

Minerals

Functions of minerals

- **provide a suitable medium for cellular activity**
 - permeability of membranes
 - irritability of muscles and nerve cells
- **play a primary role in osmotic phenomenon**
- **involved in acid base-balance**
- **confer rigidity and hardness to certain tissues (bones and teeth)**
- **become part of specialized compounds**

Metalloenzymes

- **metal is firmly bound**
- **metal is unique**
- **no enzyme activity without metal**

Examples of metalloenzymes:

- **superoxide dismutase (Zn and Cu)**
- **carboxypeptidase A (Zn)**
- **carbonic anhydrase (Zn)**
- **cytochrome oxidase (Fe and Cu)**
- **xanthine oxidase (Co and Fe)**

Metal-activated enzymes

- metal is reversibly bound
- metal is not necessarily unique
- enzyme activity may exist without metal
- **Examples of metal-activated enzymes**
 - creatine kinase (Mg, Mn, Ca or Co)
 - glycogen phosphorylase kinase (Ca)
 - salivary and pancreatic alpha-amylases (Ca)

Sodium (Na)

- **Sodium is the principal cation in extracellular fluids**
- **functions include:**
 - **osmotic equilibrium**
 - **acid-base balance**
 - **carbon dioxide transport**
 - **cell membrane permeability**
 - **muscle irritability**

Potassium (K)

- Potassium is the principal cation in intracellular fluid
- functions:
 - buffer constituent
 - acid-base balance
 - water balance
 - membrane transport
 - neuromuscular irritability

Chloride (Cl)

- **an essential anion**
- **closely connected with sodium in foods, body tissues and fluids and excretions**
- **important for osmotic balance, acid-base balance**
- **in the formation of gastric HCl**

Calcium (Ca)

- **function of calcium:**
 - **structural unit of bones and teeth**
 - **contraction and relaxation of muscles**
 - **stabilizes nervous tissue**
 - **low calcium --- irritable nerves --- tetany**
 - **high calcium --- depresses the nervous irritability**
 - **required for blood clotting**
 - **activates various enzymes (glycogen phosphorylase kinase, salivary and pancreatic amylase)**

Phosphorus

- **Very active metabolically:**
 - **High energy phosphate compounds**
 - **Nucleic acids**
 - **Phospholipids**
 - **Phosphoproteins**
 - **Coenzymes (vitamins)**

Magnesium (Mg)

- cofactor of all enzymes involved in phosphate transfer reactions that use ATP and other nucleotide triphosphates
- phosphatases
- Pyrophosphatases
- neuromuscular system

Zinc

- **Involved in many enzymes (over 20 metalloenzymes)**
 - **Carbonic anhydrase**
 - **Carboxypeptidase A**
 - **Four types of proteases**
 - » **Serine**
 - » **Cysteine**
 - » **Aspartic acid**
 - » **Zinc**
 - **ACE (angiotensin I converting enzyme)**
 - **RNA and DNA polymerases**

Iron (Fe)

- **2 types of body iron**
 - **heme iron**
 - hemoglobin, myoglobin, catalases, peroxidases, cytochromes (a, b and c – involved in electron transport), cytochrome P450 (involved in drug metabolism)
 - **non-heme iron**
 - ferritin, hemosiderin, hemofuscin, transferrin, ferroflavoproteins, aromatic amino acid hydroxylases
- **food iron is also classified as heme and non-heme**

Copper

- **component of several enzymes:**
 - **ceruloplasmin (an oxidase)**
 - **tyrosinase (production of melanin)**
 - **amine oxidase (metabolism of catecholamines)**
 - **cytochrome C oxidase**
 - **dopamine beta hydroxylase**
 - **copper/zinc superoxide dismutase**

Fluorine

- **Considered essential because of its beneficial effect on tooth enamel**
- **Benefits include: less dental caries, stronger bones, reduction in osteoporosis and calcification of the aorta**
- **In large quantities it is deleterious to teeth; dental fluorosis: pitting, chalky, dull white patches and mottling of teeth**
- **1 to 2 parts per million is adequate for drinking water**

Iodine

- **iodine is necessary for the formation of thyroid hormones**
- **deficiency of iodine is manifested by a goiter (enlargement of the thyroid gland)**

Silicon

- appears to play an important role in the development and maintenance of cartilage (chondroitin sulfate, hyaluronic acid, keratin sulfate)
- may have a protective role in cardiovascular diseases (atherosclerosis)
- found in unrefined grains and beer

Manganese

- **Manganese is an activator of several different enzymes:**
 - **Phosphoglucomutase**
 - **Isocitric dehydrogenase**
 - **Cholinesterase**
 - **Intestinal peptidase**
 - **Carboxylases**
 - **ATPases**

Selenium

- **appears to function in the metalloenzyme glutathione peroxidase, which destroys peroxides in the cytosol**
- **has antioxidant activity (may have relationship with vitamin E)**

Molybdenum

- **Mo is part of flavoproteins, xanthine oxidase, aldehyde oxidase**

Chromium

- **Cr III may act as a cofactor for insulin, enhancing glucose utilization**

Sulfur

- **Most sulfur in the diet comes in from protein sources containing sulfur amino acids such as cysteine, cystine and methionine**
- **Sulfur is also present in thiamine, biotin, sulfolipids, conjugated bile acids and coenzyme A**