Sodium (Ka^+)

BCH 282 (Lec. 7)

- Ka^+ is the principle electrolyte in the extracellular fluids the primary regulator of extracellular fluid volume.
- When the blood conc of Ka^+ increases, as when a person eats salted foods, thirst promotes the person to drink water and the body maintain Ka^+ water ratio.

East salted food → (then) ↑ Ka^+ conc → (then) thirst → (then) Ka^+/H2O maintenance

Functions

1. It's largely associated with chloride, bicarbonate and phosphate in regulation of acid-base balance;
   e.g. (H_2CO_3/$NaHCO_3$) and (NaH_2PO_4/Na_2HPO_4)
2. It's major component of cations of extracellular fluid, so it is important for the maintenance of the osmotic pressure of body fluid.
3. It's important for normal irritability of muscle and permeability of the cells.

Sodium and blood pressure:

High intake of Na^+ and low intakes of K^+, Ca^{2+}, magnesium (μg^{2+}) have been associated with hypertension.

Sodium and osteoporesis:

A high Na^+ intake has associated with Ca^{2+} and bone losses. Dietary advice to prevent osteoporosis.

Suggest both eating more Ca^{2+} - rich foods and restricting Na^+ - rich food.

Sodium recommendations and Sources: (Table salt NaCl)

Minimum requirement of Na^+ 500 mg/day

Maximum requirement of Na^+ 2400 mg/day

5g salt is about 2g sodium

1/2 table spoon salt = 1g sodium

Potassium K^+

- K^+ is the principle +ve charge ion inside the cell (mainly intracellular).
- It plays a major role in:
    1) maintaining fluid and electrolyte balance.
    2) cell integrity
    3) potassium is critical to keep the heart beat steady
    4) It also assists in CHO and protein metabolism
    5) It also keeps intracellular osmotic pressure

K^+ deficiency and Toxicity

- K^+ deficiency results from excessive losses rather than decreased intake.

K^+ Deficiency (hypokalemia) in abnormal conditions such as:

- prolonged diarrhea or vomiting
- dehydration from use regular certain medications including some steroid and diuretics
- postoperatively

In healthy people potassium toxicity from foods is not problem because the kidneys excretes excess K^+, while K^+ supplement can cause toxic level and then death.

K^+ and blood pressure:

Diet low in K^+ play a role in development of high blood pressure.

K^+ recommendation and source:

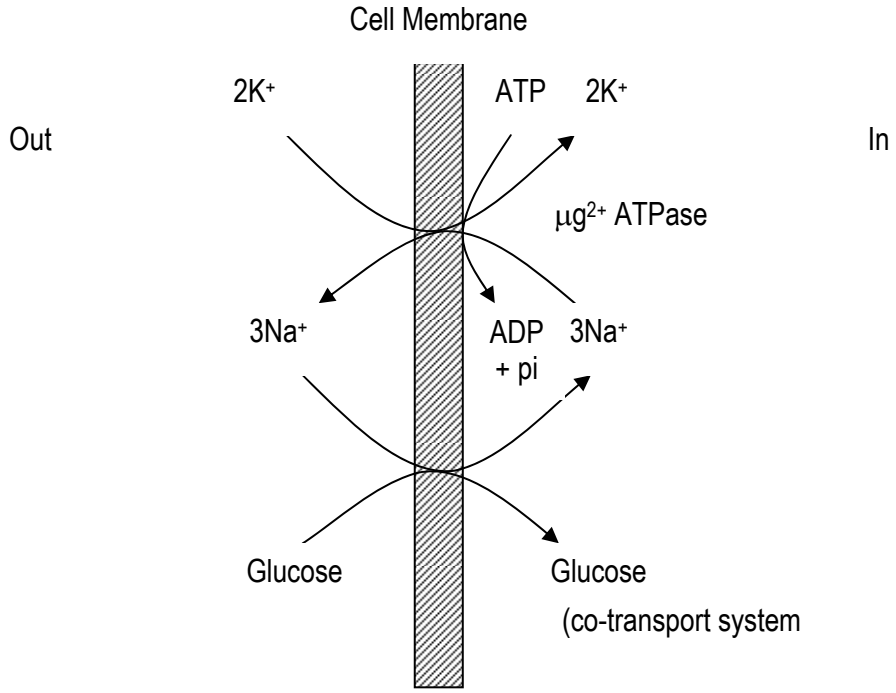
Minimum requirement 2000mg/day

Source:
- Fresh foods of all kinds especially fruits and vegetables and beaf and chicken.
- Fruits specially in bananas, juices of oranges and dried fruits.

Na^+ - K^+ pump

- The high conc. gradients of Na^+ and K^+ that exist across the cell membrane are maintained by the activity of an energy-requiring pump that transports Na^+ out of the cell in exchange for K^+.
- The energy is provided by ATP generated in the cell.
- For every molecule of ATP changed into ADP + Pi, three Na^+ ions are pumped outward and 2 K^+ ions are pumped inward.
- The enzyme used in this reaction is μg activated Na^+ - K^+ ATPase.
- Oubain (a cardiac glycoside) inhibits Na^+ - K^+ pump.

- Na+ - K^+ pump may be used at the same time in the compulsory co-transport of Na and solute molecule. So, no extra-energy is required e.g. glucose, amino acids absorption in intestine.



Na – K pump and co-transport system

Chloride

- The major –ve ion of the fluid outside the cells, where it occurs primarily in association with sodium.
- Cl^- can amove freely across cell membranes and so is also found inside the cell associated with K^+.
- Like sodium, Cl^- is critical to maintain:
    1. fluid and electrolyte balance
    2. acid-base balance
    3. osmotic pressure
- In the stomach, the Cl^- ion is part of the HCl, which maintain the strong acidity of the gastric fluids.
- Salt is a major food source of Cl^-.

Magnesium

Functions

1. It is critical to activate hundreds of enzymes e.g. (Na^+ - K^+ ATPase), (hexokinase).
2. Helps muscle relaxation after contraction.
3. Promotes resistance to tooth decay by holding Ca^{2+} in tooth enamel.

μg^{2+} deficiency: can result from:

1. Vomiting
2. Diarrhea
3. Protein malnutrition
4. Using diuretics
5. After surgery in people who have been fed incomplete fluids intravenously for long period.

μg^{2+} Toxicity: is most often reported in older adults who abuse:

1. μg^{2+} containing laxative
2. antacids

The effect can be coma, confusion and in extreme cases death.

μg^{2+} intakes and sources: (in USA)

- Dietary intake data, do not assess the μg contribution of water. However, the μg recommendation intake in USA as follows:
    - Men (19-30Y) 400 mg/day - Women (19-30Y), 310 mg/day
    - Men (31 and older) 420 mg/day - Women (31 and older) 320 mg/day
- μg – rich food sources include dark green, leafy vegetables and nuts and legumes and whole grain bread and sea food and chocolate and coca.
- μg is easily lost from food during processing, so unprocessed foods are the best choice.

Sulfurs (S)

- The body does not use sulfur by itself as a nutrient.
- Sulfur is included here because it occurs in essential nutrients like amino acids (cysteine-methionine).
- Sulfur is present in all proteins and play its most important role in shaping strands of proteins (protein structure). The particular shape of protein enable it to do its specific job especially important for enzyme activity.

Distribution

1. In CHO: In mucopolysaccharides which enter in the structure of cartilage, tendanes and bones.
2. In Lipids: Sulfolipids enter in structure of cell membranes and in bile salts.
3. In Proteins: As keratins and immunoglobulins.
4. In Enzymes: As fatty acids sysnthetase.
5. In Vitamins: As vitamin B, lipoic acid and biotin.
6. In Co-enzymes: as CoA, glutathione, thiamin pyrophosphate.
7. In Hormones: As insulin.
8. In Urine: As inorganic sulfate.
    - There is no recommended intake for sulfur.
    - No deficiencies are known.

Sources: The main sources of sulfur are proteins containing cysteine and methionins. Sulfate ions in salts are poorly absorbed.