

TRACE ELEMENTS

Trace elements occur in the human and animal body in milligrams per kilograms amount or less as against major elements which occur in gram per kg. essential elements are elements required for life- whose deficient intake results in impairment of vital functions and only intake of physiologic amounts of the element can alleviate or prevent such a disturbance in function. Certain T.Es exists in the body whose exact role is not known such includes Arsenic, Mercury, and Cyanide etc

GENERAL CHARACTERISTICS OF TRACE ELEMENTS

1. Amplification; a very small amount of the element is necessary for optimal performance in the whole organism, hence a lack of such elements even in small quantities can result in disturbances. Trace elements are constituents of or interact with enzymes or hormones and regulate the metabolism of large biochemical substrates.
2. Specificity; they are specific in their functions and are most times not replaceable by even similar compounds.
3. Homeostasis; There exists mechanisms that regulate to achieve optimal body distribution of these T.Es including their absorption, storage and excretion e.g. the rate of absorption of T.Es generally decreases with its increasing concentration in the intestinal lumen or associated tissues. Active transport mechanisms have been suggested for Fe, Zn, and Cu. Excretions of T.Es is mainly through feces.
4. There are interactions between two or more T.Es, such as an overabundance of one element interfering with the metabolic activities of another one present in normal or marginal concentrations.

SULPHUR

Sulfur represents about 0.25 percent of our total body weight, similar to potassium. The body contains approximately 140 grams of sulfur-mainly in the proteins, although it is distributed in small amounts in all cells and tissues. Approximately half of the total of body sulphur is found in them Muscles, skin and bones, as well as concentrated amounts in hair and nails; a multivalent non-metal, It is an essential element for life(Sulphur is a building block of proteins, enzymes and vitamins) Sulfur is present in four amino acids: methionine, an essential amino acid; the nonessential cystine and cysteine, which can be made from methionine; and taurine(helps produce bile acid for digestion).

SOURCES; “organic” sulphur is found in foods such as meat, fish, poultry, grains, legumes and vegetables such as Brussels sprouts, broccoli, onions and garlic.

FUNCTIONS

1. It plays an important function in the formation of amino acids. It is a component of keratin, the main protein of hair and nails. Sulfur is also present in the fur and feathers of animals. Sulphur also makes collagen and elastin, the main proteins found in skin and connective tissue. Also helps in repairing damaged skin and is important in maintaining healthy detoxification of the skin.
1. Organic sulphur can add flexibility to cell walls and allows easier passage of fluids. This may aid in eliminating pain, softening tissues and help movement.
2. Sulphur is also a component of the B vitamin Biotin and therefore contributes to fat metabolism. Sulphur is essential for insulin and thiamine production and therefore plays a role in carbohydrate metabolism.
3. Sulphur is a major component of joint tissue where it functions in the formation of cartilage, tendons and ligaments
4. Also detoxify heavy metals in conjunction with the transport of oxygen across the cell membrane.
5. Sulfur is important to cellular respiration, as it is needed in the oxidation-reduction reactions that help the cells utilize oxygen, which aids brain function and all cell activity.

Absorption

It is generally believed that the sulphate ion is poorly absorbed. Sulfur is absorbed from the small intestine primarily as the four sulfur-containing amino acids or from sulfates in water or fruits and vegetables. Sulfur is stored in all body cells, especially the skin, hair, and nails. Excess amounts are eliminated through the urine or in the feces.

IODINE

The body contains about 25 mg. of iodine. A small percentage of this is in the muscles, 20 percent is in the thyroid, and the rest is in the skin and bones.

Iodine is well absorbed from the stomach into the blood. About 30 percent goes to the thyroid gland, depending on the need. Iodine is eliminated rapidly. Most of the remaining 70 percent is filtered by the kidneys into the urine.

Iodine's main role in animal biology is as constituents of the thyroid hormones, *thyroxine* (T4) and *triiodothyronine* (T3). These are made from addition condensation products of the amino acid tyrosine, and are stored prior to release in an iodine-containing protein called thyroglobulin. T4 and T3 contain four and three atoms of iodine per molecule, respectively. The thyroid gland actively absorbs iodide from the blood to make and release these hormones into the blood, actions which are regulated by a second hormone TSH from the pituitary. Thyroid hormones are phylogenetically very old molecules which are synthesized by most multicellular organisms, and which even have some effect on unicellular organisms. The thyroid hormones, thyroxine and triiodothyronine, are also needed for normal growth and development, protein synthesis, and energy metabolism. Sources; Iodized salt -- table salt with iodine added -- is the main food source of iodine. Seafood is naturally rich in iodine. Cod, sea bass, haddock, and perch are good sources. Kelp is the most common vegetable seafood that is a rich source of iodine. Dairy products also contain iodine. Other good sources are plants grown in iodine-rich soil.

MANGENESE

Mn is usually bound to proteins in the body either in the =2 or +3 valency states, it is associated with formation of connective tissue and bony tissue, growth reproduction as well as lipid and carbohydrate metabolism.

Sources; include cereals, vegetables, fruits nuts, liver, kidney etc

FUNCTIONS

1. It functions as a constituent of metalloenzyme and as an enzyme activator
2. It binds directly to substrates e.g. ATP or protein causing conformational changes that lead to enzyme activation. Some of the enzymes activated are non specific hence this can mask Mn deficiency, however Mn activation of glycosyltransferase, phosphoenol pyruvate carboxykinase and glutamine synthetase are specific.
3. Arginase, pyruvate carboxylase and Mn superoxide dismutase are examples of enzymes composed of Mn, while hydrolases, kinases and decarboxylases are examples of enzymes that can also be activated by Mn.

Mn within the cells are concentrated in the mitochondria and the body stores are located within the skeleton, absorption of Mn is poor especially in increased intake of the same. Ca and P also decrease its absorption. Absorbed Mn is bound to plasma proteins in blood and then transported to the liver from where its excess are removed via the kidney, as well as in bile and pancreatic secretions.

COPPER

Copper is distributed widely in the body and occurs in liver, muscle and bone. Cu is an important trace element associated with some metalloproteins. It is present both in the +1 and +2 valency states within the body and is involved mainly in oxidation-reduction reactions. It is an important constituent of many compounds and enzymes including Ceruloplasmin, Cytochrome C Oxidase, Super oxide Dismutase, Tyrosinase (necessary for pigmentation of skin via the production of melanin) etc. most of these copper containing enzymes bind to and react directly with molecular oxygen.

It in addition plays a significant role in iron metabolism- Cu deficiency impairs Fe absorption and is accompanied by anemia.

Sources; meat, legumes, nuts and cereals etc.

FUNCTIONS

1. In addition to its enzymatic roles, copper is used for biological electron transport. Blue copper proteins participate in electron transport and include Azurin and Plastocyanin.

Duodenum is the site of maximum absorption of Cu; it may also be absorbed in the stomach. Within the intestinal mucosa Cu reacts with metallothionein (a sulphurhydryl group rich protein that binds Cu) which can be competed with by other metal ions. The amount of ingested Cu that is eventually absorbed depends on sex (females have been shown to absorb more), chemical form of the ingested compound, other dietary constituents like trace elements, and the amount ingested.

Cu is stored in the liver after being transported as Cu- albumin or Cu –histidine complexes from blood as metallothionein like Cuproproteins, ceruloplasmin, from where it is transported to other cells to be used in Cu containing enzymes. It is excreted in feces after being secreted from bile into the intestine.

Deficiency of Cu results in weight loss, bone disorders, anemia and myocardial atrophy.

ZINC

Zn is the second most abundant trace element in the body with about 1.4-2.3g of it occurring in a matured animal body.

Prostate, semen, liver, retina, bone and muscle tissues are rich in Zn. It is found in the +2 valency state and is an essential component of many metalloenzyme involved in all aspects of metabolism.

Sources; meat, fish, dairy products are good sources of available Zn.

FUNCTIONS

- 1.) It is an integral part of nearly 300 enzymes, contributing to their structural stability, in different species of life e.g. superoxide dismutase, carbonic anhydrase, alkaline phosphatase, RNA and DNA polymerases, thymidine kinase, carboxypeptidase, alcohol dehydrogenase etc
- 2.) It also plays a role in protein synthesis and is involved in gene expression e.g. Zn finger proteins.
- 3.) It stabilizes the structures of proteins and nucleic acids
- 4.) Zn has been shown to be an important element in wound healing as it is necessary factor in the biosynthesis and integrity of connective tissue
- 5.) It is involved in normal fetal development and influences pregnancy outcome
- 6.) It is also involved in insulin secretion
- 7.) Biosynthesis of mononucleotides
- 8.) Vitamin A metabolism (stimulate the release of vitamin A into the blood).

20-30% of ingested Zn is absorbed mostly in the duodenum and early p

Art of jejunum by active energy dependent transport. This absorption is varied and depends on certain factors such as presence of dietary Ca, P, Fe, and Cu (which decrease Zn absorption); however diets rich in protein have the opposite effect.

Zn is transported in the blood bound to albumin (mainly) α -macroglobulin, transferin and free amino acids. It is mainly excreted in feces smaller amounts are excreted in urine and sweat.

MOLYBDENUM

It is a component of about 3 metalloenzymes in animals and man including Xanthine oxidase, Aldehyde oxidase and Sulfite oxidase.

Sources; cereals and dry legumes

FUNCTIONS

- 1.) Xanthine oxidase is involved in degradation of purines to uric acid.
- 2.) Aldehyde oxidase is involved in oxidation of aldehydes
- 3.) Sulfite oxidase is involved in final oxidation of sulphur containing amino acids.

Presence of Mo helps in the utilization of Cu while excessive amounts may result in Cu deficiency.

It is absorbed mainly in the stomach and small intestine, and stored in the liver small amounts are retained in the kidney and a skeleton.

Excess are excreted from kidneys and some from bile.

CHROMIUM

Cr is a transitional element that occurs mainly in the +3 and +6 valency state in biological systems. It is widely distributed throughout the body.

Sources; meat, whole grain products and yeast.

FUNCTIONS

It helps in the control of glucose, protein and lipid metabolism i.e. it is a potentiator of insulin action.

It is absorbed poorly from the upper small intestine and is bound to β -globulin fraction of serum proteins (transferin). It is excreted via the kidneys and it is found mainly in the liver-mitochondria, microsomes and cytosol.

Deficiency results in impaired glucose tolerance secondary to parenteral nutrition.

SELENIUM

It is a constituent of glutathione peroxidase and iodothyronine deiodinases and thioredoxin reductase (selenoproteins). It is present in tissues as selenocysteine and selenomethionine which serves as a store for Se which is released in cases of dietary insufficiencies.

The biologically active form of Se is selenocysteine and it is present in the selenoproteins.

Sources; plant (grown on Se rich soils) and animal tissues.

FUNCTIONS

It helps to defend the body against oxidative stress and is also involved in the synthesis and metabolism of thyroid hormones.

GSH (reduced glutathione) catalyses the breakdown of H_2O_2 , phospholipid hydroperoxides etc, it is present in RBC. Thioredoxin reductase is thought to have an immunological function and plays a role in reproduction.

Se is well absorbed in the GIT and may not be regulated homeostasis of Se is achieved by regulation of its excretion via the urine, however high intake of Se leads to exhalation of volatile forms.

COBALT

Co is an integral part of the B vitamin B12- cyanocobalamin which is required for the maturation of RBCs.

Sources; animal tissues.

FUNCTIONS

As a cofactor for some enzymes e.g. glycyl-glycine dipeptidase, involved in bone marrow development for RBC maturation and in the formation of cobamide enzyme (adenosyl co-enzyme).

FLOURINE

It is obtained mainly from drinking water other sources include tea, salmon, sardine and mackerel. It is present in calcified tissues like bones and teeth.

It is absorbed from intestine and excreted mainly in the urine.

FUNCTIONS

It helps in tooth development-i.e. normal maintenance and hardening of enamel and prevention of dental caries. It also helps in the normal bone development as catalytic amounts of F is required for the conversion of phosphates and Ca hence helps prevent osteoporosis (softening of the bones).

Toxic levels of F in the body result in fluorosis characterized by mitochondrial damage, certain enzyme inhibition and negative effects on protein, steroid and collagen synthesis.

NICKEL

This occurs in trace amounts in humans and animal tissues. Dietary intake is poorly absorbed and it is excreted mainly in feces.

Ni plays an important role in some enzyme activities e.g. Arginase, carboxylase, trypsin and acetyl CoA synthetase.

It is also required for growth and reproduction.