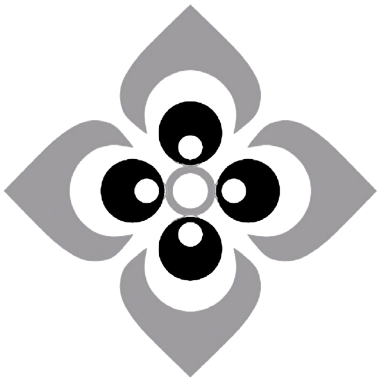

Consortium for Educational Communication

Module on

Water Soluable Vitamins

By

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TEXT

Vitamins may be regarded as organic compounds required in the diet in small amounts to perform specific biological functions for normal maintenance of optimum growth and health of the organism.

The vitamins are divided in to two subgroups on the basis of their solubility properties, such as water soluble vitamins and fat soluble vitamins.

Water soluble vitamins

Ascorbic acid

Ascorbic acid is a hexose derivative and closely resembles monosaccharides in structure. The acidic property of Vit. C is due to the enolic hydroxyl groups. Many animals can synthesize ascorbic acid from glucose via uronic acid pathway, Vit. C has become the most controversial vitamin in recent years because of the claims and counter claims on the use of vit-C in mega-doses to cure everything from common cold to cancer.

In 1947, the Scottish surgeon James Lind Discovered the citrus foods helped prevent scurvy, a deadly disease in which collagen is not properly formed causing poor wound healing, bleeding of gums, severe pain and death. Scurvy was the first disease found to be associated with diet.

A child requires about 30 mg of the vitamin per day while in an adult man, it is increased as much as 75 mg in food daily. Pregnant and lactating women require about 100-150 mg of vitamin C daily. During infection, fever and surgical operations, the amount recommended is about 200 mg per day.

Citrus fruits such as lemons, oranges, alma, plumes, guava, grapefruits, strawberry and apple are the richest sources of vitamin C. Other good sources of the vitamin are berries, melons, tomatoes, green peppers, raw cabbage and salad greens.

Physiological functions of vitamin C

1. As an antioxidant, vit-C functions as a part of the oxidation reduction system and acts in the living cell as a hydrogen transporter, thus reduces the rise of cancer and coronary heart diseases.
2. it also helps in the secretion of collagen, cement, dentine, cartilage and matrix of bones.
3. it helps the body to build resistance against infection from bacteria and the toxic products by such infections.
4. It also helps in absorption of calcium and iron from the intestine.
5. it is involved in tyrosine metabolism
6. It has been reported to act as co-enzyme for cathepsin and liver esterases.
7. It controls the cholesterol metabolism.
8. It is required to maintain the normal proportion of the plasma proteins.
9. It reduces the risk of cataract formation

Deficiency symptoms

Lack of vitamin C causes a disease called scurvy characterized by spongy and sore gums, loose teeth, anemia, swollen joints, fragile blood vessels, subcutaneous and intramuscular hemorrhage and delayed healing.

Vitamin B complex

The vitamin B complex comprises a group of water soluble factors more or less closely associated in their natural occurrence. It is now customary to refer them by their chemical names. Previously they were named B_1, B_2, B_3 etc. The only common property exhibited by these vitamins is that they form co-enzymes or prosthetic groups of different enzymes. Vitamin B group contains about 12 known vitamins and are discusses below:

1. Thiamine (vitamin B_1) also known as antineuritic, aneurine or heat liable factor. Thiamine contains a pyrimidine ring and a thiazole ring held by a methylene bridges. Thiamine is the only natural cyclobutane pyrimidine dimer (cpd) with thiazole ring.

The best source of vitamin B_1 are cereals, pulses and yeast. The rich source of vitamin B_1 are in nuts, oil seeds, eggs, fish, beef, liver, heart, kidney and many vegetables. Milk and fresh fruits also contain appreciable amounts of thiamine.

Childrens require about 0.50-1.5 mg of vitamin B1 in diet per day. Adult man requires about 1.5 to 2 mg of this vitamin daily. In adult women, its requirement is about 0.9-1.7 mg/dose. In pregnant and lactating women, slightly more contents are needed (2mg/day).

Physiological functions:

1. Thiamine is involved in carbohydrate metabolism.
2. Thiamine pyrophosphate (TPP) plays an important role in the transmission of nerve impulse.
3. Thiamine is also responsible for the normal uptake of oxygen by the brain tissue.

Deficiency:

A deficiency of this vitamin causes a serious disease known as beriberi. Its symptoms are loss of apetite inflammation of nerves, muscular weakness, and peripheral neurophathy.

2. Vitamin B2 or Riboflavin

Riboflavin contains 6,7- dimethyl isoalloxazine (a heterocyclic 3 ring structure) attached to D-ribitol by a nitrogen atom. Ribiflavin is stable to heat but sensitive to light.

It is also known as vitamin G or lactoflavin or ovoflavin.

Childrens require about 0.9-2 mg of vitamin B1 in diet per day. An adult person requires about 2 mg and pregnant and lactating women need about 2.5-3 mg daily intake of this vitamin.

Richest natural source of vitamin B2 are milk, eggs, liver, kidney and green leafy vegetables. Meat and fish contain small amounts. Cereals and pulses also contain smaller amounts, but germination increases the riboflavin contents.

Physiological functions:

It is involved in the metabolism of proteins, fats, carbohydrates and nucleic acids by forming part of the flavoprotein. Riboflavin is a part of the structure of two flavin co-enzymes, flavin mononucleotide (FMN) and flavin adenine dinucleotide (FAD).

Riboflavin is a constituent of several enzyme systems, such as amino acid oxidases, xanthine oxidase, cytochrome c-reductase etc. these enzymes are called flavoproteins. The main function of this vitamin is concerned with oxidation reduction.

Deficiency:

A shortage of this vitamin may manifest itself as cracks and sores at the corners of the mouth (cheiloses), eye disorders, inflammation of the mouth and tongue, and skin lesions.

Dermatitis, dizziness, hair loss, insomnia, light sensitivity, poor digestion, retarded growth, and slow mental responses have also been reported. Burning feet can also be indicative of a shortage.

Vitamin B3

Vitamin B3 is also known as Niacin, or niacinamide or nicotinic acid. Nicotinic acid has been known to chemists as p.p. factor (Pellagra preventing factor). The term niacin is used as the generic name to cover both nicotinic acid and nicotinamide.

Niacin can be manufactured by the body. Niacin is derived

from two compounds - nicotinic acid and niacinamide. This vitamin differs from the other vitamins of B complex group in that an essential amino acid, tryptophan serves as its precursor.

The daily intake of this vitamin in children should be about 10-15 mg in diet. Normal adults require about 12-18 mg per day while females need 15-20 mg. In addition to dietary intake, nicotinic acid may be derived in the body from tryptophan by the intestinal flora. The synthesis is inhibited by the bacteriostatic action of sulphonamides.

The rich source of vitamin B3 is Liver, kidney, meat, poultry, fish, legumes and groundnuts. Milk is poor source, but their proteins are rich in tryptophan, which is converted in the body in niacin. In cereals it occurs in bound form, so usually unavailable.

Physiological role: Vitamin B3 is required for cell respiration, helps in the release of energy and metabolism of carbohydrates, fats, and proteins, proper circulation and healthy skin, functioning of the nervous system, and normal secretion of bile and stomach fluids. It is used in the synthesis of sex hormones, treating schizophrenia and other mental illnesses, and a memory-enhancer.

Nicotinic acid (but not nicotinamide) given in drug dosage improves the blood cholesterol profile, and has been used to clear the body of organic poisons, such as certain insecticides. People report more mental alertness when this vitamin is in sufficient supply.

Deficiency of Niacin: A deficiency may cause pellagra and the symptoms of pellagra are commonly referred to as three D's-dermatitis, diarrhea, and dementia and if not treated may lead to death (4^{th} D). Symptoms include depression, diarrhea, dizziness, fatigue, halitosis, headaches, indigestion, insomnia, limb pains, loss of appetite, low blood sugar, muscular weakness, skin eruptions, and inflammation.

Vitamin B5

Pantothenic acid is also known as vitamin B5 or pantothenate is a water soluble vitamin discovered by Roger J. Williams in 1919. It is the amide between pantoic acid and β-alanine. This vitamin is present in highest concentration in whole grain cereals, legumes, avocado, eggs, royal gelly, molasses, and yogurt.

The recommended daily requirement pantothenic acid is 6-10mg/day.

Physiological role:

Pantothenic acid is formed from β-alanine and pantoic acid. Pantothenate is required for synthesis of coenzyme A, CoA, is a central molecule involved in all metabolisms (carbohydrates, lipids and proteins). At least 70 enzymes have been identified as requiring CoA or ACP derivatives for their function. Besides this, pantothenic acid itself is a component of fatty acid synthase complex and is involved in the formation of fatty acids.

Deficiency:

Co-enzyme A is concerned with the pigmentation of skin and hair. It is also known as the 'anti-graying factor. Deficiency causes pellagra like symptoms in chicks. In human beings, there occurs "burning feet syndrome" which can be cured by the injection of calcium pantothenate. In human beings, it develops irritability, restlessness, fatigue and gastrointestinal troubles.

Vitamin B6

It is also known as pyridoxine which is a primarily alcohal. It is the generic name officially given to a group of naturally occurring derivatives of pyridine. They differ from each other in the structure

of a functional group attached to 4th carbon in the pyridine ring.

The daily requirement of normal adult man is about 1.5-2mg. infants also require 2 mg per day. Pregnant women requires about 6-7 mg per day.

Liver, meat, fish, yeast, cereals and legumes are rich sources of pyridoxime.

Physiological role:

- Pyridoxine is required for the balancing of hormonal changes in women as well as assisting the immune system and the growth of new cells. It is also involved in metabolism of proteins, fats and carbohydrates.
- It is involved in the metabolism of histamine.
- It is also involved in hemoglobin synthesis and function
- It assists in the balancing of sodium and potassium as well promotes red blood cell production. It is further involved in the nucleic acids RNA as well as DNA synthesize. It is further linked to cancer immunity and fights the formation of the toxic chemical homocysteine, which is detrimental to the heart muscle.

Deficiency of vitamin B6:

Deficiency of Vitamin B6 is associated with neurogical symptoms such as Irritability, nervousness, mental confusion and insomnia as well as general weakness, skin changes such as dermatitis and acne as well asthma and allergies might develop when pyridoxine is in short supply. Symptoms may include nails that are ridged, an inflamed tongue as well as changes to your bones - which can include osteoporosis and arthritis. Kidney stones may also appear.

Vitamin B7

It is also known as biotin, co-enzyme R or Vitamin H or anti egg white injury factor. It is known as the growth factor for yeast and was isolated from egg yolk by Kogl and Tonnis. It is a heterocyclic sulfur containing monocarboxylic acid.

Rich sources are liver, kidney, egg yolk, milk and molasses. In vertebrates, nuts and cereals, it is present in moderate amount. It may be synthesized by intestinal bacteria, which is more potent source than that obtained from the diet.

Although it is synthesized in sufficient amount by intestinal bacteria, yet 150 to 300 mg is recommended daily.

Physiological functions:

It plays an important role in variety of carboxylation and decarboxylation reactions. It acts as a co-enzyme in the fixation of CO_2 in carboxylation reaction such as the conversion of pyruvic acid to oxalo-acetic acid or the carboxylation of acetyle-co-enzyme A to form malonyl co-enzyme A in fatty acid biosynthesis.

Deficiency:

Its deficiency in the human being causes dermatitis which is followed by anorexia, muscular pain and hyperesthesia. In rats, its deficiency leads to loss of hair and muscular control.

Folic acid

It is also known as pteroylglutamic acid (PGA). Several other compounds have been obtained showing similar biological properties as folic acid and are known as vitamin M, vitamin B_c, factor R, factor S, factor U, lactobacillus casei factor and the anti-anaemic factor.

In liver, kidney, yeast and mushroom, it is found in abundance. Green leaves and grass are also rich source of folic acid. It is present in good amounts in wheat, gram, dried lima beans,

peanuts and whole wheat. In small amounts, it is found in tomatoes, bananas, rice, corn, sweet potatoes and meat.

Folic acid is synthesized by bacteria in the large intestine but this is of little significance since folic acid is absorbed in the jejunum. The daily requirement of folic acid is not fairly determined but about 0.15 to 4 mg per day has been found to be adequate.

Physiological functions:

Folic acid plays an essential role in the cellular metabolism. Folic acid performs three main functions: (a) it is concerned with nucleoproteins, (b) it is essential for growth of micro-organisms and (c) it is a potent anti-anaemic factor, for this vitamin is concerned with maturation of RBC.

Deficiency:

Folic acid deficiency in man causes megaloblastic and nutritional macrocytic anaemia leucopenia, mouth lesions, glossitis and disorders of the gastrointestinal tract. In rats deficiency of this vitamin leads to graying of hair.

Vitamin B12

It is also known as cobalamine, antipernicious anaemia vitamin, and animal protein factor (APF) or extrinsic factor of castle. It is the only vitamin with complex structure.

The best source of this vitamin are liver, eggs meat, beef, muscles, milk and milk products. Vegetable food generally lack these vitamins. Intestinal flora of the microorganisms can also synthesize these vitamins. There is no interference with absorption.

The daily requirement of this vitamin recommended for an adult is about 3 µg/day. children require about 0.5-1.5 µg/day.

Physiological functions:

There are only two clinically significant reactions in the body that require vitamin B12 as a cofactor. During the catabolism of fatty acids with an odd number of carbon atoms and the amino acids valine, isoleucine and threonine the resultant propionyl-CoA is converted to succinyl-CoA for oxidation in the TCA cycle. One of the enzymes in this pathway, methylmalonyl-CoA mutase, requires vitamin B12 as a cofactor in the conversion of methylmalonyl-CoA to succinyl-CoA. The
5'-deoxyadenosine derivative of cobalamin is required for this reaction.

The second reaction requiring vitamin B12 catalyzes the conversion of homocysteine to methionine and is catalyzed by methionine synthase. This reaction results in the transfer of the methyl group from N^5-methyltetrahydrofolate to hydroxycobalamin generating tetrahydrofolate (THF) and methylcobalamin during the process of the conversion.

Deficiency:

The most important disease associated with vitamin B12 deficiency is pernicious anemia. It is characterized by low haemoglobin levels, decreased number of erythrocytes and neurological manifestations.