Osmolarity

Osmolarity is defined as the number of particles per liter of fluid. Physiologic blood plasma osmolarity is approximately **280-295** mOsmoles/L. Less than this is hypoosmotic, and greater is hyperosmotic. Cellular osmotic concentration gradients are maintained largely through the active pumping of trans-membrane ionic transport proteins. In addition to ionic components, osmolarity is partially composed of proteins such as albumin in the serum, another important osmotically active component to consider is glucose.

Physiology of total body potassium:

98% of potassium is intracellular and 2% only is in extracellular compartment, so approximately 135-150mmol/l is present intracellularly, compared to plasma levels of **3.5-5.5**mmol/l. The daily requirement is about 1mmol/kg/day, which is absorbed from the small intestine by diffusion.

Potassium Homeostasis :

Potassium enters and leaves the extracellular compartment by three main routes:

- the intestine,
- the kidneys,
- the membranes of all other cells. (affected by pH, insulin and aldosterone)

The **kidney** is the main organ involved in potassium regulation.

aldosterone which is the main hormone involved in potassium regulation secreted from adrenal gland.

1- aldosterone results in increase intracellular uptake of potassium in exchange with sodium by the action of the **Na+ /K+ ATPase pump** which in turn maintains the **resting membrane potential** and
2- Aldosterone also increase potassium excretion in urine in exchange with sodium by the kidney.

Hypokalaemia

This is typically taken as being a potassium level of less than 3.5mmol/l, though symptoms may not occur until the level is less than 3mmol/l. usually causing muscle weakness and cardiac arrhythmias

Hypokalaemia and Anaesthesia: It is used to be thought that because of the risk of developing arrhythmias, a healthy patient undergoing surgery with a potassium level of less than 3.0mmol/l should have their operation postponed if possible and have replacement therapy to normalize the plasma potassium.

Hyperkalaemia

This is defined as a plasma level of greater than 5.5mmol/l. The chronic causes are renal failure, Addisonís disease. **Hyperkalaemia is one of the serious medical emergencies that can causing sever arrhythmias leading to cardiac arrest and death.**

Hyperkalaemia and Anaesthesia: The decision to treat hyperkalaemia and is based on the symptoms and signs present. If there are ECG changes or the concentration is greater than 6.5mmol/l, the incidence of serious cardiac compromise is high and rapid intervention is necessary. A plasma potassium of

less than 6mmol/l has been suggested before an elective operation. The cause should be investigated and corrected if possible.

(Hyper- and hypokalaemia can result in serious cardiac compromise)

Chloride

Chloride is the main anion in the ECF. It is important in :

1. Maintaining a normal acid-base state (exchangeable with bicarbonate).

2. Normal renal tubular function.

3. Formation of gastric acid.

Chloride intake: Absorption from the upper part of the small intestine.

Chloride loss: From the stomach, bile, pancreatic and intestinal secretions . Regulation of chloride is passively related to sodium and inversely related to plasma bicarbonate.

Bicarbonate

About 70% of the bicarbonate produced will diffuse into the plasma and chloride shifts into the cell to maintain electrochemical neutrality. The reverse occurs when the blood reaches the lungs.

Bicarbonate has important physiological functions.

 It forms the **main buffer** and facilitates the carriage of carbon dioxide in the blood (80% as bicarbonate).

 alkalinization effect on local anesthesia: in which it

1.enhance onset of action (facilitate diffusion in nerve block).

2.prolong duration of action of local anesthesia drugs by slowing absorption

3. reduce the pain and discomfort during injection of these drugs (by reducing acidity of solution) .

Calcium

The normal level of calcium is between 8.5 - 10.5 mg/dL.

The levels of **calcium in the body are managed by:**

1. **parathyroid hormone and vitamin D which increases the calcium levels.**
2. **calcitonin which decreases calcium levels**

The calcium ion is essential for many biological processes that include normal bone health and excitability of muscles (heart and other muscles) and nervous tissue. Calcium is also a major intracellular messenger needed for normal cellular function and required by many enzymes for full activity.

Hypercalcaemia

which is a calcium level of more than 10.6 mg/dL, is most often associated with the endocrine disorder of **hyperparathyroidism**, some forms of cancer such as breast cancer and cancer of the lungs, with multiple myeloma

Hypocalcaemia

which is a calcium level less than 8.5 mg/dl, can occur as the result of **renal disease** inadequate dietary calcium, a **vitamin D deficiency** because vitamin D is essential for the absorption of calcium.

Magnesium

The normal level of magnesium in the blood is 1.7 to 2.2 mg/dl. Magnesium plays an important role in enzyme activities, brain neuron activities, the contraction

and relaxation of muscles. Magnesium also plays a role in the metabolism of calcium, potassium and sodium.

Hypermagnesaemia & Hypomagnesaemia

Hypermagnesemia: which is a blood magnesium level of more than 2.2 mg/dl.

Hypomagnesemia: which is a blood magnesium level less than 1.7 mg/dl. Hypomagnesaemia often occurs as the result of the prolonged use of diuretics, uncontrolled diabetes, hypoparathyroidism.

Phosphate

The normal level of serum phosphate is from 0.81 to 1.45 mmol/L. **Hyperphosphatemia :i**s defined as a phosphate level greater than 1.45 mmol/L. The greatest risk factor for hyperphosphatemia is severe and advanced renal disease, but other risk factors can include hypoparathyroidism, diabetic ketoacidosis, serious systemic infections, and rhabdomyolysis which is the destruction of muscular tissue with release of intracellular phosphate.

Hypophosphatemia: which is defined as a phosphate level less than 0.81 mmol/L .