

MINERALS

Lecture eight
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Chemical analysis shows that the human body is made up of specific chemical elements. Four of these elements—**oxygen, carbon, hydrogen, and nitrogen**—**make up 96% of body weight.**

All the remaining elements are *minerals*, which represent only **4% of body weight**

Importance:

1. Minerals are essential for good health.
2. A mineral is an inorganic (non-carbon-containing) element that is necessary for the body to build tissues, regulate body fluids, or assist in various body functions.
3. Minerals are found in all body tissues. Any abnormal concentration of minerals in the blood can help diagnose different disorders.
4. Minerals cannot provide energy by themselves, they contribute to the production of energy within the body.
5. Minerals are found in water and in natural foods, together with proteins carbohydrates, fats, and vitamins.
6. Minerals in the soil are absorbed by growing plants. Humans obtain minerals by eating plants grown in mineral-rich soil or by eating animals that have eaten such plants.
7. The specific mineral content of food is determined by burning the food and then chemically analyzing the remaining ash.

Note: Highly processed or refined foods such as sugar and white flour contain almost no minerals.

Iron, together with the **vitamins thiamine, riboflavin, niacin, and folate**, are commonly added to white flour and cereals, which are then labeled **enriched foods**.

Enriched foods: foods to which nutrients, usually B vitamins and iron, have been added to improve their nutritional value.

Toxicity

Because it is known that minerals are essential to good health.

1. **In a healthy individual eating a balanced diet**, there will be some normal mineral loss through perspiration and saliva.
2. **An amounts in excess of body needs** will be excreted in urine and feces.
3. **Concentrated forms of minerals are taken on a regular basis, over a period of time**, they become more than the body can handle, and **toxicity develops**.
4. An excessive amount of one mineral can sometimes cause **a deficiency of another mineral**.
5. In addition, excessive amounts of minerals can **cause hair loss and changes in the blood, hormones, bones, muscles, blood vessels, and nearly all tissues**.
6. Concentrated forms of minerals should be used only on the advice of a physician.

Major minerals include

Calcium, phosphorous, potassium, sodium, chloride, magnesium, sulfur

1-Calcium (Ca)

The human body contains more calcium than any other mineral. The body of a 154-pound person contains approximately 4 pounds of calcium

1 **pound (lb)** is equal to 0.45 **kilograms (kg)**

99% of that calcium is found in the skeleton and teeth. The remaining 1% is found in the blood.

Normal range = 8.5 - 10.5 mg/dl

(4.3 - 5.3 mEq/L or 2.2 - 2.7 mmol/L)

Regulation of Blood Calcium:

1. Each cell requires calcium.
2. It is carried throughout the body by the blood, and its delivery to the cells is regulated by the hormonal system.

When blood calcium levels are low,

The parathyroid hormone (PTH), secreted by the parathyroid glands, is responsible for regulating **blood calcium** levels; it is released whenever blood calcium levels are low. PTH increases **blood calcium** levels by stimulating osteoclasts, which break down bone to release **calcium** into the **blood** stream.

If calcium intake is low for a period of years, the amount withdrawn from the bones will cause them to become increasingly fragile. **Osteoporosis may results**

If the blood calcium level is high, osteoblasts (cells that make bones) will increase bone mass. **During growth,** osteoblasts will make more bone mass than will be broken down. With adequate consumption of calcium, phosphorus, and vitamin D, bone mass will remain stable in women until menopause.

Calcitonin is released by the thyroid gland when its plasma level is above its set normal point (in order to lower calcium level); PTH is released by the parathyroid glands when calcium level falls below set point (in order to raise it).

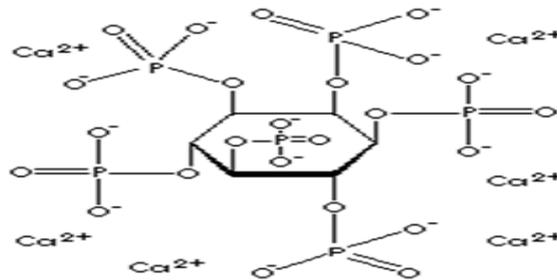
Vitamin D helps the intestines absorb **calcium**. However, the **vitamin D** must first be activated or "turned on" by parathyroid hormone (PTH). Once activated, **vitamin D** acts to greatly **increase** the amount of **calcium** that the intestines can absorb from food, sometimes by as much as two to four times.

Inhibit of calcium absorption

Ex 1: when the vegetable contains **oxalic acid**, such as spinach, the calcium remains not absorb because the oxalic acid binds it and prevents it from being absorbed.

Ex2: When the intake of fiber exceeds 35 grams a day, calcium will also bind with phytates (phosphorus compounds found in some high-fiber cereal), which also limits its absorption.

Ex3: Calcium-Rich Foods. **Milk** can **prevent** your body from absorbing an adequate amount of **iron**. **Milk** contains calcium, an essential mineral and the only known substance to **inhibit absorption** of both non-heme and heme **iron**



Factors that are believed to enhance the absorption of calcium include

1. Adequate vitamin D
2. calcium-to-phosphorus ratio that includes no more phosphorus than calcium.
3. The presence of lactose

Requirements.

Calcium is measured in milligrams (mg).

Adequate intake (AIs) for calcium at different ages and conditions.

The **recommendations** were made to achieve **optimal bone health** and to **reduce the probability of fractures in later life**.

Calcium supplements are recommended for persons who are **lactose intolerant**, those **who dislike milk**, and those **who are unable to consume enough dairy products to meet their needs**.

2- Iron (Fe)

the principal role of iron is:

1. To deliver oxygen to body tissues.
2. It is a component of hemoglobin, the coloring matter of red blood cells (erythrocytes).
3. Hemoglobin allows red blood cells to combine with oxygen in the lungs and carry it to body tissues.
4. Iron is utilized by enzymes that are involved in the making of amino acids, hormones, and neurotransmitters.
5. Iron is also a component of myoglobin, a protein compound in muscles that provides oxygen to cells,
6. It is a constituent of other body compounds involved in oxygen transport.
7. Iron is utilized by enzymes that are involved in the making of amino acids, hormones, and neurotransmitters.

Requirements

On the assumption that only 10% of ingested iron is absorbed.

The daily requirements intake for **men** has been set at 10 mg.

Women from the age of 11 through the childbearing years at 15 mg.

This is **doubled during pregnancy** and is difficult to meet by diet alone. Women should make a special effort to **include iron-rich foods** in their diets at all times. **The rapid growth periods of infancy** and **adolescence** also produce a heavy need for iron

Factors reduce iron absorption

1. Phytic acid and oxalic acid can bind iron and reduce the body's absorption of it.
2. Polyphenols, such as tannins in tea and related substances in coffee, also reduce the absorption of iron.

3. Antacids containing calcium and calcium supplements should be taken several hours before or after a meal high in iron because calcium also interferes with iron absorption.

Heme Iron and Non-Heme Iron

The two forms of dietary **iron** are **Heme Iron** and **Non-Heme Iron**:

1. **Heme iron** is found only in meat, poultry, seafood, and fish, so **heme iron** is the type of **iron** that comes from animal proteins in our diet.
2. **Non-heme iron**, by contrast, is found in plant-based foods like grains, beans, vegetables, fruits, nuts, and seeds.

NOTE: Iron to be absorbed, it must be chemically **changed from ferric to ferrous iron**. This change is accomplished by **the hydrochloric acid in the stomach**.

1. Absorption of non heme iron can be enhanced by consuming a **vitamin C–rich food and a heme iron–rich food at the same meal**. **Vit C keeps** the iron in its ferrous form, which facilitates absorption.

Iron deficiency can be caused by insufficient intake, malabsorption, lack of sufficient stomach acid, or excessive blood loss, any or all of which can deplete iron stores in the body. Decreased stores of iron prevent hemoglobin synthesis. The result is an low number of red blood cells to carry needed oxygen. What begins as iron deficiency can become.

Iron deficiency anemia. Iron deficiency anemia takes a long time to develop, but it is the most common nutrient deficiency worldwide.

Symptoms: include fatigue, weakness, irritability, and shortness of breath.

Clinical signs include **pale skin and spoon-shaped fingernails**.

Hemochromatosis is a disorder where too much iron builds up in your body.

Sometimes it's called “iron overload.” Normally, your intestines absorb just the right

amount of iron from the foods you eat. But in **hemochromatosis**, your body absorbs too much, and it has no way to get rid of it.

3- Iodine

Dietary iodine is found in: seafood , plant food grown in iodine-rich soil, cow's milk

Requirements. The daily requirements intake (DRI) for adults is **150 mg a day.**

Additional amounts are needed during pregnancy and lactation.

Deficiency. When the thyroid gland lacks sufficient iodine, the manufacture of thyroxine T4 and Triiodothyronine T3. In its attempt to take up more iodine, the gland grows, forming a goiter.

A thyroid gland that doesn't function properly causes **Myxedema** (hypothyroidism) in adults.

The children of mothers lacking sufficient iodine may suffer from **Cretinism** (retarded physical and mental development).

A goiter is an enlarged thyroid gland that causes the neck to swell. It is one of the most common thyroid disorders.

Goiters are often harmless but symptoms can occur, and treatment may be required **depending on the size and type of goiter.** ... In developed countries, **goiter** is usually

Hyperthyroidism: or an overactive thyroid gland, is another cause of goiter. Too much thyroid hormone is produced. This usually happens as a result of **Graves' disease**, an autoimmune disorder where the body's immunity turns on itself and attacks the thyroid gland, causing it to swell.

Other causes

Less common causes of goiter include the following:

- 1. Smoking:** Thiocyanate in tobacco smoke interferes with iodine absorption.
- 2. Hormonal changes:** Pregnancy, puberty, and menopause can affect thyroid function.

3. **Thyroiditis:** Inflammation caused by infection, for example, can lead to goiter.
4. **Lithium:** This psychiatric drug can interfere with thyroid function.
5. **Overconsumption of iodine:** Too much iodine can cause a goiter.
6. **Radiation therapy:** This can trigger a swollen thyroid, particularly when administered to the neck.

4-Phosphorus (P)

Phosphorus, together with calcium, is necessary for the formation of

1. Strong, rigid bones and teeth.
2. important in the metabolism of carbohydrates, fats, and proteins.
3. Phosphorus is a constituent of all body cells.
4. It is necessary for a proper acid-base balance of the blood
5. Essential for the effective action of several B vitamins.
6. Like calcium, phosphorus is stored in bones, and its absorption is increased in the

presence of vitamin D.

Sources. Is widely distributed in foods. The **best sources** are protein-rich foods such as milk, cheese, meats, poultry, and fish, cereals, legumes, nuts.

Deficiency. Because phosphorus is found in so many foods, its deficiency is rare.

Excessive use of antacids can cause it, however, because they affect its absorption.

Symptoms of phosphorus deficiency include bone demineralization (loss of minerals), fatigue, and anorexia.

5-Potassium (K)

1. Potassium is an electrolyte found primarily in **intracellular** fluid.
2. Like sodium, it is essential for fluid balance and osmosis.

Osmosis moves the fluid into and out of cells as needed to maintain electrolyte (and fluid) balance.

3. **Potassium** maintains the fluid level **within** the cell, and **sodium** maintains the fluid level **outside** the cell.

There is normally more potassium than sodium inside the cell and more sodium than potassium outside the cell.

If this balance is upset and the sodium inside the cell increases, the fluid within the cell also increases, swelling it and causing edema.

If the **sodium level outside the cell is low**, fluid enters the cell to dilute the potassium level, thereby causing a reduction in extracellular fluid and the loss of sodium **cause** a **decrease in blood pressure and dehydration can result.**

4. Potassium is also necessary for transmission of nerve impulses and for muscle contractions.

Sources: Potassium is found in many foods. Fruits—especially melons, oranges, bananas, and peaches—and vegetables—notably mushrooms, potatoes, tomatoes, lima beans, and carrots.

Deficiency or Excess.

Hypokalemia Potassium deficiency can be caused by diarrhea, vomiting, diabetic acidosis, severe malnutrition, or excessive use of laxatives or diuretics.

Symptoms of deficiency: Nausea, anorexia, fatigue, muscle weakness, and heart abnormalities (tachycardia).

Hyperkalemia (high blood levels of potassium) can be caused by:

Excessive intake, dehydration, renal failure, or cardiac failure can result.

6- Sodium (Na)

Sodium is an electrolyte whose primary function is the

1. Control of fluid balance in the body.
2. It controls the extracellular fluid and is essential for osmosis.

Osmosis is the movement of water or other solvent through a plasma membrane from a region of low solute concentration to a region of high solute concentration.

Osmosis is passive transport, **meaning** it does not require energy to be applied.

3. Sodium is also necessary to maintain the acid-base balance in the body.

4. Participates in the transmission of nerve impulses essential for normal muscle function.

Sources.

1. The primary dietary source of sodium is **table salt (sodium chloride)**, which is 40% sodium.

(One teaspoon of table salt contains 2,000 mg sodium.)

2. It is also naturally available in **animal foods**.

3. Salt is typically added to commercially prepared foods because it enhances flavor and helps to preserve some foods by controlling growth of microorganisms.

4. Fruits and vegetables contain little or **no sodium**.

5. Drinking water contains sodium.

Requirements. The DRI for sodium has been established at 1,500 mg, or 3,800 mg of salt.

Deficiency or Excess.

Deficiency or excess of sodium can cause **upsets in the body's fluid balance**.

A deficiency of sodium can occur after severe vomiting, diarrhea, or heavy perspiration. **Dehydration can result.**

A sodium deficiency also can **upset the acid-base balance in the body**.

Cells function best in a **neutral** or slightly **alkaline** medium.

If too much acid is lost (which can happen during severe vomiting), **alkalosis** may develop.

If the alkaline reserve is deficient as a result of starvation or faulty metabolism, diabetes, **acidosis** may develop.

An excess of sodium is a more common problem and may cause **edema**.

This edema adds pressure to artery walls that can cause **hypertension**. This excess of sodium is frequently associated with **cardiovascular** conditions.

such as hypertension and congestive heart failure.

Certain groups have greater (or lesser) reduction in blood pressure in response to **reduced sodium intake.**

Those with the greatest reductions in blood pressure have been termed *salt sensitive*, Whereas those with little or no reduction in blood pressure have been termed *salt resistant*. Working with your cardiologist is the best way to determine which you are, sensitive or resistant.

7-Magnesium (Mg)

Magnesium is vital in both hard and soft body tissues. It is essential for metabolism and regulates nerve and muscle function, including the heart. Plays a role in the blood-clotting process.

Sources.

Like phosphorus, magnesium is widely distributed in foods, primarily in plant foods. Like green leafy vegetables, legumes, nuts, whole grains, and some fruits such as avocados and bananas. Milk is also a good source if taken in sufficient quantity. For example, **2 cups of fat-free milk provide about 60 mg of magnesium.**

Magnesium is lost during commercial food processing. It is preferable to eat vegetables and fruits raw rather than cooked.

Deficiency.

Because of the wide availability of magnesium, its deficiency among people on normal diets is unknown. When deficiency was experimentally induced.

Symptoms: included nausea and, muscular disorders.

8- Zinc (Zn)

1. Zinc is a cofactor for more than 300 enzymes.
2. It affects many body tissues, essential for growth, wound healing, taste acuity, glucose tolerance

Sources. The best sources of zinc are protein foods, especially meat, fish, eggs, dairy products, wheat and legumes.

Requirements. The DRI for zinc in normal adult males is 11 mg, and in adult females, it is 8 mg, with increased requirements during pregnancy and further increases during lactation.

Deficiency.

Symptoms of zinc deficiency

Decreased appetite and taste acuity, delayed growth, dwarfism, **hypogonadism** (**subnormal development of male sex organs**), poor wound healing, anemia, acne like rash, and impaired immune response.

9-Selenium (Se)

Selenium is a constituent of most body tissues, but the heaviest concentration of the mineral is in the liver, kidneys, and heart

Functions. Selenium is a component of an enzyme that acts as an antioxidant. it protects cells against oxidation.

Sources. The best sources of selenium are seafood, kidney, liver, and muscle meats.

Requirements. The DRI for selenium for an adult male and female is 70 g.

Deficiency:

Symptoms of selenium deficiency are **unclear**, but **selenium supplements** appear to be effective in treating Keshan **disease**.

Keshan disease: A condition caused by deficiency of the essential mineral selenium. Keshan disease is a **potentially fatal form of cardiomyopathy (disease of the heart muscle)**. It was first observed in Keshan province in China, and it has since been found in other areas where the selenium level in the soil is low.

Toxicity: High doses (1 mg or more daily) are toxic and can cause vomiting, loss of hair and nails, and skin lesions.

Selenium has attracted attention because of its **antioxidant** properties.

Antioxidants protect cells from damage.