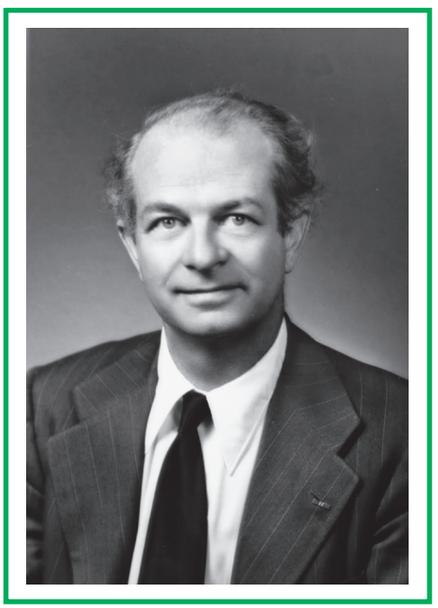
Unit 9 MINERALS



Linus Pauling

Linus Carl Pauling was an American chemist, biochemist, peace activist, author and educator. He was recognised as one of the 20 greatest scientists of all time. In addition to his contribution to chemistry and he also worked with many biologists. He demonstrated that the hemoglobin molecule changes structure when it gains or loses an oxygen atom. He also uncovered that the sickle cell anemia is caused by an abnormal protein. His success with sickle cell anemia led Pauling to speculate that a number of other diseases, including mental illnesses such as schizophrenia, might result from flawed genetics.

Learning Objectives

After studying this Unit, students will be able to

- Distinguish between the micro and macro nutrients.
- Know the various sources of micro and macro nutrients.
- Appreciate the biological functions of minerals.
- Understand the deficiency causes of various minerals.

Introduction

Minerals are inorganic elements that are present in body fluids and tissues. They are supplied to the body through diet, for example sodium from table salt and sulfur from proteins. They are required for a variety of biochemical and physiological functions such as enzyme action, nerve impulse transmission and muscle contraction. Each mineral is required in a specific amount ranging from micrograms to grams per day.

Minerals constitute about eight percent of total body mass of a human being. Unlike carbohydrates, fats and proteins, minerals donot furnish energy but they influence the rate of biochemical reactions through enzymes. Unlike vitamins, minerals are not destroyed during cooking process. However, some loss may occur due to their solubility in water.

9.1 Classification:

The minerals required in human nutrition can be classified into two main groups.

Macro elements

Macro elements like sodium and potassium are required in large amount (>100mg/day) and present in large quantities in the body.

Micro elements

Micro elements like iron and iodine are required in small quantities (<100mg/day) and are present in small amount in tissues and body fluids.

9.2 Macro elements:

Some of the macro elements are calcium, phosphorus, sodium, potassium, chloride, magnesium and sulphur.

9.2.1Calcium

Calcium (Ca) is the most abundant inorganic mineral in the body. About 99% of it exists in the bone and teeth and 1% in soft tissues and extracellular fluid.
Functions:

- Calcium plays a role in blood coagulation by producing substances for thromboplastic activity of blood.
- Calcium is essential for bone and teeth formation.
- Calcium ions are necessary for nerve transmission and muscle contraction.
- Normal excitability of heart is calcium dependent.
- Calcium is involved in the process of mitosis.
- It also acts as cofactor for certain enzymes like succinate dehydrogenase.
- Calcium plays a role as secondary messenger in hormone action.
- Calcium is involved in the process of membrane fusion in endocytosis and exocytosis.
- It involves in maintenance of plasma membrane potential.
- Calcium binds trypsin near its active site to prevent autodigestion of trypsin.

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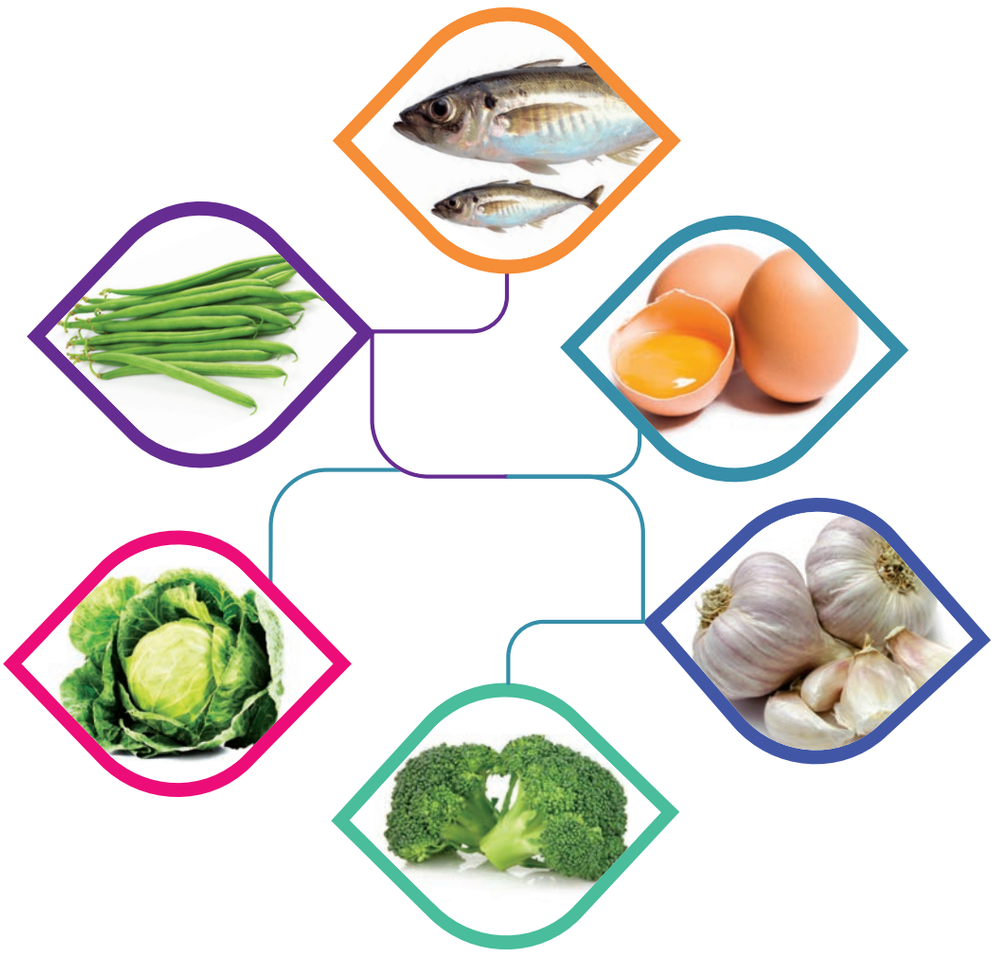

Figure 9.1 Sources of calcium

Dairy products remain one of the most important dietary sources of calcium. Other sources include egg-yolk, beans and cabbage.

Absorption:

Calcium is taken in the diet as calcium salts of phosphate, carbonate, tartrate and oxalate. Calcium is actively absorbed in the upper small intestine.

Factors affecting calcium absorption:

Many factors are said to influence the absorption of the calcium in the intestine. They are:

1. **pH:** An acidic pH favours calcium absorption.

2. **Protein:** A high protein diet favours the absorption of calcium.

3. **Vitamin D:** Vitamin D promotes absorption of calcium.

4. **Sex hormones:** Sex hormones seem to have an effect on calcium and phosphorus balance.

5. **Lactic acid:** Lactic acid produced by microbial fermentation of sugars in the gut,increases the solubility of calcium salts, and increases their absorption.

6. **Fatty acids:** When the absorption of fats is impaired, calcium salts of fatty acids are formed to a greater extent retarding the absorption of calcium.

7. **Oxalates:** Oxalic acid from vegetables like cabbage, and spinach forms insoluble calcium oxalates, thus lowering the calcium absorption.

8. **Phosphates:** Excess of phosphate in diet lowers the calcium absorption. The ratio of calcium and phosphorus in the diet should be 1:1 for optimal absorption of calcium.

9. **Phytic acid:** Phytic acid present in cereals decreases absorption of calcium.

Excretion:

The excretion of calcium is partly through the kidneys but mostly via small intestine. Small amount of calcium may also be lost in sweat.

Deficiency:

Calcium deficiency in body causes the following disorders.

Osteoporosis

Osteoporosis is characterized by demineralization of bones (bone resorption) resulting in progressive loss of bone density.

Tetany

Tetany is a condition characterized by neuromuscular irritability and convulsion, which is associated with a state of hypocalcaemia.

Rickets

Rickets is more directly related to vitamin D deficiency, but calcium and phosphorus metabolism are also involved.

Figure 9.2 Rickets

9.2.2. Phosphorus

Phosphorus is the principal anion of the cell. It is widely present as phosphates in proteins, nucleic acids and other various cellular components.Phosphorus and calcium are related in sources and metabolism.

Functions

1. Phosphorus is essential for formation of bones and teeth.
2. High-energy phosphate compounds like ATP (Adenosine Tri Phosphate) and Creatine Phosphate play a role in storage and transport of energy.
3. Phosphorylation and dephosphorylation reactions modify the activity of many enzymes.
4. Phospholipids, the important constituent lipid of cell membranes and nervous tissue contain phosphorus.
5. Acid-base balance is maintained by phosphate buffer in the kidneys.
6. Several co-enzymes such as $NADP^+$ and TPP involved in enzymatic reactions contain phosphate.

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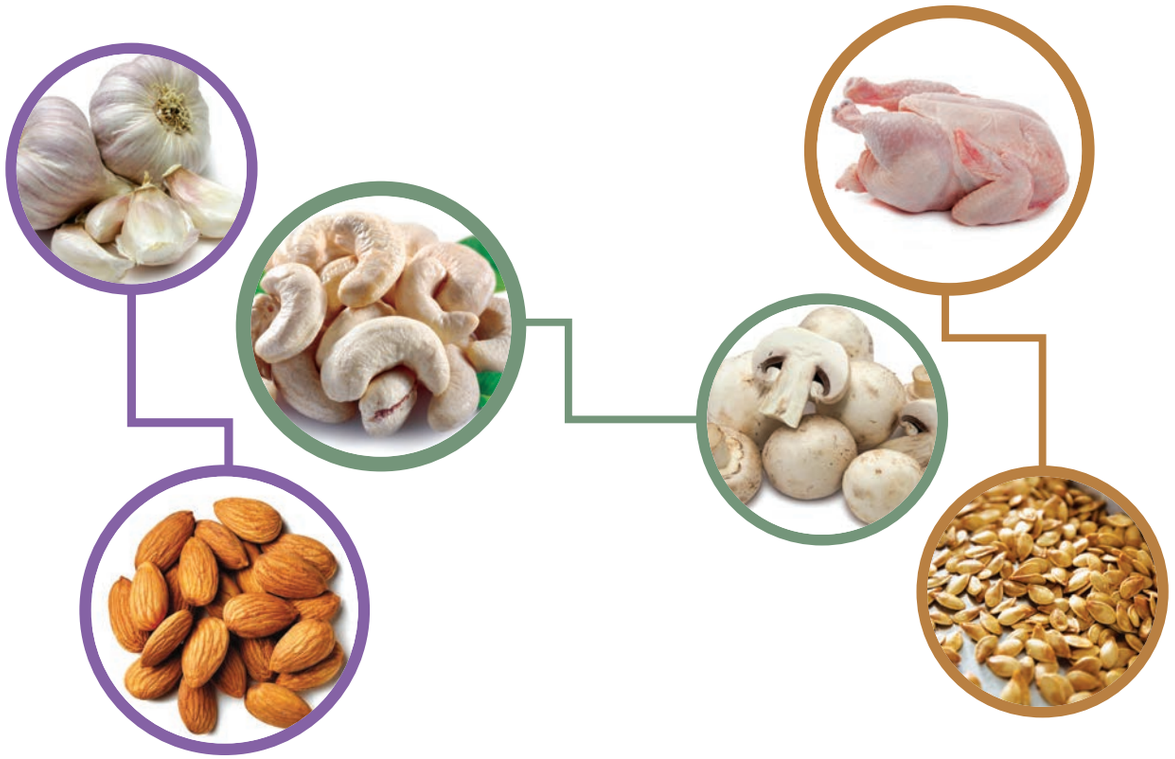

Figure 9.3 Sources of phosphorous

Foods rich in calcium are also rich in phosphorus. Animal sources include fish, meat, egg, milk, liver and kidneys. Plant sources of phosphorus are nuts, beans, green vegetables and fruits.

Absorption and Excretion:

Both calcium and phosphorus are absorbed from small intestine. Moderate amounts of fatty acid favor absorption of phosphorus. High calcium content in diet decreases the absorption of phosphorus.

Phosphates are mainly excreted by the kidneys as sodium dihydrogen phosphate through urine.

Deficiency:

Deficiency states for phosphorus are rare. Rickets, osteomalacia and osteoporosis are important dietary deficiency disorders of calcium and phosphorus. Low level of blood phosphorus is characterized by defective bone and teeth formation.

Figure 9.4 Defective teeth formation

9.2.3. Sodium

Sodium is the predominant cation of the extra cellular fluid. It is taken in the diet as sodium chloride.

Functions:

1. Sodium ion is mainly associated with chloride and bicarbonate in the regulation of acid-base equilibrium.

2. It maintains osmotic pressure of the body fluids and thus protects the body against excessive fluid loss.

3. Sodium ions are involved in the transmission of nerve impulses.

4. It plays an important role in the absorption of glucose and nutrients from small intestine by active transport.

5. Sodium ions are also involved in heart function.

Sources:

Figure 9.5 sources of sodium

Sodium is widely distributed in animal sources than plants. However, major source is common salt used in cooking. Cauliflowers, carrot and milk are also good sources of sodium.

Absorption and excretion:

Sodium is completely absorbed from the gastro intestinal tract by active transport. Normal diet contains about 5-10 grams of sodium as sodium chloride. The same amount of sodium is excreted daily through urine and sweat.

Deficiency:

Mineralocorticosteroids secreted by adrenal glands, regulate the metabolism of sodium.Decreased level of plasma sodium(hyponatremia) may be due to lack of aldosterone and loss from gastro-intestinal tract associated with conditions like diarrhoea.

9.2.4. Potassium

Potassium is the main intracellular cation, about 98% of potassium is present inside the cell.

Functions:

Many functions of potassium and sodium are carried out in co-ordination with each other.

1. Potassium maintains the intracellular osmotic pressure, water balance and acid-base balance.

2. Potassium, along with sodium influences neuromuscular activity of cardiac and skeletal muscles.

3. The glycolytic enzyme, pyruvate kinase requires potassium as cofactor.

4. It maintains the alkalinity of the bile and blood.

5. Protein synthesis is dependent on potassium levels inside the cells.

Sources:

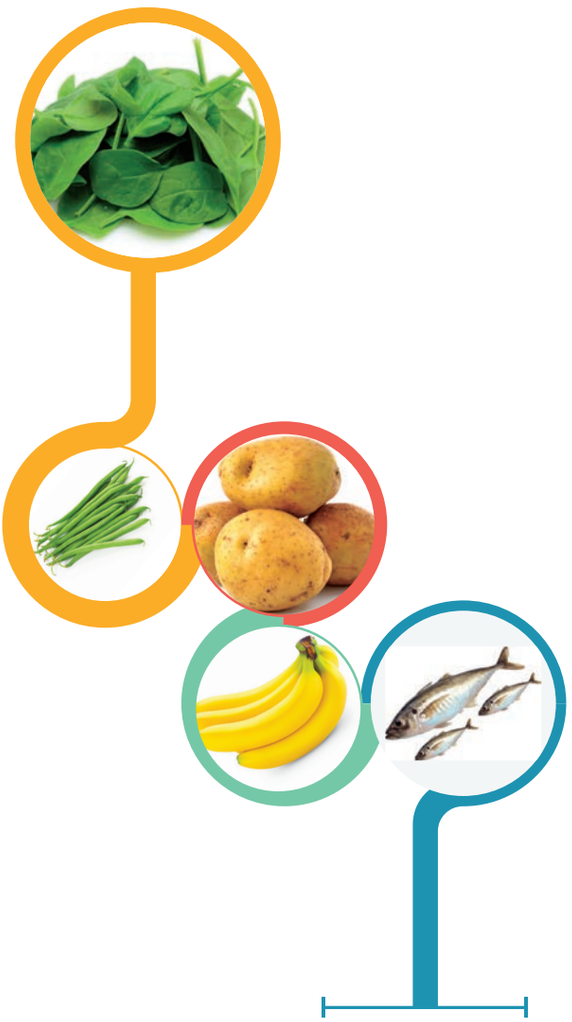

Figure 9.6 Sources of potassium

Animal sources of potassium include meat, fish, egg and milk. Vegetables like onion, carrot, fruits like apple, dates, banana, tender coconut water and grapes contain potassium.

Absorption and excretion:

Potassium is absorbed readily by passive diffusion from gastro intestinal tract and it is mainly excreted in the urine.

Deficiency

Figure 9.7: Potassium deficiency symptoms

Deficiency of potassium leads to depression in cardiac and nervous system. Severe vomiting, diarrhoea, loss of appetite, fasting or starvation over a long period of time may lead to deficiency of potassium. It also occurs during renal failure and shock. Fatigue, growth retardation, muscular weakness, heart and respiratory dysfunction are common signs of potassium deficiency.

9.2.5. Chlorine

Chlorine is taken in diet as sodium chloride. Chloride is the major anion in the extracellular fluid.

Functions:

1. Chloride plays a vital role in acid-base balance by way of chloride shift and maintains blood pH.

2. Chlorides also contribute to formation of gastric HCl.

3. It also helps to maintain plasma osmotic pressure.

4. Chloride ion is important as an activator of salivary amylase.

5. Chloride mainly acts as a counter ion against cations in maintaining the electrical neutrality in body fluids.

Sources

Table salt (Sodium chloride) is the main source of chloride.

Absorption and excretion:

Chloride is completely absorbed from the gastro intestinal tract. Chloride is mainly eliminated in the urine and also in the sweat.

Deficiency

Deficiency states of chloride are rare. Most often, sodium and chloride are associated with each other in their functions. Any clinical condition like dehydration, affecting sodium concentration has an identical effect on chloride concentration.

9.2.6. Magnesium

Magnesium is the second most abundant intracellular cation after potassium. Adult human body contains about 25g of magnesium. Bones contain nearly 70% of the body magnesium contributing as magnesium phosphate, which is about 1.5% of bone matter.

Functions

1. Magnesium, along with sodium, potassium and calcium controls the neuro muscular irritability.
2. Magnesium is involved in the synthesis of proteins and nucleic acids.
3. Magnesium is essential for the activity of peptidases and ribonucleases.
4. It is an activator of many glycolytic enzymes, particularly in muscle.

   Example : pyruvate kinase and enolase.
5. It plays an important role in oxidative phosphorylation.

Sources

Figure 9.8 Sources of Magnesium

Magnesium is widely distributed in vegetables and also found in all animal tissues. As magnesium is an essential part of chlorophyll, green vegetables are important sources.

Absorption and excretion

Greater part of the daily ingested dietary magnesium is absorbed from the small intestine. The major quantity of magnesium is excreted in the feces and remaining is excreted through urine.

Factors affecting absorption

1. Excess of calcium decreases the absorption of magnesium.

2. Vitamin D, parathormone and growth hormone increases the absorption of magnesium.

Deficiency

The decreased level of serum magnesium causes depression, tetany and muscular weakness.

Figure 9.9 Tetany

9.2.7. Sulphur

Sulphur is present in our body as sulphur containing amino acids such as methionine and cysteine and also as sulphate. B-complex vitamins like Thiamine and biotin contain sulphur.

Functions

1. S-Adenosylmethionine(SAM) acts as a methyl group donor for certain enzymes.
2. Sulphur containing amino acids are responsible for structural maintenance of proteins like insulin and keratin.
3. It is present in compounds like acetyl CoA and succinyl CoA which are needed for various reactions.
4. Glutathione is a valuable sulphur containing Tripeptide needed for the detoxification of H_2O_2.
5. Sulphur is present in heteropolysaccharides like heparin, a natural anti-coagulant.

Sources

Figure 9.10 sources of sulphur

Sulphur intake is mainly in the form of cysteine and methionine present in protein. Adequate protein in diet fulfills sulphur requirement.

Absorption and excretion:

Inorganic sulphate (SO_4^{2-}) is absorbed as such from the intestine into the portal circulation. Sulphur is excreted in the urine.

Deficiency

Specific sulphur deficiency state has not been reported in human beings.

9.3 Micro elements

The micro elements which are essential for normal body functions are Iron(Fe), Copper(Cu), Iodine(I), Fluorine(F), Zinc(Zn), Cobalt(Co), Manganese(Mn), Chromium(Cr), Molybdenum(Mo) and Selenium(Se).

9.3.1. Iron

Iron is one of the most essential micro elements in the body. It plays a vital role in many oxidation-reduction reactions. Hemoglobin and cytochromes contain Iron in them.

Functions

1. Iron is involved in the transport of oxygen by hemoglobin.
2. Iron is essential for synthesis of cytochromes, a component of electron transport chain.
3. Myoglobin is an iron containing protein similar to hemoglobin and is present in muscle tissue.
4. Succinate dehydrogenase requires iron as a co-factor.
5. Iron improves immune status.

Sources

Figure 9.11 sources of Iron

Meat, fish, liver are rich sources of iron. Cereals, nuts, spinach, dates are good plant sources of iron.

Absorption and excretion

Normally, about 5 to 10% of dietary iron is absorbed by the active transport process. Most absorption occurs in the duodenum. Infants and children absorb a higher percentage of iron from food than adults. Iron deficient children absorb twice as much as that of normal children. Excess dietary iron is stored as ferritin. Only lesser amounts are excreted in the urine, feces and sweat.

Factors affecting iron absorption

1. Impaired iron absorption takes place in patients who have total removal of stomach or a removal of the considerable amount of the intestine.

2. A diet high in phosphate causes decreased absorption due to the formation of insoluble ferric phosphate.

3. Copper deficiency reduces iron absorption, as copper helps in transport of iron.

4. Phytic acid and oxalic acid interfere with iron absorption.

5. Vitamin C increases iron absorption.

Deficiency

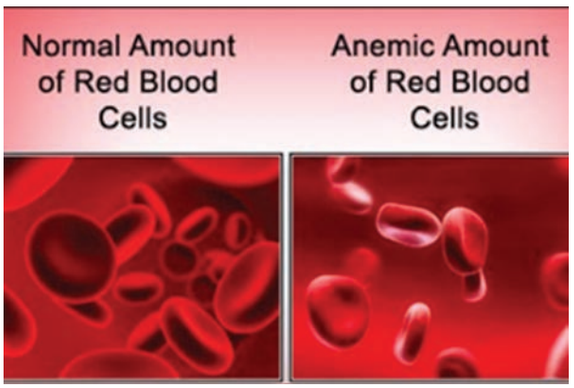

Figure 9.12 Iron deficiency anemia

Deficiency of iron causes iron deficiency anemia. The deficiency may be due to dietary or lack of iron absorption due to gastro intestinal tract diseases like diarrhoea.

9.3.2. Copper

Copper is an essential micro element. Copper content in an adult human is about 100 mg. Copper in whole blood is almost evenly distributed between cell and plasma. The highest concentrations are found in liver and kidney.

Functions

1. Copper forms integral part of certain enzymes like cytochrome oxidase and catalase.

2. Ceruloplasmin a copper containing protein is required for iron absorption.

3. Superoxide dismutase (SOD) contains copper ion, SOD converts super oxide radicals to hydrogen peroxide.

4. It is also present in cytochrome C, which is involved in electron transport in mitochondria.

5. Copper is also needed for bone formation as well as for the maintenance of myelin within the nervous system.

6. Copper helps to form insoluble elastin fibres by cross-linking soluble pro-elastin.

Sources

Figure 9.13 Sources of Copper

Copper is present in many foods and the best sources are meat, nuts, legumes and cereals.

Absorption and excretion:

Absorption of copper into the blood stream occurs via the villi of the small intestine. About 30 percent of the dietary copper is absorbed in the duodenum.Only 10 - 60 µg of copper is excreted in normal urine in 24 hours.

Deficiency

1. A diet deficient in copper causes loss of weight.

2. Copper deficiency produces microcytic hypochromic anemia.

3. Elastin formation is impaired in copper deficiency.

4. Copper deficiency turns hair grey, which however, can be controlled by administration of copper.

5. Deficiency of copper is sometimes associated with decrease in taste sensitivity, which is restored by oral administration of copper.

Figure 9.14 Grey hair (Copper deficiency)

9.3.3. Iodine

The adult human body contains about 50 mg of organically bound iodine. Nearly half of this is present in muscles. Most of the body iodine is present in the thyroid gland, but all cells contain traces of iodine.

Functions

The thyroid gland is chiefly concerned with the uptake of iodine for the synthesis of the thyroid hormones, tetra Iodothyronine(Thyroxin T4) and tri Iodothyronine(T3) which influence a large number of metabolic functions. These iodine containing hormones regulate energy metabolism, synthesis of proteins and cholesterol and also in the conversion of carotene to vitamin A.

Sources

Figure 9.15 Sources of Iodine

Sea water is rich source ofIodine. Vegetables grown in Iodine-rich soil will naturally be the good sources of iodine. Animal sources of iodine include milk, sea fish and crabs.

Absorption and excretion

Absorption is through the villi of the small intestine into the blood stream and 90 % of the iodine of the thyroid gland is in organic combination and stored in the follicular colloids as thyroglobulin.

Inorganic Iodine is mostly excreted by the kidney. Milk of lactating women also contains some iodine.

Deficiency

A deficiency of iodine leads to a decreased production of thyroxine, and in turn a lowered rate of energy metabolism. In an attempt to produce more thyroid hormones the thyroid gland enlarges. This condition is called simple or endemic goiter.

Figure 9.16 goiter

9.3.4. Fluorine

Fluorine exists in the body as compounds called fluorides.It is used as an anti-coagulant during collection of blood for the determination of blood sugar.

Functions

1. Fluorine is required in traces for the development of bones and teeth.
2. It is necessary for the prevention of dental caries.
3. It is used in combination with vitamin D for the treatment of osteoporosis.

Sources

The body receives fluorine mainly from drinking water, in which concentration varies with soil content. Some sea fish and tea also contain small amounts of fluorine.

Absorption and excretion:

Absorption of fluoride is via the small intestine into the blood stream. Most of the fluorides that are not retained by the bones and teeth are excreted rapidly into the urine. It is also excreted through sweat and intestine.

Deficiency

The absence of fluorine in the diet causes dental caries.

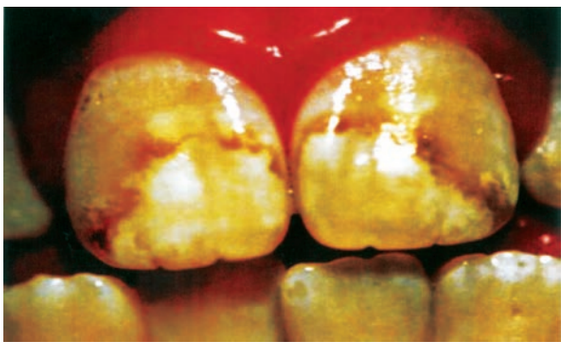

Figure 9.17 Dental Fluorosis

9.3.5. Zinc

Adult human body contains approximately 1 to 2 grams of zinc. Like iron, zinc is absorbed according to the body needs. Prostate gland is very rich in zinc.

Functions

1. Zinc forms an integral part of several metallo- enzymes in the body.
2. Zinc is essential for growth and reproduction.
3. It has role in maintaining the plasma concentration of vitamin A.
4. Zinc is essential for the storage of insulin in the β-islet cells.
5. Zinc is necessary for wound healing.

Sources

Figure 9.18 Sources of Zinc

Fish, meat, liver, egg and certain sea foods are high in zinc. Vegetable sources are cereals, pulses, yeast and wheat germ. Milk including breast milk also is a good source of zinc. The colostrum is an especially rich source.

Absorption and excretion:

Zinc present in animal foods is well absorbed in the small intestine, especially from the duodenum. Zinc present in plant foods are poorly absorbed due to the presence of phytic acid which interferes with its absorption. Zinc is mostly excreted in urine.

Deficiency

1. Zinc deficiency causes poor growth and hypogonadism during adolescence.
2. In zinc deficiency, there is poor wound healing.
3. Zinc deficiency may result in impairment of sensitivity to taste.

4. Deficiency of zinc may interfere with storage and secretion of insulin.

5. Zinc deficiency causes alopecia (hair loss)

Figure 9.19 alopecia

9.3.6.Cobalt

Cobalt is a component of vitamin B12. Elemental cobalt of the diet can be converted to Cobalamine by the intestinal bacteria. Cobalt occurs in small amount in all tissues, higher concentrations occur in liver and kidneys.

Functions

Most of the cobalt is present in vitamin B12, which is necessary for maturation of red blood cells.

Cobalt is an activator of the enzyme Phosphoglucomutase and glycyl - glycine peptidase.

Sources

It is largely available in food. Normal average diet contains about 5 to 8 micro grams of cobalt. One µg of vitamin B12 contains ~0.0225- 0.045 µg of cobalt.

Absorption and excretion

Cobalt is absorbed from the small intestine. About 65% of ingested cobalt is excreted in the urine and the remaining in the feces.

Deficiency

Cobalt deficiency is rare in human beings.

9.3.7. Manganese

Manganese is an essential trace element. It is present as Mn^{2+} ion and found in high concentrations in the mitochondria.

Functions

1. Manganese acts as a cofactor for number of enzymes including arginase, hexokinase and isocitrate dehydrogenase.
2. Manganese is essential for normal bone structure, reproduction and functioning of the central nervous system.
3. Manganese also functions with vitamin K in the formation of prothrombin.
4. It inhibits lipid peroxidation.
5. Manganese also participates in glycoprotein and proteoglycan synthesis.
6. It helps in Porphyrin synthesis.
7. Manganese is involved in fatty acid and cholesterol synthesis.

Sources

Figure 9.20 Sources of Manganese

Manganese is universally distributed in plant and animal tissues, nuts, cereals and vegetables. The average diet can provide approximately 3 to 4 mg of manganese.Tea is exceptionally rich in manganese.

Absorption and excretion

Manganese is readily absorbed in the small intestine. Normally 3 to 4 % of Manganese in diet is absorbed. Large quantity of Manganese is excreted mostly in the feces. Only very small quantities of manganese are excreted in the urine.

Factors affecting absorption:

Manganese absorption is inhibited by iron.

Deficiency

A deficiency of Mn reduces appreciably the synthesis of oligosaccharides.

The deficiency of Manganese leads to impaired growth and skeletal abnormalities.

9.3.8. Chromium

Chromium is widely distributed throughout the body. The adult human body contains only 6 mg of chromium.

Functions

Chromium accelerates the utilization of glucose.

It reduces serum cholesterol level.

Chromium is also said to be important in the metabolism of plasma lipoproteins.

Sources

Chromium is highly available in average diets. Significant amount of chromium is obtained in the diet by cooking foods in steel containers.

Absorption and excretion:

It is absorbed in the small intestine. Chromium is mainly excreted in urine.

Deficiency

Chromium deficiency is characterized by impaired growth, weight loss and disturbances in glucose, lipid and protein metabolism.

9.3.9. Molybdenum

Molybdenum occurs in traces in the human body.Molybdenum occurs in some hemoflavo proteins.

Functions

1. Molybdenum is required for the function of metallo-enzyme xanthine oxidase.
2. Presence of small amount of molybdenum helps in the utilization of copper.

Sources

Figure 9.21 Sources of Molybdenum

Molybdenum is available in normal diets. Liver and kidney are good animal sources. Whole grains and legumes are vegetable sources.

Absorption and excretion

About 50 - 70 % of the ingested Molybdenum is readily absorbed in the small intestine. About half of the absorbed molybdenum is excreted in urine.

Deficiency

Molybdenum deficiency is rare in human beings.

9.3.10. Selenium

Selenium is an essential trace element for all species including humans.

Functions

1. Selenium is essential for normal growth and fertility.
2. Selenium is a component of the enzyme which reduces oxidized glutathione.
3. It is involved in immune mechanism and synthesis of ATP.
4. Vitamin E and Selenium prevent peroxidative damage to cellular and sub-cellular organelles and chiefly the membrane.
5. Selenium may be a cancer protective agent.
6. Supplements of selenium probably protect against toxic effects of heavy metals like mercury and silver.

Sources

Selenium is largely present in different foods. Selenium is present in foods of plant origin grown in selenium rich soils. Any normal diet can meet the daily requirement of selenium.

Absorption and excretion

The principal dietary forms of selenium,selenocysteine and selenomethionine are absorbed from gastrointestinal tract. Selenium homeostasis is achieved by removal of excess selenium in urine.

Deficiency

Selenium deficiency is very rarely seen in human beings. Deficiency of selenium leads to muscular dystrophy and heart diseases.

Table9.1.Recommended Daily Allowances (RDA) of macro and micro elements for Adults

S.N	MINERALS	RDA
1	Calcium	0.8 g
2	Phosphorus	1.0 g
3	Sodium	1-5 g
4	Potassium	4 g
5	Chlorine	2-5g
6	Magnesium	300mg
7	Iron	10-15 mg
8	Copper	2.5 mg
9	Iodine	100 – 150 µg
10	Fluorine	1.5-4 mg
11	Zinc	15 mg
12	Manganese	5 mg
13	Chromium	50 – 200 µg
14	Molybdenum	0.5 mg
15	Selenium	50 – 200 µg

Table 9.2. List of some enzymes requiring or containing mineral as cofactors (or) activators

S.No.	Enzyme	Cofactor
1	Tyrosinase	Copper
2	DNA Polymerase	Zinc
3	Cytochrome Oxidase	Iron
4	Hexokinase	Magnesium
5	Glutathione peroxidase	Selenium
6	Arginase	Manganese
7	Xanthine oxidase	Molybdenum
8	Dipeptidase	Cobalt
9	Pyruvate kinase	Potassium
10	Urease	Nickel

EVALUATION

I. Choose the best answer:

1. Which one of the following is involved in bone formation?

   a. Calcium b. Selenium

   c. Iron d. Cobalt

2. Adrenocortico - steroids regulates the metabolism of

   a. Iodine b. Sodium

   c. Copper d.Chromium

3. Co-factor for pyruvate kinase is

   a. Potassium b. Iron

   c. Phosphorus d. Copper

4. Iron is needed for biosynthesis of

   a. Hemoglobin b. Myoglobin

   c. Cytochrome d. All of these

5. Goiter is caused by the deficiency of

   a. Iron b. Iodine

   c. Magnesium d.Cobalt

6. Which one of the following is necessary for the prevention of dental caries?

   a.Fluorine b.Chlorine

   c. Sodium d. Potassium

7. Cobalt is an activator of

   a. Phosphoglucomutase b. Hexokinase

   c. Pyruvate kinase d. Aldolase

8. Iodine is required for the formation of

a. Insulin b. Vitamin B12

c. Thyroxine d. Calcitonin

9. Intestinal absorption of iron is enhanced by

a. Phytic acid b. Ascorbic acid

c. Oxalic acid d. Alkaline pH

10. Which of the following mineral is associated with parathyroid hormone?

a. Calcium b. Magnesium

c. Phosphorus d. Sodium

11. Molybdenum is a constituent of all of the following, except

a. Xanthine oxidase b. Aldehyde oxidase

c. Sulphite oxidase d. Cytochrome oxidase

12. Carbonic anhydrase contains the mineral

a. Copper b. Iodine

c. Zinc d. Iron

13. Glutathione peroxidase contains

a. Calcium b. Iron

c. Selenium d. Chromium

14. In wound healing, the following trace element is involved

a. Iron b. Copper

c. Zinc d. Selenium

15. The mineral which improves vitamin E effect

a. Chromium b. Iron

c. Iodine d. Selenium

16. Transferrin is involved in

a. Hormone metabolism

b. Diagnosis of Wilson's disease

c. Transport of Iron

d. Transport of bilirubin.

II. Give short answer for the following

1. Name the macro elements
2. What are the most common sources of sodium?
3. What is the site of absorption of calcium?
4. Name the dietary sources of phosphorus.
5. Write a note on iron deficiency.
6. How is copper absorbed?
7. Name an enzyme which requires copper for activity.
8. What are sources of magnesium?
9. Give the factors affecting absorption of magnesium.
10. Mention the metabolic functions of T4 and T3.
11. Explain the deficiency symptoms of zinc.
12. Write a note on deficiency symptoms of manganese.
13. Briefly explain the toxicity of selenium.

III. Answer the following in one or two sentences

1. State the functions of potassium in the body.
2. Give the deficiency states of calcium.
3. State some important functions of magnesium.
4. List the factors which influence the absorption of iron.
5. Mention the functions of molybdenum.
6. Write the biological functions of sulphur.
7. What are functions of chromium?

Answer the following in detail

1. Explain the factors affecting absorption of calcium.
2. Give an account on functions, factors affecting absorption and deficiency state of iron.
3. Mention the functions and deficiency symptoms of copper.
4. Write down the biological functions and deficiency symptoms of selenium.
5. Give the functions of fluorine and zinc.

SUMMARY

Minerals are inorganic substances that play major roles in many metabolic functions. They are divided among two classes, macro elements and micro elements. In general, most of these elements are components of enzymes, which are catalysts of chemical reactions in the body. Additionally, minerals regulate and control the normal function of human and animal tissues, muscles, and organs.

Macro elements including sodium, potassium, calcium, magnesium, and phosphorus in large amounts. In specific, sodium, chloride and potassium play a vital role in maintaining proper pH balance of blood and water. Phosphorous & calcium acts as a major structural component of bones and teeth. These minerals are typically available in dairy products, green vegetables, nut, beans, milk, egg, meat, fish and table salt. Deficiency of macro elements like sodium, calcium, calcium, magnesium and potassium causes diarrhoea, dehydration, osteoporosis, tetany and muscle weakness respectively.

Micro elements also called trace elements are needed in small amounts but important for the proper functioning of the body. Some of the essential trace minerals include iron, zinc, copper, selenium, chromium and iodine. Iron carries oxygen throughout the body in the blood. Zinc helps in growth, reproduction and wound healing. Selenium maintains the fertility. Chromium accelerates the utilization of glucose and reduces serum cholesterol. Iodine responsible for the synthesis of thyroid hormones and regulates the energy metabolism. Drinking water, vegetables, whole grains, legumes, cereals, nuts, seafood, liver, kidney, meat, & fish are the rich sources of micro elements. Iodine deficiency leads to simple goiter and iron deficiency causes anaemia and diarrhoea. Shortage of micro elements leads to loss of weight, dental caries, skeletal abnormalities, weight loss and disturbance in metabolism are the other effects.

CONCEPT MAP

Minerals

Macro elements

- **Calcium**
  - Dairy products
  - Blood coagulation
  - Osteoporosis
- **Phosphorus**
  - Fish, egg, nuts & beans
  - Formation of bone & teeth
  - Defective in bone & teeth formation
- **Sodium**
  - Animal source, milk & common salt
  - Absorption of glucose and nutrients
  - Diarrha
- **Chloride**
  - Table salt
  - Maintains blood pH
  - Dehydration
- **Potassium**
  - Meat, fish, egg and milk
  - Acid base balance & water balance
  - Muscle weakness
- **Magnesium**
  - Vegetables & green vegetables
  - Oxidative Phosphorylation
  - Tetany & Muscle weakness
- **Magnesium**
  - Protein diet
  - Maintains the protein structure
  - Not reported

Micro elements

- **Iron**
  - Cereal, nuts, meat & fish
  - Transport of O_2 by haemogolobin
  - Anaemia and Diarrhea
- **Copper**
  - Meat, nuts, legumes & cereal
  - Cofactor of several enzymes
  - Loss of weight
- **Iodine**
  - Milk, sea fish & crabs
  - Regulate energy metabolism
  - Simple goiter
- **Fluorine**
  - Drinking water, sea fish & tea
  - Development of bones and teeth
  - Dental caries
- **Zinc**
  - Fish, meat, liver, egg & sea foods
  - growth & reproduction
  - Poor growth & poor wound healing
- **Cobalt**
  - Available in food
  - Maturation of red blood cells
  - Not reported
- **Manganese**
  - Nuts, cereals & vegetables
  - Reproduction & bone structure
  - Skeletal abnormalities
- **Chromium**
  - Average diets
  - Reduces serum cholesterol
  - Weight loss and disturbance in metabolism
- **Molybdenum**
  - Whole grains, legumes liver & Kidney
  - Functions of metallo - enzyme
  - Not reported
- **selenium**
  - Food of plant origin
  - Normal growth & fertility
  - Muscular dystrophy & heart diseases.