Membrane Transport and Protein Synthesis

Lecture 4

Cell Membrane and Transport

• Semi-permeable: Cell membranes allow some materials to pass through them and prevent others from doing so. Regulators like hormones can change permeability of a cell membrane.
• Transport across membrane can be Passive or Active.
  - Passive Transport
  - 1. From high to low conc.
  - 2. Energy (ATP) not needed
  - 3. Carrier Protein not needed
  
  - Active Transport
  - 1. Independent of conc. Gradient
  - 2. ATP needed
  - 3. Carrier Protein needed

Passive Transport

• Passive Transport includes Diffusion, Osmosis and Facilitated Diffusion.
• **Diffusion**: All fluids (liquids + gases) move from area of higher concentration to area of lower concentration (concentration gradient). This movement of substances is called Diffusion. It can be through cell membranes. For example, spreading of fragrance, dissolving of ink drop in water, movement of O2 and CO2 between lungs and blood.

Diffusion versus Osmosis

<table>
<thead>
<tr>
<th>Diffusion</th>
<th>Osmosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Movement of solute</td>
<td>Movement of water</td>
</tr>
<tr>
<td>Membrane not needed</td>
<td>Semi-permeable memb needed</td>
</tr>
<tr>
<td>High conc \rightarrow low conc</td>
<td>Low conc \rightarrow High conc of solution</td>
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</tbody>
</table>

Osmosis

• **Osmosis** is always the net movement of water through cell membrane from its higher concentration (dilute solution) to its lower concentration (concentrated solution) when the 2 solutions are separated by semi-permeable membrane.

Osmotic Flow across a Cell Membrane

• Isotonic – when a cell is placed in a medium with equal concentration of a solute. For example 0.89% NaCl solution or 5% glucose solution. No net osmosis. Same size of cell.
• Hypertonic - When cell is placed in higher concentration medium with > isotonic concentration. Exosmosis. Cell shrinks, and undergo Crenation.
• Hypotonic - When cell is placed in higher concentration medium with < isotonic concentration. Endosmosis. Cell swells, may hemolyse = burst.

Facilitated diffusion

• **Facilitated diffusion** is faster than normal diffusion but needs a carrier protein though no ATP needed. For example absorption of glucose and amino acids in intestine.

Active Transport

• Only active transport can operate against concentration gradient.
• It is the fastest mode of transport.
• It always consumes ATP directly or indirectly.
• It always needs one or more transport proteins.
• For example absorption of minerals by plant roots, absorption of nutrients when their concentration is already higher inside the cells.

Vesicular Transport
• Large molecules like proteins cannot transport through membrane by passive or active transport discussed so far. These are packed into membrane bound sacs, the vesicles, and transported across cell membrane.

• **Endocytosis** is the bulk transport into the cell. If solid material including prey is brought in as Food Vacuole, the process is called **Phagocytosis**. For example, white blood cells eating bacteria. When cell brings in liquid bound in sac the process is called **Pinocytosis**.

• **Exocytosis**: When the cells releases solid or liquid in sacs the process is called exocytosis. For example Amoeba throws excess water outside to maintain required concentration (osmoregulation).

• **DNA- replication**: Both chains separate from each other (Helicase enzyme) and act as template. 2 new chains are synthesized. Each daughter DNA molecule has one new and one old chain. This is called semi-conservative replication. DNA-polymerase is used to synthesize fragments of DNA from nucleotides. DNA-ligase seals the fragments together.

  DNA- replication

  Central Dogma

  Transcription  Translation

  DNA --------→ m-RNA --------→ protein

  Transcription

  • Transcription: Only one chain of DNA acts as template to form m-RNA by RNA polymerase
  • Transcription takes place in nucleus.
  • AAT  CGA  CCC  AAA  TCT  (DNA with TCAG)
  • UUA GCU GGG UUU AGA  (m -RNA with UCAG)
  • m-RNA formed goes out through nuclear pores and enters cytoplasm.

  Translation – 3 steps

  • **Initiation** takes place when m-RNA, smaller subunit of ribosome and t-RNA with 1st amino-acid, combine with one another. Then larger subunit also combines to complete the complex. The chain initiator codon is AUG and 1st t-RNA carries amino-acid Methionine and has the anti-codon UAC.
  • **Elongation** consists of adding amino-acids to polypeptide chain. 2 t-RNA’s are attached to larger subunit. The first t-RNA carries the chain already synthesized. 2nd t-RNA, with complementary anti-codon to the next codon, carries the amino-acid to be added to the chain. A peptide bond is formed between last amino-acid, at the base of chain already formed, and the new amino-acid. The chain is shifted to new t-RNA and Ribosome now moves one codon forward. These steps are repeated till the complete chain is synthesized.
  • **Termination** is achieved by a releasing factor. It occupies the last codon, called terminator codon (UGA, or UAA or UAG). It causes the separation of 2 ribosomal subunits, m-RNA, releasing factor and polypeptide chain.
  • The polypeptide chain usually forms an alpha-helix and gets folded in a unique way to form 3 dimensional molecule called protein.