**Water and Electrolytes**

Water is the major component of our body. Water is an essential component of every cell of our body. Water is an essential nutrient next only in importance to oxygen. Deprivation of water even for a few days can lead to death. All body processes require water. Approximately 60 percent of total body weight is made up of water, but the percentage varies between 55 to 70 per cent. The percentage of water tends to decrease as a person gets older. Thus infants and children have a much higher content of water than adults. Fat individuals have less water than lean ones.

There is a variation in the water content of various tissues. Metabolically active tissues such as brain, liver, blood and muscles contain more water than bone and fat tissue, which are less active. For example, blood plasma has 90 per cent, muscle tissue 75–80 per cent and fat tissue 20 per cent water.

Water holds body components in solution or suspension (dissolved constituents). Therefore, it is more appropriate to refer to these as fluids.

Fluid compartment

1. Intercellular fluids: The fluids, **which exist inside the cells,** are called **intracellular** fluids. It comprises of 2/3 of the body’s weight. If body has 60% water, ICF is about 40% of body weight. ICF is called the **cellular soup.**
2. Extracellular Fluids:Fluids outside the cells. The remaining 1/3 of the body’s water is ECF which is about 20% of body weight. It is further divided into 3 compartments: interstitial fluid (fluid between cells or tissues), plasma (it circulates the ECF), transcellular fluid( fluid outside the normal compartment e.g cerebrospinal fluid, mucus, tears.

The fluid balance is maintained between the compartments as also between blood and interstitial

fluid; kidneys are the final regulators of fluid balance.

**Functions :**

1. Water serves as a building material for each cell of the body.
2. Water is a **universal solvent** and is able to dissolve all the products of digestion.
3. it helps in the **transport of the products** of digestion to the appropriate organs. For example, **blood,** which contains 90 per cent water, **carries carbon dioxide to the lungs, nutrients to the cells** and **waste nitrogenous material** and **salt** to the kidneys. **Urine** which contains 97 per cent water has all the **waste material dissolved** in it and the body is thus able to **excrete** **soluble waste** products of metabolism.
4. Water is needed for many **chemical reactions** to occur in the body. For example, the breakdown of sugar to simpler substances needs the presence of water.
5. Water acts as a **lubricant** preventing friction between moving parts of the body.
6. The body temperature is **regulated** through the evaporation of water from the skin and lung

**Water Balance**

The body normally maintains a water balance precisely, i.e., the amount of water ingested is equal to the water excreted or lost from the body. This water balance is maintained even though the fluid intake may vary widely from day-to-day. How exactly this regulatory mechanism works is not known; but certain regions of the hypothalmus are believed to regulate the intake. The water excretion is controlled by hormones.

**Sources:** The water we drink as such is the main source from which maximum water is obtained

by the human body. In addition to this, the intake of all beverages and liquid foods that contain water, contribute water to the system. Certain metabolic reactions carried on inside the body also release water and this is another source of water. In a water balance study it was found that of the total 2200 ml available water in the system, 1100 ml was obtained by drinking water as such, 900 ml was obtained from the diet and 200 ml obtained from the metabolic oxidation.

**Requirement:** About 1 ml of water is needed per 1 kcal enery intake; thus about 2000 ml water

is necessary when energy intake is 2000 kcal. Infants who have a large body surface area, in proportion to body weight, need 1.5 ml water/1 kcal energy intake.

The amount of water needed by an individual will depend on many factors such as the **environmental temperature, humidity, occupation and the diet.** In general, apart from water

obtained in the food, an individual may need to drink about 1.5 to 2 litres of water per day. An athlete or a player, playing a strenuous game such as football or hockey, may lose several litres of water and dissolved salts during the game and would need replacement early. On the other hand, a sedentary individual would need much less water.

**Problems**

* Dehydration**:** When intake of water and other fluids is less than the body needs, dehydration occurs. Dehydration is a serious medical problem, which needs **prompt attention and remedial action.** Dehydration results from excessive loss of water due to vomiting and/or diarrhoea. Infants who have a high body water content and high water requirement get dehydrated very quickly, when they suffer from diarrhoea. If the loss of water and electrolytes is not promptly made up by feeding beverages such as oral rehydration solution, coconut water, weak tea, lemon sherbet, etc., the infant may not survive.
* Vomitting due to either gastrointestinal disturbances or any other cause can lead to appreciableloss of fluid from the body.
* Excessive perspiration due to strenuous exercise, while playing games such as hockey, football can result in losses of many litres of water.
* Protracted fevers can lead to appreciable loss of water due to perspiration.

In all such instances where there is loss of water, it is important to **replace** the water and soluble salts lost quickly to **maintain body composition.** Any **loss more than 10 per cent of fluid** from the body can be serious. Progressively, deprivation of water can cause poor absorption of food, delayed elimination of wastes, elevation of body temperature and failure of the circulatory system and malfunctioning of the renal system.

**Oedema** is accumulation of excess fluid in the tissues. It occurs when the sodium content in the

extracellular fluid increases due to the inability of the kidneys to excrete sodium. Water is retained with the excess sodium, resulting in oedema. In protracted protein deficiency, the tissues are unable to ensure water balance, and the oedema, which follows, is called nutritional oedema. Other conditions, which lead to oedema, are kidney disease, cirrhosis of the liver and heart ailment.

**Electrolytes**

Chemical compounds, which break up into their constituent ions, when dissolved in water, are known as **electrolytes,** because each carries an electric charge. The positively charged electrolyte is known as a **cation** and the negatively charged one as an **anion.** In an electrolyte solution, the total number of cations is exactly equal to the total anions. Electrolytes are necessary to regulate the water and acid-base balance in the body. Sodium is the principal cation and chloride the anion in blood plasma. The other cations are potassium, calcium and magnesium; other anions are bicarbonate, phosphate, sulphate, proteinate and organic acids.

In contrast, inside the cell, the main cation is potassium and the main anion is phosphate. There is a strict maintenance of concentration of electrolytes in the fluids inside and outside the cell in a healthy person. Thus sodium stays mainly outside the cell and potassium inside the cell. Any change in the level of electrolytes in the blood plasma is an early warning of disorder in the body.

**Sodium**

Sodium is an essential nutrient, which participates along with other minerals in many regulatory

functions.

**Functions:** The regulatory functions of sodium include normal muscle contraction, maintenance

of normal osmotic pressure, water balance and cell permeability, and transmission of nerve impulses and regulation of acid-base balance. It facilitates the absorption of sugars and amino acids, through the sodium pump. The adult body contains about 85 g sodium; halt of it is in the extracellular fluid, about two-fifths in the bone and about a tenth in the intracellular fluid.

**Food Sources:** The main source of sodium in the diet is salt. It is used as a preservative in a variety of pickles. It is also used in processed foods, snack foods such as potato wafers and other

savoury foods. Other sodium compounds used in food preparation include baking soda, baking powder, monosodium glutamate (MSG) (ajinomoto). The typical diet contains about 500 mg sodium, when **no** salt or sodium containing salts are added during preparation. Most of this sodium is present in animal foods such as milk and meats. Most of the plant foods, with a few exceptions are low in sodium.

**Utilisation:** About 95 per cent of sodium intake is absorbed. The sodium not utilised is excreted

in the urine. Actually the sodium content of the body is regulated by the kidneys.

**Requirement:** Dietary deficiency of sodium does not occur in normal circumstances, as common salt is a very cheap ingredient.

Sodium, which is available from common salt (sodium chloride) in the diet, helps to maintain the

fluid and acid-base balance of the body. People, who do rigorous exercises or who work in hot places such as furnaces or mines, lose salt from the body in perspiration and urine, and so need an extra intake of salt. Deficiency of salt in the diet may cause cramps of muscles, headache, tiredness or sickness. Salt may need to be restricted in diets of persons suffering from kidney or heart malfunction.

**Reduction of Sodium Intake:** Hyperactivity in children has been found to be related to excessive intakes of sodium from use of processed supplementary foods. Intake of salt in diets has increased with the increase in use of processed and readymade foods in the diet. There has been an increase in the incidence of heart ailments as also diabetes mellitus. Hence a number of health organisations recommend that most people would benefit by reducing their sodium intake. Since the taste for salt is an acquired taste, it is possible to modify it. An intake of 3 to 5 g salt is sufficient to prepare a palatable diet. The following changes will help to reduce salt intake:

1. Do not add salt on the table to foods.

2. Reduce the amount of salt used in preparation. Try ½ to ¾ amount of the amount used

earlier.

3. Use minimal amounts of oil and spices in seasoning food, so that the amount of salt needed

in preparation will be reduced.

4. Prepare desserts without adding salt.

5. Use a variety of herbs and spices to flavour vegetables, meats and reduce the need for salt.

6. Use salty foods sparingly, e.g., pickles*,* foods baked with soda, etc.

7. Read labels of processed foods to note presence of salt and sodium compounds and avoid

those with high sodium content.

**Potassium**

Potassium is primarily present in the intracellular fluid (about 12.6 g/per kg), so that the body is

able to conserve it.

**Functions:** Like sodium, potassium helps to maintain the normal osmotic pressure of the body

fluids and the acid-base balance of the body. It is also involved in muscle contraction and transmission of nerve stimuli. It acts as an activator of several enzyme reactions in metabolism.

**Food Sources:** Potassium is widely distributed in foods. Meat, fish and poultry are good sources.

Fruits such as bananas, oranges, mausambi, lemons and vegetables like potatoes, carrots, leafy vegetables and whole-grain cereals are also good sources of potassium.

**Requirement and Utilisation:** About 3 to 7 g per day as potassium chloride, which is the intake

in ordinary diet, appears to be adequate. About 90 per cent of ingested potassium is absorbed from the intestine, the rest is excreted in urine.

**Deficiency and Related Problems:** Normally dietary deficiency of potassium does not occur.

But persons, who take diuretics for weight reduction, may lose excessive amounts and need to consume potassium rich foods to make up the loss. Severe vomiting and diarrhea may increase losses and thus precipitate a deficiency. Abnormal elevation of blood plasma potassium known as **hyperkalemia** occurs in severe dehydration and kidney failure, which needs immediate action. Rehydration fluids rich in sodium, potassium and glucose/sucrose help to reverse the situation and pave the way to recovery.

**Acid-base Balance**

**pH**: The concentration of hydrogen ions in a solution is referred to by the symbol pH. It is the

measure of acidity or alkalinity of the solution. Neutral pH, which is the pH of water, is 7.0. The pH below 7.0 denotes acidity which increases with decrease in the pH. The alkalinity on the other hand increases with increase in the pH. The pH of **body fluids is maintained** in the **narrow** range between **7.35 and 7.45**, which is slightly alkaline. The maintenance of pH in this narrow range is known as acid-base balance.

**Regulation of Acid-base Balance**: Mineral elements act as buffer salts, which prevent change in

the pH. In the body the carbonate and the sodium phosphate buffer systems are important in pH

regulation. Proteins, which hydrolyse to form amino acids, contain an alkaline (NH2) and an acidic (COOH) group, are also good buffers. The kidneys are able to excrete very acidic urine, when excess acid is produced in the body, thus preventing changes in blood pH. The kidneys act as the regulators of acid-base balance.

**Disturbances in Acid-base Balance:** If the pH of body fluids drops below pH 7.3, it is called

acidosis. When diabetes is not controlled, the patients suffer from acidosis and excrete large amounts of ketones. In severe starvation, the body fat reserves are metabolised in the absence of carbohydrate and acidosis occurs. In renal failure, acidosis occurs, as the kidneys are not able to get rid of excess acid. If the pH increases above 7.5., it is called **alkalosis.** Any condition which leads to loss of stomach acid, results in alkalosis. Severe vomiting is one such condition. Another is excessive intake of antacids Any change in pH needs immediate action to avoid disturbance in the metabolism and restore normalcy.

**Tutorial Questions**

1. List the functions of water in the body.

2. What is acid-base balance?

3. How is the acid-base balance regulated in the body?