





(Section B)

Q. No. 2 Part (I)

Glomerulus	Peritubular Capillaries
⇒ Most of the blood i.e water, ions, amino acids, glucose, electrolytes are filtered out of Glomerulus	⇒ Majorly toxins and excreta i.e NH^+ - amonium ions and H^+ - Hydrogen ions are filtered out into renal tubule.
⇒ Erethrocytes RBCs and large molecules i.e proteins are retained and passes to efferent arterioles.	⇒ Peritubular capillaries reabsorb most water and nutrients from tubule i.e electrolytes and glucose etc.
⇒ They assist in Ultrafiltration or pressure filtration.	⇒ They assist in Selective Reabsorption (Counter-current Multiplier) and Tubular Secretion.

Q. No. 2 Part (II)

⇒ **A - Renal Corpuscle** :- is involved in Pressure filtration. Water and elatrolytes and nutrients are filtered out of Glomerulus into Bowmann's capsule under high hydrostatic pressure.

⇒ **B - Proximal Convoluted Tubule** :- Here maximum Selective reabsorption of H_2O and filtrate occurs which entered Renal tubule during ultrafiltration.

⇒ **C - Loops of Henle** :- Selective reabsorption via Counter current multiplier occurs. Aldosterone actively transports Na^+ while Anti-diuretic hormone allows osmosis of H_2O into vasa recta determining concentration of urine.

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Q. No. 2 Part (iii) a) **Role of Ca^{+2} ions in Muscle Contraction:** - As action potential approaches sarcolemma, it is transmitted through Transverse Tubule and finally reaches Sarcoplasmic Reticulum opening Ca^{+2} gates. Ca^{+2} ions moves inwards and binds with troponin C to cause displacement of tropomyosin exposing myosin heads to myosin binding sites of actin forming cross bridges.

b) Variation in Sarcomere: - During Muscle contraction, distance b/w Z-lines is reduced. I-bands also shortens as actin filaments slide past the myosin. A bands remains unaffected as myosin doesn't change lenght while H-zone disappear due to greater overlap.

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Q. No. 2 Part (iv)

Given Data :-

3, 21, 6, 18, 9, 15, 12

Arranged in Ascending order :-

3, 6, 9, 12, 15, 18, 21

$\Rightarrow$ Mean $= \frac{\Sigma x}{n}$

$= \frac{84}{7}$

$\boxed{\bar{x} = 12}$

$\Rightarrow$ Median (for odd no.) $= \left\{\frac{n+1}{2}\right\}^{th}$

$\tilde{x} = \left\{\frac{7+1}{2}\right\}^{th}$

$= 4^{th}$ value

$\boxed{\tilde{x} = 12}$

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Q. No. 2 Part (v) **Monoclonal Antibodies :-** are laboratory synthesizes antibodies via in-vitro synthesis which are exact clones or copies of a single specific antibody thus trigerrs focused targeting of particular antigen.

Advantages of Monclonal Antibodies over Traditional Drugs :-

⇒ They are better than polyclonal antibodies as they induce **precise specificity** targetting particular antigens reducing off-target risks.

⇒ They are better than antibiotics in terms of enhanced specifity, **less vulnerability** and susceptibility minimizing side effects stimulating effective treatment against bacterial infections.

Q. No. 2 Part (vi) **Skin As Impenetrable Barrier Against Pathogens :-**

⇒ Epidermis has **dead keratinized cells** that donot allow microbial growth when they land on skin surface.

⇒ Sweat Glands produce salty solution of **sweat** that dehydrate and kill bacteria.

⇒ Sebacious Glands secrete **sebum** that has considerable concentration of lactic acid that inhibit bacterial replication.

⇒ **Desquamation** is shedding of dead cells that removes microbes too.

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Q. No. 2 Part (vii) **High Pressure Arterial**

Baroreceptors :- are located in walls of carotid sinus and aorta. Baroreceptors detect fluctuation in Blood pressure that transmit impulse to Hypothalamus that triggers baroflex. High and low blood pressure is mediated by parasymphatatic and symphatatic nerves respectively.

Volume Receptors :- are located in walls of atrja and carotid sinus. They detect low blood pressure and fluid volume and informs Hypothalamus that releas Vassopressin **ADH** stimubting H_2O retention in Kidneys.

Q. No. 2 Part (viii) **Absorption of Fats in Ilium :-**

Fatty acids and glycerol enters the simple columnar epthileal cells where fatty acids condense together to form lipids which in association with proteins and cholesterol forms chylomicrons. Chylomicrons then enter the lacteal by moving across interstitium. Once, it enters the lymphatic capillary - lacteal, it becomes the part of lymph that passes to lymphatic vessels, nodes, lymphatic trunk and then collecting ducts (Thoracic or Right lymphatic duct) and reaches subclavian via opening in vena cava carrying fats to Right atrium.

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Q. No. 2 Part (ix) **Hormones of Anterior Pituitary:**

Anterior Pituitary secrete it's hormones under stimulation of Hypothalamic hormones. Following are some hormones secreted by Anterior lobe of Pituitary Gland:-

Growth Hormone :- triggers protein synthesis and enhances growth.

TSH (Thyrotrophin) :- or Thyroid Stimulating Hormone stimulates Thyroid to release T_3 & T_4.

Adrenocorticotrophic Hormone :- stimulates Adrenal cortex to release corticosteroids.

Gonadotrophins :- include FSH & LH which are sexual hormones responsible for spermatogenesis & oogenesis and influence testosterone level.

Q. No. 2 Part (x) **Complement System** :- of protective proteins include various types of proteins which get activated on entry of pathogen and further reinforces activation of other proteins in blood.

Mechanisms :-

⇒ Some proteins like **histamine** cause inflamation resulting in fever, pain and induces release of prostaglandins to raise set point of thermostat This complements the ability of immune cells to efficiently combat infection.

⇒ **Membrane Attack Complex** proteins pours holes in bacterial cell wall allowing diffusion of salts & fluids inward leading to lysis and death of microbe.

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Q. No. 2 Part (xi) **Plasmids** :- are artificially designed vectors that are responsible for carrying gene of interest to host cell-Expression System for replication and expression of gene of interest.

Plasmids in Recombinant DNA Technology:- Usually, pBR 322 and pUC 18/pUC19 are used as plasmids. Plasmids are cleaved out of circular DNA via restriction endonucleases at specific palindromic sequences where the isolated gene of interest inserts via DNA Ligase forming Recombinant Vector that enters the expression system allowing replication and expression of gene of interest via ORigin of Replication sites, promotor regions etc.

Q. No. 2 Part (xii) **Roles of Liver :-**

⇒ **Metabolism :-** Hepatic cells assist various metabolic processes i.e Glycogenesis (Polymerization of Glycogen from Glucose) and Gluconeo-genesis (Formation of Glucose from non-sugars i.e amino acids, fatty acids etc.

⇒ **Detoxification of Drugs :-** Smooth ER of Hepatic cells detoxify drugs filtering the blood while also contributes in urea formation

⇒ **Bile Synthesis :-** Liver synthesize bile juice that is stored in Gall Bladder and added to duodenum via bile duct. Bile emulsifies fats aiding in it's digestion.

⇒ **Bilirubin** is a pigment that provides characteristic brown colour to Stool.

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Q. No. 2 Part (xiii) **Drug Addiction** :- involves the continuous intake of illicit drugs or narcotics that alter dopamine level inducing the feelings of intense euphoria, pleasure, hapiness and emotional stimulation. Rising dopamine **distrupts** our **nervous system** and brain reword system.

Drug Tolerance :- When a person regularly intake drugs like **opoids**, it would alter the secretion of endorphin - natural analgesics and thus body relies on opoid intake for pain relieve. With time, body demands increased dosage for consistent effects.

Q. No. 2 Part (xiv) **Vasodilation** :- is the dilation of arterioles via smooth muscle **relaxation** which routes more blood flow to capillaries and thus greater heat dissipation results through **radiation**. Increased heat loss leads to decline in Body temperature back to set point.

Sweating :- is the production of sweat by sweat glands that **evaporate** from skin surface to environment carrying excess body heat providing **cooling sensation**. Sweat also removes excess salts regulating osmotic adjustment Both above actions are stimulated by Hypothalamic Thermostat.

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Q. No. 3 (Page 1)

a) Impacts of Climate Change on Flora :-

⇒ Changes in Seasonal Durations :-

Due to rising temperature and increased green house effect, climate has triggered Seasonal variations. In some areas, seasons are quite suitable for growth and fruit production but in others, they are deteriorating.

⇒ Increased Stress from Extreme Conditions :-

Global Warming has induced severe stress by influencing rainfall patterns. Floods destroy plant vegetation while droughts makes them dry out due to scarcity of H_2O.

⇒ Migration of Plants :-

Due to unfavourable conditions, seeds may migrate to other regions under influence of wind, insects and Water. New habitats may not sufficiently appropriate for migrants.

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b) Impacts of Climate Change on Fauna :-

⇒ **Loss of Habitat :-** Due to climate change, animals lose their habitats. Like polar bears rely on ice to feed on seals. As ice melts they have to migrate leaving their ordinary habitats.

⇒ **Disturbone in Hybernation / Breeding Cycles :-** Some animals like frogs hibernate during winter seasons, sleep for months and wake up in Summer seasons to feed and find nutrients. However, changing climatic conditions may alter their sleeping cycle, they may wake up in wrong season.

⇒ **Food Chain Disruptions :-** When animals loses their habitats or plants migrates it would obviously affect food chain as herbivores and carnivores which

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feed on them suffer and disrupts food web patterns severely.

⇒ **Invasive Species :-** When specie migrate to other regions they might harm the local communities by competing for habitats and natural resources which disturbs ecosystem.

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Q. No. 4 (Page 1)

Production of Insulin Via Recombinant DNA Technology:-

⇒ **Detection and Isolation of Gene of Interest:-** Insulin consists α-polypeptide chain and β-polypeptide chaine. Insulin is secreted by β-cells of Islets of Langherans. first of all, insulin gene is identified and cleaved out from 11th chromosome via restriction endonucleases at palindromic sequences.

⇒ **Selection of Plasmid Vector:-** Usually, pBR 322 is selected as plasmid vector due to smaller size of 4361 bps and high copy number. It can easily insert gene for insulin at restriction sites. It has numerous origin of replication sites.

⇒ **Formation of Recombinant Vector:-** Gene for α-chain and that for β-chain of

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Q. No. 4 (Page 2) insulin are separately inserted into two distinct pBR322 strains as E-coli can't directly produce insuline.

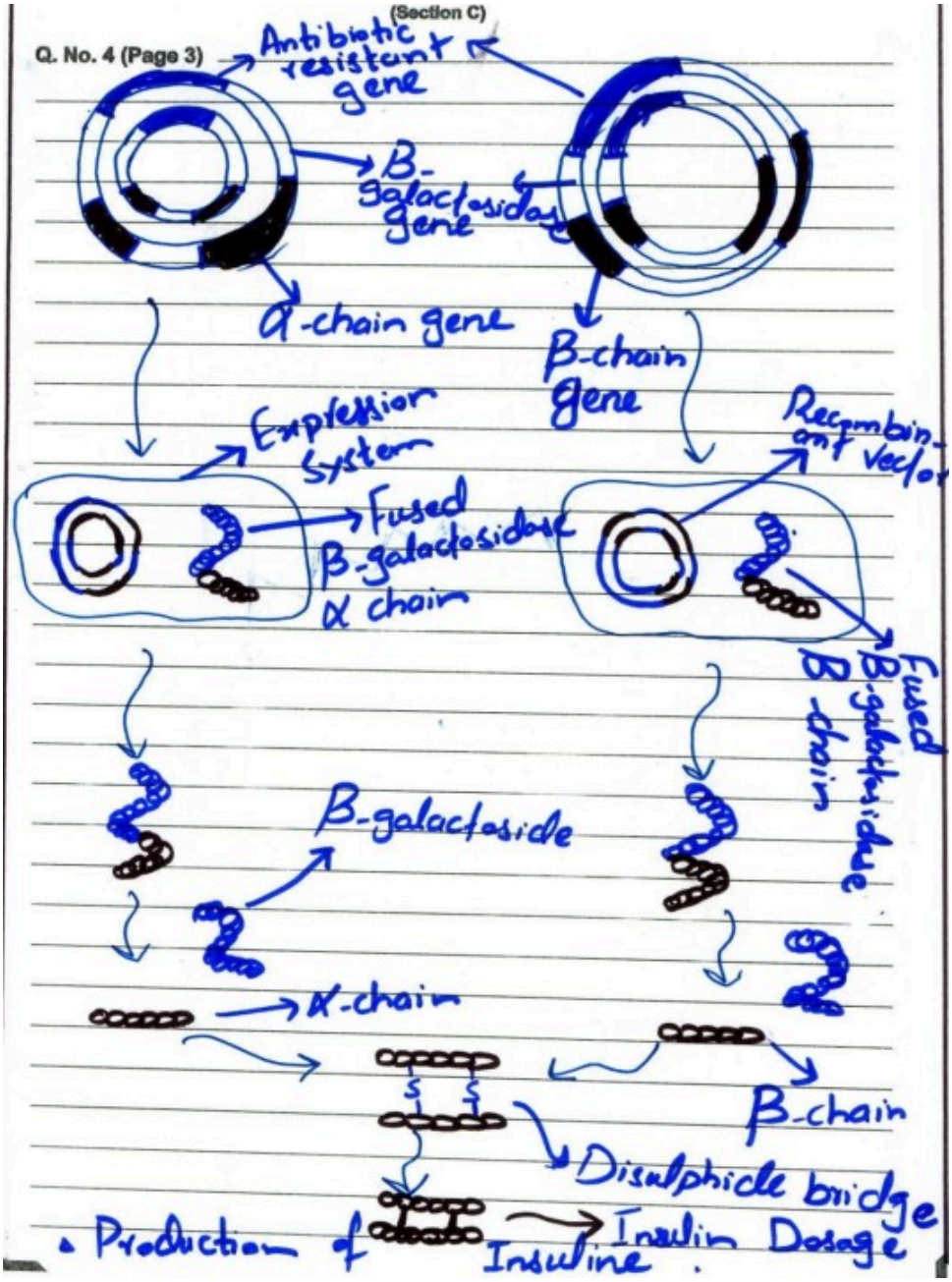
⇒ **Transformation of Expression System** :- Once recombinant Vectors are formed, they are inserted in two separate culture of E-coli. Optimum temperature, pH and favourable conditions are provided to fasten Replication and Expression Rate.

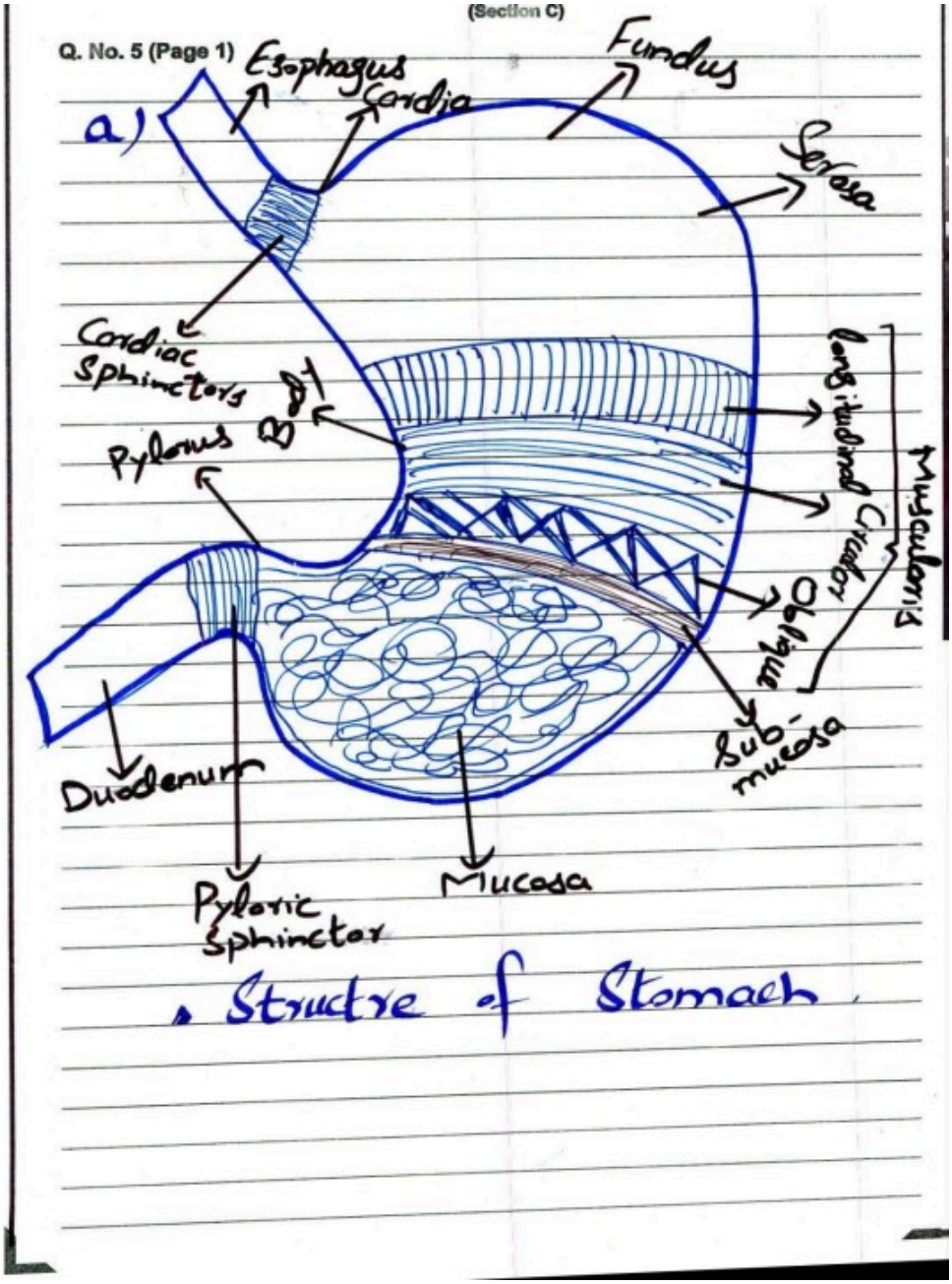
⇒ **Extraction and Purification** :- Since, pBR322 has anti-biotic resistant gene - selectable markers so transformed E-coli are extracted. Fused B-galactosidase chain is separated by treated it with cyanogen bromide so we get α-chain and β-chain.

⇒ **Disulphide Bridges** :- α & β-chains are treated with Sodium disulphonate and Sodium sulphite and disulphide bridges are formed as cysteine.

⇒ **Further Purification** :- Insulin is further purified and cleaned to get pharmacokinetic, effective insulin protein.

⇒ **Packaging / Dosage and Commerce** :- Insulin is then packed and stored in optimal conditions prescribed for usage.


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Antibiotic resistant gene
B-galactosidase gene
α-chain gene
B-chain gene
Expression System
Recombinant Vector
Fused B-galactosidase α chain
Fused B-galactosidase B-chain
B-galactoside
α-chain
B-chain
Disulphide bridge
Insulin
Insulin Dosage
• Production of


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Q. No. 5 (Page 1)
a)
Esophagus
Cardia
Fundus
Serosa
Cardiac Sphincter
Pylorus
Longitudinal Muscularis
Circular Muscularis
Oblique
Sub-mucosa
Duodenum
Pyloric Sphincter
Mucosa
Structre of Stomach.

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b) Chemical Digestion in Stomach :- Chemical secretions of stomach wall in stomach lumen are called **gastric juice**. Gastric juice is composed of **mucus, HCl, intrinsic factor, Pepsin, gastrin etc.** Following are the cells of Stomach Mucosa that secrete gastric juice :-

⇒ **Parietal Cells :-** or oxyntic cells are the part of Gastric Gland. They secrete HCl & intrinsic factor. Intrinsic factor binds and favours the absorption of Vitamin - B12 (Biotin). HCl lowers the pH to 2 providing acidic medium - optimum for pepsin activity. HCl also kills bacteria ingested. Moreover, it also denatures proteins to allow easier hydrolysis by pepsin. It also inhibits the Salivary Amylase enzyme.

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Chief Cells :- or zymogenic cells secrete pepsinogen in stomach granules. When pH = 2 is regulated by HCl, granules releas pepsinogen and it is activated to pepsin. Pepsin is proteilytic enzyme that brooks pepticle bonds breaking polypepticles to peptides.

Surface Mucus Cells :- of Gastric pits release mucus that lubricates bolus and mixes it with gastric juice.

Endocrine Cells :- control and release **Gastrin** hormone into blood that circulates to Parietal cells stimulating additional secretion of gastric juice.

By the effect of above, bolus mixed with gastric juice turns to a thick suspension **-chyme**.

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Q. No. 6 (Page 1)

a) **In Form of HCO_3^- :-**

Almost 70% of CO_2 is transported in blood as bicarbonate ions = HCO_3^- ions. Greater **partial pressure** of CO_2 in tissue allows it to diffuse in blood capillary and enter Red Blood Cells where it reacts with warter to form Carbonic acid.

$$CO_2 + H_2O \xrightarrow{\text{Carbonic Anhydrase}} H_2CO_3$$

Carbonic Acid then dissociates to bicarbonate ions and Hydrogen ion.

$$H_2CO_3 \rightleftharpoons HCO_3^- + H^+$$

This increase in conc. of H^+ ions may reduce blood pH but it is buffered by Haemoglobin to form **haemoglobinic acid**.

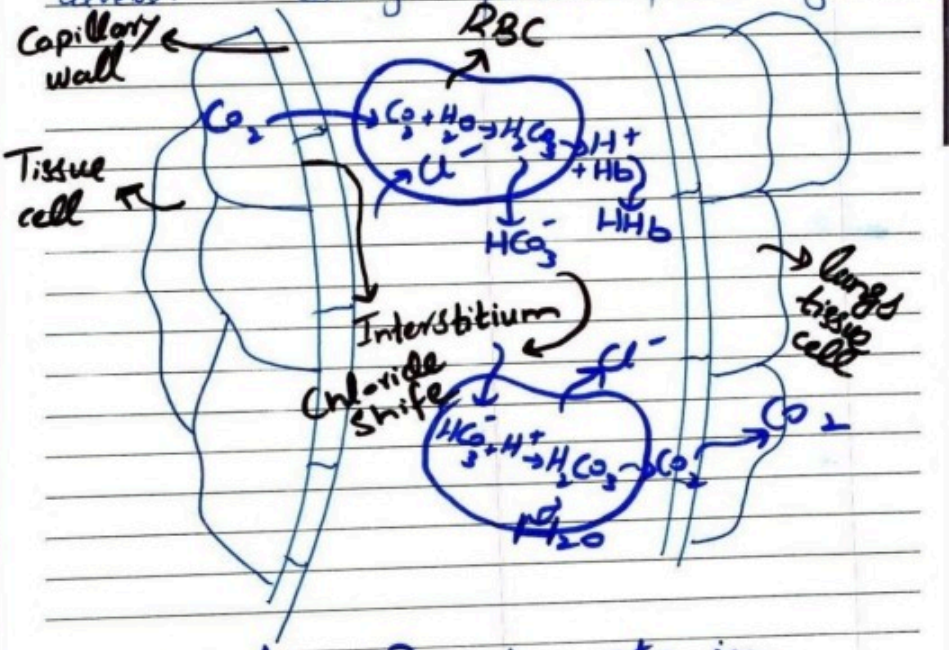
$$H^+ + HbO_2 \longrightarrow HHb + O_2$$

HCO_3^- ions moves out of RBC while Cl^- ions enter inward via special **Bicarbonate - Chloride**

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Carrier protein is called Hamburger's phenomenon. This phenomenon HCO_3^- may add Na^+ ions forming Sodium bicarbonate while Cl^- ions form Potassium Chloride. Bicarbonate ions travel to lungs. Here the process reverses. HCO_3^- combines with H^+ to form H_2CO_3 that gives H_2O and CO_2 that diffuses in to alveoli along partial pressure gradient.



As Bicarbonate ion

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Q. No. 6 (Page 3)

b) As Carboxyhaemoglobin :-

CO_2 when diffuses in blood capilarries, it enters RBC to react with Haemoglobin & form Carbamino haemoglobin. Carboxyhaemoglobin travels through blood up to lungs where it releases CO_2 into lungs along partial pressure gradient. ~23% of CO_2 is transported in this way.

c) As Dissolved in Plasma :-

Only 7% of CO_2 directly dissolves in plasma. This is least efficient process but it does occur.