

TABLE(2) Physiology and Sources of Nutritionally Important Minerals		Effects of deficiency	Effects of Excess	Sources
Function and Metabolism				
Calcium	Structure of bone and teeth, muscle contraction, nerve irritability, coagulation of blood, cardiac action ,production of milk absorbed from upper small intestine : aided by vitamin D ascorbic acid lactose ,medium ; hindered by excesses of dietary oxalic acid, phytic acid trabeculas and maintained in dynamic equilibrium with body tissue through action of parathyroid hormone and thyro calcitonin about 70% excreted in feces ,10 % in urine ,15-25% retain , depending on growth rate . Serum level 9- 11 mg / dl, 60% ionized	Poor mineralization of bones and teeth; osteomalacia ; osteoporosis ;tetany ; rickets ; impairment of growth	Unknown (dietary) heart block and renal stones (Parenteral)	Milk , cheese , green , leafy vegetables, clams, oysters , canned salmon
Chloride	Osmotic pressure ; acid – base balance ; HCl in gastric juice. Readily absorbed; about 92% of intake is excreted , mainly in the urine , some in feces and sweat ; blood serum level ,99-106 mEq / L ; in intracellular and extra cellular fluids ; parallels sodium intake and out put	Hypochloremic alkalosis or excessive sweating with vomiting or excessive ACTH therapy ,and with congenital alkalosis	Unknown	Table salt, meat , milk , eggs
Chromium cobalt	Glycemia regulation and insulin metabolism component of vitamin B12 cyanocobalamin Molecule	Diabetes in animals none known ? Hypothyroidism	None known cardiomyopathy ; medically , it may be goitrogenic or may produce cardiomyopathy	Yeast widely distributed
Copper	Essential for production of red blood cells ; transferrin hemoglobin Formation ; absorption of iron , activities , of tyrosinase catalase , Uri case ,cytochrome C oxidase, 8 – aminolevulinic acid dehydrase, lysyl oxidase . Absorbed with sulfur – rich proteins ; transported bound to alpha -2- globulin as ceruloplasmin; present in erythrocytes in a labile form and the more stable hemocuprein ; highest concentration in liver and central nervous system (cerebrocuprein) deranged metabolism in Wilson disease Hepatolenticular degeneration) and menkes syndrome	May be cause of refractory anemia , osteoporosis neutropenia , depigmentation and delayed bone infractions , pseudoparalysis , ataxia . Increase of serum cholesterol	Cirrhosis, gastritis, hemolysis	liver , oysters , meats fish grains nuts legumes

Fluorine	tooth and bone structure . Retained when intake is above 0,6 excreted in urine and sweat; deposited in bones as fluorapatite (dynamic equilibrium)	Tendency to dental caries	Fluorosis : mottling of teeth with intake of more than 4-6 mg /24 hr	Water ,sea foods plant and animal foods (dependent on content in soil and water
Iodine	Constituent of thyroxine(14) and tri iodothyronine (T3) readily absorb from intestine ; circulates as inorganic and organic iodide ; selectively concentrated about 25:1 in the thyroglobulin ; iodized and incorporated into thyroglobulin ; proteolytic enzymes release thyroxine and triiodothyronine into the blood . Excretion mainly in urine . Ant thyroid compounds : goitrins and brassicae certain drugs interfere with iodine metabolism	Simple goiter, endemic cretinism	Not harmful (less than 1 mg /24 hr) ; medically ,may cause goiter	Iodized salt sea food , food grown in non goitrous areas
Iron	Structure of hemoglobin and myoglobin for O ₂ and CO ₂ transport ;oxidative enzymes ; cytochrome C and catalase . Absorbed in ferrous form according to body need , aided by gastric juice and ascorbic acid ; hindered by fiber phytic acid steatorrhea . Transport in plasma in ferric state bound to transferrin ; store in liver spleen bone marrow, and kidney as ferritin and reused ;minimal losses in urine and sweat about 90% of intake excreted in the stool	Anemia hypo chromic, microcytic , growth failure; hyperactivity (?)	Hemosiderosis in Bantu people of Africa due to low phosphorus and high iron contents of diet . Poisoning by medicinal iron	Liver, meat egg yolk green vegetables, whole grains legumes nuts
Magnesium	Structure of bones and teeth ; activation of enzymes in carbohydrate metabolism ;muscle and nerve irritability important intracellular cat ion essential to metabolic processes . principal cat ion , essential to absorption from small intestine varies with intake ; some urinary excretion but excellent renal conservation antagonist to calcium action	Occurs in malabsorption and deficiency states; diabetes ,may be expressed clinically as tetany ; assisted frequently with hypocalcaemia ; hypokalemia	None (dietary) ; toxicity from intravenous medication	Cereals ,legumes , nuts , meat , milk

Manganese	Enzyme activation , especially super oxide dismutase; normal bone structure , carbohydrate metabolism . Poor absorption from intestine ; transported in plasma ;particularly high turnover rate in mitochondria; excretion mainly via the intestine in bile ; competes with iron	Not known	None (dietary); toxicity from chronic inhalation	Legumes, nuts, whole grain cereals green leafy vegetables
Molybdenum	Component of enzymes; xanthine oxidase for conversion to uric acid mobilization of ferritin iron in liver , liver aldehyde oxidase . Readily absorbed from in bile ; competes with iron	Not observed in humans	Not established	Legumes, grains dark green leafy vegetables, animal organs
Phosphorus	Constituent of bones and teeth ; structure of nucleus and cytoplasm of all transmission of nerve impulses ; metabolism of carbohydrate , protein and fat . About 70% of intake absorbed as free phospholipid or panic esters and inorganic phosphates ; inorganic phosphates 4-7mg / dl ; ratio of inorganic to organic phosphates in whole blood is about 1:20	Rickets may develop in rapidly growing very low – birth weight babies with low intakes of both P and Ca; muscle weakness	Possibility of tetany during recovery from rickets or in newborn on formula with low ca: p (1:1) ratio	Milk, milk products , egg , , yolk fresh , food , legumes, nuts whole grains
Potassium	Muscle contraction; nerve impulse conduction ; intracellular osmotic pressure and fluid balance ; heart rhythm . Primary intracellular ; excretion 80% retained by growing child ; blood serum level 4.0- 5.6 MEq / L	In starvation or in such pathologic condition as diarrhea , diabetic acidosis, ACTH excess; muscle weakness anorexia, nausea, abdominal distention , nervous irritability , drowsiness, confusion .	Heart block at sacrum level of 10 mEq/L ; important in Addison disease , renal failure or administration potassium – containing salts	All foods
Selenium	Cofactor of glutathione peroxidase in tissue respiration	Kashin cardiomyopathy arthritis (?), kashin cardiovascular disease moistest	Alopecia nail abnormalities , garlic odder to breath	Vegetables, meat

Sodium	Osmotic pressure ; acid – balance ; water balance ; muscle and nerve irritability . Readily absorbed from intestine; excreted chiefly in urine (98%) ; parallels chloride intake ; renal excretion by small amount in muscle and cartilage ; blood serum level 135-145 me/ L	Nausea; diarrhea , muscle cramps dehydration hypo tension	Not harmful excreted in urine as sulfates	Protein foods contain about 1%
Sulfur	Constituent of cellular protein; co carboxylase; melamine; mucopolysaccharides vitreous humor synovial fluid, connective tissues, cartilage, heparin, insulin ; metabolism of nerve tissue ; detoxification mechanisms ; SH group in coenzyme A, cystathionine , and glutathione . only sources utilized are cystine and methionine ; inorganic forms unavailable to body; excreted as inorganic sulfate or ethereal sulfate via urine and bile	Not known ; growth failure from protein deficiency may be due in part to deficiency of – sulfur – containing amino acids	Gastrointestinal upsets(from galvanized iron cooking utensils); copper deficiency ; decreased high – density lipoprotein	Meat, grain , nuts , cheese
Zinc	Constituents of several enzymes ; carbonic anhydrase (in erythrocytes) essential for CO ₂ exchange; carboxypeptidase of intestine for hydrolysis of protein ; dehydrogenase of liver . Found in liver and organs , muscles bones red and blood cells ; higher tissue concentrations in young subjects ; excreted chiefly from intestine , competes with copper	Dwarfism , iron – deficiency anemia hepatosplenomegaly, hyper – pigmentation and hypogonadism acrodermatitis enteropathica depression of immune competence poor wound healing		