Topic 3: Vitamins

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Relevance of the topic: Vitamins are a group of chemically diverse organic compounds that an organism requires for normal metabolism. Apart from a few exceptions (e.g., vitamin D), the human body cannot synthesize vitamins on its own in sufficient amounts and must, therefore, ensure a steady supply through the diet. Vitamins are micronutrients that do not provide energy (like macronutrients) but instead have very specific biochemical roles. They can be coenzymes in various reactions (B vitamins, vitamins A and K) and/or antioxidants that protect the cell and its membrane from free radicals (vitamins C and E). They can also enable cell signaling (vitamin A) and gene transcription (vitamins A and E) or function as hormones (e.g., vitamin D).

Aim of the topic: Give information to you about water-soluble vitamins, main functions of each water-soluble vitamin in school-aged children's body, their sources and the required amount of vitamins per a day.

Questions for prepare:

1. What are vitamins?
2. How are vitamins classified?
3. What vitamins are water soluble-vitamins?
4. What are the functions of water-soluble vitamins?
5. What are high nutrient sources of water-soluble vitamins?
6. How many vitamins do school-aged children need a day?

5.1 Role of Vitamins

Vitamins are a group of chemically diverse organic compounds that an organism requires for normal metabolism. Apart from a few exceptions (e.g., vitamin D), the school-aged children's body cannot synthesize vitamins on its own in sufficient amounts and must, therefore, ensure a steady supply through the diet. Vitamins are micronutrients that do not provide energy (like macronutrients) but instead have very specific biochemical roles. They can be coenzymes in various reactions (B vitamins, vitamins A and K) and/or antioxidants that protect the cell and its membrane from free radicals (vitamins C and E). They can also enable cell signaling (vitamin A) and gene transcription (vitamins A and E) or function as hormones (e.g., vitamin D).

Vitamins are classified into **fat-soluble vitamins**, which the body can store, and **water-soluble vitamins**, which, with the exception of vitamins B9 (folate) and B12 (cobalamin), the body cannot store over significant periods of time and, therefore, require continuous intake. A balanced diet typically supplies the body with all vitamins it requires. Deficiencies occur mainly due to malnutrition, malabsorption disorders, or restrictive diets (e.g., vitamin B12 deficiency in a vegan diet).

5.2 Water-Soluble Vitamins

Sources:

1. Mainly diet;
2. Intestinal flora: small amounts of vitamin B7, B9, and B12 are synthesized by intestinal bacteria.

Absorption: Absorption in the intestine via specific luminal transporters.

Storage:

1. Not stored in the body, except vitamins B9 and B12, which are stored in the liver
2. Hepatic stores of B9 last for approx. 3-4 months, whereas hepatic stores of B12 last for approx. 3-4 years.

5.3 Main functions, sources, deficiency and toxicity of water-soluble vitamins

- Vitamin B1 (thiamine)
- Vitamin B2 (riboflavin)
- Vitamin B3 (niacin)
- Vitamin B5 (pantothenic acid)
- Vitamin B6 (pyridoxine)
- Vitamin B7 (biotin)
- Vitamin B9 (folate)
- Vitamin B12 (cobalamin)
- Vitamin C (ascorbic acid)

Vitamin C

Functions: This famous "cold" fighter is a strong antioxidant known for strengthening the immune system by fighting off colds and other infectious diseases. It helps promote cardiovascular and eye health, and ward off wrinkles and the signs of aging skin.

Sources: Found only in fruits and vegetables, especially citrus fruits, vegetables in the cabbage family, cantaloupe, strawberries, peppers, tomatoes, potatoes, lettuce, papayas, mangoes, kiwi fruit.

The recommended daily allowance of Vitamin C:

- For children under 10 years is 15-45 mg per a day,
- For teens is 65-75 mg per a day,

Deficiency: Scurvy, Weakened immune response.

Toxicity:

- Fatigue
- Nausea, vomiting, diarrhea
- Calcium oxalate nephrolithiasis
- Increased risk of iron toxicity in predisposed individuals (e.g., hereditary hemochromatosis)

Thiamin HCL (Vitamin B1):

Functions: The school-aged children's body needs B1 to convert food into energy, and for DNA and RNA to work together. It plays a role in maintaining heart function and a healthy nervous system.

Sources: Found in all nutritious foods in moderate amounts: pork, whole-grain or enriched breads and cereals, legumes, nuts and seeds.

The recommended daily allowance of Vitamin B1:

- For adult and teens is 1,1-1,2 mg per a day,
- For children from 1 to 10 years is 0,5-0,9 mg,
- 0,3mg of thiamin more for pregnant women,
- 0,4mg of thiamin more for nursing mothers.

Deficiency: Wernicke-Korsakoff syndrome**,** Beriberi.

Toxicity: No toxicity has been described

Riboflavin (Vitamin B2)

Functions: The "yellow" B Vitamin that can be used for food coloring is essential to the creation of red blood cells and cell growth. It promotes healthy muscle, nerve, and heart function and affects certain enzyme functions.

Sources: Milk and milk products; leafy green vegetables; whole-grain, enriched breads and cereals.

The recommended daily allowance of Vitamin B2:

- For teens is 1-1,3 mg per a day,
- For children from 1 to 10 years is 0,5-0,9 mg per a day,

Deficiency: Conjunctivitis with corneal vascularization, Cheilosis.

Toxicity: No toxicity has been described.

Niacin, vitamin PP (Vitamin B3)

Functions: Essential for converting food to energy, Niacin helps to maintain cardiovascular health. It also promotes a healthy nervous system, as well as healthy skin, hair, and eyes.

Sources: Meat, poultry, fish, whole-grain or enriched breads and cereals, vegetables (especially mushrooms, asparagus, and leafy green vegetables), peanut butter.

The recommended daily allowance of Vitamin B3:

- For school-aged children is 6-12 mg per a day,

Deficiency: Glossitis, Pellagra.

Toxicity:

- Flushing,
- Possibly: nausea, vomiting, pruritus, hives,
- Hyperglycemia,
- Hyperuricemia.

Pantothenic acid (Vitamin B5)

Functions: Vitamin B5 supports metabolism and helps to convert food into energy. It aids in overall growth and development, supports the adrenal glands, and is critical in the production of hemoglobin.

Sources: Liver, kidney, egg yolks, broccoli, milk, widespread in foods.

The recommended daily allowance of Vitamin B5:

- For teens is 5 mg per a day,
- For children under 10 years is 2-4 mg per a day,

Deficiency:

- Dermatitis
- Enteritis
- Alopecia
- Adrenal insufficiency

Toxicity: No toxicity has been described.

Vitamin B6 (Pyridoxine)

Functions: This Vitamin B superstar supports healthy brain function and reduces the risk of cardiovascular disease. It aids in the production of serotonin and helps to maintain the health of the nervous system, immune system, and red blood cells.

Sources: Meat, fish, poultry, vegetables, fruits.

The recommended daily allowance of Vitamin B6:

- For children under 10 years is 0,5-1,0 mg per a day,

Deficiency:

- Convulsions,
- Irritability,
- Sideroblastic anemia,
- Peripheral neuropathy.

Toxicity:

- Dizziness,
- Nausea,
- Peripheral neuropathy,
- Dermatosis, photosensitivity.

Biotin (Vitamin B7)

Functions: Biotin, also known as B7, promotes healthy skin, hair, and nails. It is needed for the metabolism of protein and carbohydrates, and regulating blood sugar levels.

Sources: Eggs, meat, fish, seeds, nuts.

The recommended daily allowance of Vitamin B7:

- For adults is 30 microgram per a day,
- For teens is 25 microgram per a day,
- For children under 10 years is 8-20 microgram per a day,
- 5 microgram more of Vitamin B7 for nursing mothers.

Deficiency:

- Dermatitis,
- Conjunctivitis,,
- Alopecia,
- Enteritis,
- Neurologic symptoms,
- Muscle pain.

Toxicity: No toxicity has been described.

Folic acid (Vitamin B9)

Functions: Vitamin B9 is an essential player in the development of a healthy central nervous system in embryos. Ongoing, it supports nervous system function, repairs DNA damaged by toxins, and aids in the production of blood cells.

Sources: Leafy green vegetables and legumes, seeds, orange juice, and liver; now added to most refined grains.

The recommended daily allowance of Vitamin B9:

- For teens is 0,4 mg per a day,
- For children under 10 years is 0,15-0,30 mg per a day,

Deficiency:

- Most common vitamin deficiency in developed countries,
- Macrocytic, megaloblastic anemia,
- Hyper segmented polymorphonuclear cells,
- Glossitis,
- In pregnancy: fetal neural tube defects.

Toxicity: No toxicity has been described.

Vitamin B12

Functions: This powerful B vitamin, that the body does not produce, has a hand in nerve function and development. It helps to keep blood cells healthy and to produce DNA. It can also aid in the prevention of certain types of anemia. It is the exception to water soluble vitamins as it can be stored in your liver.

Sources: Meat, poultry, fish, seafood, eggs, milk and milk products; not found in plant foods.

The recommended daily allowance of Vitamin B12:

- For teens is 2,4 microgram per a day,
- For children under 10 years is 0,9-1,8 microgram per a day,

Deficiency:

- Macrocytic, megaloblastic anemia,
- Neurologic symptoms (e.g., paresthesias),
- Hyper segmented polymorphonuclear cells.

Toxicity: No toxicity has been described.

References:

1. Vitamins - https://www.amboss.com/us/knowledge/Vitamins

2. Water Soluble vs. Fat Soluble Vitaminshttps://gettespo.com/blog/water-soluble-vs-fat-soluble-vitamins/

3. Vitamins: Their Functions and Sourceshttps://www.healthlinkbc.ca/health-topics/ta3868

Fat-soluble vitamins

Relevance of the topic: Fat-soluble vitamins are soluble in fats. They are absorbed by fat globules that travel through the small intestines and into the general blood circulation within the body. Unlike water-soluble vitamins, fat-soluble vitamins are stored in the body when they are not in use. Typically, they are stored in the liver and fat tissues. Although only small amounts of these vitamins are necessary to maintain good health, Vitamin D deficiency has been reported as a growing public health concern. It has been associated with an increased risk of certain diseases.

Aim of the topic: Give information to students about fat-soluble vitamins, main functions of each fat-soluble vitamin in human body, their sources and the required amount of vitamins per a day.

Questions for prepare:

1. What are vitamins?
2. How are vitamins classified?
3. What vitamins are fat-soluble vitamins?
4. What are the functions of fat-soluble vitamins?
5. What are high nutrient sources of fat-soluble vitamins?
6. How many vitamins do school-aged children need a day?

6.1 Role of Fat-soluble vitamins

Sources:

1. Mainly diet;
2. Intestinal flora: small amounts of vitamin K are synthesized by intestinal bacteria;
3. Vitamin D is predominantly synthesized in the body.

Absorption:

1. Absorption depends on intestinal and pancreatic function;
2. Require lipids for absorption.

Storage: Can be stored for long periods of time in the liver and adipose tissue**.**

- Vitamin A (retinol)
- Vitamin D (calciferol)
- Vitamin E (tocopherol)
- Vitamin K (phytomenadione)

6.2 Main functions, sources, deficiency and toxicity of fat-soluble vitamins

Vitamin A

Functions: Enhancing vision, immunity, bone growth, and the production of new cells are just a few of the roles this powerful antioxidant plays. Available in fat-soluble (Palmitate) and water-soluble (Beta Carotene) forms.

Sources: Vitamin A from animal sources (retinol): fortified milk, cheese, cream, butter, fortified margarine, eggs, liver.

Beta-carotene (from plant sources): Leafy, dark green vegetables; dark orange fruits (apricots, cantaloupe) and vegetables (carrots, winter squash, sweet potatoes, pumpkin).

The recommended daily allowance of Vitamin A:

- For children is 300-600 microgramper a day,

Deficiency:

- Night blindness,
- Xerosis cutis,
- Bitot spots,
- Keratomalacia,
- Immunosuppression.

Toxicity:

- Acute toxicity: nausea, vomiting, blurred vision, dizziness,
- Chronic toxicity,
- Alopecia,
- Arthralgias,
- Hepatic toxicity,
- Pseudotumorcerebri,
- Teratogenicity.

Vitamin D (Calciferol)

Functions: The sunshine Vitamin's myriad talents include supporting heart health, blood sugar levels, healthy aging, immunity, and strengthening bones. It plays a key role in helping the body absorb calcium.

Sources: Egg yolks, liver, fatty fish, fortified milk, fortified margarine. When exposed to sunlight, the skin can make vitamin D.

The recommended daily allowance of Vitamin D:

- For children and teens is 5 microgram per a day.

Deficiency:

- Rickets (in children),
- Osteomalacia (in adults),
- Hypocalcemictetany.

Toxicity:

- Hypercalcemia,
- Hypercalciuria.

Vitamin E (Tocopherol)

Functions: Vitamin Eis an antioxidant that supports the immune system, helps to improve blood circulation, protects against cell damage, and promotes the healing of tissues.

Sources: Polyunsaturated plant oils (soybean, corn, cottonseed, safflower); leafy green vegetables; wheat germ; whole-grain products; liver; egg yolks; nuts and seeds.

The recommended daily allowance of Vitamin E:

- For teens and school-aged children is 15 mg per a day.

Deficiency:

- Muscle weakness,
- Demyelination of posterior columns and spinocerebellar tract,
- Hemolytic anemia.

Toxicity:

- Infants: ↑ risk of necrotizing enterocolitis (NEC),
- ↑ Anticoagulant effect of warfarin.

Vitamin K (Phytomenadione)

Functions: Sometimes known as "the forgotten vitamin" Vitamin K is a fat-soluble vitamin that is well known for its blood clotting capabilities and is absolutely essential to building strong bones and cardiovascular health. It is found in spinach, soybeans, and eggs, but is hard for the body to absorb.

Sources: Leafy green vegetables such as kale, collard greens, and spinach; green vegetables such as broccoli, Brussels sprouts, and asparagus; also produced in intestinal tract by bacteria.

The recommended daily allowance of Vitamin E:

- For teens is 75 microgram per a day,
- For children under 10 years is 30-60 microgram per a day.

Deficiency: Coagulopathy

Toxicity:

- Hemolytic anemia,
- Hyperbilirubinemia,
- Jaundice,
- Infants: kernicterus.

References:

1. Vitamins - https://www.amboss.com/us/knowledge/Vitamins

2. Water Soluble vs. Fat Soluble Vitamins https://gettespo.com/blog/water-soluble-vs-fat-soluble-vitamins/

3. Vitamins: Their Functions and Sourceshttps://www.healthlinkbc.ca/health-topics/ta3868