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"The importance of diffusion to living organisms"

Diffusion is the net movement of molecules or ions from a region where they are more highly concentrated to one where their concentration is lower, until evenly distributed. The molecules move down a concentration gradient and the higher the concentration gradient, the faster the diffusion. Diffusion is also passive. Diffusion is important in many areas of science, from cell membranes in the human body, to insects and fish. There are different types of diffusion, from simple and facilitated diffusion to osmosis.

Gas exchange in most living organisms is made up of lots of diffusion. In small organisms, they have a large surface area to volume ratio which allows sufficient gas exchange across outer surface by simple diffusion. They have a short diffusion distance, making gas exchange for them very simple and fast.

In plants, leaves have a large number of stomata, providing a large surface area. Carbon dioxide enters the stomata by diffusion, down a concentration gradient. In the leaf there are air spaces, making diffusion through the leaf faster and the leaves and cell walls are very thin to provide a short diffusion pathway. This diffusion in plants is important as without it the plant would not be able to photosynthesise because they need CO_2 to do so, this means no oxygen would be produced, so no oxygen would be released into the atmosphere. In insects, diffusion is important in their gas exchange. The spiracles on an insect are selectively permeable and allow oxygen to diffuse in down a concentration gradient. There is also a short diffusion pathway from cell to tracheoles meaning no cell is far from a source of oxygen. Without this diffusion occurring, the insect would not be able to respire and therefore would die, so it plays an important role in keeping the insect alive. Also when the CO_2 reaches critical levels in the insect, the spiracles open allowing the CO_2 to diffuse out down a concentration gradient. Without this diffusion the insect would not be able to have sufficient gas exchange and would not be able to survive. Diffusion plays a huge role in the gas exchange of fish and they have many adaptations to make this diffusion more efficient. The first adaptation is the gills have many filaments and secondary lamellae which provides a large surface area, making diffusion more efficient. There is also a thin epithelium meaning there is a short diffusion pathway between the water and the blood. Furthermore here is a counter current flow which is where the water and blood flow in opposite directions, to maintain a concentration gradient along the entire length of the gill meaning that blood always encounters water with a high oxygen concentration. This increases the rate of diffusion. Without this diffusion in the gills of a fish, fish would not get the oxygen that they need from the water, meaning that they wouldn't be able to survive.

Humans have many adaptations to help diffusion to be more efficient during gas exchange. Humans have many alveoli which provides a larger surface area for diffusion meaning an increased rate of exchange. The walls of the alveoli and the capillaries are 1 cell thick and very close together meaning that there is a short diffusion pathway which leads to faster gas exchange. Furthermore the walls of the alveoli and the capillaries are squamous providing a short diffusion distance. In addition, the cell membrane is permeable allowing gases to pass through it which increases the rate of gas exchange. There are many blood capillaries, proving a larger surface area and good circulation which leads to the maintaining of a steep concentration gradient. This diffusion is very significant in humans and without it, we wouldn't be able to breath in oxygen. We also wouldn't be able to breath out carbon dioxide, and a high carbon dioxide concentration in the body leads to the blood becoming acidic as the pH level lowers. Also when we are exercising we breath faster, to exhale carbon dioxide faster so without diffusion this would not be able to happen.

Diffusion is also very important in nervous coordination. In reflex actions diffusion plays a very important role. The first major part diffusion plays in reflex actions is in depolarisation were the sodium ion channels open and the sodium ions diffuse into the cell. This is via facilitated diffusion. Facilitated diffusion is the net movement of molecules or ions from a region where they are more highly concentrated to one where their concentration is lower until evenly distributed, with the use of protein channels and carrier proteins. Diffusion is also important in repolarisation when the potassium channels open and more potassium ions move out. Also in hyper polarisation the potassium ion channels stay open for longer, meaning more potassium ions move out. The role of diffusion in the process of an action potential to be fired is very important in the human body as without it the body would not be able to respond to internal and external environmental changes.

A synapse is a junction between 2 neurones. There is a very narrow gap of about 20nm between neurones called the synaptic cleft. An action potential cannot cross the synaptic cleft so chemicals called acetylcholine(a neurotransmitter) is used. Synapses that use acetylcholine are called cholinergic synapses. Diffusion plays an important role in the sequence of events at a synapse. When the

How does acetylcholinesterase help to maintain this gradient?

neurotransmitters are released from the presynaptic membrane they diffuse across the synaptic cleft and bind to specific receptors on the post synaptic membrane. Diffusion is important in the sequence of events at a synapse as without it, the neurotransmitters would not be able to cross the gap between the 2 neurones meaning that no action potential could be fired. This means the body would not be able to move any muscles in response to these changes. ✓Relevance ✓NS

Diffusion is also important in osmoregulation. If blood plasma water potential is low then a cell called the osmoreceptor in the hypothalamus of the brain detects changes in water potential. The water potential inside is higher than the water potential in the blood and water leaves the osmoreceptor by osmosis down a water potential gradient. The osmoreceptor shrinks deforming the membrane of the sensory neurone and an increased frequency of action potentials to the pituitary gland stimulates the release of ADG into blood capillaries. If the water potential in the blood plasma was too high then the osmoreceptor expands preventing the deformation of the membrane of the sensory neurone meaning that the release of ADH is prevented. This process is important in living organisms as it keeps the water potential of the blood plasma constant. ✓NI ✗ADG why does Ψ of blood need to be constant?

Diffusion is also important in the light dependent reaction. Light hits photo system 1 and 2. Light energy is absorbed by accessory pigments and pass energy to the reaction centre. Chlorphyl a uses energy to excite 2e- out of photo system 1 and 2 which is called photoionisation. 2e- from photo system 1 move down the electron transport chain releasing energy used to pull/pump hydrogen from the stroma to intermembranal space. This sets up a proton gradient which is chemeostasis. Photolysis then happens. Hydrogen ions facilitatedly diffuses through ATP synthase from intermembranal space to storm down a concentration gradient. NADP picks up 2H and 2e- from photo system 2 to form H2. NADP reduced producing NADPH2. This process is not only important in the light dependent reaction but also the light independent reaction because the products of this are needed for the independent stage. ✗ wrong term.

In conclusion, diffusion is a very important aspect to living organisms and without it they wouldn't be able to survive.

What's the effect of MS on ATP synthase?
why can't the H^+ diffuse through the membrane anywhere?