

**Inorganic pharmaceutical
Chemistry 3 rd stage / 1 st semester**

Major Intra and Extracellular Ions

Body consists of ~ 65% water

- The body fluids are solutions of inorganic and organic solutes.
- The concentration balance of the various components is **maintained** in order for the cell and tissue to have a constant environment

The volume and composition of the body fluids vary extremely from one compartment to another, and are maintained remarkably constant despite the variation of daily life and the stress imposed by disease.

Disturbance of fluid and electrolyte metabolism involve four properties (**body fluid-volume**, **osmolarity**, **hydrogen ion concentration (pH)** and **the concentration of other specific ions**)

Major Electrolytes

The total body water is divided into three compartments:

- 1) The intracellular compartment (fluid inside cells) ICF.
- 2) The extracellular compartment, which consists of the plasma and the interstitial fluid (fluid is outside the cells) ECF.
- 3) The transcellular compartment, which includes the fluid within the gastrointestinal tract, aqueous humor of the eye and the excretory system of the kidneys and glands.

Major Electrolytes

Extracellular fluid (45–50%) contains large amounts of sodium Na^+ , chloride Cl^- and bicarbonate HCO_3^- ions plus nutrients for the cell such as oxygen, glucose, fatty acids and amino acids.

Intracellular fluid contains large amounts of potassium K^+ , magnesium Mg^{+2} , and phosphate HPO_4^{-2} ions.

Major Electrolytes

The electrolyte balance of the body is maintained by a regulation between the intake and output of water.

- The intake of water includes the fluid taken orally
 - The release of water during the oxidation and other metabolic process in body
- Water is eliminated from body by urine, expiration (lungs) and feces. Excessive loss of water results in concentration of body fluids which causes rise in osmotic pressure, as a result water moves out from intracellular compartment to maintain the osmotic pressure in extracellular fluid, this results in dehydration of cells.
 - Loss of water above 20% may prove to be fatal.

Major Electrolytes

Electrolyte concentration can be expressed as:

1. Percent solutions (w%) (w/v)
2. Millimoles (mmol) and Micromoles (μmol)
3. Milliosmoles (mOsmol)
4. Milliequivalents (mEq)

calcium

About 99% of body calcium is found in bones and the remaining is present in extracellular fluid compartment.

- Poorly absorb (20–40%), according to body need.
- Absorption: aided by vit. D, lactose, acidity and hindered by excess fat
- calcium level in plasma is regulated within narrow limits by parathyroid hormone. (parathyroid hormone mobilizes bone Ca^{+2} into the bloodstream.).
- Best food source: milk, milk products.

calcium

The calcium in plasma is present in three form:

- About 40% is combined with plasma proteins and is non diffusible through the capillary membrane
- About 10% is combined with other substances of plasma and interstitial fluid (citrate, phosphate for instance) and is diffusible through the capillary membrane in such a manner that it is not ionized
- The remaining 50% calcium present in plasma is diffusible through the capillary membrane and ionized.

calcium

Calcium is important for:

1. Blood clotting
2. Contraction of various smooth muscles.
3. Formation of apatite in bones and teeth.
4. In cardiovascular system (CVS)

calcium

Hypercalcemia causes:

- The nervous system is depressed, and the reflex action of CNS can become slow.
- It also decreases the QT interval of the heart (is the space between the start of the Q wave and the end of the T wave. The interval is the time it takes for the heart to contract and refill with blood before it beats again) which can lead to cardiac arrhythmia.
- It causes constipation and lack of appetite and depresses contractility of the muscle walls of the GIT.

calcium

Hypocalcemia causes:

- Rickets (child)
- Osteoporosis (adult)
- Poor growth

Hypocalcemia occurs due to:

- hypoparathyroidism
- vitamin D deficiency
 - Osteoblastic metastasis
- steatorrhea (fatty stools)
- Cushing syndrome (hyper active adrenal cortex)
- acute pancreatitis and acute hyperphosphatemia

Sodium

The sodium and its associated anions, mainly chloride, account for more than 90% of the solute in extracellular fluid compartment.

- Plasma sodium is a reasonable indicator of plasma osmolarity under many conditions.
- Readily absorb, aldosterone increase reabsorption in renal tubules.
- Best food sources: table salt, salty foods, milk, some vegetables

Function:

- The main biological roles of sodium ions are the maintenance of body fluids in humans.
- The functioning of neurons and transmission of nerve impulses.

Sodium

Hyponatremia:

can result from loss of sodium chloride from the extracellular fluid. Conditions that cause hyponatremia owing to loss of sodium chloride include

1. excessive sweating
2. diarrhea and vomiting
3. over use of diuretics that inhibit kidney to conserve sodium.
4. Addison's disease, which results from decreased secretion of hormone aldosterone

Hypernatremia: can be due to:

1. Excessive water loss from extracellular fluid, as in ADH deficiency
2. Secretion of sodium- retaining hormone aldosterone (Cushing syndrome) excessive treatment with sodium salts

Potassium (K)

Potassium is a major intracellular cation present in a concentration approximately 23 times higher than the concentration of potassium present in extracellular fluid compartment (about 95% in the cells).

Extracellular fluid potassium concentration is normally just regulated at 4.2mEq/l. ,this is because many of the cell functions are sensitive to change in the extracellular fluid potassium concentration.

Potassium (K)

Best food sources:— vegetable, fruits, whole grain, milk, meat.

Maintenance of potassium balance depends primarily on its excretion by kidney because only 5–10 percent is excreted in feces.

- Both, elevated and low levels of potassium, can be fatal

Potassium (K)

Hyperkalemia occurs due to high intake of potassium or in kidney damage, increase in potassium concentration can cause cardiac arrhythmias and lead to cardiac arrest by fibrillation

Hypokalemia due to vomiting, diarrhea, burns, over use of thiazide diuretics.

Chloride (Cl)

Chloride major extracellular anion is principally responsible for maintaining proper hydration, osmotic pressure, and normal cation anion balance in vascular and interstitial compartment.

- The concentration of chloride is 103mEq/l in extracellular fluid, and 4 mEq/l in intracellular fluid.

Chloride (Cl)

Decreased chloride concentration

Hypochloremic alkalosis can be the result of :

- salt losing nephritis, leading to lack of tubular reabsorption of chloride
 - metabolic acidosis such as found in diabetes mellitus
 - in renal failure
- prolonged vomiting

Chloride (Cl)

Increased concentration of chloride may be due to:

- dehydration, excessive chloride uptake
- decreased renal blood flow found with congestive heart failure (CHF).
- **Best food sources: Table salts**