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Physiological functions of minerals and vitamins in human body

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ABSTRACT

B vitamins are a group of water-soluble nutrients that are necessary for life. These must be obtained through dietary sources; they cannot be synthesized independently in the body. Although they are grouped together and often referred to as vitamin B complex, each of the eight B vitamins is characterized by an important, unique role in the body. All the B vitamins are cofactors that work with a cognate enzyme, or chemical precursors of a cofactor. Cofactors are required for the functioning of some enzymes.B vitamins are a group of 8 water-soluble vitamins. The body does not store them, so they need to be replaced daily. B vitamins are found in animal proteins, dairy products, leafy green vegetables, and beans. Their function can generally be divided into catabolic metabolism, leading to energy production, and anabolic metabolism, resulting in bioactive molecules. They are critical cofactors for axonal transport, synthesis of neurotransmitters, and many cellular metabolic pathways.

Keywords: Vitamin, Mineral, bioactive, enzyme

INTRODUCTION

Types of vitamins and their functions Vitamins

Vitamins and minerals are nutrients called micronutrient that are needed in small amounts.Micronutrients don't give us energy, they are involved in the metabolic processes that enable us to get energy from carbohydrates, protein and fat, which are also known as macronutrients.There are 13 vitamins in total and 8 of these come from the B group of vitamins.

Vitamin A

Food sources of vitamin A: There are different compounds with vitamin A activity in animal and plant foods. Plant **foods** can be easy to spot as they tend to have orange/yellow pigment known as beta-carotene.

Plant sources

- orange and yellow fruit and vegetables – such as carrots, red capsicum, mangoes, sweet potatoes, apricots, pumpkin and cantaloupe
- Leafy green vegetables – such as spinach, peas and broccoli.

Animal sources

- liver
- eggs
- Some fortified milk and milk products (with added vitamin A).

Vitamin A functions

- makes the immune system work effectively so it can fight disease and infections
- keeps skin healthy
- supports reproduction and growth
- Helps with vision.

Vitamin A deficiency

Vitamin A plays an important role in the body, deficiency causes several health effects. These include:

- increased risk of infections
- night blindness and irreversible blindness is called xeropthalmia
- Excessive keratin build-up of the skin[1-3].

Vitamin B

Vitamin B group help our bodies use the energy-yielding nutrient for fuel. Some B group vitamins are needed to help cells to multiply by making new DNA.Except for B_{12} and folate which are stored by the liver, most B group vitamins can't be stored by the body. They must be consumed regularly in a healthy diet that includes a range of wholefoods and limits the intake of alcohol and processed foods. There 8 types of vitamin B are:

- thiamin (B1
- riboflavin (B2)
- niacin (B3)
- pantothenic acid (B5)
- pyridoxine (B6)
- biotin (B7)
- folate or 'folic acid' when included in supplements (B9)
- cyanocobalamin (B12).

Vitamin B sources:

Even though the B-group vitamins are found in many foods, they are water soluble and are generally quite delicate. They are easily destroyed, particularly by alcohol and cooking. Food can also reduce the amount of B-group vitamins in foods – either by destroying them, or in white flours, white breads and white rice removing the parts that contain the most B-group vitamins. This is one of the reasons white flours, white breads and white rice are less nutritious than their wholegraincounterparts.

Types of vitamin B

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- cyanocobalamin (B12).

Thiamin (B1):

Thiamin is also known as vitamin B1. It helps to convert glucose into energy and has a role in nerve function.

Good sources of thiamin

- wholemeal cereal grains
- seeds (especially sesame seeds)
- legumes
- wheatgerm
- nuts
- yeast
- pork.

Thiamin deficiency:

Beriberi is a condition caused by thiamin deficiency and affects the cardiovascular, muscular, gastrointestinal and nervous systems. It can be classified as 'wet' and 'dry' beriberi. 'Dry' beriberi affects the nervous symptom while 'wet' beriberi affects the cardiovascular system.Wernicke-Korsakoff syndrome (also called 'wet brain') is another thiamin-deficiency disease linked to alcohol excess and a thiamin-deficient diet. Alcohol reduces thiamin absorption in the gut and increases its excretion from the kidneys[4-6].

Riboflavin (B2)

Riboflavin is primarily involved in energy production and helps vision and skin health.

Good sources of riboflavin

- Yoghurt
- Cottage cheese
- Wholegrain breads and cereals
- Egg white
- Leafy green vegetables
- Meat
- Yeast
- Liver
- Kidney
- Milk

Riboflavin deficiency

Riboflavin deficiency is rare and is usually seen along with other B-group vitamin deficiencies. People at risk include those who consume excessive amounts of alcohol and those who do not consume milk or milk products.

Niacin (B3)

Niacin is essential for the body to convert carbohydrates, fat and alcohol into energy. It helps maintain skin health and supports the nervous and digestive systems. Unlike other B-group vitamins, niacin is very heat stable and little is lost in cooking.

Good sources of niacin

- meats
- fish
- poultry
- milk
- eggs
- wholegrain breads and cereals
- nuts
- mushrooms

Niacin deficiency

People who drink excessive amounts of alcohol or live on a diet almost exclusively based on corn are most at risk of pellagra. The main symptoms of pellagra are commonly referred to as the 3 Ds – dementia, diarrhoea and dermatitis. This disease can lead to death if not treated.

Pantothenic acid (B5)

Pantothenic acid is needed to metabolize carbohydrates, proteins, fats and alcohol as well as produce red blood cells and steroid hormones.

Good sources of pantothenic acid

Pantothenic acid is widespread and found in a range of foods, but some good sources include:

- liver
- meats
- milk
- kidneys
- eggs
- yeast
- peanuts
- legumes.

Vitamin B6 (pyridoxine)

Pyridoxine is needed for protein and carbohydrate metabolism, the formation of red blood cells and certain brain chemicals. It influences brain processes and development, immune function and steroid hormone activity.

Good sources of pyridoxine

- cereal grains
- legumes
- green and leafy vegetables
- fish and shellfish
- meat and poultry
- nuts
- liver
- fruit.

Pyridoxine deficiency: Pyridoxine deficiency is rare. People who drink excessive amounts of alcohol, women (especially those on the contraceptive pill), the elderly and people with thyroid disease the most at risk.

Biotin (B7)

Biotin (B7) is needed for energy metabolism, fat synthesis, amino acid metabolism and glycogen synthesis. High biotin intake may raise blood cholesterol levels[7-8].

Sources of biotin

- liver
- cauliflower
- egg yolks
- peanuts
- chicken
- yeast
- mushrooms.

Biotin deficiency:

Biotin deficiency is very rare, it's widely distributed in foods and only required in small amounts. Over consumption of raw egg whites over periods of several months can induce deficiency because a protein in the egg white inhibits biotin absorption.

Folate or folic acid (B9)

Folic acid is needed to form red blood cells, which carry oxygen around the body. It helps the development of the foetal nervous system, as well as DNA synthesis and cell growth. Women of child-bearing age required a diet rich in folate.A pregnant women should visit doctor to make sure getting enough folate. This is important to reduce the risks of neural tube defects such as spina bifida in the baby[9].

Good sources of folate

- green leafy vegetables
- legumes
- seeds
- liver
- poultry
- eggs
- cereals
- Citrus fruits.

Cyanocobalamin (B12)

Cyanocobalamin helps to produce and maintain the myelin surrounding nerve cells, mental ability, red blood cell formation and the breaking down of some fatty acids and amino acids to produce energy. Vitamin B12 has a close relationship with folate, as both depend on the other to work properly.

Good sources of B12:

liver,meat,milk,cheese,eggs,Almost anything of animal origin

Vitamin B12 deficiency: Vitamin B12 is only found in foods from animal sources, people following strict vegan diets, as well as breastfed babies of vegan mothers; tend to be most commonly affected. Absorption of B12 from the gut also tends to decrease with age, so the elderly is another group who are more at risk of deficiency.

Vitamin C (Ascorbic acid)

Dietary intake of vitamin C is essential for human body because it cannot synthesize in the body. Vitamin C should be place in regular diet because the body cannot store vitamin C for very long.

Vitamin C is important for many metabolic processes, including:

- Infection fighting – the immune system, particularly cells called lymphocytes, requires vitamin C for proper functioning.
- Collagen formation: collagen is used in different ways throughout the body. Its primary role is to strengthen the skin, blood vessels and bone. The body also relies on collagen to heal wounds.
- Antioxidant function:the metabolism of oxygen within the body releases molecular compounds called 'free radicals', which damage cell membranes. Antioxidants are substances that destroy free radicals, and vitamin C is a powerful antioxidant.
- Iron absorption – the process of iron absorption is aided by vitamin C, particularly non-haem iron (found in plant foods such as beans and lentils).

Dietary sources of vitamin C

Adults need about 45mg of vitamin C per day and any excess amount (above 200mg) is excreted. Vitamin C is sensitive to heat, so some of its nutritional benefits can be lost during cooking. Raw foods are more beneficial as dietary sources of vitamin C. These include:

1. Fruits: oranges, lemons, limes, grapefruits, blackcurrants, mangoes, kiwifruits, rock melon, tomatoes and strawberries

2. Vegetables: particularly green vegetables (such as cabbage, capsicum, spinach, Brussels sprouts, lettuce and broccoli), cauliflower and potatoes[10-12].

Vitamin C deficiency and scurvy

A severe lack of vitamin C can lead to scurvy. We may think of it as a disease of the past, but it does still exist. Factors or lifestyle issues that may increase your scurvy risk include:

- regularly eating unhealthy foods
- being malnourished due to inadequate care
- very strict allergy diets
- having an eating disorder
- smoking – smokers need more vitamin C to cope with the extra stress on their body.

Vitamin D

Vitamin D is important for strong bones, muscles and overall health. Ultraviolet (UV) radiation from the sun is necessary to produce vitamin D in the skin and is the best natural source of vitamin D.Regular physical activity also assists with the body's production of vitamin D.The body can only absorb small amounts of Vitamin D.Spending too much time in the sun may increase your risk of skin cancer. Remember to use daily sun protection, especially at times when UV index levels are at their highest (3 or above).

Food sources of vitamin D

Only a small amount (around 5-10%) of Vitamin D is sourced from our diet. Sources include:

- fatty fish (such as salmon)
- eggs
- Margarine and some milk have added vitamin D.

Vitamin D deficiency:

It is important to achieve a good peak bone mass early in life. Vitamin D deficiency can result in a decline in bone density in adult life, increasing the risk of osteoporosis, falls and bone fractures (especially for older people),rickets (in young children) – a preventable bone disease.

Treatment options include improved sunlight exposure, diet, exercise, vitamin and mineral supplements[13-15].

Vitamin E

Vitamin E is an antioxidant that helps protect body against damage from free radicals, such as exposure to cigarette smoke or radiation. It is also important for our:

- Vision
- Immune system
- Skin

Dietary sources of vitamin E

Vitamin E is best obtained from a healthy diet that contains plenty of fresh minimally processed foods. Vitamin E is also vulnerable to heat (especially cooking methods such as deep frying.

Dietary sources include:

- meats (e.g. liver)
- egg yolks
- leafy green vegetables – spinach, broccoli
- nuts and seeds – such as almonds, sunflower seeds, peanuts and hazelnuts
- healthy oils – such as extra virgin, sunflower, soybean
- Unprocessed cereals and whole grains – such as wheat germ.

Vitamin E deficiency

Deficiency is rare but can happen in people with diseases that cause fat malabsorption (like cystic fibrosis).Erythrocyte haemolysis is another deficiency – it's seen in infants born before vitamin E is transferred to them from their mother prior to birth.

Vitamin K

Vitamin K is important for:

- healthy bones
- blood clotting and wound healing
- Newborn babies to prevent a serious bleeding condition called hemorrhagic disease of the newborn (HDN).

Dietary sources of vitamin K

We get vitamin K from food and the bacteria in our gastrointestinal tract. Newborn babies are given a booster to increase their vitamin K levels because they are born without bacteria in their gastrointestinal tract. We get much of our vitamin K from our diet.

Food sources include:

- leafy green vegetables – spinach and kale
- fruits – such as avocado and kiwi fruit
- Some vegetable oils such as soybean oil.

Vitamin K deficiency

Vitamin K deficiency is unlikely except when fat is not absorbed properly or when certain medications are used. For example, antibiotics can kill the gastrointestinal bacteria that produce vitamin K[16-17].

Types of minerals and their functions

There are hundreds of minerals available, among them, usually classified as either major or trace minerals. Although the amount need differs between minerals, major (or macrominerals) are generally required in larger amounts. Some examples include calcium, phosphorus, potassium, sulphur, sodium, chloride, magnesium. Trace minerals also called micro minerals are equally important to body functions are required in smaller amounts. Examples include iron, zinc, copper, manganese, and iodine selenium.

Some of the important minerals to keep us healthy are listed below.

1. Calcium

Calcium is vital to keep to bones strong and healthy. If it is not sufficient levels, bones will eventually become weak and brittle and can lead to conditions like osteoporosis.

- Calcium helps in blood clotting
- transmission of nervous system messages
- Enzyme function.
- strengthen bones and teeth
- regulate muscle and heart function

Food sources of calcium: Good sources of calcium include dairy foods like milk, yoghurt and cheese and some plant-based foods with added calcium (for example, soymilk, tofu and breakfast cereals).Other sources of calcium include almonds, bok choy, kale, parsley, broccoli and watercress.

2. **Iodine**

Iodine is essential substance for synthesis of thyroid hormones. These hormones control metabolic rate. They also help to brain function, body growth and development.

Food sources of iodine

Small amount of iodine is required in the diet for normal thyroid function. Iodine is found naturally in some foods such as: dairy, seafoods, seaweed, eggs, some vegetables. Iodine can also be found in iodised salt[18].

3.Iron

Iron is an important mineral that is involved in various bodily functions, including the transport of oxygen in the blood the provision of energy to cells. It also play vital role in immune system function effectively to fight against infection.

Food sources of iron

Iron can be found in animal and plant foods including: legumes, eggs, breakfast cereals with added iron, red meat and offal, fish and poultry.

Iron deficiency

Iron deficiency is common in adults and children. Around one in eight people do not consume enough iron to meet their needs. Some factors like certain foods and drinks can affect the absorption of iron.

3. Zinc

Zinc is an important mineral involved in various bodily functions – growth and development as well as immune function. Zinc also helps to produce the active form of vitamin A and transports it around the body.

Food sources of zinc

Zinc is highest in protein rich foods but may also be found in some plant foods. Dietary sources include: red meat, shellfish, poultry, milk and cheese, whole grains and cereals with added zinc.

4. Magnesium

Magnesium is important for many functions in the body including maintaining bone health and using glucose for energy. Magnesium also supports immune function and helps regulate blood pressure and lung function.

Food sources of magnesium

Dietary sources include:nuts (such as cashews),legumes,dark green vegetables,seafood,whole grains,chocolate and cocoa.

5. Potassium

Potassium is important for the nerves, muscles and heart to work properly. It also helps lower blood pressure.

Food sources of potassium

It is much better to eat unprocessed foods,such as fruit, vegetables and lean meats, eggs, fish and other healthy, everyday foods.

Foods high in potassium include:

- bananas and apricots
- mushrooms and spinach
- Nuts and seeds.

6. Sodium

A small amount of sodium is important for good health as it helps to maintain the correct volume of circulating blood and tissue fluids in the body.Many are consuming more sodium than need. Too much sodium can lead to high blood pressure (hypertension) and other health conditions.

Food sources of sodium: Salt is the main source of sodium in our diet. It is a chemical compound (electrolyte) made up of sodium and chloride. Many foods like whole grains, meat and dairy products naturally contain small amounts of sodium, while highly processed foods usually contain large amounts.

7. Iron

Like copper, iron is also great importance for life. It contains redox active metal, is involved in photosynthesis, mitochondrial respiration, nitrogen assimilation, hormone biosynthesis, production and scavenging of reactive oxygen species, osmoprotection, and pathogen defense. Up to 80% of the cellular iron is found in the chloroplast that is consistent with its major function in photosynthesis[19-20].

8. Manganese

Manganese is essential for plant metabolism and development and occurs in oxidation states II, III, and IV in approximately 35 enzymes of a plant cell. Manganese can fulfill two functions in proteins: it serves as catalytically active metal; it exerts an activating role on enzymes. Examples for the catalytic role are manganese containing superoxide dismutase protecting the cell from damaging effects of free radicals, the oxalate oxidase, and the manganese containing water

9.Boron

The unusual nature of boron chemistry suggests the possibility of a wide variety of biological functions for the micronutrient; however, the exact metabolic functions are not understood. Boron is involved in various functions, including protein synthesis, transport of sugars, respiration, RNA and carbohydrate metabolism, and the metabolism of plant hormones (eg:indole acetic acid) and related to cell wall synthesis.

10. Molybdenum

Only a handful of plant proteins are known to contain molybdenum. These proteins, however, are very important as they are involved in nitrogen assimilation, sulfur metabolism, phytohormone biosynthesis, and stress reactions. Nitrate reductase is the key-enzyme for nitrate assimilation while nitrogenase is found in nitrogen fixing bacteria inside nodules of symbiotically growing species. The last step of abscisic acid biosynthesis is catalyzed by the molybdenum enzyme aldehyde oxidase.

11. Chlorine

Chlorine is known to exist in more than 130 organic compounds in plants. Most soils contain sufficient levels of chlorine. However, chlorine deficiencies have been described in sandy soils in high rainfall areas or could be created artificially in experiments to prove its requirement as a micronutrient for higher plants. Because chloride is a mobile anion in plants, most of its functions are related to electrical charge balance. In the chloroplast, chloride is a structural constituent

12. Copper

Copper is also important mineral for life. Copper is essential for photosynthesis and mitochondrial respiration, for carbon and nitrogen metabolism, for oxidative stress protection, and is required for cell wall synthesis. Under physiological conditions, copper exists in the two oxidation states Cu^{1+} and Cu^{2+} and can interchange between these forms (monovalent copper is unstable). This allows copper to function as a reducing or oxidizing agent.

CONCLUSION

Essential micronutrients were found as constituents in over 1500 proteins where they fulfill catalytic, (co-)activating, and/or structural functions. The largest group (>1200) is formed by zinc-proteins (with transcription factors as major subgroup). Proteins containing iron, copper, or manganese make up groups in the range of 50–150 members each, while molybdenum and nickel proteins can be counted on one hand each. Boron and chlorine are very important, but proteins or compounds that were….

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