

Minerals
Non-energetic micronutrient with plastic and regulatory function
Absorption: intraluminal, translocation and mobility to blood
Elimination: blood (urine) or bile
Macroelements: electrolytes (Na, K, Cl) plastic (Ca, P, Mg)
Microelements: organic (Fe, I), metalloenzymes (Cu, Zn, Se, Mn, Cr)



Water and Electrolytes (Na, K, Cl)
Non-energetic macronutrient with plastic and regulatory function BW x 35 g/kg/day = mL
Water and beverages, food and oxidative reactions
Negative balance: dehydration
Positive balance: Rehydration, possible edemas
Na ⁺ and K ⁺ —Simple diffusion—blood—Na ⁺ to interstitial liquid, K ⁺ to intracellular liquid—urine excretion and non-absorbed through faeces
Natraemia = 140 mM; Potassaemia = 4 mM
Vegetables better Na ⁺ /K ⁺ ratio
Renin-Angiotensin-Aldosterone = sodium reabsorption activation, thirst inhibition and vasoconstriction when natraemia
Sodium Na⁺ : extracellular cation 90%, electrolyte, sodium potassium pump, homeostatic control, sodium may cause arterial hypertension. RDA = 5g of salt a day
Potassium K⁺ : intracellular cation, it's an hypotensive, promoting Na ⁺ elimination. Hypokalaemia (diarrhoea, vomits, exercise, Cushing disease) Hyperkalaemia (necrosis, renal failure, diuretics). 150mg K ⁺ /70kg.

Plastic Elements (Ca, P, Mg, F)
Calcium : 1,2kg in the body, 40% of minerals
Plastic: hard tissues (hydroxyapatite) bones & teeth Regulatory: electrolyte, muscle, coagulation, metabolism. Calcaemia controlled by PTH and Vitamin D
Ca ²⁺ —AT or SD 30%—blood (10mg/dL) free or bound —bones and teeth 99%—elimination through urine and faeces
(+) Important the ratio with P. Vit D. Proteins (-) Phytates, oxalates, fiber, ageing or drugs
1 g/day in adults. Same as Vit D deficiencies: bones, muscle and hypertension problems. Toxicity same as Vit D but rare
Dairy, fish & seafood. Brassicas (toxicates), sesame seeds, legumes, nuts and citric fruits
Phosphorus : 800 g in the body, 80% of hard tissues
Plastic: hard tissues (hydroxyapatite) bones & teeth Regulatory: electrolyte (buffer), metabolism.
RDA = 700 mg/day. Deficiency is rare, toxicity maybe due to kidney problems— kidney stones or via P ₁ Ca diet—nutritional hyperparathyroidism
Dairy, eggs, fish & meat. Vegetables contain less quantities. Amounts in Additives
Magnesium : 60% of hard tissues
Plastic: hard tissues (reservoir) bones & teeth Regulatory: electrolyte (intracellular cation), muscle recovery and metabolism.
RDA = 320-420 mg/day. Deficiency— kidney stones, muscle spasms, hypertension and general tiredness
(-) Phytates, oxalates, fiber, Ca ²⁺ or drugs. Majority of the elimination is through faeces
Whole grains, legumes, nuts, leafy greens. in animals
Fluorine : tooth enamel
Plastic: Protects teeth from decay. Sugar is fermented to lactic acid that lowers pH causing corrosion of the enamel
In water with < 0.8 mg/L → cavities In water with > 0.8 mg/L → dental fluorosis
Water, fish and seafood, liver and tea

Organic Elements (Fe, I)
Iron : Haemoglobin and Myoglobin
Functions: Hb in blood and myo in the muscle. Fe ³⁺ —Fe ²⁺ (metabolic form brown colour. Ceruloplasmin involved) Metalloenzyme: oxidative phosphorylation, FAD, Krebs cycle, Purines and catecholamines metabolism, detox processes and immune response.
Active iron: muscles/lungs/bone marrow Iron reservoir: liver, enterocytes and blood vessels (Inorganic iron—FD)/(Iron home—vesiculosis) —Fe ³⁺ /(Hemo—Fe ²⁺ + bilirubin)—Fe ³⁺ /(Ferritin)—AT—transferrin (blood)
(+) inorganic iron absorption: Vit C, reducing sugars, proteins (sulphur) (-) inorganic iron absorption: phytic acid, fiber, tannins, oxalates
8-18 mg/day. Iron deficiency anaemia. Haemochromatosis. Liver, kidneys, red meat, oily fishes & seafood. Legumes (soy), sesame seeds, whole grains, nuts, watercress and spinach
Iodine : Thyroid Hormones T ₃ and T ₄
Basal metabolism regulation: aerobic respiration (fatty acids) and heat production (electron transport chain). Hyperglycaemic, HMG-reductase = Cholesterol
RDA = 150 µg/day. Deficiency causes hypothyroidism: endemic goitre—genetic and dietary factors involved (I ₂ muscinogenic substances— thyronate + thyroid confusion)
Cretinism and Myxedema
Toxicity causes the hyperthyroidism—Graves' disease
Iodised Salt, Seafood, Dairy, meats & eggs and fruits & veggies

Metalloenzymes Elements (Zn, Cu, Mn, Mo, Se, Cr)	Metalloenzymes Elements (Zn, Cu, Mn, Mo, Se, Cr)
Zinc : 1,5-2,5 g in the body	Molybdenum : 6-16 g in the body
Cofactor of 1300 enzymes: protein synthesis, Carboxypeptidase, Alcohol D.H., Alkaline Phosphatase, Pyruvate carboxylase, carbon anhydrase, Retinol D.H., Superoxide dismutase (cytoplasm)	Meat & liver, fish & seafood and dairy. Yeast, whole grains, nuts, chocolate, coffee, tea, mushrooms
Absorption via FD and SD 25-50% (+) aa's, sugars (lactose) and citrate (-) fitates, fiber, oxalate, tannins, alcohol, Fe, Cu, Ca It has a reservoir in the enterocytes as well as Fe. Uses AT to reach the bloodstream in where travels bound to albumin or transferrin—Muscle30% / Bone60% → excretion (bile—faeces)	Recommended doses = 25-35µg/day. Insulin problems. Toxicity only with Cr ⁶⁺
15 mg/day. Various deficiency reasons: growth, taste change, nervous disorders, immunosuppression. NO toxicity.	Cr ³⁺ —FD (ascorbate & oxalate facilitates, sugar inhibit)—blood (plasmatic protein) → liver (reservoir). Renal excretion
Seafood & fish, meats & eggs, milk & dairy. Whole grains, Legumes and nuts	Not a metalloenzyme (glucose tolerance factor). 2 types (one toxic Cr ⁶⁺ one nutrient Cr ³⁺). Nicotinic acid, Insulin anabolic effect.
Copper : 50-120 g in the body	Chromium : 4-6 g in the body
Superoxide dismutase (cytoplasm), Cytochrome C oxidase (ETC), collagen synthesis, Ceruloplasmin, Various enzymes	Fish and Seafood, eggs, meats and liver, milk and dairy Whole grains, nuts (brazil nuts), mushrooms and garlic.
Absorption 40-60%: SD and AT. Can stay in the enterocytes with metallothioneins. —blood (albumins or transcuprein)—liver (reservoir with metallothioneins)—tissues via ceruloplasmin—excretion bile to faeces	RDA = 55µg/day. Bimodal effect. Deficiency—Keshan & Kashin-Beck. Adequate—Diseases prevention. Toxicity—seleniosis
RDA= 0,9mg/day. Deficiency similar to Menkes Disease and Toxicity causes Wilson Disease. Fish & seafood, Liver & meats. Whole grains, legumes, nuts, mushrooms and cocoa	Bound to aa's (selenocysteine and selenomethionine)—AT as aa's—blood (erythrocytes & selenoprotein P) → liver (metallothioneins)—bone, muscle, kidney and spleen. Bile and urine excretion
Manganese : 10-20 g in the body	Glutathione peroxidase (powerful antioxidant) and type I tetraiodothyronine deiodinase (T4 → T3 thyroid hormones)
Superoxide dismutase (mitochondrion), Pyruvate carboxylase (gluconeogenesis), Acetyl-CoA carboxylase (fat synthesis), Isocitrate D.H. (Krebs Cycle), collagen & bone, melanin & urea Peptidases free it in food → FD—AT—blood (albumins)—liver (Mn ²⁺ bound to transferrin or transmanganin) → tissues —bile to faeces	Selenium : 3-15 g in the body
RDA = 1,8-2,3 mg/day. Rare deficiency because of Mg. Causes degenerative diseases, glycaemia, bone and reproductive problems. No dietary toxicity.	Whole grains, legumes and nuts
Whole grains, legumes and nuts, tubers, coffee & tea and leafy greens	RDA = 45µg/day, total parenteral nutrition. Associated to Se deficiency as well. Toxicity not common—Se
	AT/FD(amounts 80%—blood (erythrocytes)—Liver, kidney, bone, skin—urine excretion mainly
	Xanthine D.H. oxidase (uric acid production), Aldehyde oxidase (dihydroxymanidolic acid—catecholamines), Sulphite oxidase (treatment of sulphur from aa's—urine)