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# UNIT 7 THE MICRONUTRIENTS-II :

## MINERALS

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### Structure

- 7.1 Introduction
- 7.2 Minerals Required in Larger Amounts
  - 7.2.1 Calcium and Phosphorus
  - 7.2.2 Sodium
  - 7.2.3 Potassium
  - 7.2.4 Chloride
  - 7.2.5 Magnesium
- 7.3 Minerals Required in Smaller Amounts
  - 7.3.1 Iron
  - 7.3.2 Iodine
  - 7.3.3 Others
- 7.4 Summing Up
- 7.5 Glossary
- 7.6 Answer to Check Your Progress Exercises

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## 7.1 INTRODUCTION

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Minerals, like vitamins, are micronutrients which perform regulatory and protective functions. The human body contains as many as 19 minerals in widely varying amounts. The total mineral content of the body is, however, small and accounts for only 4-6 per cent of the total body weight. Some of the important minerals found in our body include calcium, phosphorus, iron, iodine, sodium, potassium, zinc and chloride. All these minerals are derived from the food we eat.

Of the minerals we have just mentioned some are required in larger amounts and others in much smaller amounts as you will learn in this Unit. Let us now study some of the minerals required by our body, the role they play, their food sources and their absorption and utilization by the body.

### Objectives

After studying this Unit, you will be able to:

- differentiate between minerals required in larger amounts and smaller amounts
- describe the functions performed by these minerals in the body and
- list the food sources of each of these minerals.

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## 7.2 MINERALS REQUIRED IN LARGER AMOUNTS

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We have just mentioned some of the minerals required by our body. Of these calcium, phosphorus, sodium, potassium, chloride and magnesium are the minerals required in larger amounts by the body. This set of minerals constitute more than three-fourths of the total mineral content of the body. Figure 7.1 reflects this proportion.

Let us now begin the study of minerals with calcium and phosphorus.

### 7.2.1 Calcium and Phosphorus

Of all the minerals found in our body calcium and phosphorus are by far present in the largest amount. Calcium and phosphorus work together in the body in order to maintain the health and strength of our bones. Each of them also has its own unique regulatory functions as you will just read.

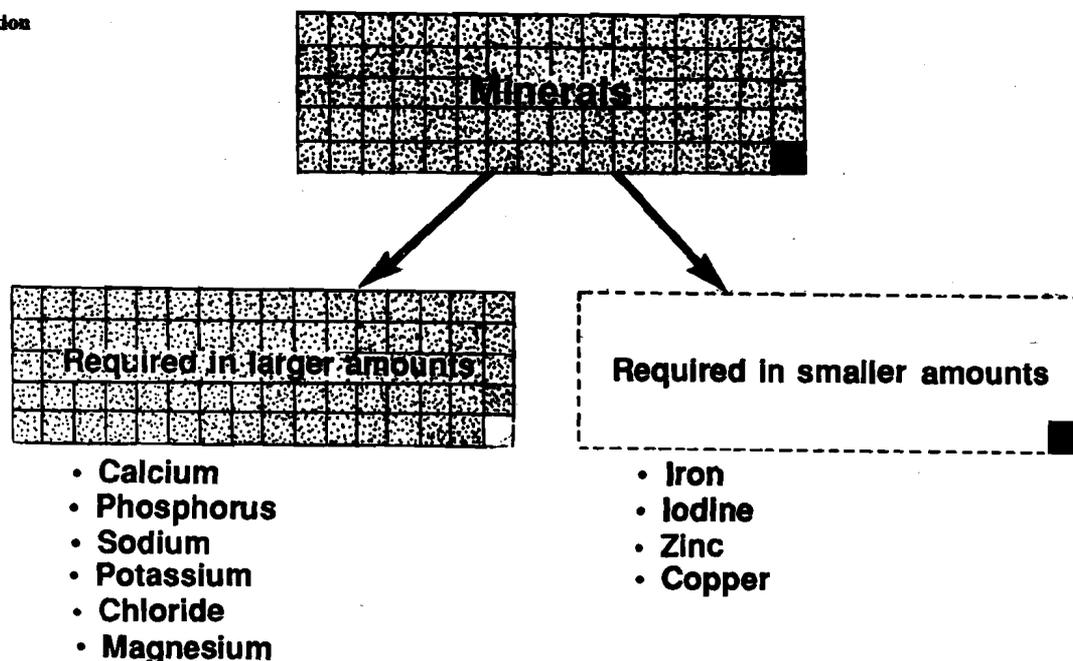


Fig. 7.1 : Some minerals required by the body

**Functions:** What role do calcium and phosphorus play in our body? Calcium and phosphorus basically serve two important functions in the body—one relating to the development of bones and teeth and the other to the regulation of body processes.

- 1) **Development of bones and teeth:** Calcium and phosphorus are mainly present in bones and teeth. The ratio of calcium and phosphorus in the bones is roughly 2:1. Calcium in the bone combines with phosphorus, some other minerals and water to form a compound. It is this compound which provides rigidity and firmness to the bones. Teeth, like the bones, also require calcium for their proper development. It is for this reason that the need for calcium is the most during the growing years.
- 2) **Regulation of body processes:** Apart from building bones and teeth, calcium and phosphorus perform regulatory functions as well.

*Calcium* helps in:

- a) regulating the contraction and relaxation of muscles especially that of the heart
- b) regulating the passage of substances into and out of the cells
- c) conveying messages from one nerve cell to another and
- d) the clotting of blood.

*Phosphorus* also performs several important functions. It is required for the:

- a) formation of a substance which aids in transport of fat in the blood
- b) synthesis of certain substances which promote the action of enzymes which play a crucial role in metabolism
- c) formation of certain basic genetic material. This genetic material is involved in passing on of specific characteristics from parents to children and
- d) capture and storage of vital energy in the cells of many tissues by forming a high-energy compound. Muscle tissue is a prominent example where phosphorus helps in energy storage and thus fuels muscle contraction.

**Food sources:** Which foods provide good amounts of calcium? Milk and milk products like curd, khoa, channa (cottage cheese) are excellent sources of calcium. Foods like fish (e.g. chingri, chela) especially dried fish and other sea foods (e.g. crab, shrimp) provide substantial quantities of calcium.

Among the plant sources, ragi (a millet grown in South India) is particularly rich in calcium. Pulses like bengal gram, black gram, green gram, moth beans, rajmah, soyabean contribute substantial amounts of calcium. Green leafy vegetables (like amaranth leaves, colocasia leaves, fenugreek leaves, mustard leaves) also contain good amounts. Among nuts and oilseeds, gingelly (til) seed is particularly rich in calcium. Others like coconut, almonds, walnuts have a fairly good amount of calcium.

As for the sources of phosphorus, a diet that furnishes enough protein and calcium would normally provide sufficient phosphorus. Eggs, milk, poultry, fish are excellent sources of phosphorus. Cereals too are rich sources of this mineral.

Only a small proportion of the calcium in the diet is absorbed. Foods such as cereals and green leafy vegetables contain substances which hinder absorption of calcium.

However, certain nutrients like vitamin D, protein, carbohydrate present in the diet help to improve calcium absorption. (Figure 7.2)

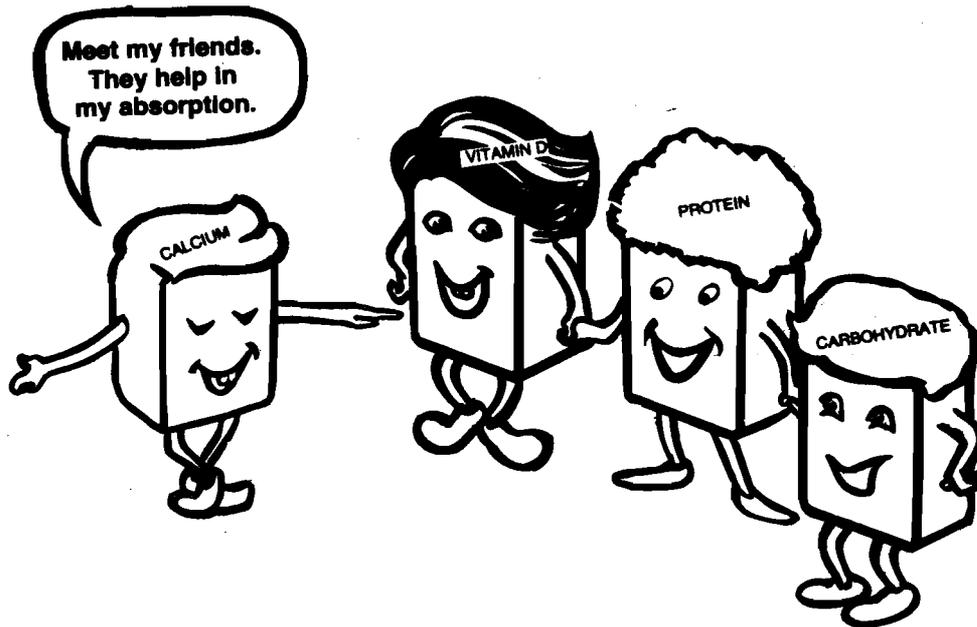


Fig. 7.2 : Nutrients that increase calcium absorption

### Check Your Progress Exercise 1

- 1) Fill in the blanks.
  - a) The total mineral content of the body amounts to ..... per cent of the total body weight.
  - b) The minerals ..... and ..... are present in the largest amounts in our body.
  - c) ..... and ..... are rich sources of calcium.
  - d) Calcium absorption is hindered by presence of ..... in foods.

- 2) How do calcium and phosphorus play a role in body building?

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### 7.2.2 Sodium

An adult body contains approximately 120 g of sodium. Most of this is present in the extracellular fluid. Extracellular fluid refers to the fluid outside the cell just as intracellular fluid refers to fluid inside the cell. Let us now learn what role sodium plays in our body.

**Functions:** Some of the important functions of sodium are listed here:

- a) **Regulating the balance of extracellular and intracellular fluid:** Sodium, the principal mineral in the extracellular fluid, is responsible for maintaining the fluid balance. By fluid balance we mean the process of maintaining a balance between the fluid present within the cells (intracellular) and that circulating outside the cells (extracellular). Sodium along with potassium (another mineral) helps to maintain this balance.

- b) **Regulating the alkalinity and acidity of the body fluids:** Sodium tends to make the body fluids alkaline. Another mineral namely chloride present in the body fluids tends to make them acidic. Sodium combines with chloride in the fluid and together they help maintain the balance between the alkalinity and acidity of the body fluids.
- c) **Aiding in the passage of messages** from one nerve cell to another.
- d) **Aiding the contraction of muscles** and
- e) **Regulating the passage of substances** into and out of the cell.

**Food sources:** Do you know what items in our diet provide maximum sodium? You are familiar with common table salt which is nothing but sodium chloride. Common table salt is the principal source of sodium in our diet. One teaspoon of salt provides almost 2000 mg sodium. Other rich sources of sodium include milk, egg white, meat, poultry, fish among the animal foods and green leafy vegetables (such as spinach, fenugreek leaves) and pulses among the plant sources.

Sodium losses are high whenever we sweat more as in hot weather. Any disease condition in which water is lost from the body also causes excessive sodium loss. A common example is diarrhoea i.e. loose motions. Excessive sodium loss is not good as it affects the fluid balance of the body. This requires special attention. Intake of fluids and salt should be increased during such times so as to make up for the loss.

### 7.2.3 Potassium

Most of the potassium is present in the cells i.e. in the intracellular fluid. When you read this section, you will find how closely the functions of sodium and potassium are interlinked.

**Functions:** The functions of potassium include:

- a) **Regulation of the balance of intracellular and extracellular fluid:** Potassium along with sodium helps maintain fluid balance within the cell and outside the cell. Sodium is the main mineral present in extracellular fluid (the fluid outside the cell). Potassium, on the other hand, is the principal mineral in the intracellular fluid. Together these two minerals help maintain fluid balance.
- b) **Regulation of the alkalinity/acidity of body fluids:** Potassium, like sodium, is alkaline. It combines with chloride which is acidic and together they help maintain the acidity/alkalinity of body fluids. Sodium also has this function as you studied earlier.
- c) **Role in muscle activity:** Potassium has a significant role in the activity of skeletal and heart muscle. It helps in the transmission of messages which results in the contraction of muscle tissue.

**Food sources:** Potassium is widely distributed in foods. Meat, poultry and fish are good sources. Among the plant foods, pulses, fruits, vegetables especially the green leafy vegetables are good sources of potassium. The water of the tender coconut is, however, the best source of potassium. Among the other fruits and vegetables, bananas, potatoes, carrots, tomatoes and lemons contain appreciable amounts of this mineral. Whole grain cereals also provide some amounts of potassium.

### 7.2.4 Chloride

Most of the chloride is found in the extracellular fluid (especially in the blood plasma). The rest of the chloride is present inside the cell. Chloride is present in the extracellular fluid as sodium chloride and in the cell as potassium chloride.

**Functions:** The functions of sodium, potassium and chloride are closely interlinked as is evident from our earlier discussion. Chloride combines with sodium and potassium and helps regulate fluid balance and acidity/alkalinity of body fluids.

**Food sources:** Chloride is widely distributed in all plant foods. But the most important source of chloride in our diet is common table salt i.e. sodium chloride.

1) Define the following.

a) Extracellular fluid

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b) Intracellular fluid

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.....

c) Fluid balance

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.....

2) Fill in the blanks.

a) ..... is the main mineral present in the intracellular fluid and ..... present in extracellular fluid.

b) Chloride is present in ..... as sodium chloride and in ..... as potassium chloride.

c) ..... is the principal source of sodium and chloride in our diet.

d) Bananas, potatoes, lemons, tomatoes contain large amounts of .....

### 7.2.5 Magnesium

Most of the magnesium (about two third) in our body is present in bones along with calcium and phosphorus. The rest is distributed in various tissues and body fluids.

**Functions:** Magnesium helps in:

- a) regulating the passage of substances into and out of the cells
- b) maintaining the activity of many enzymes. Magnesium functions as a coenzyme in metabolism
- c) building bones and teeth. It is involved in bone mineralization
- d) maintaining the functions of the nervous system, whereby it helps in the passage of messages from one nerve cell to another
- e) maintaining smooth muscle action and
- f) building proteins.

**Sources:** Which are the food sources that are rich in magnesium? Magnesium is widely distributed in plant foods. The most concentrated sources of magnesium include nuts (groundnut, cashewnut, walnut, almond), oilseeds (sesame seeds), pulses (rajmah, moth beans, soyabean), whole grains (wheat, bajra, jowar). Among sea foods shellfish is particularly rich in magnesium. Other foods which contain appreciable amounts of magnesium include dark green leafy vegetables, peas, lotus stem, fish (salmon, haddock), sea foods (crab, oyster) and meat.

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## 7.3 MINERALS REQUIRED IN SMALLER AMOUNTS

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You have just studied about the minerals required in larger amounts by the body. There are other minerals required in very small amounts by our body. These minerals are called *trace elements*. Just a tiny amount required, but what significant functions they perform! Minerals like iron, iodine, zinc and copper belong to this group. Let us begin our study of trace elements with iron.

### 7.3.1 Iron

Where is iron found in the body? Most of it is found in the blood. All cells and tissues especially the muscle tissues contain a little iron and the rest of the iron is stored in the body organs such as the liver, spleen, kidney and bone marrow collectively.

**Functions:** After many years of research, there are still many puzzling aspects about the role of iron, especially about those related to brain functioning. Let us now study some of the known and well established functions of iron.

- Oxygen transport:** Iron is a major constituent of a red-coloured compound called *haemoglobin* present in the blood. What is the role of haemoglobin? Haemoglobin is necessary for transport of oxygen to various parts of the body. Haemoglobin carries oxygen from the lungs to the tissues. It then helps in carrying carbon dioxide from the tissues to the lungs as indicated in Figure 7.3. From the lungs carbon dioxide is then exhaled out. Carbon dioxide, in fact, is a waste product formed in all cells as a result of metabolism and it needs to be removed from the body.
- Provision of oxygen for muscle contraction:** Iron is also present in the muscle in the form of a substance which has the capacity to store oxygen. This oxygen is used for muscle contraction and for other immediate needs of the muscle cells.
- Promotion of oxidation within cells:** When carbohydrates, proteins and fats are broken down in body cells, energy is released. Iron helps in complete breakdown of these nutrients. You know that energy is required for the various physical activities we perform every day. This is the reason why iron is crucial in helping us to perform physical work.

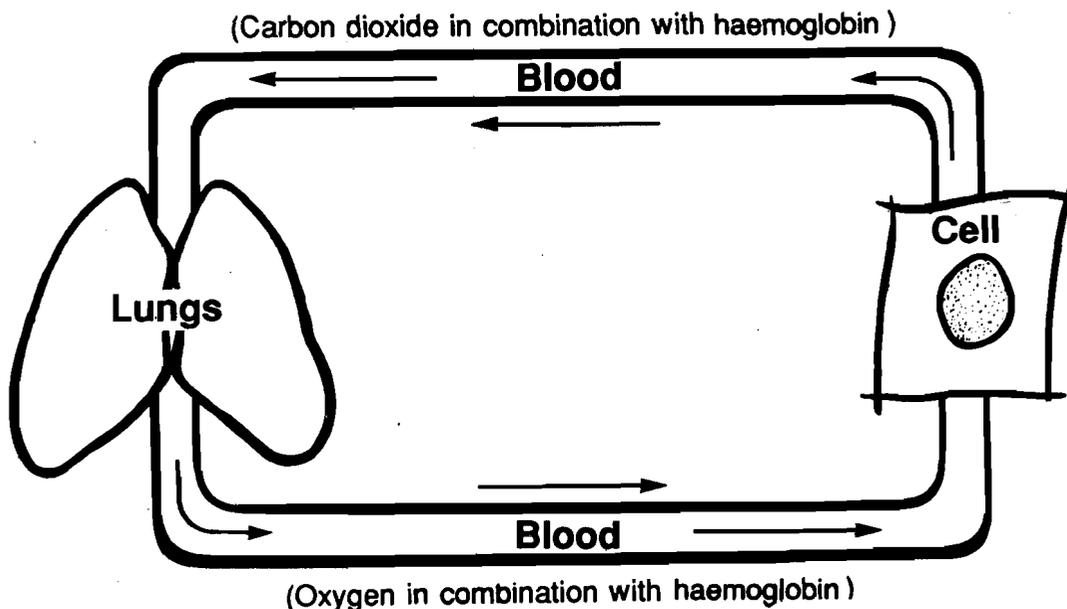


Fig. 7.3 : Haemoglobin as a carrier for oxygen and carbon dioxide

- Iron plays an important role in maintenance of specific brain functions like immediate memory, capacity to learn and attention span.
- Iron forms a vital component of certain enzymes and substances that aid in metabolism.
- Iron has protective functions as well. Like vitamin A, iron too helps in preventing infections.

**Food sources:** Are you familiar with the rich food sources of iron? Liver is an excellent source. Other organ meats like kidney, spleen also contain substantial amounts of iron. Among the plant foods the list of iron sources includes green leafy vegetables (like amaranth leaves, mustard leaves, colocasia leaves, mint leaves), cereals (like whole wheat flour, rice flakes, bajra, ragi, jowar) and pulses (especially the whole ones). Soyabean is an example of a pulse containing good amounts of iron. Jaggery is another food that contains fair amounts of iron.

We have mentioned several foods which contain substantial amounts of iron. However, we have a paradoxical situation here. There is so much of iron present in food and yet very little gets into the body.

What is happening to the iron once it enters the body? The ingested iron gets absorbed from the upper part of the intestine. The extent of iron absorption from different foodstuffs varies. In general, its absorption from animal foods is high. But the amounts of iron absorbed from many of the plant sources is very low. This is because certain substances present in plant foods hinder its absorption. These substances are called *inhibitors*. You would remember reading earlier that some plant foods such as green leafy vegetables and cereals contain fairly substantial amounts of iron. Unfortunately they also contain inhibitors which prevent much of the iron from being absorbed. On the other hand, there are substances like protein and vitamin C present in foods that aid in the absorption of iron. These substances can be called *enhancers* (Figure 7.4). It is, therefore, suggested that protein-rich foods like milk and vitamin C-rich foods like oranges, lime, amla and guava should be included in the diet so as to promote the absorption of iron. The inclusion of animal foods, if possible, in the diet greatly enhances iron absorption.

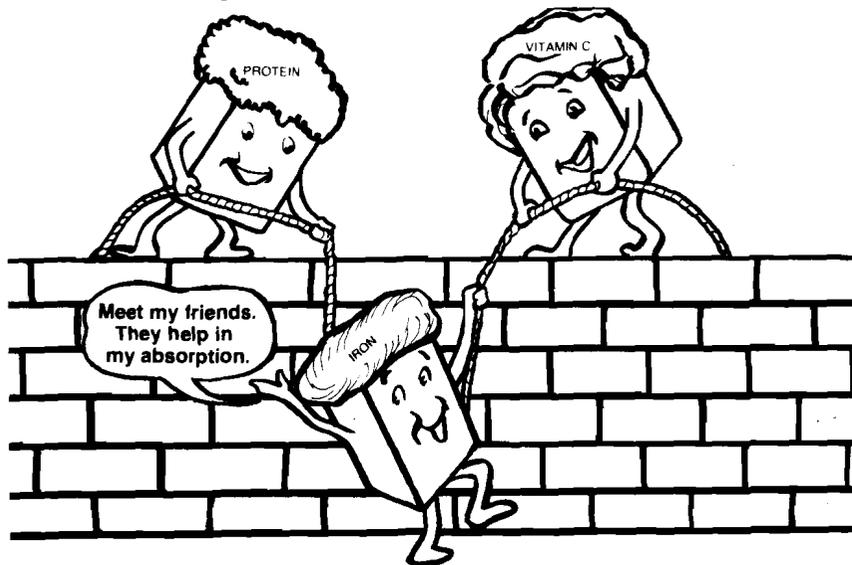


Fig. 7.4 : Nutrients that increase iron absorption

### Check Your Progress Exercise 3

- 1) List the foods containing inhibitors/enhancers that decrease/increase absorption of iron.

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### 7.3.2 Iodine

Have you noticed how packets of salt available in the market are labelled "iodized salt"? (Figure 7.5). Iodized salt, in fact, is table salt to which iodine is added. But why are we taking so much care to add iodine to the salt? Why is iodine so important? Let us try to find out.

The adult body contains a very small amount of iodine. The maximum concentration of this mineral is found in the thyroid gland which is located in the neck region.

**Functions:** Why do we need iodine? Iodine is a component of the hormone *thyroxine* secreted by the thyroid gland. Thyroxine regulates the rate at which chemical reactions take place in the body cells. If this regulation does not take place, both physical and mental growth will be affected. Iodine is also believed to help in the functioning of nerve and muscle tissues.

**Food sources:** The amount of iodine in most foods is limited and it varies widely depending on the iodine content of soil and water. Crops such as vegetables especially those grown in coastal areas where iodine content of the soil is high have substantial amounts of iodine. In hilly areas, however, the iodine content of both the soil and water is low. Hence the crops grown in such areas contain little iodine.

The iodine content of animal foods like eggs, dairy products and meat depends, of course, on the iodine content of the food that is part of the animal's diet. Sea foods like fish, shell fish are among the best sources of iodine.

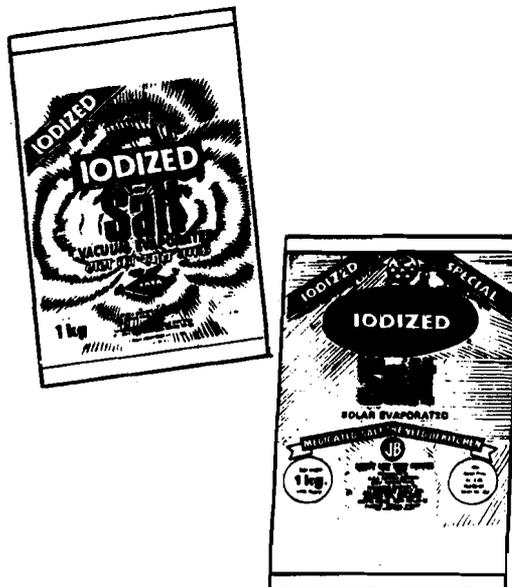


Fig. 7.5 : Iodized salt

It is now known that soils are deficient in iodine not only in the hilly regions but in several other parts of our country. This means that the foods grown in these areas would also be poor in iodine. In such a situation it becomes important to ensure that iodized salt forms a part of the daily diet.

Certain plant foods like cabbage, cauliflower, radish, ladies finger, groundnuts and oilseeds contain substances called *goitrogens* which interfere with the body's ability to produce and use thyroxine. Goitrogens can be easily destroyed on thorough cooking. Hence it is advisable to cook the foods mentioned above properly before eating.

**Check Your Progress Exercise 4**

1) Match the items in Column A with those in Column B.

COLUMN A

- i) Iodine
- ii) Iron
- iii) Iron containing complex
- iv) Goitrogens present in cabbage, cauliflower

COLUMN B

- a) Storage of oxygen in the muscles
- b) Synthesis of thyroxine
- c) Poor utilization of thyroxine
- d) Synthesis of haemoglobin

2) Indicate whether the following statements are true or false. Correct the false statements.

a) Plant foods enhance the absorption of iron. (True/False)

.....  
 .....

b) Iodine content of food is influenced by the iodine content of soil/water. (True/False)

.....  
 .....

c) Iron influences the capacity to work. (True/False)

.....  
 .....

d) Maximum concentration of iodine is found in the blood. (True/False)

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 .....

e) Iodine is stored in the bones. (True/False)

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.....

f) Thyroxine carries oxygen to the cells. (True/False)

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.....

g) Vitamin C helps in the absorption of iron. (True/False)

.....  
.....

### 7.3.3 Others

Zinc and copper are two of the other trace elements present in our body. Though present in traces, these minerals perform certain vital functions. Zinc is essential for growth and like iron has protective functions as well. Copper helps in haemoglobin synthesis and is an essential constituent of certain enzymes.

Zinc and copper are widely distributed in nature and are not usually lacking in Indian diets.

## 7.4 SUMMING UP

In this Unit you studied about the inorganic substances called minerals. Minerals perform major functions in the body. They provide protection against diseases and regulate metabolic processes. Some, like calcium and phosphorus, help to build the body.

Body requirements of minerals vary. Minerals like calcium, phosphorus, sodium, potassium are required in larger amounts by the body. They are basically concerned with development of bones and teeth and with the regulation of body processes (Figure 7.6). On the other hand, minerals like iron, iodine, zinc, copper are required in much smaller amounts and constitute a very small proportion of the body's inorganic material. These minerals are called trace elements and each performs its own specific functions. Iron is a major constituent of haemoglobin which helps in the transport and release of oxygen in the cells. It has a vital role in maintaining physical work capacity and cognition and has protective and regulatory functions as well. Iodine, on the other hand, is required for the synthesis of the thyroid hormone thyroxine, which regulates the rate of oxidation within the cells.

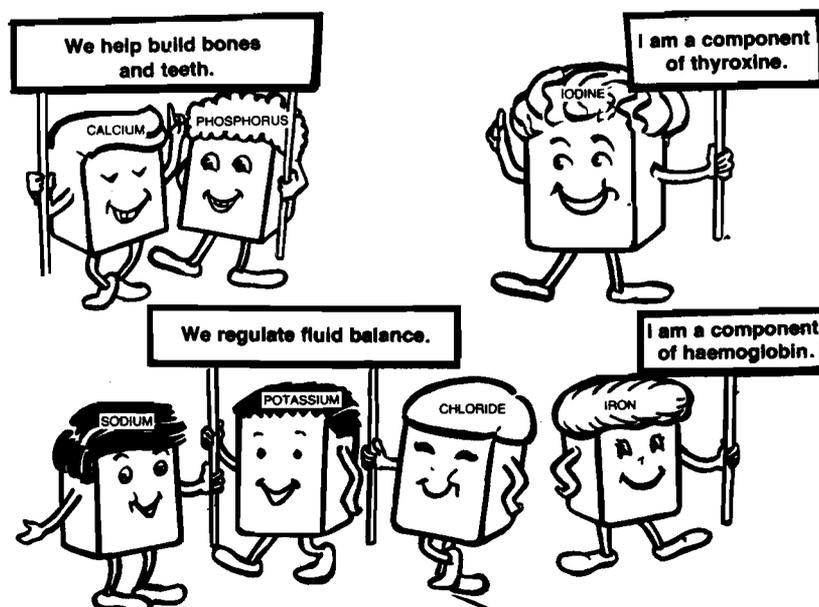


Fig. 7.6 : Key functions of minerals

The absorption, utilization and excretion of each of these minerals varies in the body. The absorption of some of the minerals like calcium and iron is dependent on the presence of inhibitors and enhancers in foods.

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## 7.5 GLOSSARY

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<b>Extracellular fluid</b>	:	Refers to the fluid present outside the cell.
<b>Immediate memory</b>	:	The memory of an event immediately preceding a given moment.
<b>Intracellular fluid</b>	:	The fluid present inside the cells.
<b>Mineralization</b>	:	The process of deposition of minerals in the bone.
<b>Synthesis</b>	:	The process of forming or producing a substance in the body.

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## 7.6 ANSWERS TO CHECK YOUR PROGRESS EXERCISES

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### Check Your Progress Exercise 1

- 1) a) 4-6 per cent  
b) Calcium, phosphorus  
c) Milk, green leafy vegetables  
d) Inhibitors
- 2) Both calcium and phosphorus are major components of bones and teeth. They thus serve a body building function as well.

### Check Your Progress Exercise 2

- 1) a) Extracellular fluid is the fluid present outside the cell. Examples are blood plasma and the fluid surrounding the cells.  
b) Intracellular fluid is the fluid present inside the cells.  
c) Fluid balance refers to the balance between the fluids circulating within the cells and that circulating outside the cells.
- 2) a) Potassium, sodium b) extracellular fluid, intracellular fluid  
c) common salt d) potassium

### Check Your Progress Exercise 3

- 1) Foods containing enhancers—protein-rich foods like milk; vitamin C-rich foods like oranges, lime.  
Foods containing inhibitors—green leafy vegetables, cereals.

### Check Your Progress Exercise 4

- 1) i) b; ii) d; iii) a; iv) c
- 2) a) False; protein-rich foods like milk and vitamin C-rich foods like citrus fruits (oranges, lemon etc.) enhance the absorption of iron.  
b) True  
c) True  
d) False; maximum concentration of iodine is found in the thyroid gland.  
e) False; calcium is stored in the bones.  
f) False; thyroxine regulates the rate of chemical reactions within the cells.  
g) True