Notes

10

VITAMINS

10.1 INTRODUCTION

The term "vitamin" is used to describe certain organic compounds that are needed by the body but that cannot be manufactured by the body. They mainly serve as catalysts for certain reactions in the body. The amounts of vitamins required are very small, perhaps hundredths of grams. Vitamins are mainly obtained from our foods.

OBJECTIVES

After reading this lesson, you will be able to

- classify vitamins
- describe Water soluble vitamins
- describe Fat soluble vitamins

10.2 CLASSIFICATION OF VITAMINS

Based on solubility Vitamins are classified as either fat-soluble (lipid soluble) or water-soluble. Vitamins A, D, E and K are fat-soluble Vitamin C and B is water soluble.

WATER-SOLUBLE VITAMINS

10.3 B-COMPLEX VITAMINS

Eight of the water-soluble vitamins are known as the vitamin B-complex group: thiamin (vitamin B1), riboflavin (vitamin B2), niacin (vitamin B3), vitamin B6 (pyridoxine), folate (folic acid), vitamin B12, biotin and pantothenic acid. The

B vitamins are widely distributed in foods and their influence is felt in many parts of the body. They function as coenzymes that help the body obtain energy from food. The B vitamins are also important for normal appetite, good vision, and healthy skin, nervous system, and red blood cell formation.

10.3.1 Thiamin: Vitamin B1

Thiamin, or vitamin B1, helps to release energy from foods, promotes normal appetite, and is important in maintaining proper nervous system function.

Food Sources for Thiamin

Sources include peas, pork, liver, and legumes. Most commonly, thiamin is found in whole grains and fortified grain products such as cereal, and enriched products like bread, pasta, rice, and tortillas. The process of enrichment adds back nutrients that are lost when grains are processed. Among the nutrients added during the enrichment process are thiamin (B1), niacin (B3), riboflavin (B2), folate and iron.

RDA (Required Daily allowance)

Males: 1.2 mg/day; **Females**: 1.1 mg/day

Thiamin Deficiency

Under-consumption of thiamin is rare due to wide availability of enriched grain products. However, low calorie diets as well as diets high in refined and processed carbohydrates may place one at risk for thiamin deficiency. Alcoholics are especially prone to thiamin deficiency because excess alcohol consumption often replaces food or meals. Symptoms of thiamin deficiency include: mental confusion, muscle weakness, wasting, water retention (edema), impaired growth, and the disease known as beriberi. Thiamin deficiency is currently not a problem in the United States.

Thiamin toxicity

No problem with overconsumption are known for thiamin.

10.3.2 Riboflavin: Vitamin B2

Riboflavin, or vitamin B2, helps to release energy from foods, promotes good vision, and healthy skin. It also helps to convert the amino acid tryptophan (which makes up protein) into niacin.

Food Sources

Sources include liver, eggs, dark green vegetables, legumes, whole and enriched grain products, and milk. Ultraviolet light is known to destroy riboflavin, which is why most milk is packaged in opaque containers instead of clear.

Notes

RDA

Males: 1.3 mg/day; **Females:** 1.1 mg/day

Deficiency

Under consumption of riboflavin is rare. However, it has been known to occur with alcoholism, malignancy, hyperthyroidism, and in the elderly. Symptoms of deficiency include cracks at the corners of the mouth, dermatitis on nose and lips, light sensitivity, cataracts, and a sore, red tongue.

Riboflavin toxicity

No problems with overconsumption are known for riboflavin.

10.3.3 Niacin: Vitamin B3, Nicotinamide, Nicotinic Acid

Niacin, or vitamin B3, is involved in energy production, normal enzyme function, digestion, promoting normal appetite, healthy skin, and nerves.

Food Sources for Niacin

Sources include liver, fish, poultry, meat, peanuts, whole and enriched grain products.

RDA

Males: 16 mg/day; **Females:** 14 mg/day

Niacin Deficiency

Niacin deficiency is known to occur with alcoholism, protein malnourishment, low calorie diets, and diets high in refined carbohydrates. Pellagra is the disease state that occurs as a result of severe niacin deficiency. Symptoms include cramps, nausea, mental confusion, and skin problems.

Niacin toxicity

Consuming large doses of niacin supplements may cause flushed skin, rashes, or liver damage. Over consumption of niacin is not a problem if it is obtained through food.

10.3.4 Vitamin B6: Pyridoxine, Pyridoxal, Pyridoxamine

Vitamin B6, otherwise known as pyridoxine, pyridoxal or pyridoxamine, aids in protein metabolism and red blood cell formation. It is also involved in the body's production of chemicals such as insulin and hemoglobin.

Food Sources for Vitamin B6

Sources include pork, meats, whole grains and cereals, legumes, and green, leafy vegetables. The RDA for vitamin B6 is 1.3 mg/day for adult males and females through age fifty.

Vitamin B6 Deficiency

Deficiency symptoms include skin disorders, dermatitis, cracks at corners of mouth, anemia, kidney stones, and nausea. A vitamin B6 deficiency in infants can cause mental confusion.

Too much Vitamin B6

Over consumption is rare, but excess doses of vitamin B6 over time have been known to result in nerve damage.

10.3.5 Folate: Folic Acid, Folacin

Folate, also known as folic acid or folacin, aids in protein metabolism, promoting red blood cell formation, and lowering the risk for neural tube birth defects. Folate may also play a role in controlling homocysteine levels, thus reducing the risk for coronary heart disease.

Food Sources for Folate

Sources of folate include liver, kidney, dark green leafy vegetables, meats, fish, whole grains, fortified grains and cereals, legumes, and citrus fruits. Not all whole grain products are fortified with folate..

RDA

The RDA for folate is 400 mcg/day for adult males and females. Pregnancy will increase the RDA for folate to 600 mcg/day.

Folate Deficiency

Folate deficiency affects cell growth and protein production, which can lead to overall impaired growth. Deficiency symptoms also include anemia and diarrhea. A folate deficiency in women who are pregnant or of child bearing age may result in the delivery of a baby with neural tube defects such as spina bifida.

Folate toxicity

Over consumption of folate offers no known benefits, and may mask B12 deficiency as well as interfere with some medications.

10.3.6 Vitamin B12: Cobalamin

Vitamin B12, also known as cobalamin, aids in the building of genetic material, production of normal red blood cells, and maintenance of the nervous system.

Notes

Food Sources for Vitamin B12

Vitamin B12 can only be found only in foods of animal origin such as meats, liver, kidney, fish, eggs, milk and milk products, oysters, shellfish. Some fortified foods may contain vitamin B12.

RDA

The Recommended Dietary Allowance (RDA) for vitamin B12 is 2.4 mcg/day for adult males and females

Vitamin B12 Deficiency

Vitamin B12 deficiency most commonly affects strict vegetarians (those who eat no animal products), infants of vegan mothers, and the elderly. Symptoms of deficiency include anemia, fatigue, neurological disorders, and degeneration of nerves resulting in numbness and tingling. In order to prevent vitamin B12 deficiency, a dietary supplement should be taken. Some people develop a B12 deficiency because they cannot absorb the vitamin through their stomach lining. This can be treated through vitamin B12 injections.

Vitamin B12 toxicity

No problems with overconsumption of vitamin B12 are known.

10.3.7 Biotin

Biotin helps release energy from carbohydrates and aids in the metabolism of fats, proteins and carbohydrates from food.

Food Sources for Biotin

Sources of Biotin include liver, kidney, egg yolk, milk, most fresh vegetables, yeast breads and cereals. Biotin is also made by intestinal bacteria.

RDA

The Adequate Intake (AI) for Biotin is 30 mcg/day for adult males and females

Biotin Deficiency

Biotin deficiency is uncommon under normal circumstances, but symptoms include fatigue, loss of appetite, nausea, vomiting, depression, muscle pains, heart abnormalities and anemia.

Biotin toxicity

No problems with overconsumption are known for Biotin.

10.3.8 Pantothenic Acid

Pantothenic Acid is involved in energy production, and aids in the formation of hormones and the metabolism of fats, proteins, and carbohydrates from food.

Food Sources for Pantothenic Acid

Sources include liver, kidney, meats, egg yolk, whole grains, and legumes. Pantothenic Acid is also made by intestinal bacteria.

RDA

The Adequate Intake (AI) for Pantothenic Acid is 5 mg/day for both adult males and females.

Pantothenic Acid Deficiency

Pantothenic Acid deficiency is uncommon due to its wide availability in most foods.

Pantothenic Acid toxicity

No problems with overconsumption are known for Pantothenic Acid. Rarely, diarrhea and water retention will occur with excessive amounts.

10.4 VITAMIN C: ASCORBIC ACID, ASCORBATE

The body needs vitamin C, also known as ascorbic acid or ascorbate. Vitamin C benefits the body by holding cells together through collagen synthesis; collagen is a connective tissue that holds muscles, bones, and other tissues together. Vitamin C also aids in wound healing, bone and tooth formation, strengthening blood vessel walls, improving immune system function, increasing absorption and utilization of iron, and acting as an antioxidant.

Since our bodies cannot produce or store vitamin C, an adequate daily intake of this nutrient is essential for optimum health. Vitamin C works with vitamin E as an antioxidant, and plays a crucial role in neutralizing free radicals throughout the body. An antioxidant can be a vitamin, mineral, or a carotenoid, present in foods, that slows the oxidation process and acts to repair damage to cells of the body. Studies suggest that vitamin C may reduce the risk of certain cancers, heart disease, and cataracts. Research continues to document the degree of these effects.

Food Sources for Vitamin C

Consuming vitamin C-rich foods is the best method to ensure an adequate intake of this vitamin. While many common plant foods contain vitamin C, the best sources are citrus fruits (orange, kiwi fruit, grape etc,)

Notes

RDA

The Recommended Dietary Allowance (RDA) for Vitamin C is 90 mg/day for adult males and 75 mg/day for adult females For those who smoke cigarettes, the RDA for vitamin C increases by 35 mg/day, in order to counteract the oxidative effects of nicotine.

Vitamin C Deficiency

Severe vitamin C deficiency result in the disease known as scurvy, causing a loss of collagen strength throughout the body. Loss of collagen results in loose teeth, bleeding and swollen gums, and improper wound healing. More commonly, vitamin C deficiency presents as a secondary deficiency in alcoholics, the elderly, and in smokers.

Vitamin C toxicity

Despite being a water-soluble vitamin that the body excretes when in excess, vitamin C overdoses have been shown to cause kidney stones, gout, diarrhea, and rebound scurvy.

FAT-SOLUBLE VITAMINS

The fat-soluble vitamins, A, D, E, and K, are stored in the body for long periods of time and generally pose a greater risk for toxicity when consumed in excess than water-soluble vitamins. Eating a normal, well-balanced diet will not lead to toxicity in otherwise healthy individuals. However, taking vitamin supplements that contain megadoses of vitamins A, D, E and K may lead to toxicity. The body only needs small amounts of any vitamin.

While diseases caused by a lack of fat soluble vitamins are rare symptoms of mild deficiency can develop without adequate amounts of vitamins in the diet. Additionally, some health problems may decrease the absorption of fat, and in turn, decrease the absorption of vitamins A, D, E and K. Consult a medical professional about any potential health problems that may interfere with vitamin absorption.

10.5 VITAMIN A: RETINOL

Vitamin A, also called retinol, has many functions in the body. In addition to helping the eyes adjust to light changes, vitamin A plays an important role in bone growth, tooth development, reproduction, cell division, gene expression, and regulation of the immune system. The skin, eyes, and mucous membranes of the mouth, nose, throat and lungs depend on vitamin A to remain moist.

Vitamin A is also an important antioxidant that may play a role in the prevention of certain cancers.

Food Sources for Vitamin A

Eating a wide variety of foods is the best way to ensure that the body gets enough vitamin A. The retinol, retinal, and retinoic acid forms of vitamin A are supplied primarily by foods of animal origin such as dairy products, fish and liver. Some foods of plant origin contain the antioxidant, betacarotene, which the body converts to vitamin A. Beta-carotene, comes from fruits and vegetables, especially those that are orange or dark green in color. Vitamin A sources also include carrots, pumpkin, winter squash, dark green leafy vegetables and apricots, all of which are rich in beta-carotene.

How much Vitamin A

The recommendation for vitamin A intake is expressed as micrograms (mcg) of retinol activity equivalents (RAE). Retinol activity equivalents account for the fact that the body converts only a portion of betacarotene to retinol. One RAE equals 1 mcg of retinol or 12 mcg of beta-carotene. The Recommended Dietary Allowance (RDA) for vitamin A is 900 mcg/ day for adult males and 700 mcg/ day for adult females.

Compared to vitamin A, it takes twice the amount of carotene rich foods to meet the body's vitamin A requirements, so one may need to increase consumption of carotene containing plant foods. Recent studies indicate that vitamin A requirements may be increased due to hyperthyroidism, fever, infection, cold, and exposure to excessive amounts of sunlight. Those that consume excess alcohol or have renal disease should also increase intake of vitamin A.

Vitamin A Deficiency

Vitamin A deficiency is rare, but the disease that results is known as xerophthalmia. It most commonly occurs in developing nations usually due to malnutrition. Since vitamin A is stored in the liver, it may take up to 2 years for signs of deficiency to appear. Night blindness and very dry, rough skin may indicate a lack of vitamin A. Other signs of possible vitamin A deficiency include decreased resistance to infections, faulty tooth development, and slower bone growth.

Vitamin A toxicity

The Tolerable Upper Intake Level (UL) for adults is 3,000 mcg RAE. It would be difficult to reach this level consuming food alone, but some multivitamin

Notes

supplements contain high doses of vitamin A. If you take a multivitamin, check the label to be sure the majority of vitamin A provided is in the form of beta-carotene, which appears to be safe. Symptoms of vitamin A toxicity include dry, itchy skin, headache, nausea, and loss of appetite. Signs of severe overuse over a short period of time include dizziness, blurred vision and slowed growth. Vitamin A toxicity also can cause severe birth defects and may increase the risk for hip fractures.

10.6 VITAMIN D

Vitamin D plays a critical role in the body's use of calcium and phosphorous. It works by increasing the amount of calcium absorbed from the small intestine, helping to form and maintain bones. Vitamin D benefits the body by playing a role in immunity and controlling cell growth. Children especially need adequate amounts of vitamin D to develop strong bones and healthy teeth.

Food Sources for Vitamin D

The primary food sources of vitamin D are milk and other dairy products fortified with vitamin D. Vitamin D is also found in oily fish (e.g., herring, salmon and sardines) as well as in cod liver oil. In addition to the vitamin D provided by food, we obtain vitamin D through our skin which produces vitamin D in response to sunlight.

RDA

The Recommended Dietary Allowance (RDA) for vitamin D appears as micrograms (mcg) of cholecalciferol (vitamin D3). From 12 months to age fifty, the RDA is set at 15 mcg. Twenty mcg of cholecalciferol equals 800 International Units (IU), which is the recommendation for maintenance of healthy bone for adults over fifty.

Exposure to ultraviolet light is necessary for the body to produce the active form of vitamin D. Ten to fifteen minutes of sunlight without sunscreen on the hands, arms and face, twice a week is sufficient to receive enough vitamin D. This can easily be obtained in the time spent riding a bike to work or taking a short walk. In order to reduce the risk for skin cancer one should apply sunscreen with an SPF of 15 or more, if time in the sun exceeds 10 to 15 minutes.

Vitamin D Deficiency

Symptoms of vitamin D deficiency in growing children include rickets (long, soft bowed legs) and flattening of the back of the skull. Vitamin D deficiency in adults may result in osteomalacia (muscle and bone weakness), and osteoporosis (loss of bone mass).

Recently published data introduces a concern that some adults and children may be more prone to developing vitamin D deficiency due to an increase in sunscreen use. In addition, those that live in inner cities, wear clothing that covers most of the skin, or live in northern climates where little sun is seen in the winter are also prone to vitamin D deficiency. Since most foods have very low vitamin D levels (unless they are enriched) a deficiency may be more likely to develop without adequate exposure to sunlight. Adding fortified foods to the diet such as milk, and for adults including a supplement, are effective at ensuring adequate vitamin D intake and preventing low vitamin D levels.

Vitamin D deficiency has been associated with increased risk of common cancers, autoimmune diseases, hypertension, and infectious disease. In the absence of adequate sun exposure, at least 800 to 1,000 IU of vitamin D3 may be needed to reach the circulating level required to maximize vitamin D's benefits.

Vitamin D toxicity

The Tolerable Upper Intake Level (UL) for vitamin D is set at 100 mcg for people 9 years of age and older. High doses of vitamin D supplements coupled with large amounts of fortified foods may cause accumulations in the liver and produce signs of poisoning. Signs of vitamin D toxicity include excess calcium in the blood, slowed mental and physical growth, decreased appetite, nausea and vomiting.

It is especially important that infants and young children do not consume excess amounts of vitamin D regularly, due to their small body size.

10.7 VITAMIN E: TOCOPHEROL

Vitamin E benefits the body by acting as an antioxidant, and protecting vitamins A and C, red blood cells, and essential fatty acids from destruction. Research from decades ago suggested that taking antioxidant supplements, vitamin E in particular, might help prevent heart disease and cancer. However, newer findings indicate that people who take antioxidant and vitamin E supplements are not better protected against heart disease and cancer than non-supplement users. Many studies show a link between regularly eating an antioxidant rich diet full of fruits and vegetables, and a lower risk for heart disease, cancer, and several other diseases. Essentially, recent research indicates that to receive the full benefits of antioxidants and phytonutrients in the diet, one should consume these compounds in the form of fruits and vegetables, not as supplements.

Food Sources for Vitamin E

About 60 percent of vitamin E in the diet comes from vegetable oil (soybean, corn, cottonseed, and safflower). This also includes products made with

Notes

vegetable oil (margarine and salad dressing). Vitamin E sources also include fruits and vegetables, grains, nuts (almonds and hazelnuts), seeds (sunflower) and fortified cereals.

RDA

The Recommended Dietary Allowance (RDA) for vitamin E is based on the most active and usable form called alpha-tocopherol. Food and supplement labels list alpha-tocopherol as the unit International units (IU) not in milligrams (mg). One milligram of alpha-tocopherol equals to 1.5 International Units (IU). RDA guidelines state that males and females over the age of 14 should receive 15 mcg of alpha-tocopherol per day. Consuming vitamin E in excess of the RDA does not result in any added benefits.

Vitamin E Deficiency

Vitamin E deficiency is rare. Cases of vitamin E deficiency usually only occur in premature infants and in those unable to absorb fats. Since vegetable oils are good sources of vitamin E, people who excessively reduce their total dietary fat may not get enough vitamin E.

Vitamin E toxicity

Vitamin E obtained from food usually does not pose a risk for toxicity. Supplemental vitamin E is not recommended due to lack of evidence supporting any added health benefits. Megadoses of supplemental vitamin E may pose a hazard to people taking blood-thinning medications such as Coumadin (also known as warfarin) and those on statin drugs.

10.8 VITAMIN K

Vitamin K is naturally produced by the bacteria in the intestines, and plays an essential role in normal blood clotting, promoting bone health, and helping to produce proteins for blood, bones, and kidneys.

Food Sources for Vitamin K

Good food sources of vitamin K are green, leafy-vegetables such as turnip greens, spinach, cauliflower, cabbage and broccoli, and certain vegetables oils including soybean oil, cottonseed oil, canola oil and olive oil. Animal foods, in general, contain limited amounts of vitamin K.

RDA

Males and females age 14 - 18: 75 mcg/day; Males and females age 19 and older: 90 mcg/day

Vitamin K Deficiency

Hemorrhage can occur due to sufficient amounts of vitamin K. Vitamin K deficiency may appear in infants or in people who take anticoagulants, such as Coumadin (warfarin), or antibiotic drugs. Newborn babies lack the intestinal bacteria to produce vitamin K and need a supplement for the first week. Those on anticoagulant drugs (blood thinners) may become vitamin K deficient, but should not change their vitamin K intake without consulting a physician. People taking antibiotics may lack vitamin K temporarily because intestinal bacteria are sometimes killed as a result of long-term use of antibiotics. Also, people with chronic diarrhea may have problems absorbing sufficient amounts of vitamin K through the intestine and should consult their physician to determine if supplementation is necessary.

Vitamin K toxicity

Although no Tolerable Upper Intake Level (UL) has been established for vitamin K, excessive amounts can cause the breakdown of red blood cells and liver damage. People taking blood-thinning drugs or anticoagulants should moderate their intake of foods with vitamin K, because excess vitamin K can alter blood clotting times. Large doses of vitamin K are not advised.

INTEXT QUESTIONS 10.1

1. Fill in the balnks:

1. Vitamins are classified into ..... and .....
2. Vitamin B complex comprises ..... vitamins in total.
3. Pellagra and Scurvy are caused by ..... and ..... deficiency.
4. Water soluble vitamins are excreted through .....
5. ..... can be synthesized by human body.

2. Match the following

1. Vitamin A deficiency	(a) Vitamin D
2. Vitamin K	(b) Vitamin E
3. Bone formation	(c) Vitamin B12
4. Cobalamin	(d) Night blindness
5. Tocopherol	(e) Coagulation

Notes

3. True or false:

1. Vitamins are required in large amounts.
2. Vitamin B2 is otherwise known as Riboflavin.
3. All vitamins are synthesized in our body. (false)
4. Fat malabsorption leads to deficiency of fat soluble vitamins.
5. Water soluble vitamins are stored in our body.

WHAT HAVE YOU LEARNT

- The term vitamin is used to describe certain orgain compounds that are needed by the body but they cannot be manufactured by the body
- Vitamins serve as catalysts for certain reactions in the body
- Based on solubility vitamins are classified as either fat soluble or vitamin soluble
- Vitamins A, D, E and K are fat soluble and vitamins C and B is water soluble

TERMINAL QUESTIONS

1. Name the B complex vitamins.
2. Classification of vitamins.
3. Give the RDA of thiamine, folate, niacin, vitamin C.
4. Name the fat soluble vitamins and where they are stored?
5. What are the symptoms of Pellagra and Scurvy?

ANSWERS TO INTEXT QUESTIONS

1.
1. fat soluble and water soluble
2. Eight
3. Niacin and vitamin C
4. urine
5. vitamin D

2. 1. (d) 2. (e) 3. (a) 4. (c) 5. (b)

3. 1. false 2. true 3. false 4. true 5. false