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VITAMINS & MINERALS: AN OVERVIEW

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ABSTRACT

This review will discuss some common methods used to study vitamin absorption and the proposed mechanisms of absorption, and will conclude with a section about dietary regulation. Vitamins are essential organic nutrients. Minute amounts of vitamins participate in three general functions of the body: growth, protection and energy regulation. There are a total of 16 vitamins. Four are fat-soluble: vitamins A, D, E and K. The rest are water-soluble. Eight vitamins are in the B complex: RIBOFLAVIN (B1), THIAMIN (B2), NIACIN (B3), VITAMIN B6, and vitamin B12, FOLIC ACID, PANTOTHENIC ACID and BIOTIN. VITAMIN C is also water-soluble but is not considered a B vitamin, which functions as enzyme helpers (coenzymes). Two additional substances that have vitamin functions are known as CHOLINE and INOSITOL. Vitamins either cannot be synthesized by the body or they cannot be made in adequate amounts, so they must be supplied by the diet. As examples of the latter, vitamin D can be made in the skin when exposed to sunlight, while some niacin can be made from the amino acid tryptophan. The intestine is a source of BIOTIN, pantothenic acid and VITAMIN K; these are supplied by "friendly" intestinal bacteria, though the exact amounts supplied are difficult to assess. The term '"vitamin" dates from 1912, and the first vitamin to be isolated was vitamin A in 1913. Thiamin was discovered in 1926, vitamin K in 1929, and vitamin C in 1932. Vitamin B12 was the most recent vitamin to be discovered (1948). Before a compound can be classified as a vitamin, it must be proven that animals must obtain the compound from their diet. Typically, scientists test lab animals such as mice with a diet free of the test substance, together with a dose of antibiotics to eliminate intestinal bacteria. The concept of homeostasis might apply to several of the vitamins as it does to minerals, water, etc.

Keywords: Water-soluble vitamins, fat-soluble vitamins, vitamin deficiency, Supplements.

INTRODUCTION

Polish Chemist Casimir Funck coined the term vitamin in 1910 after isolating from rice a substance curing the disorder beriberi. He called the substance 'vital amine' which then vitamins grew (and shrank, as some vitamins were relegated to 'vitamin-like substances'). The name of a vitamin is a letter representing a group of chemical compounds (e.g. vitamin A, vitamin B). A number to distinguish between the various subgroups of chemicals then follows this letter (e.g. vitamin B12). There may be a further subdivision, where a lower case letter is added to the name (e.g. vitamin B12b).The presence of all vitamins is essential to a healthy physiology. They perform a variety of vital functions within the body e.g. as cofactors for enzymatic reactions. A severe deficiency, or a vitaminosis, causes some form of disease (1-3).

Each type of vitamin deficiency is associated with its own disease (deficiency of vitamin D leads to rickets, of vitamin C to scurvy and of vitamin A to blindness). Deficiencies also have subtler influences on health the importance of which have not always been understood. For example UNICEF mentions that vitamin A is essential for a child's immune system to function properly as it improves resistance to disease, and is key to improving a child's survival, growth and development. It then goes on to state - "In the past, vitamin A deficiency (VAD) has been seen solely as a cause of blindness, and in many countries, vitamin A activities are still limited to blindness prevention. As a rule, vitamins cannot be synthesized at all or in large enough quantities in the human body and must be supplied from the environment through diet. Just as with carbohydrates, it is possible to

construct 'food-chains' for vitamins, starting with bacteria or yeast (2, 4-6).

Vitamins can be said to be associated with various illnesses in 3 ways:

- Problems are caused by a lack of a vitamin (vitamin deficiency or avitaminosis)
- Problems are caused by an excess of a vitamin (vitamin toxicity or hypervitaminosis)
- A vitamin is used for therapy (high dosage for a limited time span).
- Other uses - e.g. E300 or vitamin C is used as an antixodant (3).

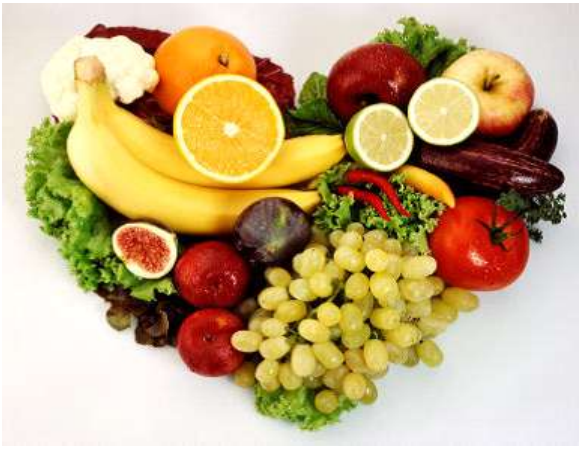

Figure 1: Various natural sources of vitamins

Vitamins (4-7)

Definition

- It is an organic compound, required in small amounts by an organism to obtain cellular functions.
- It is called vitamin, when it cannot be synthesized in sufficient quantities by the organism, and must therefore be supplied by the diet.
- Vitamins are the nutrients our bodies need in order to maintain functions such as immunity and metabolism. There is very little in our bodies that can be done without a vitamin being needed and it is important to know the types, fat soluble and water soluble, before learning about each one.
- Fat soluble vitamin is the classification of vitamins that are stored in fat cells when excess is present. They have toxicity levels associated with them as they are not gotten rid of by the body. They also need fat in order to be absorbed.
- Water soluble vitamins are not stored in the body. The body takes what it needs from food and then excretes what is not needed as waste. They also are easily destroyed by cooking and care should be taken when cooking vegetables.

History of Vitamins

- In ancient Egypt: Feeding of patients with liver to prevent night blindness (now known as vitamin A deficiency)
- In 1749, the prevention of scurvy by citrus foods, was first discovered by the Scottish surgeon James Lind.
- In the Orient: Beriberi was common (a disease caused by the deficiency of Vitamin B1), because of polished white rice (5).

Properties of vitamins

The vitamins are organic, low molecular weight substances that have key roles in metabolism. Few are single substances; most are families of chemically-related substances sharing biological activities. The vitamins comprising a vitamin family may vary in biopotency. Otherwise, vitamin families are chemically heterogeneous; therefore, it is convenient to classify the vitamins according to their physical properties. Some vitamins are fat-soluble; the others are water-soluble. The water-soluble vitamins (C, thiamin, riboflavin, pyridoxine, biotin, pantothenic acid, folate, B12) tend to have one or more polar or ionizable groups, whereas the fat-soluble vitamins (A, D, E, and K) have predominantly aromatic and aliphatic characters. These traits determine the nature of their absorption, transport, tissue distribution, and metabolic function. Vitamins function as antioxidants, affectors of gene transcription, H+/e− donors/acceptors, hormones, and coenzymes (6, 7).

Supplements of Primary Importance

1. Zinc, Manganese: Anti-Oxidants: Vit. A (or betacarotene), C, E, Selenium (6-8)

Free radical damage is the leading theory of at least some forms of aging. Anti-oxidants intercept free radicals (chemicals with extra available electrons) before they damage (oxidize) the cell and its DNA.
Vit. A (betacarotene = pro-vit. A) and C: Water soluble vitamins. Betacarotene protects the skin from sunburn. Vit. C is an important co-factor in protein chemistry and has many other uses.
Vit. E: Oil soluble vitamin (Acts as an anti-oxidant in fat cells, etc).

Minerals: Act as agents in the formation of anti-oxidants. For example, selenium is the limiting mineral inglutathione per oxidase, one of the body's primary anti-oxidants.

Extra vitamin C is recommended, especially if you take Choline and/or Cysteine or are under emotional or physical stress. We take a total of 4 gm of Vit C a day. Note: All vertebrates, with the exception of primates, make their own Vit. C. To have the average Vit. C concentration of the typical vertebrate, a 160pound person must consume roughly 10 gms of Vit. C per day. We use Trader Joe's anti-oxidant capsules (2 pills morning. 2 pills evening), and Time release Vit. C (1 gm morning, afternoon, evening).

2. B Vitamins: B-1, B-2, B-3, B-5, B-6, B-12

B Vitamins are the primary co-factors in almost all protein chemistry reactions (note that a lot of the B vitamins go by other names, e.g. B-3 = Niacin—there are also a lot of B-Vitamin-like substances, e.g. GABA).So not to have them in abundant supply means that your body cannot efficiently produce the 50,000 known proteins that occur in the human body. We use Trader Joe's time release B-100 capsules (providing100 mg of most almost

all of the B vitamins—B12 in microgram amounts). Take one pill before bed.

3. Minerals: More protein co-factors and anti-oxidant co-factors.

Note: Men do not need any additional iron, especially in the iron fortified American diet. In fact, too much iron in men has been shown to be bad for the heart. In general, minerals should not be taken with anti-oxidants since some constituents will cancel each other out (reactive minerals with oxidize the anti-oxidants).
Be sure to use chelated or coloidal minerals. Elemental minerals are almost of no use (less than 10% bioavailable). Chelated minerals are roughly 50% bio-available. Coloidal minerals are almost 100% bioavailable but are very expensive. We use Trader Joe's multi-minerals (chelated minerals). We recommend to take 2 to 4 pills in the afternoon.

4. Cysteine: Sulfur containing amino acid.

The second amino acid in the sulfur containing amino acid chain (methionine, cysteine, taurine). The sulphur containing amino acids are extremely important. Sulfur-sulfur bonds are largely responsible for the catalytic shape of protein molecules and sulfur is what holds proteins in cell membranes—see essential fatty acids below. Cysteine is normally the limiting amino acid in the formation of glutathione peroxidase, an important anti-oxidant, an antitoxin, an immune system stimulant 1,a cancer preventative, 2, and a neuro-transmitter, 3. Note, taking glutathione peroxidase directly is expensive, and the body breaks it down before absorption anyway. Available at Henry's. 500 mg in morning and 500 mg in afternoon. Good for hair and skin.

5. L-Phenylalanine: Top of the Norepinephrine (nor-adrenaline) Cycle

Phenylalanine, "the Pain Reliever", is one of the 8 essential amino acids. Phenylalanine is one of the aromatic amino acids (the others being tyrosine and tryptophan). Phenylalanine gives energy, especially in the morning, enhances learning, alertness, and memory (4,5). Source of important neurotransmitters. 500 mg per day in morning. supplement should not be taken by phenyl keto nurics. DL-Phenylalanine is also sometimes taken. For this amino (and a few others) the D form is nontoxic and of benefit. The D form is also used as a pain reliever.

6. Chromium Picolinate: Helps with sugar metabolism. Antifat nutrient.

Chromium is the limiting trace mineral in glucose tolerance factor (GTF), the substance that determines when the body will bring out more insulin to store blood sugar as fat. Picolinate is the form of niacin that is also used in GTF. Chromium in its trivalent form is well known to cut sugar cravings, increase the basal metabolism, and reduce caloric absorption6.

7. Broad-Spectrum Amino Acid Supplement.

Several varieties are available: pills and powders. Get predigested proteins that have been broken down to free-form amino acids and di- and tri-peptide bonded amino acids. That's why we're taking the aminos, i.e. for easy absorption in case the body is having trouble breaking up our food protein or in producing specific amino acids in certain protein-protein chemical reactions. Also, several of the di- and tri-peptide bonded aminos are now suspected of being essential, i.e. needed and unable to be produced by the body (9-12).

Figure 2: Various natural sources of respective vitamins

Functions and Categories (6, 9-12)

- Vitamins have various functions that help to regulate metabolism, to prevent chronic diseases (such as heart disease and cancer), and to maintain normal appetite, mental health, and immunity.
- Vitamins can basically be classified into the following two categories:

Water soluble vitamins	Fats soluble vitamins
• Thiamin	A
• Riboflavin	D
• Niacin	K
• B6	E
• B12	
• Biotin	
• Pantothenic acid	
• Vitamin C	

WATER SOLUBLE VITAMINS (13-18)

Vitamin B1

Natural sources of vitamin B1

Animal products:

Offal (liver, kidneys, heart), fish, meat (porc)

Vegetable products:

Cereals, leafy vegetables, fruits (dried), pulses, nuts
Other:
Brewer's yeast.

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The role of vitamin B1

> Energy metabolism (co-enzyme)
> Essential for metabolism of carbohydrates, lipids, proteins (co-enzyme)
> Required for proper functioning of the nervous system and muscles, which has implications for proper functioning of the cardiovascular system.

Physical symptoms of vitamin B1 deficiency

> Beriberi (still occurs in South-East Asia),

Groups at risk of deficiency:

> Alcoholics

Thiamine (Vitamin B1)

- Was the first B vitamin identified?
- Is part of the coenzyme thiamine pyrophosphate (TPP).
- TPP coenzyme is required by enzymes in the decarboxylation of alpha-keto carboxylic acids.
- Deficiency results in beriberi (fatigue, weight loss, and nerve degeneration).

Thaimine

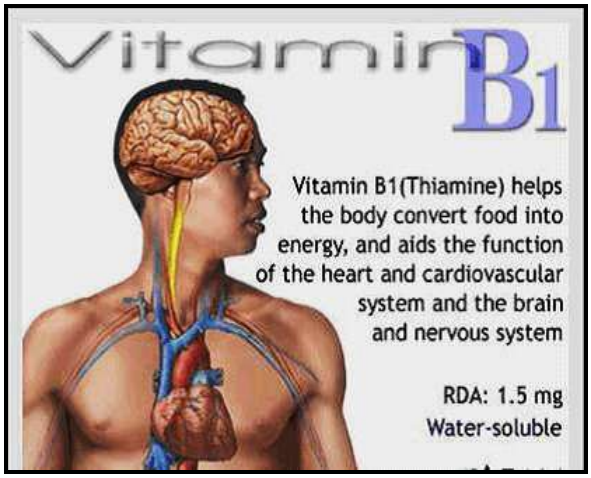

Figure 3: Uses of Vitamin B1

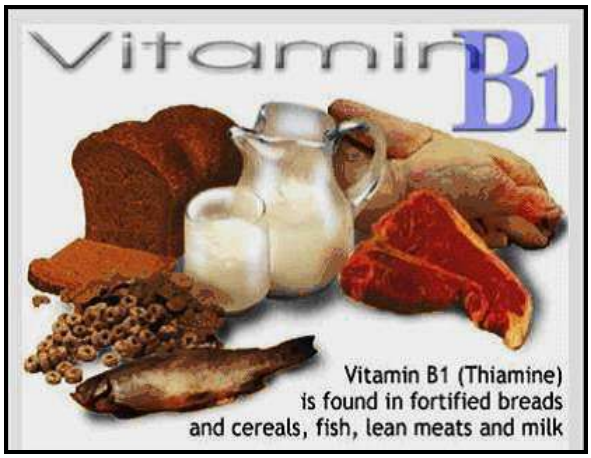

Figure 4: Sources of Vitamin B1

- Influences sacharide metabolism
- Helps against tiredness
- Is destroyed by severe washings of rice and vegetables
- Severe deficiency leads to beri-beri
- Sources: yeasts, cereals, rice, liver, legumes (15,16)

Vitamin B2

Natural sources of vitamin B2

Animal products:

Offal (liver, kidneys, heart), eggs, meat, milk, cheeses

Vegetable products:

Cereals, vegetables
Other:
Brewer's yeast

The role of vitamin B2

> Essential for the metabolism of carbohydrates, lipids and proteins (co-enzyme in many reactions)
> General effect on tissues and organs (maintains health of mucosa)
> Stimulates growth and reproduction
> Conversion of vitamin (B6, folic acid and niacin) into their active co-enzyme forms.

Physical symptoms of vitamin B2 deficiency

> Skin and tissue membrane lesions (lips, tongue, fissures at corners of mouth)
> Ocular symptoms (corneal vascularisation associated with sensitivity to bright light, impaired vision, itching)
> Inflamed mucosal membranes.

Groups at risk of deficiency:

> Individuals whose food intake is unadequate
> Chronic dieters
> Individuals who exclude milk products

Riboflavin (Vitamin B2)

- Made of the sugar alcohol ribitol and flavin
- Part of the coenzymes flavin adenine dinucleotide (FAD) and flavin mononucleotide (FMN).
- Needed for good vision and healthy skin.

Riboflavin

- Sacharide and lipids metabolism
- Curing of skin diseases
- Support of sight function
- Light sensitive (18).

Vitamin B3

Natural sources of vitamin B3

Animal products:

Offal (liver, kidneys, heart), fish, meat

Vegetable products:

Cereals, pulses, fruit (avocados, figs, dates, prunes), nuts
Other:
Synthesized from tryptophan

The role of vitamin B3

> Required for the energy supply to all metabolic reactions in the body
> Required for growth.

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Physical symptoms of vitamin B3 deficiency

> Pellagra
> Skin lesions
> Digestive inefficiency
> Insomnia
> Fatigue
> Loss of appetite

Groups at risk of deficiency:

> Chronic alcoholics
> Individuals whose staple diet is maize or barley
> Patients with Hartnup's disease.

Niacin (Vitamin B3)

- Is part of the coenzyme nicotinamide adenine dinucleotide (NAD+) involved in oxidation-reduction reactions.
- Deficiency can result in dermatitis, muscle fatigue, and loss of appetite.
- Is found in meats, rice, and whole grains (19,20).

Vitamin B6

Natural sources of vitamin B6

Animal products:

Chicken, liver (cattle, pig), fish (salmon, tuna, sardines, halibut, herring)

Vegetable products:

Nuts (walnut, peanut), corn and whole grain cereals, bread, vegetables, fruit.

The role of vitamin B6

> Required for the majority of biological reactions (i.e. amino acid metabolism, antibody production, neurotransmitter synthesis, red blood cell formation)

Physical symptoms of vitamin B6 deficiency

> Deficiency of vitamin B6 alone is uncommon; usually it occurs in combination with a deficit in other B-vitamins
> Poor growth
> Kidney stones
> Depression
> General fatigue
> Dizziness
> Nerve problems
> Irritability
> Convulsions
> Cutaneous lesions

Groups at risk of deficiency:

> Pregnant and breastfeeding women

Pyridoxine (Vitamin B6)

- Pyridoxine and pyridoxal are two forms of vitamin B6, which are converted to the coenzyme pyridoxal phosphate (PLP).

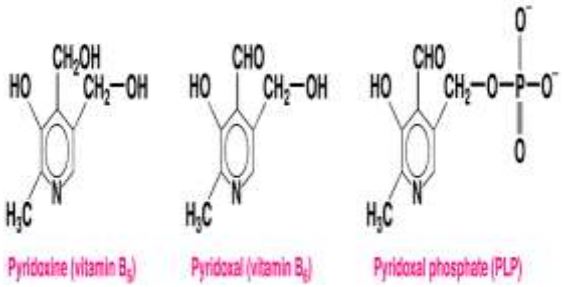

Figure 5: Chemical structure of vit B5 and B6

•PLP is required in the transamination of amino acids and decarboxylation of carboxylic acids.

- Deficiency of pyridoxine may lead to dermatitis, fatigue, and anemia.

Pyridoxine

- Aminoacids and protein metabolism
- Cure of anemy
- Formation of red blood cells
- Sources: meat, fish, liver, vegetables, cerals, yolk, legumes. (21,22)

Vitamin B12

Natural sources of vitamin B12

Animal products:

Offal (liver, kidneys, heart, brain), meat, eggs, fish, dairy products

The role of vitamin B12

> Required for the formation of red blood cells to prevent anemia
> Essential growth factor.

Physical symptoms of vitamin B12 deficiency

> Pernicious anemia
> General fatigue
> Loss of appetite
> Neuromuscular pain.

Cobalamin (Vitamin B12)

- Consists of four pyrrole rings with a Co2+.
- Is a coenzyme for enzymes that transfer methyl groups and produce red blood cells.
- Deficiency can lead to pernicious anemia and nerve damage (23).

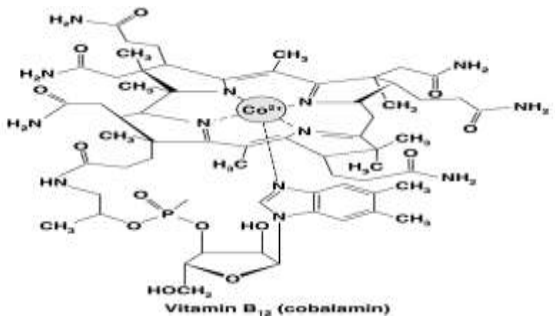

Figure 6: Chemical structure of vit B12

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Vitamin C

Natural sources of vitamin C

Animal products:

Milk, liver (ox/calf)
Vegetable products: Fruits (especially citrus fruits), vegetables, lettuce.

The role of vitamin C

> Multiple roles at a tissue and cell level (synthesis of collagen, Absorption of iron, formation of carnitine and tyrosine)
> Biological antioxidant (free radical scavenger).

Physical symptoms of vitamin C deficiency
> Scurvy (fatigue, loss of appetite and weight, lowered immune resistance to infections)
Groups at risk of deficiency:
> Smokers (active and passive)
> Individuals with a low-vitamin diet.

Ascorbic Acid (Vitamin C)

- Is required in collagen synthesis.
- Deficiency can lead to weakened connective tissue, slow-healing wounds, and anaemia.
- Is found in Indian gooseberries, blueberries, citrus fruits, tomatoes, broccoli, red and Green vegetables.

Vitamin C

- Hormone, collagen synthesis
- Infection resistance, cure of cuts
- Hypervitaminosis: addiction, diarrhea
- Source: fruits, vegetables. (23&24)

FAT SOLUBLE VITAMINS

Vitamin A

- Vitamin A is obtained from meats and beta-carotenes in plants.
- Beta-carotenes are converted by liver enzymes to vitamin A (retinol).

Natural sources of vitamin A

Animal products: Liver, egg yolk, butter, whole milk, cheese.

Vegetable products in the form of carotenoids (provitamin A):

Certain fruits (i.e. melon, apricot), green leafy vegetables (i.e. spinach,broccoli), carrots, pumpkins, palm oil.

The role of vitamin A

> Plays a role in mechanisms required for sight (11-cis retinal is the chromophore in the visual cycle)
> Essential for growth and development
> Required for healthy skin, epithelia and mucosa
> Effects on certain endocrine glands
> Important for fertility
> Essential for proper immune functions β-Carotene: Provitamin A, biological antioxidant.

Physical symptoms of vitamin A deficiency

> Delayed growth and development
> Night-blindness
> Ocular lesions and xerophthalmia
> Cutaneous lesions (dry and rough skin)
> Impaired immune functions
> Destruction of epithelial tissue (i.e. in lungs, intestines, urinary tract, genitals).

Groups at risk of deficiency:

> Pregnant and lactating women
> Infants and young children
> Populations suffering from poor nutrition (i.e. only rice, maize, potatoes as staple foods).

Vitamin A and provitaminA

- Retinol
- Cancer cure and prevention
- Skin, eyes, genital glands
- Sources: liver, egg yolks, dairy products
- provitamin: carrots, pepper, spinach, yellow fruits. (25 &26).

Vitamin D

- Is synthesized in skin exposed to sunlight.
- Regulates the absorption of phosphorus and calcium during bone growth.
- Deficiency can result in weakened bones.
- Sources include cod liver oil, egg yolk, and enriched milk.

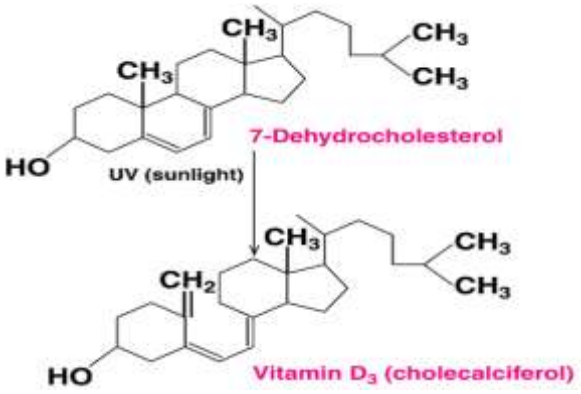

Figure 7: Chemical structure of vit D3

Natural sources of vitamin D

Animal products (main source for D3):

Oily fish, egg yolk.

Plant products (main source for D2):

Mushrooms
Other:
Synthesized in the skin by the action of ultraviolet light
Vitamin D3 is superior to vitamin D2 in increasing and maintaining 25(OH)D serum levels.

The role of vitamin D

> Regulation of metabolism of calcium and phosphorus
> Essential for normal bone development and maintenance.

Physical symptoms of vitamin D deficiency

> Rickets in children
> Osteomalacia in adults

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Groups at risk of deficiency:

> Populations suffering from poor nutrition (i.e. only rice, maize) (27, 28).

Table 1: Daily values in mg of vitamins

Vitamin:	Daily values [mg]
A (Retinol)	1-3
B1 (Thiamine)	30 - 200
B2 (Riboflavin)	25 - 200
B3 (Niacin, niacinamid)	30 - 100
B5 (Pantothenic acid)	20 - 500
B6 (Pyridoxine)	10 - 15
B12 (Cynocobalamin)	5 - 8
H (Biotin)	300 - 5000
C (Ascorbic acid)	2 - 12 g
D (Cholecalciferol)	10
E (Tocoferol)	400-2000
K (Minaquine)	80

Vitamin E

- Is an antioxidant in cells.
- May prevent the oxidation of unsaturated fatty acids.
- Is found in vegetable oils, whole grains, and vegetables.

Natural sources of vitamin E

Animal products:

Milk, butter, eggs.

Vegetable products:

Vegetable oils, cereal germ, vegetables (i.e. spinach,lettuce, cabbage, avocados), nuts.

The role of vitamin E

> Biological antioxidant
> Protects lipids (cell membranes), proteins, and DNA from oxidation and thereby contributes to cellular health

Physical symptoms of vitamin E deficiency

> Leads to destruction of red blood cells
> Impaired immune function
> Long-term impact includes neuromusclar diseases.

Groups at risk of deficiency:

> Newborn babies, particularly premature
> Individuals unable to efficiently absorb fats from the intestine.

Vitamin E (Tocoferols)

- Antioxidant (lipid protection).
- Sources: green vegetables, vegetable oil, corn, eggs, bread, dairy products, peas, beans (29).

Vitamin K

- Vitamin K1 in plants has a saturated side chain.
- Vitamin K2 in animals has a long unsaturated side chain.
- Vitamin K2 is needed for the synthesis of zymogens for blood clotting.

Natural sources of vitamin K

Animal products (main source for K2):

Some dairy products (i.e. cheese & curd cheese), meat including liver.

Vegetable products (main source for K1):

Green leafy vegetables (i.e. parsley, spinach, cauliflower)

The role of vitamin K

> Essential anti-haemorrhaging agent (promotes blood clotting)
> Helps to maintain bone health

Physical symptoms of vitamin K deficiency

> Ecchymosis
> Hematomas

Groups at risk of deficiency:
> Newborn babies (due to lack of intake) (30).

CONCLUSION

It is necessary for the proper development of the red blood cells and nervous tissues. A lack of Vitamin B12, because of degeneration of these special cells of the stomach, which produce the intrinsic factor, is the cause of pernicious anaemia. This disease, called pernicious when it was first discovered because the anaemia does not respond to the intake of iron, is treated by giving Â12 by injection. As a final summary, let me say that vitamins are essential to good health.

A normal balanced diet contains all these essential food factors. And therefore, the taking of extra vitamins does no good whatever. However, in certain disease states where there is a poor absorption of foodstuffs, or where an inadequate intake occurs, such as with the poor, the elderly, the unprivileged, the artificially fed infant or the food faddists, supplements of vitamins may be necessary. For the rest of us they are not of much use. They will not necessarily do what you expect them to do. But if you avoid taking an excessive quantity of them, you probably will do yourself no harm. I suppose that if you believe that something will do you good, then it just might be of benefit.

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