FUNCTIONS

Water performs its functions within the body in the following ways :

As Part of Structure

Water is a part of all tissues and is essential for growth. Glycogen is two-thirds water. Fat tissue is one-fifth water and muscle is close to three-fourths water.

Provides Turgor

The cell water and its contents in solution provide a normal turgor or fullness to the tissues, a distension or degree of rigidity of the cells resulting from the fluid pressure of the cell contents on the cell membranes. Without this normal tissue turgor that cell water makes possible, the body form would not exist.

Acts as a Solvent

Water is the solvent of life. In the presence of water as a solvent, many metabolic reactions of life are able to proceed and the remaining chemicals can react together to generate the integrated chemical complexity of a living body. By being dissolved in or otherwise exposed to intracellular and extracellular water, the chemistry of life gains the fluidity and flexibility that makes life possible.

When food enters the body, it is soon exposed to the watery secretions of saliva and the watery solutions in the stomach and intestine that allow the food to mix with and react with the compounds responsible for digestion. The digested nutrients are then absorbed into the blood, which contains an average of about 3 litres of water. It is this intravascular water that actually makes blood a fluid and allows absorbed nutrients to dissolve in blood and so be transported to every tissue of the body. The water of blood also acts as a solvent transporting many internally generated substances such as hormones and antibodies from their sites of manufacture in the body to the sites where they perform their function. Waste products of metabolism, such as carbon dioxide and urea also dissolve in the intravascular water to be transported to the lungs or kidneys for excretion.

The 12 litres or so of intercellular fluid found in the spaces between cells, carry nutrients from the blood capillaries to the outer membranes of the body's cells, allowing them to be transported across the membranes and into the watery intracellular fluid within the cells. Within cells the intracellular water serves as a suitable medium for nutrients to be transformed into the compounds needed to build and maintain cells.

Water is a solvent for electrolytes. It helps to regulate the electrolyte balance of the body and maintains a healthy equilibrium of osmotic pressure exerted by the solutes dissolved in water.

Some of the compounds of the body are not dissolved in water, such as the lipid-based cell membranes, but water plays an important role in allowing such structures to form and maintain their structural integrity.

Is a Reactant

Water is a reactant that participates directly in a variety of different reactions within the body. During these reactions the water molecules often split up, to donate hydrogen atoms (H), hydrogen ions (H^+), oxygen atoms (O), oxide ions (O^{2-}), hydroxyl groups (OH) or hydroxide ions (OH^-) to other reactants of the reactions concerned. Common examples of such reactants are polysaccharides, fats and proteins which are split into smaller molecules by reaction with water. During hydrolysis reactions a hydrogen atom derived from a water molecule ends up attached to one of the smaller products of the reaction, while a hydroxyl group containing the remaining atoms of the original water molecule is attached to the other product of the reaction. Water is also formed as a product of many chemical reactions within the cell, such as the reversal of hydrolysis, known as condensation.

Acts as Lubricant

Water-based fluids act as lubricants in various parts of the body, most notably within joints, where synovial fluid makes movement easier and minimises wear and tear on cartilage and bone. The water in saliva and mucus acts as lubricant in the mouth and oesophagus.

Regulates Body Temperature

Water plays an important role in the distribution of heat throughout the body and the regulation of body temperature. Heat in the body is generated by the metabolism of the energy yielding nutrients. All of the energy released by the oxidation of these nutrients is eventually released as heat, apart from any stored within the compounds involved in net growth. Some of this heat, is required to maintain the body's normal temperature of 98.6°F. The excess heat must be released to the surroundings because any significant rise in temperature to above normal levels causes illness and eventually death. Some heat is lost by radiation and simple conduction between the body and the air. The most effective route of heat loss from the body, however, is via the evaporation of the water as perspiration from the surface of the skin. The evaporation of 1 litre of perspiration from the skin is accompanied by the loss of 600 kcal of heat energy from the body.

Provides Dietary Minerals

Water contains significant amounts of minerals such as calcium, magnesium, sodium, zinc, copper, iodide and fluoride. The actual amounts depend on the source of the water.

Hence water is an effective solvent for many minerals and other chemicals. It may also carry significant quantities of toxic elements such as lead or cadmium, pesticides, herbicides and industrial waste products.

REQUIREMENTS

MAINTENANCE OF FLUID / WATER BALANCE

...of the most important factors determining the distribution of water among water compartments of the body is osmotic pressure. When a membrane permeable to water impermeable to solute particles separates two fluid compartments of unequal solute concentrations. There is a net movement of water through the membrane from the solution with higher water (lower solute) concentration towards the solution with lower water (higher solute) concentration. The movement of water is called osmosis and it can be opposed by applying an external pressure across the membrane in the opposite direction. The amount of pressure required to exactly oppose osmosis into a solution across a semi-permeable membrane separating it from pure water is the osmotic pressure of the solution.

The theoretic osmotic pressure of a solution is proportional to the number of solute particles per unit volume of solution. This concentration is expressed in terms of the osmolarity or osmoles per litre of solute particles. One mole of nonionic solute such as glucose or urea, is the same as 1 osm but 1 mol of a solute that dissociates into 2 or more ions is equivalent to 2 or more osm. For example 1.0 mol of sodium chloride equals 2.0 osm because of its dissociation into Na and Cl ions. The theoretic osmotic pressure is not generally equal to the actual or effective osmotic pressure. When the membrane is permeable to the solute it lowers the effective osmotic pressure of the solution, at the given osmolarity. Cell membranes are much more permeable to nonionic substances as urea than to ionic substances such as sodium and chloride. Therefore, the effective osmotic pressure of a solution of urea across the cell membrane would be much less than a solution of sodium chloride of the same osmolarity.

The effective osmotic pressure of plasma and interstitial fluid across the capillary endothelium that separates them is mainly due to large molecules such as proteins that cannot pass through the endothelium. Protein concentration is much higher in the plasma than in the interstitial fluid, rendering a relatively higher osmotic pressure in plasma. The osmotic pressure imparted by proteins is also termed as colloid osmotic pressure.

Water distribution across the capillary endothelial surface is controlled by the balance of forces that tend to move water from the plasma to the interstitial fluid (filtration forces) and by forces that move water from the interstitial fluid into the plasma (reabsorption forces).

At the arteriolar end of the capillaries, the average values of these forces are

Hydrostatic pressure in plasma	Pp l + 25 mm Hg
Interstitial filtration force	II is f + 5 mm Hg
Interstitial hydrostatic pressure	P is f –6
Plasma osmotic pressure	IIpl –28 mm Hg
Filtration pressure	= (25 + 5) – (28 + (–6))
	= 30 – 28 + 6
	= 8 mm Hg

The positive filtration pressure indicates that a net filtration of water from the plasma to the interstitial fluid (ISF) occurs at the arteriolar end of the capillaries. When filtration pressure is negative a net reabsorption of water from ISF to the plasma takes place, as seen in the venous end of the capillaries. At the venous end the hydrostatic pressure of plasma is significantly reduced while the concentration of plasma protein and therefore the plasma osmotic pressure correspondingly increases.

Thus, it is important to understand that osmotic pressure together with proper intake of fluids and their output by body mechanisms is an important factor in the maintenance of fluid balance and compartmentalization.

The body's extracellular water volume is determined mainly by its osmolarity. The osmolarity inturn acts as a signal to the regulatory factors that are responsible for maintaining fluid homeostasis. The regulation of extracellular water osmolarity and volume is largely the responsibility of the hypothalamus, the renin - angiotensin- aldosterone system and the kidneys.

WATER DEPLETION

Water can be depleted in the body due to reduced intake or increased losses. The possible reasons for these are given below:

Reduced intake

Water unavailable	:	After a calamity like shipwreck, earthquake or floods.
Inability to obtain water	:	Infants, elderly and debilitated patients, unconscious patients.
Inability to swallow		Diseases of mouth and esophagus.

Increased losses

From the skin	:	Hot environment, excessive exercise, fever, hyperthyroidism.
From the lungs	:	Hyperventilation, fever, high altitudes.
From the alimentary tract	:	Prolonged vomiting, diarrhoea.
In the urine	:	Osmotic diuresis in diabetes mellitus, too concentrated food e.g., with tube feeding and infant milk powders. Drinking sea water, various kidney disorders, diabetes insipidus.

Effect of Water Deprivation

Evidence of dehydration is sunken features, particularly the eyes which recede into the orbit. The skin and tongue are dry. The skin becomes loose and lacks elasticity. On pinching it stands away from the subcutaneous tissues. The patient is usually but not always thirsty.

Water deprivation causes a reduction in the volume of the extracellular fluid (ECF) and intracellular fluid (ICF). The urine output is reduced. There is a rapid decrease in body weight and a state of dehydration of the cells occur. After a few days, a decrease in plasma volume

...d also in blood volume) occurs which will reduce cardiac output and lead to circulatory ...ure. An adult who has lost 5 to 10 litres of water from the body will be seriously ill and ...th will occur when the water loss from the body is about 15 litres.

Dehydration of the body comes about when water is not taken in adequate amounts to ...ke up for the water loss. Dehydration occurs rapidly in severe diarrhoea and vomiting in ...nts and children. The ECF is reduced in volume and its electrolyte content and osmotic ...ssure increases. Water is consequently drawn from ICF to ECF. The initial water loss is from ...e ECF but in later stages water is lost from the ICF. The metabolism of the shrunken cells ... disturbed, leading to breakdown of protein and loss of K^+. The volume of urine excreted ... diminished to the minimum by increased secretion of ADH to minimise water loss. The ...retion of electrolytes is also increased.

In simple water deprivation, there is not only water loss but also losses of both K^+ and Na^+ ...r reasons given above. As the plasma volume decreases, the venous and capillary pressures ...ll while the osmotic pressure of the plasma proteins increases. These two factors tend to ...intain plasma volume at the expense of ICF. The subject should be given water, electrolytes ...d glucose intravenously.

WATER EXCESS (WATER INTOXICATION)

...verhydration with a reduced plasma (Na^+) and plasma osmolality may occur with an excessive ...take. This may happen if large quantities of water are drunk to quench thirst in a hot climate ...hen at the same time there are additional sodium losses in sweat. Overhydration may also arise ...conditions where water excretion by the kidneys is impaired e.g., in nephrotic syndrome.

Overhydration leads to an increase in intracellular water and is a potentially dangerous ...d even lethal condition. There is difficulty in concentrating, drowsiness and giddiness ...metimes associated with headache and nausea. In severe cases there may be confusion, ...havioural disturbances, convulsions and coma.

Hyponatremia is commonly caused by either retention of water or loss of sodium. Loss of ...tassium may cause hyponatremia as sodium shifts into the cell in exchange for potassium.