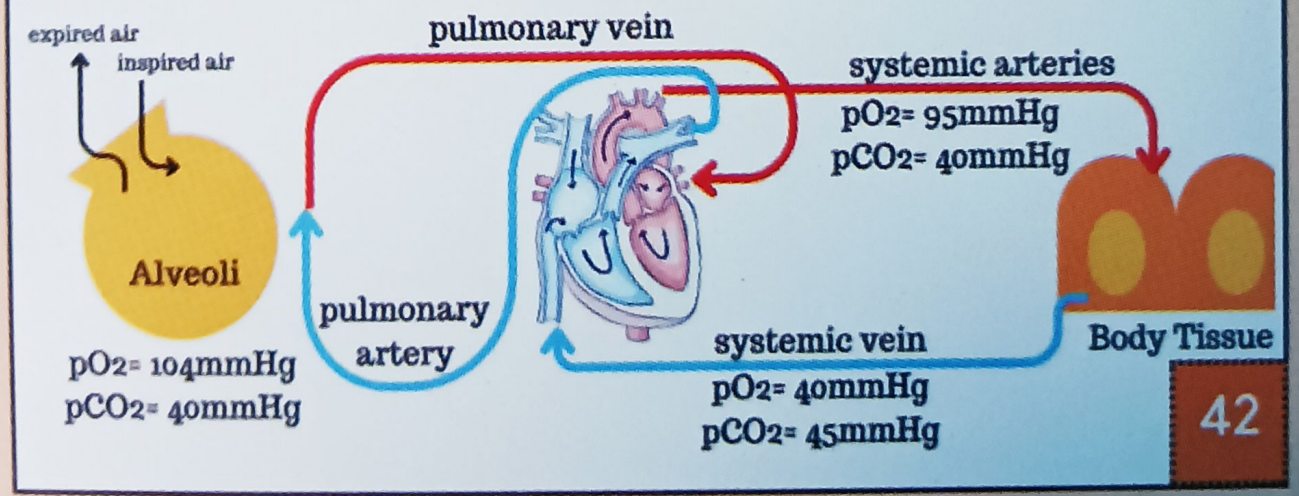
GASEOUS EXCHANGE

Alveoli and blood	Blood and Tissue

Diffusion of gases is based upon

1. **Pressure / conc. gradient**
2. **Solubility of gases = CO_2 > O_2 (20-25 times)**
3. **Thickness of diffusion membrane**

Thin squamous epithelium (alveoli)	Endothelium (alveolar capillary)	Basement membrane



Transport of O_2

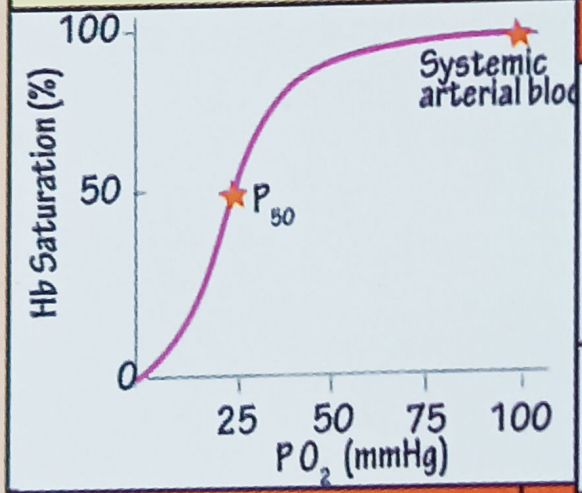
97% (by RBC's)	3% (dissolved in plasma)
Formation of oxyhaemoglobin	

Transport of CO_2

70% (In form of bicarbonates)	20-25% (In RBCs) Formation of carbamino- haemoglobin	7% (as carbonic acid) in plasma

$$CO_2 + H_2O \underset{\text{anhydrase}}{\overset{\text{carbonic}}{\rightleftharpoons}} H_2CO_3 \overset{\text{carbonic}}{\underset{\text{anhydrase}}{\rightleftharpoons}} HCO_3^- + H^+$$

- 100 ml oxygenated blood → delivers 5ml O_2 to tissues.
- 100mL deoxygenated blood → delivers 4mL CO_2 to alveoli.



Sigmoid curve

Binding of 1st molecule is difficult but it facilitates binding of 2nd, 3rd & 4th O_2 molecule (conformational changes)

- After the binding of 4th molecule, Hb is saturated.

Right Shift	Left Shift
pO_2 decreases; pCO_2 increases	Foetal blood (affinity of O_2) > adult
acidic conditions pH decreases, H+ increases	pO_2 increases; pCO_2 decrease, pH (High)
Temp increases	Temp low

DISORDERS

Asthma - Inflammation to bronchi & bronchioles (problem in breathing)

Occupational Respiratory Disorders -Inflammation & fibrosis of lung (cause-Long exposure, to dust produced by stone-grinding)

eg. Silicosis (due to breathing silica)
Asbestosis (due to breathing asbestos particles)

Emphysema - Damaged alveolar walls causing decreased respiratory surface.
(Cause - cigarette smoking)

Regulation of Respiration

Respiratory Rhythm centre - Medulla oblongata (Dorsal region)

Chemosensitive area, Adjacent to rhythm centre (Sensitive to CO_2 & H)

Receptors are also associated with aortic arch & carotid artery.

Pneumotaxic centre - Pons