Selective transport

Kategorie:Vložené články (https://www.wikiskripta.eu/index.php?curid=59490#/media/Soubor:Kapitola-12-12-05.jpg) 350px|vpravo|Transport látek přes hematoencefalickou bariéru

Selective transport can be divided into:

1. Passive transport
2. Active transport
3. Permeation of macromolecules

This diagram shows the transport of substances across the blood-brain barrier (blood-brain barrier - the barrier between blood and nervous tissue)as an example:

Passive transport

It takes place **without energy consumption**, based on the physical principle of diffusion, only using the concentration gradient of the substance between both sides of the membrane. Without the existence of a gradient, passive transport stops. We distinguish two basic types of passive transport – simple and facilitated diffusion..

simple diffusion

It is the transfer of substances through the membrane without the help of transport proteins. Substances must pass through the hydrophobic center of the membrane, and therefore this type of transport is particularly typical for:

- small non-polar molecules – gases (CO_2, O_2, ...);
- small polar molecules – water, Urea;
- vlarger non-polar molecules – MK, cholesterol, Fat-soluble vitamines .

Hydrophilic and larger molecules (especially with M r > 200) undergo simple diffusion only very slowly, or almost not at all. The transport of ions, whose molecules are relatively small, is mainly prevented by the bulky **hydration shell** formed by water molecules.

Facilitated (facilitated) diffusion

This is passive transport with the help of **transport proteins**, to which the transferred molecule is non-covalently bound and through which it is transferred to the other side of the membrane. Facilitated diffusion takes place faster than simple diffusion and can be associated with the transport of another substance in the opposite direction – the so-called. **antiport**, e.g. ATP for ADP, $Cl^-$for HCO_3^-). There is also the possibility of transport through a **a tunnel protein** passing through the entire thickness of the membrane. During transfer, its conformation changes. Some channels can be controlled based on changes in membrane potential (voltage-gated channels).

Diffusion kinetics

The kinetics of simple and facilitated diffusion are different. In simple diffusion, there is a linear increase in the rate of diffusion as the concentration of the transported substance increases. Carrier proteins of facilitated diffusion have a limited capacity (it is determined by their total number in the membrane) and at high concentrations of the substance, the rate of diffusion slows down until it stabilizes at the maximum speed at which the carrier proteins are fully saturated.

náhled|GLUT 2 (https://www.wikiskripta.eu/index.php?curid=59490#/media/Soubor:Kapitola-09-03-07.jpg)

GLUT transporter

The most important examples of facilitated diffusion include glucose transport via**GLUT** transporters (Glucose transporters). The continuous existence of a concentration gradient for glucose is ensured by its intracellular conversion to **glucose-6-phosphate** and its subsequent use in metabolic pathways. In total, there are up to seven types of GLUT transporters. We will mention only some of them in more detail:

1. **GLUT 1 and 3** serve to maintain basal glucose uptake by tissues whose metabolism is **dependent on glucose**, e.g. brain, erythrocytes, but also kidneys and placenta.
2. **GLUT 2** located on the membrane of **β-cells of the pancreas** and **hepatocytes** also enables the transfer of glucose from the resorptive epithelia (proximal tubule of the kidney, enterocytes of the intestine) into the blood.
3. **GLUT 4** is a glucose transporter in so-called **insulin-dependent tissues** (skeletal muscle, myocardium and adipose tissue). Its exposure on the membrane is conditioned by the presence of higher levels of insulin in the blood. This happens especially after a meal, when the mentioned tissues are responsible for the metabolism of up to 80% of glucose from the blood. In the period between meals, on the contrary, they do not absorb it and save it for tissues dependent on it.

Active transport

It can also take place **against a concentration and electrochemical gradient**. In this case, the transport is coupled with the **hydrolysis of ATP** → ADP and P_i and the released energy is **used for transport**.We distinguish between two basic types of active transport:

1. Primary active transport
2. Secondary active transport

náhled|vpravo|Na^+/K^+-ATPáza – animace (https://www.wikiskripta.eu/index.php?curid=59490#/media/Soubor:AP.gif)

Primary active transport

ATP energy is used **directly to transfer the relevant substance** across the membrane. Examples include **Na^+/K^+-ATPáza**, **H^+/K^+-ATPáza** and **Ca^{2+}-ATPáza**.

Na^+/K^+-ATPáza

It is a tetramer composed of **two alfa** and **two beta subunits**. Alpha subunits penetrate the entire width of the membrane, intracellularly have a**binding site for Na^+** and extracellularly for **K^+**. Unlike them, beta subunits are glycosylated and are not transmembrane (they are turned by their oligosaccharide chains towards the extracellular space).

The enzyme can be present in two different conformations depending on whether it is phosphorylated or not. Na^+/K^+-ATPáza functions as an **antiport** and **when ATP is consumed, it transports 3 Na^+ cations out of the cell in and 2 cations K^+ into the cell**. in this way, it creates an uneven distribution of ions on the membrane, which is the basis of the **resting membrane potential** . Na^+/K^+-ATPáza je **ubiquitous** – it is most likely found on all cells of the human body.

H^+/K^+-ATPáza

It is an antiport functioning similarly to Na^+/K^+-ATPáza, it is localized in the **parietal cells of the stomach**, where it participates in the formation of gastric juice, and in the **proximal tubules of the kidneys**. **transfers one H^+ ion out of the cytoplasm in exchange for one K^+ ion**.

Ca^{2+}-ATPáza

It is a calcium pump that occurs most in muscle and nerve cells. It actively pumps calcium ions out of the cytoplasm, either into the **sarcoplasmic reticulum** či **extracellularly**. In the muscles, it makes it possible to reduce the concentration of Ca 2+ to the level before contraction.

==== Secondary active transport (secondary active transport or cotransport)====

in case of ATP is used not directly during the transfer of the relevant substance (e.g. glucose), but to transfer another substance (e.g. sodium cation), for which a concentration or electrochemical **gradient** is created in the cell. This is the engine for the transfer of the relevant substance (glucose) using its transporters (Sodium Glucose Transporter - SGLT). A transporter carrying out secondary active transport (SGLT) therefore moves at least**two particles** – one that is to be transported (glucose) , and one that drives this transport (Na^+) – or for which there is a gradient in the cell.

In order to maintain this gradient, a **second transporter** (např. Na^+/K^+-ATPáza), is required, which can also be located on another part of the membrane. This second transporter is where **energy** (ATP) is consumed – hence active transport. In parentheses is an example of secondary active transport of glucose driven by a sodium cation gradient through the **Sodium Glucose Transporter**, the gradient for Na^+ is created by the Na^+/K^+-ATPáza. According to the direction of transport, we distinguish between **symport** (both particles are transported in the same direction – e.g. into the cell) and **antiport** (the particles are transferred in the opposite direction – one into the cell and one out of the cell). **SGLT performs the symport of glucose and Na^+**.

The existence of tertiary active transport also works on a similar principle ..

Permeation of macromolecules through the membrane

It can be by direction:

1. **Exocytosis**: the process by which macromolecules leave the cell. During exocytosis, the membrane of the transport vesicle and the cytoplasmic membrane fuse, and macromolecules can either be released into the intercellular space or remain part of the cell surface.
2. **Endocytosis**: the process by which macromolecules are taken up by a cell. The cytoplasmic membrane invaginates into the cell until a transport vesicle is formed. According to the chemical nature of the transferred molecules, these are:

- **Pinocytosis**: transfer of macromolecules in the form of a solution. The process can be non-selective (the site of invagination on the cell surface is random) or selective (at the site of specific surface receptors).
- **Phagocytosis**: ingestion of large particles, which the cell first wraps around protrusions of the cytoplasmic membrane(pseudopodie) and then forms a vacuole around them.

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