**Most Commonly Asked Questions and Answers**

**Na-K Pump:**

- Particles enter the pump on the side with a lower conc. & initially bind to a specific site to that type of particle.
- Energy from ATP is required, & a phosphate group is transferred for the conformational change in shape of the pump.
- The pump's shape change opens a channel to the outside of the cell, and the three sodium ions are released. A particle is released on the side of higher conc.
- (3 $Na^+$ out and 2 $K^+$ in)
- Pump returns to its original shape.
- The slight electrical imbalance allows a potential difference.

**Collagen:**

- Almost every third amino acid in each polypeptide is glycine, the smallest amino acid. Glycine is found on the insides of the strands and its small size allows the three strands to lie close together and so form a tight coil. Any other amino acid would be too large.
- Each complete, three-stranded molecule of collagen interacts with other collagen molecules running parallel to it. Covalent bonds form between R groups of amino acids lying next to each other. These cross-links hold many collagen molecules side by side, forming fibrils.
- The ends of the parallel molecules are staggered; if they were not, there would be a weak spot running right across the collagen fibril. Finally, many fibrils lie alongside each other, forming strong bundles called fibers.
- Polypeptide (mostly repeat of amino acid sequence proline-alanine-glycine) $\rightarrow$ Triple-helical collagen molecule $\rightarrow$ fibrils $\rightarrow$ fibers

**Cellulose:**

- Cellulose is made by many condensation reactions joining long chains of beta-glucose molecules joined by $\beta$-1,4-glycosidic linkages.
- Long straight chains lie parallel & held together by many hydrogen bonds forming rope-like microfibrils, which are layered to form a mesh network

called fibrils. Hydrogen bonds are weak, however collectively they provide strength & maintain shape. Cellulose is very strong & prevents cells from bursting when they take in excess water.

**Induced fit:**

- When the enzyme and substrate form a complex, structural changes occur so that the active site fits precisely around the substrate (the substrate induces the active site to change shape).
- The reaction will take place and the product, being a different shape to the substrate, moves away from the active site. The active site then returns to its original shape.
- Substrate binds to the enzyme's active site.
- The shape of the active site changes and moves the substrate closer to the enzyme. Amino acids are moulded into a precise form.
- Enzyme wraps around substrate to distort it. *This lowers the activation energy.*
- An enzyme-substrate complex forms

**Na Glucose Co-Transport:**

- This process is facilitated by symporters which could transfer 2 substances in the same direction. E.g. sodium-glucose symporter. This symporter uses the sodium ions to move glucose into the cell. The movement of sodium ions through the symporter provides the required energy for the glucose to move through the symporter as well.
- Absorption of sodium ions and glucose by cells lining the mammalian ileum takes place by co-transport.
- An electrochemical gradient, created by primary active transport, can move other substances against their concentration gradients, a process called co-transport or secondary active transport.

**Sucrose H+ symport:**

- A sucrose $H^+$ symporter in the companion cell membrane then cotransports sucrose & $H^+$ back into the cell, using stored energy from the proton gradient. This allows sucrose to move into the companion against the concentration gradient without the direct use of ATP.

**Endocytosis:**

- In endocytosis, an outside molecule is engulfed by the cell membrane and brought inside the cell.
- The cellular uptake of macromolecules and particulate substances by localized regions of the plasma membrane that surround the substance and pinch off to form an intracellular vesicle.

**Translation:**

- two codons at a time are exposed (to the large subunit)
- a specific tRNA brings a specific amino acid
- a tRNA anticodon binds to the mRNA codon
- complementary base pairing occurs (by hydrogen bonding)
- a second tRNA brings another amino acid (next to the first amino acid)
- peptide bond formation between the two amino acids
- ribosome moves along the mRNA, one codon at a time / and next codon is 'read'
- the first tRNA leaves the ribosome
  AVP ; e.g. first codon is always AUG
  first anticodon is always UAC
  first amino acid is always methionine ribosome moves along mRNA in a 5' to 3' direction
  role of peptidyl transferase eventually a stop codon is reached (and translation stops)

**Translocation:**

- Proton pumping: companion cells use ATP to power a proton pump which actually transports $H^+$ ions out of the cell and into the apoplastic pathway. This creates a proton gradient. (Higher $H^+$ outside)
- Sucrose $H^+$ symporter in the companion cell membrane then cotransports sucrose & $H^+$ back into the cell, using stored energy from the proton gradient. This allows sucrose to move into the companion against the concentration gradient without the direct use of ATP.

- Sucrose transfer to sieve tube element: once inside the companion cells, sucrose moves into the sieve tube element through the plasmodesmata via passive diffusion.
- The high concentration of sucrose in the sieve tube element lowers the water potential there. The hydrostatic pressure at the source increases. Sucrose moves out of these tubes and water moves in by osmosis.
- A pressure gradient by an increase in charge of pressure is created, & mass flows in the phloem from the source to the sink.

**Hemoglobin Structure:**

- Hemoglobin is the oxygen-carrying pigment found in red blood cells & is a globular protein. We have seen that it is made up of 4 polypeptide chains. Each chain is itself a protein known as globin.
- There are many types of globin; $\alpha$-globin, & $\beta$-globin. 2 hemoglobin chains are made of $\alpha$-globin, while 2 chains are made of $\beta$-globin.
- Each polypeptide chain contains the haem group. A group like this is a permanent part of a protein molecule but is not made of amino acids, is called a prosthetic group.

**The importance of iron in hemoglobin:**

- Each haem group contains an iron atom. One oxygen molecule, O, can bind with each iron atom. A complete hemoglobin molecule, with four haem groups, can carry four oxygen molecules (eight oxygen atoms) at a time.
- It is the haem group that is responsible for the color of hemoglobin. This color changes depending on whether or not the iron atoms are combined with oxygen.
- If they are, the molecule is known as oxyhemoglobin, & is bright red. If not, the color is purplish.

**Bohr's Shift:**

- The Bohr shift describes the affect of high carbon dioxide concentration on hemoglobin's affinity for oxygen. When the partial pressure of carbon dioxide in the blood is high, hemoglobin's affinity for oxygen is reduced. This is the

case in respiring tissues, where cells are producing carbon dioxide as a waste product of respiration.

- This occurs because $CO_2$ lowers the pH of the blood. This is a helpful change because it means that hemoglobin gives up its oxygen more readily in the respiring tissues where it is needed.
- On a graph showing the dissociation curve, the curve shifts to the right when $CO_2$ levels increase. A second line is drawn to the right of and below the standard curve.
- Chloride Shift: The chloride shift is a process in red blood cells (RBCs) where chloride ions move into the cell in exchange for bicarbonate ions moving out.
- Carbon Dioxide Transport: When carbon dioxide is produced in tissues, it diffuses into the blood and enters RBCs. Within the RBC, it's converted into bicarbonate ions (HCO3-) and hydrogen ions (H+) with the help of the enzyme carbonic anhydrase.
- Maintaining Electrical Neutrality: As bicarbonate ions move out of the RBC into the blood plasma, they leave behind a net positive charge inside the RBC. To maintain electrical balance, chloride ions ($Cl^-$) from the blood plasma move into the RBC, effectively replacing the lost bicarbonate ions.
- Role in Gas Exchange: This chloride shift, also known as the Hamburger phenomenon, is crucial for the efficient transport of carbon dioxide. By ensuring that bicarbonate ions are moved out of the RBC and replaced with chloride ions, the process allows the blood plasma to act as a storage site for bicarbonate and helps maintain the pH of the blood.
- Reverse Shift in the Lungs: In the lungs, the process is reversed. Bicarbonate ions move back into the RBC, chloride ions move out, and carbon dioxide is released from the RBC to be exhaled.

**T lymphocytes:**

- The antigen-presenting macrophage display the antigen on its cell surface membrane.
- As a result, T-cell is activated.
- These activated T-lymphocytes (those that have receptors specific to the antigen) divide by mitosis to increase in number (similar to the clonal selection

and clonal expansion of B lymphocytes) and differentiate into two main types of T cell:

- Helper T cells and Killer T cells

- Different kinds of T-cells respond in various ways. For e.g. Helper T-cells ($T_H$ cells) aid in the release of chemical signals like cytokines and interleukins which stimulate and activate cytotoxic T-cells ($T_C$ cells) and phagocytes that kill foreign and abnormal cells.
- Furthermore, Cytokines released T-Cytotoxic Cells & also facilitate in activating B-cells.
- Both T helper and Cytotoxic killer cells can divide to form memory cells to fight future infections.

**Monoclonal Antibodies:**

- They are produced by injecting mice with an antigen that stimulates the production of antibody-producing plasma cells.
- Isolated plasma cells from the mice are fused with immortal tumor cells, which result in hybridoma cells. The fusion of plasma and tumor cells can be assisted with the use of fusogens such as polyethylene glycol or an electric current.
- These hybrid cells are grown in a selective growth medium and screened for the production of the desired antibody.
- They are then cultured in a selective growth medium & screened to produce large numbers of monoclonal antibodies.