Essential and trace ions

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Essential and trace ions

The basic elements in the human body are the **chemical elements** necessary for **life and vital body functions.** These elements constitute about **99% of the body mass**, and **include: Oxygen 65%, Carbon 18%, Hydrogen 10% , Nitrogen 3% , Calcium 1.5% , Phosphorus 1%**

In addition to these elements, there are **other elements** that are considered essential in small quantities **(trace elements)** such as potassium, sodium, magnesium, iron, zinc, and copper. These elements are necessary to **maintain vital functions** such as **transmitting nerve signals**, regulating **blood pressure**, and **electrolyte balance**.

Trace Element In Analytical Chemistry

In analytical chemistry, a trace element refers to an element that is present at **very low concentrations**, typically measured in **parts per million (ppm) or parts per billion (ppb)** relative to the sample's total composition.

- **Trace elements** are often studied because even at such **low levels**, **they can significantly impact biological processes**, **environmental conditions, or material properties**. Examples include trace metals **like iron, copper, and zinc, which play essential roles in biochemical systems**, or **toxic elements** like **lead** and **mercury**, which can have harmful effects even at very low concentrations.

Analytical techniques

Analytical techniques used for detecting and quantifying trace elements include:

- Inductively Coupled Plasma Mass Spectrometry (ICP-MS)
- Atomic Absorption Spectroscopy (AAS)
- X-ray Fluorescence (XRF)

- These methods offer the sensitivity required for trace-level detection.

Classification of Trace Elements

The human body requires trace elements to maintain normal, complex physiological processes related to growth and development.

Depending on their biological impact, diseases caused by a deficiency, and toxicity from an overdose, these are classified as essential, probably essential, or non-essential.

Essential Trace Elements	Iron, Zinc, Copper, Cobalt, Chromium, Fluorine, Iodine, Manganese, Molybdenum, and Selenium
Probably Essential Trace Elements	Nickel, Tin, Vanadium, Silicon, Boron
Non-essential Trace Elements	Aluminum, Arsenic, Barium, Bismuth, Bromine, Cadmium, Germanium, Gold, Lead, Lithium, Mercury, Rubidium, Silver, Strontium, Titanium, and Zirconium

1- Iron (Fe)

- **The most prevalent metal** in a human body is Fe. The Fe content of the body is approximately **3-4 g** nearly equals a concentration of **40–50 mg** of iron per kilogram of body weight.
- The established RDA for Fe in normal healthy adults is **8 mg/day for men**.

Source

Good sources of iron

- liver (but avoid this during pregnancy)
- red meat.
- beans, such as red kidney beans, edamame beans and chickpeas.
- nuts.
- dried fruit – such as c
- fortified breakfast cer
- soy bean flour.

Function of Iron

- **Hemoglobin**, an erythrocyte protein that transports **oxygen** from the **lungs** to the **tissues**, contains **the majority of Fe in the body**.
- **The red color of blood** is also a result of the **Fe present in hemoglobin.**
- The protein myoglobin, which transports oxygen to muscles, depends on fe.
- Fe is also required for development, **normal cellular function**, the production of **some hormones,** and the **synthesis of connective tissue**.

Deficiency of Iron

- Fe deficiency is a condition caused when the **body's supply of readily available Fe** is **insufficient**. The most prevalent **nutritional deficiency** in the world is a deficiency in Fe.
- Fe deficient individuals **are unable to produce enough hemoglobin** to meet their body's needs for oxygen transport.

- **Anaemia** can be caused by excessive **loss of blood or destruction or** they may be due to **decreased blood formation**.
- Excessive blood loss can be caused by **bleeding ulcer, haemorrhaging** and **menstrual flow**

Official iron product

- Ferrous sulphate FeSo4.7H2O
- it is oxidizes readily in moist air to form basic ferric sulphate Fe(OH)2(SO4)5
- Ferrous sulphate is the **most widely used oral iron** preparation and is considered as the drug of choice for treating **uncomplicated iron deficiency anaemia.**
- It can be irritating to **GIT(Gastrointestinal tract)**

mucosa due to the astringent action of soluble iron but iron salt equivalent doses are used.

2.Zinc (Zn)

- **The established recommended daily amount (RDA) for Zn is 8 mg/day for women and 11 mg/day for men.**
- **Source:** Zn is found in wheat, brown rice, oats, lentils, soybeans, dried peas, black-eyed peas, lima beans, walnuts, peanuts, cashews, brazil nuts, cheeses, any kind of liver, and animal flesh such as beef, lamb, chicken, turkey, and various fish and seafood.

Function of Zinc

- **Zn** is a crucial trace element that is present in nearly **300 distinct enzymes** and serves as a **cofactor for some enzymes** involved in **metabolism and cell growth.**
- **Zn** plays a role in the **metabolism of proteins**, **carbohydrates, lipids, and energy** as a component of numerous enzymes. It is essential for the proper operation of **many bodily systems** and **is involved in numerous biochemical pathways**.

Deficiency of Zinc

- Stunted development in **infants, children**, and adolescents are two other severe **deficiency symptoms**.
- Early zinc deficiency also causes **neuronal atrophy, behavioral issues, memory loss, impaired immune function, behavioral issues, and behavioral problems**.
- In more severe cases, Zn deficiency results in **hair loss**, **delayed sexual maturation**, impotence, hypogonadism in men, and eye and skin lesions.

Official Zinc product

- **Topical Creams**: Zinc oxide is commonly found in sunscreens, diaper rash creams, and other **skin**-protecting products.
- **Cold Remedies**: Zinc lozenges are sometimes used to shorten the duration of colds.

3.Copper (Cu)

- **Cu** is an essential trace element in plants and animals. The human body only contains about 150 mg of this vital mineral.
- **The established RDA for Cu in normal healthy adults is 2 mg/day.**
- **Source:** Wheat, barley, sunflower seeds, almonds, pecans, walnuts, peanuts, cashews, prunes, raisins, apricots, various dried beans, mushrooms, chicken, and most fish are the best food sources of copper for humans.

Function of Copper

- **Many enzymes**, including **cytochrome oxidase**, **monoamine oxidase**, **catalase**, **peroxidase**, **ascorbic acid oxidase,** lactase, tyrosinase, and **superoxide dismutase** (SOD), require copper as a component.
- A crucial micronutrient for the **hematologic and nervous systems**, copper (Cu) .
- It also aids in the incorporation **of iron into hemoglobin**, **the growth and development of bone**, the development of myelin sheaths in the nervous system, the absorption of iron from the gastrointestinal tract, and the transfer of **iron from tissues to the plasma.**

Deficiency of Copper

- Cu deficiency is uncommon in healthy adults, but it can **happen in newborns**.
- **Fatigue, anemia, and a reduction in white blood cells** are among the most typical signs of Cu deficiency.
- **Nerve damage or osteoporosis can occur occasionally.** Tingling and a loss of sensation in the **hands and feet can result from nerve damage**.
- On the other hand, **Menkes disease** is a genetic Cu deficiency disorder with a wide range of symptoms and a high mortality rate.

Official Copper product

- **Topical Creams and Wound Healing**: **Copper peptides** are often used in wound healing creams and skin care products due to their anti-inflammatory and tissue-regenerative properties.
- **Medical Devices**: Copper is sometimes used in medical tools and hospital surfaces for its antimicrobial properties, helping reduce infection transmission.

4.Magnesium (Mg)

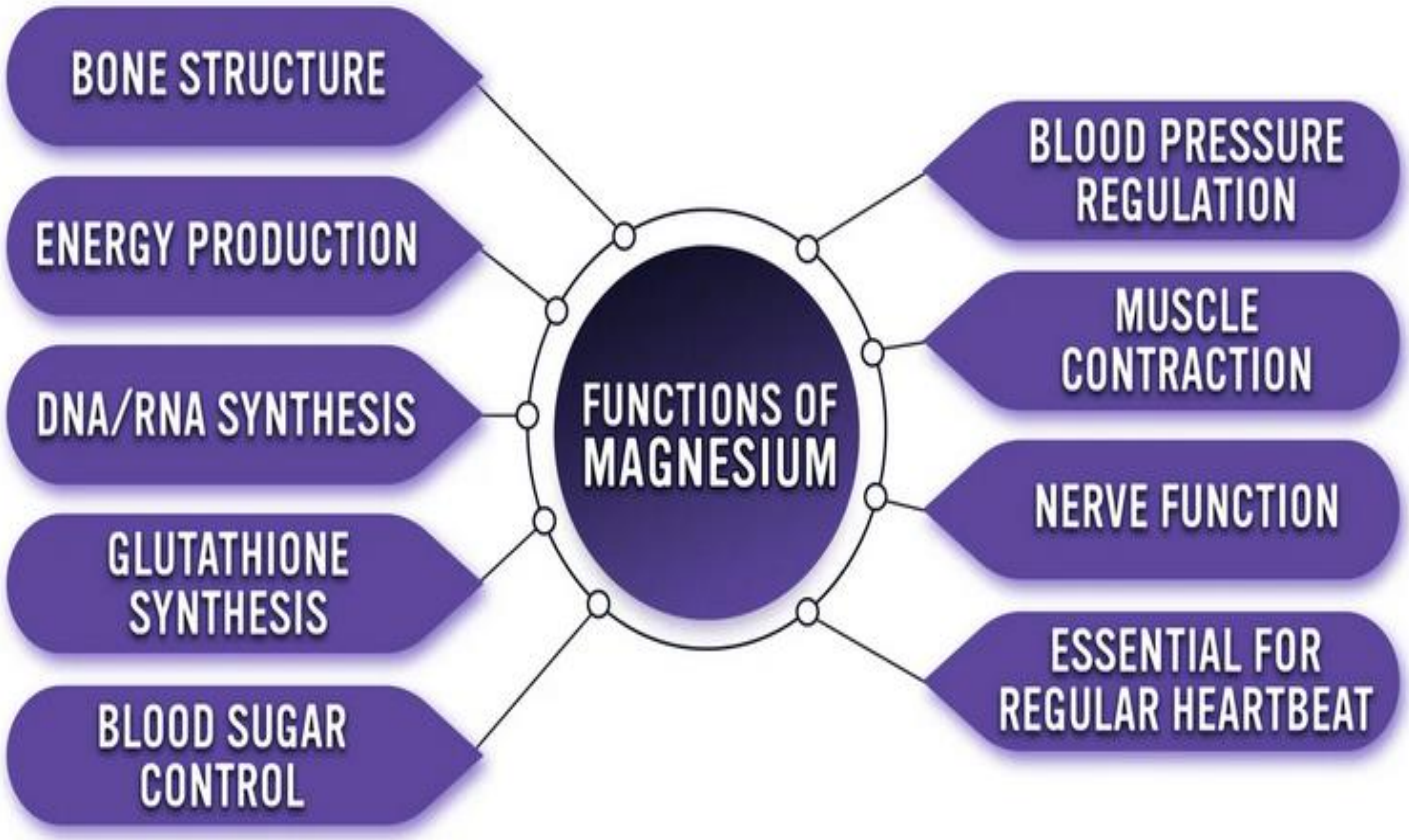
- **Magnesium is the forth most common mineral overall**. More importantly, it is the **fourth most prevalent mineral in the human body** and is required for over 300 **bodily reactions**. The average adult human body weighs about 25 g of magnesium.
- **With an RDA of 400** mg for healthy adult males and 320 mg for healthy adult females, magnesium is one of the ten essential minerals.

Source

8 Food Sources of Magnesium

Function of Magnesium

- **Mg** serves a variety of **biological purposes**, including it serves as a cofactor in over **300 enzymes**, systems that control a variety of **biochemical processes** in the body, **such as muscle, protein synthesis, and blood sugar regulation, nerve activity, and blood pressure control, necessary for the synthesis of DNA, RNA, and the antioxidant glutathione and aids in the structural development of bone.**


FUNCTIONS OF MAGNESIUM
BONE STRUCTURE
ENERGY PRODUCTION
DNA/RNA SYNTHESIS
GLUTATHIONE SYNTHESIS
BLOOD SUGAR CONTROL
BLOOD PRESSURE REGULATION
MUSCLE CONTRACTION
NERVE FUNCTION
ESSENTIAL FOR REGULAR HEARTBEAT

Deficiency of Magnesium

Despite the fact that Mg deficiency is rare, it can happen, especially in those with poor diets or alcohol abusers. Additionally, taking certain medications (such as diuretics) can lead to magnesium deficiency.

Loss of appetite, nausea, vomiting, fatigue, tingling or numbness, rapid heartbeat, delirium, hallucinations, sodium retention, low parathyroid hormone levels in the blood, and weakness are some of the early and moderate symptoms of magnesium deficiency.

5.Molybdenum

- It is present in all plant and animal tissues. The largest amounts are found in liver, kidneys, bone and skin.
- The only current use of molybdenum today is as the oxide together with ferrous sulfate as a hematinic preparation in the form of tablets, capsules and drops.

6.Selenium

- It considered toxic when taken internally.
- As a selenium sulfide suspension used for treatment of seborrheic dermatitis of the scalp (dandruff).
- There have been attempts to replace sulfur with selenium in **pharmacologically active** and metabolically important compounds, because it is below sulfur in periodic table.

Negative Electrolytes

1.Chloride

- **Fluid Balance**: Chloride, along with sodium and potassium, helps regulate the balance of fluids inside and outside cells, which is vital for the proper functioning of organs.
- **Acid-Base Balance**: Chloride contributes to maintaining the body's acid-base balance, which is essential for enzyme stability and cellular functions.
- **Digestion**: It plays a role in producing hydrochloric acid (HCl) in the stomach, which aids in digestion and helps kill harmful bacteria.

Chloride Levels in Blood

- **Normal Range**: Typically between 96-106 mEq/L.
- **High Chloride Levels:** Can result from dehydration, excessive salt intake, or certain conditions like acidosis (high acidity) or kidney failure.
- **Low Chloride Levels:** Can occur due to severe vomiting, excessive sweating, or conditions like metabolic alkalosis or heart failure.

PHOSPHATE

Phosphate is the principal anion of intracellular fluid compartment.

- **Inorganic phosphate** in the plasma is mainly in two forms **HPO4-- and H2PO4-** ,the concentration of **HPO4-- is 1.05 mmole/L and the concentration of H2PO4- 0.26 mmole/L.**
- Important **acid-base buffer** in body fluids

Trace element deficiencies can result from a variety of causes, which may include?

- **Inadequate Dietary Intake.**
- **Gastrointestinal Disorders.**
- **Alcohol Consumption.**
- **Medications.**
- **Chronic Stress.**
- **Kidney Disorders.**
- **Diabetes.**