Importance of osmosis in living organisms and beings

Science, Biology

What is the importance of osmosis in living organisms?

Osmosis is the process by which there is a net movement of water through a semi-permeable membrane from an area of high water potential to an area of low water potential. Within a cell, osmosis has the following effect. If the water potential of the cell is lower than that around the cell water will move across a concentration gradient into the cell. If this is the case, the increase in water in the cell, may cause the cell to swell, which could consequently lead to the cell bursting.

If the concentration of water is the same both inside the cell and surrounding the cell there will be a dynamic equilibrium between the number of water molecules entering and leaving the cell, hence the cell does not change size. For example, red blood cells in the blood plasma retain their shape because of the isotonic nature of the plasma. If the concentration of water is higher within the cell then that of outside the cell, there will be a net movement of water out of the cell, this will cause the cell to shrink and shrivel.

Within animal cells there is no cell wall therefore when there is a higher water potential outside the cell to inside the cell, water diffuses into the cell, and as there is no cell wall to prevent it from bursting, the cell swells and bursts and the cell cannot become turgid. However, when an animal cell is in danger of bursting, organelles within the cell pump water out of the cell to prevent this from happening. When a cell contains excess fluid it causes the membrane to split and the cell to burst, when this happens due to an overabundance of fluid, it is known as lysis.

It is therefore very important to maintain an osmotic balance within animal cells. Like with all cells when the water potential inside the cell is higher than that outside the cell water moves out of the cell, causing the cell to shrink in size. Therefore it is necessary for animal cells to be always surrounded by an isotonic solution. In the human body, the kidneys provide the necessary regulatory mechanism for the blood plasma to be an isotonic solution to prevent excesses amounts of water and salts leaving the body and maintain the correct concentration of water by removing salt from the blood.

This process within the kidneys is controlled by part of the brain called the medulla. Almost all of the water which enters the intestines is absorbed across the walls of the small intestine through the action of osmosis. Chyme which enters the intestines is digested and broken down, this increases the osmotic pressure, and therefore as digestion continues there is an increase in osmotic pressure. This causes water to move into the gut via the process of osmosis. On the other hand the broken down molecules move out of the lumen and into the bloodstream.

This decreases the osmotic pressure, and water is reabsorbed back into the body. An additional bodily function which uses osmosis is the production of sweat. The body uses osmosis by lowering the water potential near the skin by exerting a small amount of salt inside the sweat glands, this lowers the water potential inside the gland, and this causes water to move into the gland via osmosis as the water potential is higher outside the gland then within it. When the glands are full of water, sweat leaves the body, as mainly

water, and the salt remains in the glands which allow water to continually move into the glands when needed to.

Therefore it is clear that osmosis plays a large role in the body, and is needed to maintain many processes within the body. Tissue fluid also requires the process of osmosis, tissue fluid is the fluid which surrounds cells and tissues which contains blood plasma, the function of tissue fluid is to carry oxygen and glucose to cells, and carry carbon dioxide and waste products away from the cells and into the tissue fluid to be reabsorbed by the blood. At the arteriole end of the capillary, due to a high hydrostatic pressure in comparison to the solute potential of the blood is forced out which creates the tissue fluid.

At the venule end of the capillary the pressure is much lower, but the capillary contains the proteins which were not forced out with the tissue fluid. This increases the osmotic potential; therefore the tissue fluid is reabsorbed back into the venule via osmosis. Plant cells are slightly different to animal cells in terms of their reaction to osmosis. When a plant cell has a lower water potential than around the cell, like animal cells, there is a net movement of water into the cell causing the cell to begin to swell.

However, the turgid cell walls prevent the cell from bursting, once this has happened the plant cell is said to have become turgid, as it has become swollen and hard. This causes the pressure inside the cell to be equal to that outside of the cell, this hydrostatic pressure prevents further uptake of water by the plant cell. This is very important to the plant as osmosis cause the

turgidity of the cells it allows the plant tissue to maintain its turgidity and stability.

This is further helped by the fact the pressure of the cells is exerted on the neighbouring cells this allows green plants to photosynthesis more efficiently as it allows them to remain straight and tall towards the sunlight. When a plant cell is in hypertonic conditions, water is exuded from the cell, but there is no change in the size or shape of the cell wall but the cytoplasm shrinks, and the cell membrane and cytoplasm are pulled away from the cell wall, this process is known as plasmolysis.

Osmosis is important within plants, as it allows water to be taken up by the roots, and move up the plant. Firstly it is necessary for moving water and dissolved mineral ions through the xylem. When the water potential is greater in the soil surrounding the roots than in the outer layer of root cells, water moves into the reels via osmosis. This causes and increase of water concentration in the outer root cells, than in surrounding root cells, water therefore moves in to adjacent root cells by osmosis.

This movement of water continues as long as the adjacent cells have lower water potential, this allows water to continue moving up the entire plant. Once the water has been taken up by the roots it can continue in two ways, either down the symplast pathway or the apoplast pathway. The symplast pathway does not require osmosis as there are no further membranes to pass through until the water reaches the xylem. The apoplast pathway stops when the water reaches the endodermis because of the waterproof casparian strip, which seals the cell walls.

Therefore the water has to cross the cell membrane by osmosis and enter the symplast. The uptake of water by the plant causes a pressure which pushes the water up the xylem; this is known as root pressure. However this is not enough on its own to cause water to move up the xylem, the main forces which causes water to move up the xylem comes from transpiration from the leaves. Osmosis is also an important part of mass flow hypothesis in the phloem of plants; the process involves the movement of substances and is nown as translocation.

Sucrose is important to plants and needs to e transported around the plant, firstly the sucrose is loaded into the phloem, usually from a photosynthetic leaf. The sucrose is then actively transported into surrounding cells, this causes the water potential of these cells to reduce, this causes water to enter by osmosis. As the sucrose moves out of the cells, the water follows via the process of osmosis. This results in the mass flow of substances in the phloem.

Therefore osmosis is proven to be a very important element to plant survival water movement, and mass movement in plants. Therefore the process of osmosis is a vital; it allows both plants and animals to function efficiently. Osmosis is involved in many processes around the body and within different sections of plant, it is necessary for absorption in the gut, water movement in plant, the formation of tissue fluid, the stability and turgidity of plants and many other processes mentioned previously.