ToppersNotes

NEET/AIIMS

BIOLOGY-III

SAMPLE BOOK

Sierra Innovations Pvt. Ltd.

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RESPIRATORY SYSTEM

* Endoparasites (Ascaris, Tapeworm) show anaerobic respiration.
* In human RBC and white muscle fibre anaerobic respiration.
* CO_2 is universal harmful substance.
* Internal parasites of blood show aerobic respiration.
* The surface on which gaseous exchange occur is c/a respiratory membrane.
  It has 4 characters - Thin, moist, more surface area, blood capillary network.
* Mammals donot respire through skin because skin is not moist (have no mucous glands).
* Frog ⇒ * On land → skin (35%), lungs (56%), buccal cavity (8-9%)
  * In water → only skin.
  * during hybernation + aestivation → only skin.
  * always respires by → skin.
  * Blood plays role in respiration.
* In insects (cockroach) circulatory fluid does not help in transport of gases. They have tracheal tube network.
* In fishes, counter current flow of blood and water increases respiration efficiency.
* In birds presence of non-respiratory air sac increases respiration efficiency.
* In human presence of residual air decreases respiration efficiency.

Respiration

Direct	Indirect
* Blood plays no role.	* Blood plays role.
* Through general body surface by diffusion.	* They have respiratory organs.
Eg:- Amoeba, Hydra, flatworm, sponges.	

→ Bowman's gland
→ Schneiderian memb.

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Indirect

Cutaneous	Branchial	Pulmonary	Buccopharyngeal
* By skin.	* By gills (Ctinidia)	* By lungs.	* By buccal cavity.
* In (air + water).	* In water	* In air.	* In air.
Eg:- Frog, Earthworm.	Eg:- Fish, Mollusca, Aq. arthopoda, Tadpole larva.	Eg:- Birds, Mammals, reptiles.	Eg:- Frog.

	Animal		Respiratory Organ
(1)	Earthworm	→	Moist skin.
(2)	Cockroach	→	Tracheal system.
(3)	Tadpole larva	→	Gills.
(4)	Whale / Dolphine	→	Lungs.
(5)	Spider / Scorpion	→	Book lungs.
(6)	Rabbit	→	Lungs.
(7)	Snake	→	Lungs.
(8)	Hydra	→	Body surface.
(9)	Prawn	→	Gills.
(10)	Frog in water	→	Skin.

Nasal Passage →

* Nasal cilia pass mucus in.
* Tip of nose = Elastic cartilage.
* Nasal septum = Hyaline cartilage.
* Bowman's gland found in nasal passage below olfactory epithelium.
* Nostrils of human are similar to spiracles of ~~frog~~ cockroach.

VRO

Nasal Passage

Vestibular Zone	Respiratory Zone	Olfactory zone
* Hair + Oil gland.	* PSCCGE	* Schneiderean membrane.

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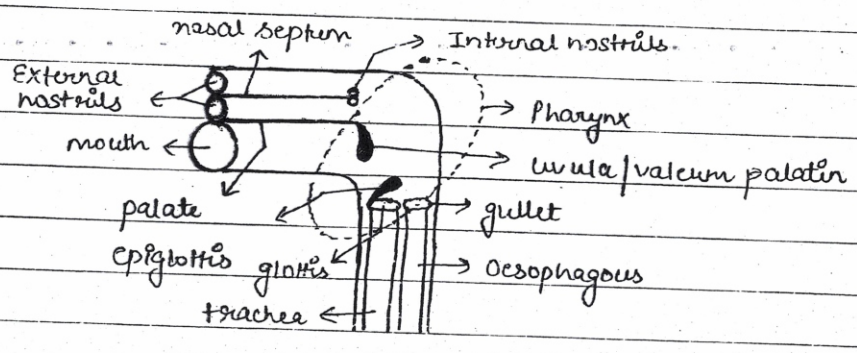
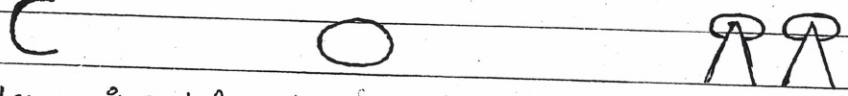
Buccopharyngeal cavity :→

* Common passage of food and air in pharynx.
* During swallowing epiglottis covers the glottis and uvula covers internal nares.
* Epiglottis is a flat elastic cartilage.
* During swallowing breathing rate is zero.
* During eating breathing rate is normal.
* Min^{m}. breathing rate at time of sleeping.



Larynx

Thyroid (1)	Cricoid (1)	Arytenoid (2)	Santorini (2)
* C-shaped	* Singlet ring	* pyramid shaped	* rounded.
* Hyaline	* Hyaline	* Hyaline	* Elastic.



* Larynx is a triangular cartilagenous box, help in sound production so u/a Sound box.
* True vocal cords made up of Yellow elastic CT.
* Vocal cords are arranged b/w arytenoid and thyroid cartilage.

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Trachea :→

C - shaped ⇒ Trachea ⇒ human
complete spiral ⇒ Syrinx of cockroach

* Lined by PSCCGE.
* Tracheal cilia pass mucus out.
* In trachea 16-20 C-shaped dorsally incomplete hyaline cartilage, supporting rings tnt which prevents its collapsing.
* In dorsal wall of trachea involuntary tracheolaris muscle tnt.
* Trachea divides into right and left 1° bronchi branches. Right bronchii is shorter and wider than left.

Respiratory tubules :→

* All respiratory tubules are classified into 2 major gps –

Bronchial Tree	Respiratory Tree
(1) More in diameter.	(1) Less in diameter.
(2) Cartilagerous rings tnt.	(2) Rings - nt.
(3) Dead space vol^{m}. tnt.	(3) Dead space vol^{m}. - nt.
(4) No gaseous exchange.	(4) Gaseous exchange occur.
(5) Lined by PSCCGE.	(5) Lined by sensory simple Sq. epithelium.

Trachea → 1° bronchi → 2° bronchi → 3° bronchi / segmental bronchi
[Rt = 3, Lt = 2] [Rt = 10, Lt = 8]

Bronchial tree

Intrapulmonary bronchiole
(Total pulmonary bronchiole)

Respiratory tree

Terminal bronchiole

Alveoli ← Alveolar sac ← Atria ← Alveolar duct ← Respiratory bronchiole

* Ext. nostrils upto terminal bronchioles = Conducting Zone.
* Respiratory bronchioles upto alveoli = Exchanging Zone.

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Ques :- Gaseous exchange occur in —
(1) 1° bronchi and Trachea.
(2) Trachea and Alveoli.
(3) Alveoli and alveolar duct.
(4) Alveolar duct and 2° bronchi

Ques :- Which have dead space vol^{m} —
(1) Terminal bronchioles.
(2) Respiratory bronchioles.
(3) Alveolar duct.
(4) Alveolar sac.

Lungs :→

* Mammalian lungs are solid and spongy, have no actual cavity (Sucker lungs).
* Muscles are -nt in lungs so self contraction and expansion -nt. It depends on thoracic cavity.
* Any change in thoracic cavity can reflect pulmonary cavity because we can't alter pulmonary vol^{m}. directly.
* Structural and functional unit of lungs = Alveoli.
* Total no. of alveoli = 300 million.
* Total respiratory surface area = 100 m^2.
* Phagocytic cells in alveoli = Dust cell.
* Pores in alveoli wall = Pores of Kuhn.
* Outer layer of alveoli = Yellow fibrous CT.
* Inner layer of alveoli = Simple Sq. Epithelium.
* Lecithin is a surfactant. It is made up of phospholipid. It prevent collapsing of alveoli by reducing its surface tension.
* Due to deficiency of lecithin in premature baby causes RDS (Respiratory distress syndrome).
* Lungs is covered by double layer sac of a pleura. Pleural membrane is mesodermal and lungs endodermal.
* Inflammation in pleural memb. causes pleurasy.
* Pleural cavity is a coelome.
* Amt. of pleural fluid = 150 ml.
* Rt. lungs has 3 lobes and Lt. lungs has 2 lobes.
* Residual vol^{m}. always +nt in lungs after birth.
* Spirometer not measure residual vol^{m}.

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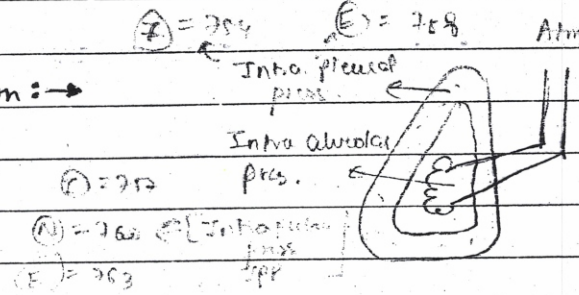
Diaphram :→

* Found in mammals and crocodiles. It has radial muscles.
* In normal condition it is dome/arch shaped. When its muscle contract it becomes flat so thoracic cavity vol^{m}. increase in A-P axis. Its main role in breathing.
* In human 12 pairs ribs hnt. B/w ribs intercostal muscls hnt. These are EICM, IICM. Due to contraction in EICM, ribs are pulled outward and Sternum upward so thoracic vol^{m}. increase in D-V axis.

Breathing / Ventilation :→



Inspiration	Expiration
* Active process.	* Passive process.
* (Diaphram + EICM) contract.	* (Diaphram + EICM) relax.
* Thoracic vol^{m}. ↑.	* Thoracic vol^{m} ↓.
* Pressure on lungs ↓.	* Pressure on lungs ↑.
* Lungs expands.	* Lungs compress.
* Pulmonary vol^{m}. ↑.	* Pulmonary vol^{m}. ↓.
* IPP less than atm. pressure.	* IPP more than atm. pressure.
* Time = 2 sec.	* Time = 3 sec.

→ Inspiratory muscles = Diaphram + EICM.
→ Pressure of pleural fluid on lungs i/a Intrapleural pressure.
→ Pressure on alveolar air inside lungs i/a Intra alveolar pressure / Intrapulmonary pressure (IPP).
→ Inspiration can occur if IPP is less than atm. pressure. Expiration can occur if IPP is more than atm. pressure.

* DRG ⇒ active in inspiration. No role of brain signal in expiration. During forceful exp. & ins. VRG active. During normal breathing VRG inactive.

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→ Normal breathing is also c/a Abdominal breathing in which diaphram play 75% role and ribs play 25% role.
→ In pregnant lady ribs play more role than in case of normal female.

* Mammals show -ve pressure breathing and sucken pump mechanism so we can eat and breath together.
* Frog show +ve pressure breathing and pressure pump mechanism. → Frog doesnot have diaphragm.
* Forceful breathing is due to help of some other muscles. In this more air is released rapidly.
* Forceful expiration is an active process in which expiratory muscle contract.
* Expiratory muscle = IICM + Abdominal muscles.
* Forceful expiration →
  - IICM ⇒ contract
  - EICM ⇒ relax
  - diaphragm ⇒ relax
  - Abdominal muscles ⇒ contract.
* Forceful breathing is also c/a thoracic breathing in which ribs play more role than in normal breathing.
  * except expiration, all these processes are active.

Imp.

Regulation of Breathing :→

* Respiratory rythm centre lie on medulla.
* Pneumotaxic centre lie on pons.
* DRG regulate normal breathing. It is for basic rythm of breathing.
* During normal breathing VRG inactive. VRG activates during forceful breathing and regulate both expiration and inspiration.
* Impulse for voluntary breathing sent by cerebrum.
* Pneumotaxic centre can reduce the duration of inspiration and can alter the breathing rate. It is for limit of inspiration. Generally it is c/a switch off point of inspiration. When it activates then breathing rate increase and lungs are partially fulfilled.
* Apneustic centre is for depth of breathing.
* In the wall of bronchioles of lungs stretch receptors are pnt which are

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sensitive for air pressure. When air pressure more increased in lungs (forceful inspiration) then these receptors send inhibitory signal to DRG through vagus nerve and DRG inactivates, so normal expiration occurs. This protective reflex action is c/a Hering Breuer Reflex Action. It remain inactive during normal breathing.

* Brain donot sent any signal for normal expiration.
* In brain chemosensitive area hnt. It recognises CO_2 and H^+ conc. in blood. When CO_2 and H^+ conc^n. increase in arterial blood then this area activates DRG and increase breathing rate.
** Brain is sensitive for CO_2 conc^n. and not for O_2 so in regulation of breathing O_2 role is insufficient.
* Other chemoreceptors carotid body and aortic body are located in common carotid artery and dorsal aorta. They are sensitive for very low pO_2 and activates DRG through vagus and glossopharyngeal nerve. ↑ and ↑ breathing rate. They also can recognise CO_2 and H^+ conc^n. in blood.

Pulmonary Volumes :→

* Instrument for pulmonary vol^m = spirometer.
* Value of T.V. = 500 ml.
** Healthy person can inspire or expire 6000 – 8000 ml of air in a min.
* Vol^m. of air not participate in gaseous exchange and remain in bronchial tree is c/a anatomical dead space. Its value is 150 ml. Its value slightly increases with age so 350 ml air available for gaseous exchange.
** Pulmonary ventilation is higher than alveolar ventilation.
* Residual vol^m. always remain in lungs. It can't be measured by spirometer.
* & Functional Residual Capacity also can't be measured directly by spirometer. For it helium dilution method is used.
* All pulmonary vol^{m}s. and capacities are 20–25% higher in male and than ♀ and also greater in athalete.
* VC depends on age, sex and height. It is much higher in young one, athalete, ♂, non-smoker.

S.No.	Pulmonary Volumes	Value
1.	Tidal volume (T.V)	500 ml.
2.	Inspiratory Reserve vol^m (IRV)	3000 ml.
3.	Expiratory reserve vol^m (ERV)	1000 – 1100 ml.
4.	Residual volume (R.V)	1200 ml.
5.	Inspiratory capacity = TV + IRV	3500 ml.
6.	Expiratory capacity = TV + ERV	1600 ml.
7.	Functional Residual cap. = ERV + RV	2300 ml.
8.	Vital capacity = TV + IRV + ERV	4600 ml.
9.	Total lung capacity = VC + RV = TV + IRV + ERV + RV	5800 ml.

Ques 1:- Vol^m. of air which is expired forcefully after normal inspiration.
Sol^n:- TV + ERV.

Ques 2:- Vol^m. of air which is expired normally after forceful inspiration.
Sol^n:- TV + IRV

Ques 3:- Vol^m. of air which is expired forcefully after forceful inspiration.
Sol^n:- TV + IRV + ERV.

① TV = Amt. of air inspired/expired during normal breathing (500ml)

② Pul. ven = Vol^m. of air which is ventilated along both lungs in 1 min.
= TV × Breathing rate = 500 × (12–16) = 6000 – 8000.

③ Alv. ven = Vol^m of air which is ventilated along the alveoli of both lungs
= 70% × Breathing rate = 350 × (12–16) = 4200 – 5600

∴ Pul. ven is always higher than alv. ven.

④ Anatomical dead space (TV) : (Alveolar air) Physiological dead space air
= vol^m. of air in the conducting bronchial tree region = vol^m. of air in exchanging respiratory zone or tree which is not involved in gaseous ex. = 150 ml. which is not inv. in gaseous exch.

⑤ RV = Vol^m of air left in lungs after forceful expiration (1200 ml) (only in case when person's normal activity deviates due to some reason)

Breathing rate :→
* Adult human = 12–16 /min.
* Child = 25 /min.
* New born baby (Infants) = 44 /min.
* Embryo = 0 /min.
* Rabbit = 38 /min.
* Frog = 64 /min.

(I) Breathing rate $\propto$ CO_2 conc^n $\propto$ Acidity $\propto \frac{1}{PH} \propto$ Temp. $\propto$ B.P.

max^m = Shrew

(II) Applicable only for mammals: Breathing rate & Heart beat rate, BMR $\propto \frac{1}{\text{Body size}}$

Min^m = whale / elephant

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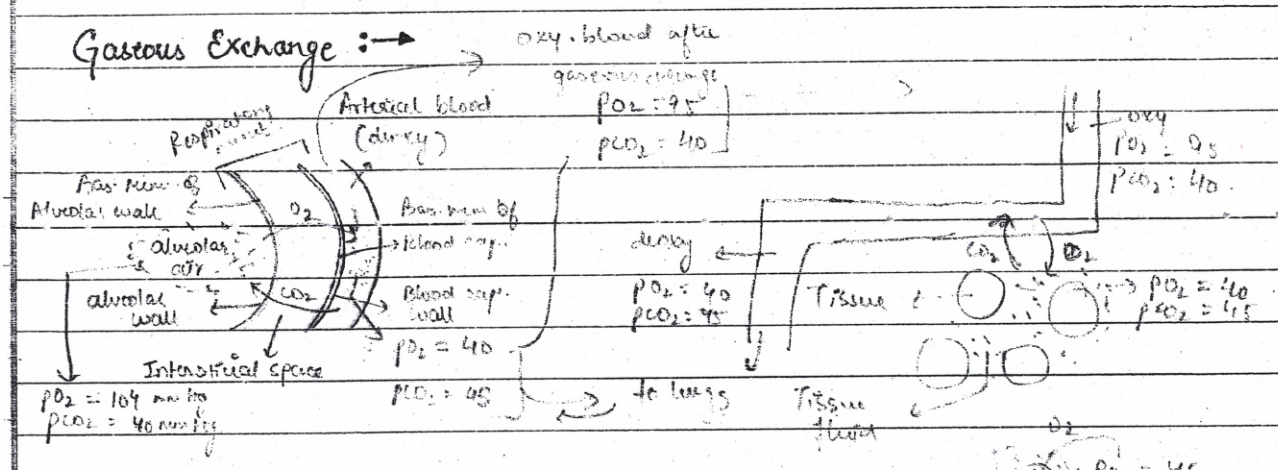
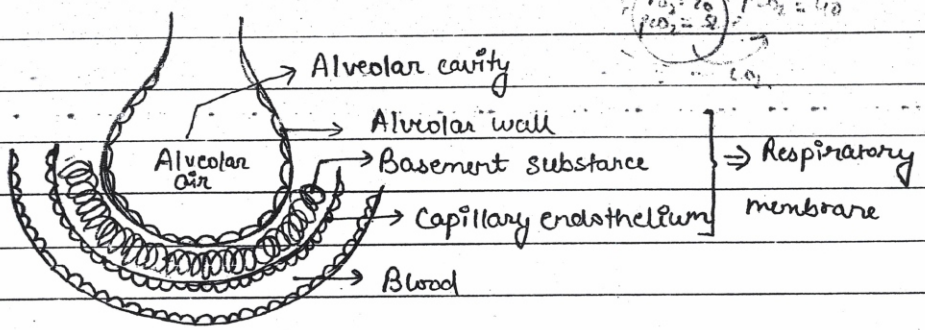
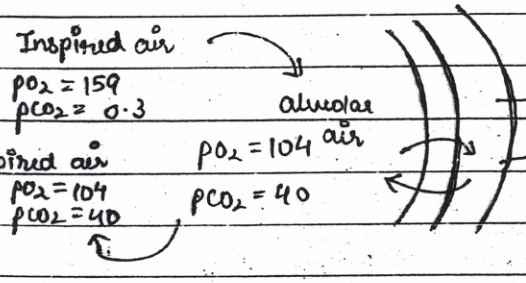
* At high altitude, Breathing rate, no. of RBC increases because of low O_2 density (O_2 pressure [pO_2] decrease).
* Here O_2 supply to tissue reduce (hypoxia condition). Here Hb affinity with O_2 decrease so to compensate it RBC production increase.

Gaseous Exchange :→





Gas	Atm. air	Alveolar air	Deoxy. blood	Oxy. blood	Tissue fluid	Inside cell	Expired air
pO_2	159	104	40	95	40	20	116
pCO_2	0.3	40	45	40	45	52	28



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* In body gaseous exchange occurs at two sites - (i) Alveoli (ii) Tissue.
* Alveoli is 1° site for gaseous exchange. Here exchange occurs b/w alveolar air and deoxygenating blood through respiratory membrane.
* Gaseous exchange is done by simple diffusion method.
* Pressure of every gas is c/a partial pressure. It depends on conc. of gas.
* Diffusion capacity of gas depends on solubility of gas and thickness of respiratory membrane.
* Solubility of CO_2 is 20 to 25 times much higher than O_2 solubility so diffusion capacity of CO_2 is higher than O_2 diffusion.
* In tissue exchange occurs b/w oxygenated blood and tissue fluid.
* In inspired air O_2 is 20% and CO_2 is 0.04% but in expired air O_2 is 16% and CO_2 is 3.6% nt.
* Dead space air has same composition as that of inspired air.

Transport of Gases :→

* Blood transport O_2 from lungs to tissue. About 97% O_2 transported by RBC as oxyhaemoglobin. About 3% O_2 by plasma as dissolved form.
* Blood transport CO_2 from tissue to lungs. About 7% CO_2 transported by plasma as dissolved form. About 20-25% CO_2 transported by RBC as carbaminoHb form. About 70% CO_2 by plasma as bicarbonate form.

CO_2 Transport :→

* About 20-25% CO_2 react with NH_2 gp. of globin protein of Hb and form carbaminoHb in reversible manner.
* Bulk of CO_2 is transported by plasma as bicarbonate form.
* During CO_2 transport blood protein acts as a buffer.
* pH of arterial blood (7.44) is slightly higher than pH of venous blood (7.33).
* More amt of carbonic acid is found in RBC because in RBC carbonic anhydrase enzyme is mt. It is Zn containing fastest enzyme.

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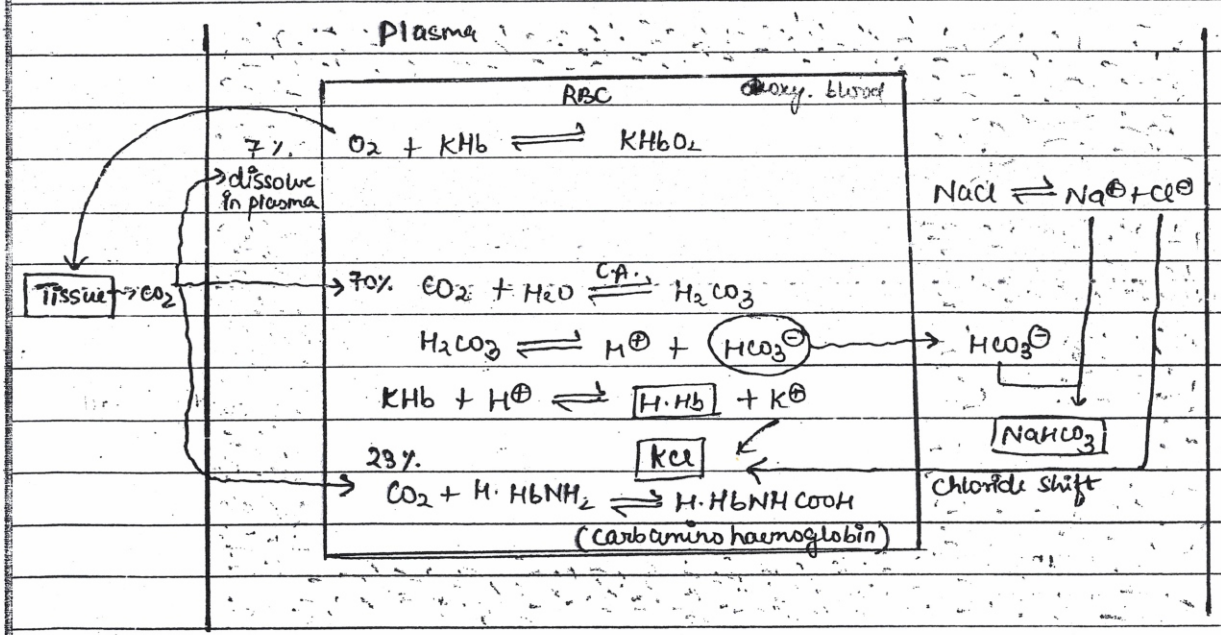
* During CO_2 transport to maintain ionic eq^m. Cl^- moves from plasma to RBC. This is c/a Chloride Shift or Hamburger process.
** Due to chloride shift Cl^- content in RBC of venous blood is higher than RBC of arterial blood.
* When this deoxygenated blood enter into lungs then due to low pCO_2 and high pO_2 in alveoli all CO_2 compounds dissociates and CO_2 diffuse into alveoli. In alveoli reverse chloride shift occur in which Cl^- moves from RBC to plasma and HCO_3^- moves from plasma to RBC.
* In alveoli CO_2 compound dissociates due to high pO_2 / OxyHb. This is c/a Haldane's effect.



O_2 Transport :→ $Hb + O_2 \rightleftharpoons HbO_2$

* Bulk of O_2 transported by RBC as oxyHb form. Formation of oxyHb is not an oxidation process because both Hb and HbO_2 have Fe in +2 state so it is an Oxygeration process.

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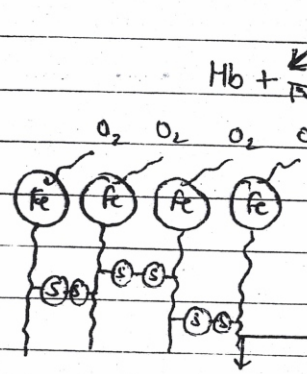
* Formula of oxyHb = Hb_4O_8.
* Oxidised product of Hb is Methanoglobin. It is colourless, stable comp., have Fe in +3 state.
** CO is a poisonous gas. It reacts with Hb and form stable carboxyHb so free Hb is not available to transport O_2 to tissue. CO has max^m. affinity with Hb (200-300 times more than O_2).



O_2 ⇒ oxyHb.
O_3 ⇒ Methanoglobin.
CO_2 ⇒ Carbamino Hb.
CO ⇒ Carboxy Hb.

Hb = Conjugated protein

Haem part (4-5%)
→ 4 pyrol rings.
→ 4 Fe in +2 state.

Globin protein (95-96% part)
→ 4 polypeptide chain
141 AA, 146 AA
Hb (A) ⇒ $2\alpha + 2\beta$
Hb (E) ⇒ $2\alpha + 2\gamma$

* 1 molecule of Hb has 4 Fe in +2 state. Oxygen always binds with Fe by loosely co-ordinate bond in molecular stage. So, 1 molecule of Hb can carry $4O_2$ molecules. (or 8 O atoms).
* 1 gm Hb carry 1.34 ml O_2.
* 100 ml blood contains 15 gm Hb so 100 ml blood carry 20 ml O_2.
* Blood deliver 25% of its O_2 to tissue and 75% remain in blood.
* Every 100 ml deoxygenated blood deliver 5ml O_2 to tissue under normal physiological condition.
* Due to structure affinity of foetus Hb with O_2 is higher than adult Hb.
* Total quantity of Hb in body = 5gm × 15 = 750 gm.

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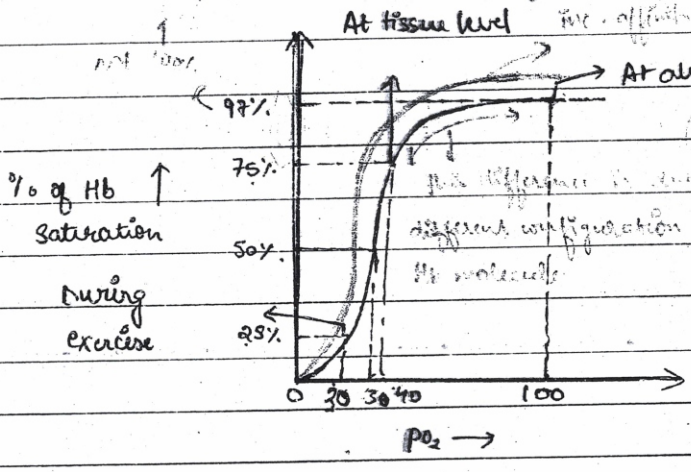
Oxygen dissociation Curve :→



* Oxygen dissociation curve for Hb = Sigmoid shape.
** Binding of Hb with O_2 mainly depends on pO_2 but pCO_2, H^+ conc^n, temp. are other factors which can interfere in this binding.
* When pO_2 ↑ then Hb saturation ↑.
* When pO_2 ↓ then HbO_2 dissociate and release O_2.
* In tissue pO_2 = 40 so, 25% HbO_2 dissociate.
* During heavy exercise pO_2 of tissue becomes 15–18 mm Hg so 75% HbO_2 dissociate. It means 100 ml blood deliver 15 ml O_2 to tissue (In reality 20–21 times more due to increase of cardiac output by 7 times).
* Shifting of curve towards right side represents dissociation of HbO_2 and decrease of affinity of Hb with O_2.
* Shifting of curve towards left side represents more affinity of Hb and formation of HbO_2.
* Following factors are responsible for dissociation of HbO_2 and curve shifts towards right side –

(a) Low pO_2.
(b) High pCO_2.
(c) High H^+ conc^n.
(d) low pH
(e) high temp.
(f) excess of 2,3 – DPG.

* In alveoli high pO_2, low pCO_2, lesser H^+ conc^n, lesser to temp. are favourable for formation of HbO_2.

25 | 50 | 75 | 97%
20% | 30% | 40% | 100

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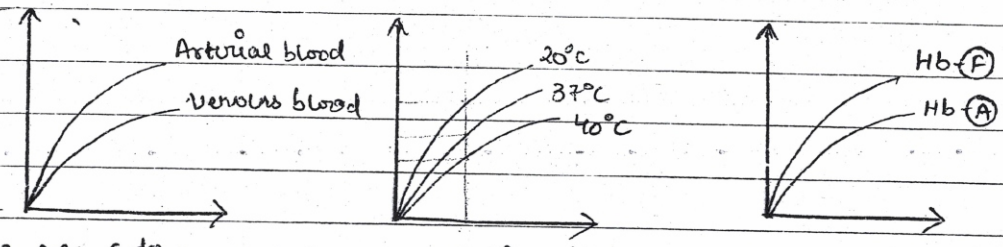
* In tissue HbO_2 dissociate due to low pO_2 and high CO_2 conc^n.
* Due to more affinity dissociation curve of foetus Hb will appear on left side of maternal Hb.
* Dissociation of HbO_2 in tissue due to high CO_2 conc^n. is c/a Bohr's effect.
* Dissociation of HbO_2 due to low pH = Root effect.



* 2,3 DPG (diphospho glyceric acid) is a biproduct of glycolysis. It is formed in RBC. When its conc^n. in RBC increases then its extra amt. strongly binds with β-chain of Hb so, affinity of Hb with O_2 decrease and HbO_2 dissociate.

P_{50} :→

* Partial pressure of O_2 at which 50% Hb is saturated is c/a P_{50}. For adult its value is 25-30 mm Hg.
* CO_2 conc^n ↑, P_{50} ↑.
* Affinity of Hb with O_2 ↑, P_{50} ↓.
* P_{50} of foetus Hb is less than adult Hb. It's value is 15-20 mm Hg.
* pH of blood falls then p50 increases.

Myoglobin :→

* Respiratory pigment of muscle. It also has Fe. It's one molecule has 1 Fe. So, its 1 molecule can carry 1 O_2. Myoglobin has higher affinity with O_2 than Hb but it releases O_2 at very low pO_2. (15-20 mm Hg). Its dissociation curve is Hyperbola.

Hiccough :→ Due to muscular spasm or incomplete movement of diaphram.
Yawning :→ Due to low pO_2 (or high CO_2 conc^n.) in body.

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Disorders :→

① Asthma :→ Due to muscular spasm in smooth muscles of bronchii and bronchioles.

② Emphysema :→ Due to cigarette smoking. In this alveoli wall damage so respiratory surface area decrease and more residual air in lungs.

③ Occupational lung disease :→ Results into fibrosis.

④ CO poisoning :→ Patients can be treated by injecting of pure O_2 and injected 5% CO_2 in alveolar air simultaneously.

* Abt. 98% blood flow in alveoli, participate in exchange but 2% blood flow in bronchial tree and remain deoxygenated. This is shunted blood so we have 2% physiological shunt.

Eupnoea – Normal breathing.

Dyspnoea – Painful breathing.

Asphyxia – Suffocation due to high CO_2 in atm.

Hypoxia – O_2 supply reduced to tissue.

Anoxia – O_2 supply –nt to tissue.

Hypercapnoea – CO_2 conc^n. increase in blood.

- Kidney excrete only monovalent ions
- Colon excrete divalent ions.

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EXCRETORY SYSTEM

* To maintain constant internal body environment = Homeostasis.
* Regulation of osmolarity of body fluid = Osmoregulation.

Osmoregulation

Osmoconformers.	Osmoregulators.
* They can't regulate osmolarity of body fluid.	* They can regulate osmolarity of body fluid.
* Eg:→ All marine invertebrates, Some fresh water invertebrates, Only one vertebrate [Hag fish = Myxine]	* Eg:→ All vertebrates.

Osmoregulation in fresh water	Osmoregulation in marine water.
* Osmolarity of fresh water = 50	* Osmolarity of sea water = 1000
* Animal live in Hypotonic medium.	* Animal live in Hypertonic medium.
* Problems –	* Problems –
→ Continuous entry of water.	→ Entry of monovalent salts.
→ Loss of salts.	→ Loss of water.
* Solution –	* Solution –
→ They donot drink water.	→ They drink sea water.
→ They excrete dilute (hypotonic) urine.	→ Monovalent ions are excreted by ionocyte cells actively.
→ They have Ionocyte / Cl^- cells on gill membrane which actively import ions.	→ Divalent ions excreted by excreta / stool.

* Osmolarity of human blood plasma = 300.
* Fresh water protozoa have contractile vacuole (CV) for osmoregulation. It excretes excess of water from body.
* Some fishes like Hilsa, Salmon live in both fresh and marine water. They excrete lot of salt from body when it is in marine water.

* L/H is responsible for conc^{n} of urine.
Longer L/H → conc^{n} of urine ↑

* Urea formed by Liver through ornithine cycle and transported by blood plasma and Excreted by kidney.

Chordata → Vertebrata
↓
PARAH

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* Shark, Ray live in marine water. They accumulate organic substance (urea, TMAO) in their body fluid which inc. osmolarity of their body fluid so, shark is hyperosmotic and hyperionic.

* Kangaroo Rat → Nocturnal desert animal.
→ Never drink water, use metabolic water.
→ Excrete very conc^{n}. urine (Henle's loop long)
→ Feeds on dry seeds.
→ Sweat glands are few.
→ Slow breath rate.

* Camel also excretes very conc^{n}. urine. When water is not available then camel does not produce and excrete urine but store urea in its tissue.

Imp.
Nitrogenous Waste Products :→

Ammonia	Urea	Uric Acid
* Protozoa (Amoeba)	– Mammals (Rabbit, human),	– Birds.
– Porifera (Sponges)	– Adult amphibia (frog)	– Reptiles.
– Coelenterata (Hydra)	– Earthworm.	– Insects (cockroach)
– Flatworm (Planaria)	– Cartilagenous fishes (Elasmobranchii).	– Land snail.
– Aschelminthes (Ascaris)		
– Aq. arthropoda (Prawn)		
– Mollusca.		
– Echinodermata.		
– Fresh water bony fishes.		
– Aquatic amphibia.		
– Tadpole larva.		
– Aquatic reptiles.		

Fishes → Cartilagenous (Urea)
Fresh water Bony Fishes (NH$_3$)
Marine water bony fishes (TMAO)

* Toxicity Sequence = Ammonia (NH_3) > Urea > Uric acid

** NH_3 is highly toxic and requires large amt. of water for elimination.

* Uric acid is least toxic and require min^{n}. amt. of water for elimination.

* Ketone body in urine ? → in case of diabetes mellitus, → in case of prolonged starvation } both case blood glucose level decrease.

Mammals [purine, pyrimidine → Allantoin

human → Purine (UA) Pyrimidine → Isobutyric acid, allanin → UA in birds

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* Waste product of Spider, Scorpion = Guanine.
* Waste product of marine bony fish, marine tortoise = TMAO.
* Ammonia → 1st metabolic waste.
  → ATP not required in production and elimination.
  → Excreted through general body surface by diffusion but in fish through gill membrane as ammonium salts.
  → Kidney play minor role in elimination.
  → Highly toxic.
* Urea act as both waste product and osmoregulatory substance.
* Urea is formed in liver, transported by blood plasma and excreted by kidney.
* 100 ml blood contain 18-38 mg urea.
* Uricotelism is a terrestial adaptation.
* Uric acid is 2,6,8-Trioxy purine.
* Frog is ureotelic but its larva is ammonotelic.
* Earthworm is ureotelic but when plenty of water available then become ammonotelic.
* Chief waste product of crocodile = NH_3.
* Mammals excrete purine and pyrimidine as allantoin form but human excrete purine as uric acid form and pyrimidine as isobutyric acid, allanin form.
* Bird excrete purine, pyrimidine as UA form.
* If protein rich diet intake then more urea in urine but uric acid component does not much change.
* In prolonged starvation more ketone bodies in urine. → due to incomplete oxidation of fat.
* Mammals excrete benzoic acid as hippuric acid form but birds excrete it as ornithuric acid form.
* Creatinine is not in normal urine.
* Creatin is not in normal urine. It is not in urine of pregnant lady, infants and lactating mother.

* Hydra → waste product → general body surface; undigested food → mouth.

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Variety of Excretory Organs :→

S.No.	Group	Excretory Organ
1.	Protozoa	General body surface.
2.	Porifera	General body surface.
3.	Coelentrata	General body surface.
4.	Flatworm [Planariaa] ⇒ First time excretory system appeared.	Flame cell / Protonephridia / Solanocytes.
5.	Aschelminthis	Rotta Rotatte cell. [H-shaped].
6.	Annelicla [Earthworm]	Nephridia.
7.	Arthopoda	
	→ Insecta, centripede, millipede.	Malphigian tubules.
	→ Crustaceans [Prawn].	Green gland / Antennal gland.
	→ Spidar, scorpion.	Coxal gland.
8.	Mollusca	Organ of Bojanus / Keber's organ.
9.	Echinodermata	Body surface.
10.	Hemichordata [Ballarogiosus].	Proboscis gland.
11.	Urochordata [Hardmania].	Neural / Pyloric gland.
12.	Cephalochordata [Amphioxus].	Protonephridia.
13.	Vertebrates.	Kidney.

Kidney

Pronephric	Mesonephric	Metanephric
* Nephrostome, tubule nt.	* Bowman's capsule nt but H/L - nt.	* Bowman's capsule, H/L both nt.
* Bowman's capsule, H/L - nt.		* Most advanced kidney.
Eg:- Cyclostome, Tadpole larva.	Eg:- Fish, Amphibia	Eg:- Reptiles, birds, Mammals.

→ Incomplete Henle's loop found in birds, Reptiles.

→ Complete Henle's loop found in Mammals.