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Roles of vitamins and Minerals in Health

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ABSTRACT

Vitamins and minerals are essential nutrients because they perform hundreds of roles in the body. Eating a healthy diet remains the best way to get sufficient amounts of the vitamins and minerals you need. Every day, the body produces skin, muscle, and bone. It churns out rich red blood that carries nutrients and oxygen, and it sends nerve signals skipping along thousands of miles of brain and body pathways. It also formulates chemical messengers that shuttle from one organ to another, issuing the instructions that help sustain your life. But to do all this, the body requires some raw materials. These include at least 30 vitamins, minerals, and dietary components that the body needs but cannot manufacture on its own in sufficient amounts. Vitamins and minerals are considered essential nutrients, because acting in concert, they perform hundreds of roles in the body. They help shore up bones, heal wounds, and bolster your immune system. They also convert food into energy, and repair cellular damage.

Keywords: Vitamins, minerals, nutrients and immune system

INTRODUCTION

Most vitamins are provided by food so they are classed as 'essential' and are divided into two groups: fat soluble and water soluble [1]. Some people can easily meet the daily vitamin needs by eating a varied diet based on bread, cereals, fruit and vegetables, try to also include some meat, fish, eggs, milk, yoghurt and cheese [2], [3], [4]. Because only vitamins A, E, and B12 are stored to any significant extent in the body, a regular intake of most vitamins is important [5]. Vitamins are team players - they help other nutrients work better, e.g. vitamin D enhances the absorption of calcium, vitamin C is needed to absorb iron, and B vitamins work together in cells.

Fat soluble vitamins

These are fewer in number than water soluble vitamins, and can be stored in our fat cells for later breakdown and use when needed. For this reason it's possible to accumulate these vitamins to toxic levels if you eat them in larger amounts than your body needs in extreme cases this can be fatal. The key to avoiding such dangers is using common sense and moderation, and taking care with supplements. Almost anything can be poisonous if consumed in sufficient quantity [6].

Table1:

Vitamin A (retinol)	Forms part of the visual pigments in the eye.	Liver, oily fish (salmon, tuna, kahawai, herring), full-fat dairy products. Also from orange and yellow fruits and veges, leafy green veges.	Blindness and death from infections in children in 3rd world. In New Zealand, low levels may lead to low immunity against colds and flus. Early signs: dry, damaged skin and mucous	RDI: Men, 900µg.Women, 700µg.UL: 3,000µg/day.

			membranes, and night blindness.	
Vitamin D (cholecalciferol, ergocalciferol)	Increases absorption of calcium and phosphorus into bones.	Cholecalciferol produced by action of sunlight on skin; and ergocalciferol comes from dark-fleshed fish (salmon, herring, mackerel), eggs and fortified margarines. Almost impossible to get enough from the diet alone, so it has to be obtained from exposure to sunlight.	Loss of calcium from bones, leading in severe cases to rickets in children, causing bowed legs and knocked knees. In adults, deficiency can lead to increased bone turnover and osteoporosis.	RDI: None available. AI:Males 19–50 yr 5µg /day,51–70 yr 10µg /day,>70 yr 15µg /day.Females 19–50 yr 5µg /day, 51–70 yr 10µg /day, >70 yr 15µg /day.

Who is at risk of low vitamin D levels?

In Australasia, those at most risk from vitamin D deficiency are:

- dark-skinned people - and breast-fed babies from these groups
- veiled women (who see sunlight less often) - and breast-fed babies from these groups
- older people

Australasian studies have shown up to 41% of females 20–39 years may have some degree of deficiency at the end of winter. Others who may be affected:

- Those who have intestinal, liver, kidney or heart and lung disease.
- People taking anticonvulsants may also be at increased risk.
- People who always use sunscreen.
- People who wear protective clothing.
- Youngsters growing rapidly, with low calcium intakes [7].

Vitamin D fortification

In New Zealand, fortification of margarine or milk products with vitamin D is not mandatory. However, since 1996, voluntary fortification of margarine has been permitted. It is also permitted to add vitamin D to dried milk, dried skim milk and non-fat milk solids, skim milk and reduced fat cows' milk, legume beverages and 'food' drinks, e.g. soy milk. This fortification is currently under evaluation [8].

Seasonal influences on vitamin D production

In winter, there's less UV light, people spend less time outdoors and wear more clothes, so vitamin D deficiency is more common. However, after regular sun exposure, people under the age of 50 can produce and store about 6 months' worth of vitamin D, so it's available during winter months. Older people are unable to make and store as much vitamin D as younger folk, so they are more at risk during the winter months.

Vitamin E (α-tocopherol) is an antioxidant that protects red blood cells, muscle cells, vitamin A and unsaturated fatty acids from oxidation (it destroys 'free radicals').

Vitamin D is important for protection from:

- heart disease
- some cancers
- immune disorders
- degenerative diseases

Vitamin E works together with:

- the mineral selenium
- a wide variety of plant foods
- seafood

However, be careful as vitamin E is destroyed by cooking at high

temperatures. Vitamin E deficiency is rare in humans, but can lead to:

- haemolysis (the bursting of red blood cells)
- anaemia
- sterility (in rats)

RDI (recommended daily intake) for vitamin E:

- men, 10mg
- women, 7mg

Vitamin K (phylloquinone and menaquinon) is needed to make prothrombin, important for blood clotting. Vitamin K works with vitamin A to keep bones and teeth healthy.

Vitamin K can be obtained from:

- our own gut bacteria
- eating wholegrain cereals
- leafy green veges
- vege oils
- liver
- green tea
- fortified milks such as Anlene

Deficiency can cause bleeding in newborns who lack the intestinal bacteria needed to produce vitamin K. There is currently no available RDI (recommended daily intake) for vitamin K.

Vitamin K - AI (average intake):

- men, 70µg/day
- women, 60µg/day

Important note: vitamin K supplements (and foods fortified with vitamin K) can be dangerous for people taking blood thinning agents,
like warfarin or aspirin, which will not work as effectively.

* RDI: Recommended Daily Intake; AI: Average Intake; UL: Upper Limit.

Water soluble vitamins

These vitamins are also known as co-enzymes, and are needed during the breakdown of food to make energy. They are excreted by the kidney, so are not stored in the body.

Table 2:

Vitamin B1(thiamin)	Works with other B group vitamins in breakdown of carbohydrates to make energy - mostly in muscles, brain, liver and kidneys.	Meat (especially pork), fish, wholegrain cereals and bread, fortified breakfast cereals, pulses (dried beans and lentils), nuts and yeast extract. Fortified breakfast cereals and bread mixes. 25% lost in cooking.	Mild: headache, tiredness, loss of appetite and muscle weakness. In most populations, deficiency doesn't occur, with exceptions found in chronic alcoholism, some older people, and those with chronic diseases involving vomiting, diarrhoea and anorexia.	RDI: Men, 1.2mg.Women, 1.1mg.UL: None estimated.
Vitamin B2 (riboflavin)	Works with other B vitamins helping with protein and carbohydrate use in cells. Helps with absorption of minerals iron, zinc and calcium.	Liver, dairy products, eggs, cereals and green vegetables. Easily destroyed by light.	Very rare: inflammation and breakdown of skin (particularly lips and corners of mouth), swollen tongue, eye irritation.	RDI: Males 1.3mg men 19-70 years, 1.6mg over 70 years, 1.1mg.Females, 19-70 and 1.3mg women >70.UL: Cannot be estimated
Vitamin B3(niacin, nicotinic acid)	Used in cells for energy transfer and to repair DNA.	Wide variety of foods: beef, pork, liver, beans, yeast extracts, eggs,	Deficiency very rare in New Zealand: fatigue, inflammation of	RDI: Men,16mg.Women, 14mg.UL: 35mg/day.

		wholegrain cereals, cow's milk. Human milk contains more niacin than cow's milk.	the nerves and skin.	
Vitamin B6 (pyridoxine)	Regulation of mental function and mood, and a role in the breakdown of homocysteine.	Found in most foods.	Deficiency: anaemia, irritability, convulsions, inflammation of nerves.Toxicity: in large amounts, this vitamin is toxic to sensory nerve cells.	RDI: Males, 19-64 years,1.3-1.9mg.Females, 19-54 years, 0.9-1.4mg, > 54 years, 0.8-1.1mg.
Vitamin B12 (cyaocobalamin)	Essential for the manufacture of DNA and normal blood and brain function.	All foods of animal origin: meat, especially liver, fish and seafood, eggs, and milk products. Soy milk is often fortified with vitamin B12.	Deficiency affects nearly all body tissues, particularly those containing rapidly dividing cells in times of growth. Most serious affect is pernicious anaemia and degeneration of the nervous system.	RDI: Adults 2.0µg

NB: Vitamin B12 is made only by certain bacteria found in the gut, and is contained only in foods of animal origin. This has implications for vegans. In addition, vitamin B12 can only be absorbed in the presence of 'intrinsic factor', a protein secreted by the stomach, which has implications mainly for the elderly and those who have undergone gastric surgery. These people may need regular replacement vitamin B12.

Folic acid(folate)	Formation of chromosomes and red blood cells, promotes normal digestion. Has been shown to prevent neural tube defects, like spina bifida, in babies, and thought to play role in reduction of chronic disease risk, from cardiovascular disease and dementia to bone fractures, cancers and DNA damage.	Good sources of folate come from: liver, yeast extract, some fortified breakfast cereals, pulses, wholegrain cereals, nuts, some fruits, asparagus and dark green leafy vegetables.*	Deficiency can cause some types of anaemia. Low daily intake in women trying to conceive and who are pregnant is linked to neural tube defects and other malformations in babies.	RDI: Men and women, 400µg.Pregnant women: 600µg per day dietary intake. plus a supplement.**Breastfeeding women: 500µg

Folate requirements can be affected by nutrient interactions, smoking, certain drugs and your genetic make-up. Intakes of folate in Australian and New Zealand populations are currently significantly below the recommended intakes, with median intakes of about 300µg/day for men and 230µg/day for women.
The main sources are cereals, cereal products and dishes based on cereals (about 27%) and vegetables and legumes (about 29%). Fruit provides about 8–10%. Some orange juice are fortified with folate. From September 2009, all bread-making flour in New Zealand was to be fortified with folic acid, but this decision has now been put on the back burner for 3 years. Maximum protection against neural tube defects is reached when a women is consuming high levels of folic acid as supplements, in the month preceding conception and in the first trimester. In New Zealand, daily 400µg folate supplements, in addition to a folate-rich diet, are recommended to women one month before conception and right up to their 12th week of pregnancy.

Pantothenic acid	Part of the body's co-enzyme system, a key molecule in carbohydrate and fat metabolism, and essential to almost all forms of life.	Widely distributed in food: chicken, beef, potatoes, oat-based cereals, tomatoes, liver, kidney, egg yolks and whole grains are major sources.	Deficicency not seen in people who eat 'real' food, only in those fed synthetic diets; symptoms include irritability, restlessness, fatigue, apathy, malaise, sleep disturbance, nausea, vomiting and cramping, numbness, staggering gait, hypoglycaemia, increased insulin sensitivity.	AI: Men 6mg/day.Women, 4mg/dayUL: Not yet be determined.
Biotin	Fat metabolism.	Many foods, especially in egg yolk and liver.	Deficiency rare, but can be caused by over-consumption of raw egg white (protein combines with biotin and makes it unavailable). Can also occur when solely intravenously fed. Symptoms include dermatitis, conjunctivitis, alopecia,central nervous system abnormalities, including developmental delay in infants. Some people have a gene that makes them need more biotin than others.	AI: Men, 30µg/day.Women, 25µg/day.UL: None set.

Vitamin C (ascorbic acid or ascorbate)	Essential vitamin: helps make bone, neurotransmitters, collagen, teeth, cartilage, connective fibres. Maintains resistance to infection, frees iron to make haemoglobin. An antioxidant thought to be important in anti-cancer and anti-ageing processes. Aids the absorption of iron and copper.	Fresh and frozen fruit (not dried) and vegetables, particularly soft and citrus fruits. Those rich in vitamin C include: potatoes, broccoli, spinach, kumara, sprouts, strawberries, kiwifruit, oranges and melon, blackcurrants and guava*.	RDI: Men and women 45mg.In the UK, smokers' RDI is 80mg or greater.UL: Not yet set, but the *Nutrient Reference Values for Australia and New Zealand* suggest 1000 mg/day is a prudent limit.

*The Australian bush food *terminalia ferdinandiana* is the richest source. Many manufactured foods, especially juices and cordials, contain vitamin C as an antioxidant to prolong shelf life. Vitamin C is susceptible to destruction by food heating and processing – damaged by cutting and bruising and leaching into cooking water. Microwaving and steaming is best way to preserve vitamin C in your cooked food. Vitamin C content can also be affected by season, transport, shelf life, storage time and chlorination of water.

* RDI: Recommended Daily Intake; AI: Average Intake; UL: Upper Limit.

Micronutrients with a big role in the body

Vitamins and minerals are often called micronutrients because your body needs only tiny amounts of them. Yet failing to get even those small quantities virtually guarantees disease. Here are a few examples of diseases that can result from vitamin deficiencies:

Scurvy. Old-time sailors learned that living for months without fresh fruits or vegetables the main sources of vitamin C causes the bleeding gums and listlessness of scurvy [9]. Blindness. In some developing countries, people still become blind from vitamin A deficiency. Rickets. A deficiency in vitamin D can cause rickets, a condition marked by soft, weak bones that can lead to skeletal deformities such as bowed legs. Partly to combat rickets, the U.S. has fortified milk with vitamin D since the 1930s.

Just as a lack of key micronutrients can cause substantial harm to your body, getting sufficient quantities can provide a substantial benefit. Some examples of these benefits:

Strong bones. A combination of calcium, vitamin D, vitamin K, magnesium, and phosphorus protects your bones against fractures.

Prevents birth defects. Taking folic acid supplements early in pregnancy helps prevent brain and spinal birth defects in offspring. Healthy teeth. The mineral fluoride not only helps bone formation but also keeps dental cavities from starting or worsening [9].

The difference between vitamins and minerals

Although they are all considered micronutrients, vitamins and minerals differ in basic ways. Vitamins are organic and can be broken down by heat, air, or acid. Minerals are inorganic and hold on to their chemical structure.

So why does this matter? It means the minerals in soil and water easily find their way into your body through the plants, fish, animals, and fluids you consume. But it's tougher to shuttle vitamins from food and other sources

into your body because cooking, storage, and simple exposure to air can inactivate these more fragile compounds.
Many micronutrients interact. Vitamin D enables your body to pluck calcium from food sources passing through your digestive tract rather than harvesting it from your bones. Vitamin C helps you absorb iron.
The interplay of micronutrients isn't always cooperative, however. For example, vitamin C blocks your body's ability to assimilate the essential mineral copper. And even a minor overload of the mineral manganese can worsen iron deficiency [10].

A closer look at water-soluble vitamins

Water-soluble vitamins are packed into the watery portions of the foods you eat. They are absorbed directly into the bloodstream as food is broken down during digestion or as a supplement dissolves.
Because much of your body consists of water, many of the water-soluble vitamins circulate easily in your body. Your kidneys continuously regulate levels of water-soluble vitamins, shunting excesses out of the body in your urine.
Water-soluble vitamins
(Click on the links below for more information from the Harvard School of Public Health nutrition source website)
B vitamins
Biotin (vitamin B7)
Folic acid (folate, vitamin B9)
Niacin (vitamin B3)
Pantothenic acid (vitamin B5
Riboflavin (vitamin B2)
Thiamin (vitamin B1)
Vitamin B6
Vitamin B12
Vitamin C
What they do
Although water-soluble vitamins have many tasks in the body, one of the most important is helping to free the energy found in the food you eat. Others help keep tissues healthy. Here are some examples of how different vitamins help you maintain health:
Release energy. Several B vitamins are key components of certain coenzymes (molecules that aid enzymes) that help release energy from food [9].
Produce energy. Thiamin, riboflavin, niacin, pantothenic acid, and biotin engage in energy production.
Build proteins and cells. Vitamins B6, B12, and folic acid metabolize amino acids (the building blocks of proteins) and help cells multiply.
Make collagen. One of many roles played by vitamin C is to help make collagen, which knits together wounds, supports blood vessel walls, and forms a base for teeth and bones.
Words to the wise
Contrary to popular belief, some water-soluble vitamins can stay in the body for long periods of time. You probably have several years' supply of vitamin B12 in your liver. And even folic acid and vitamin C stores can last more than a couple of days.
Generally, though, water-soluble vitamins should be replenished every few days.
Just be aware that there is a small risk that consuming large amounts of some of these micronutrients through supplements may be quite harmful. For example, very high doses of B6—many times the recommended amount of 1.3 milligrams (mg) per day for adults—can damage nerves, causing numbness and muscle weakness [7].
A closer look at fat-soluble vitamins
Rather than slipping easily into the bloodstream like most water-soluble vitamins, fat-soluble vitamins gain entry to the blood via lymph channels in the intestinal wall (see illustration). Many fat-soluble vitamins travel through the body only under escort by proteins that act as carriers. Absorption of fat-soluble vitamins

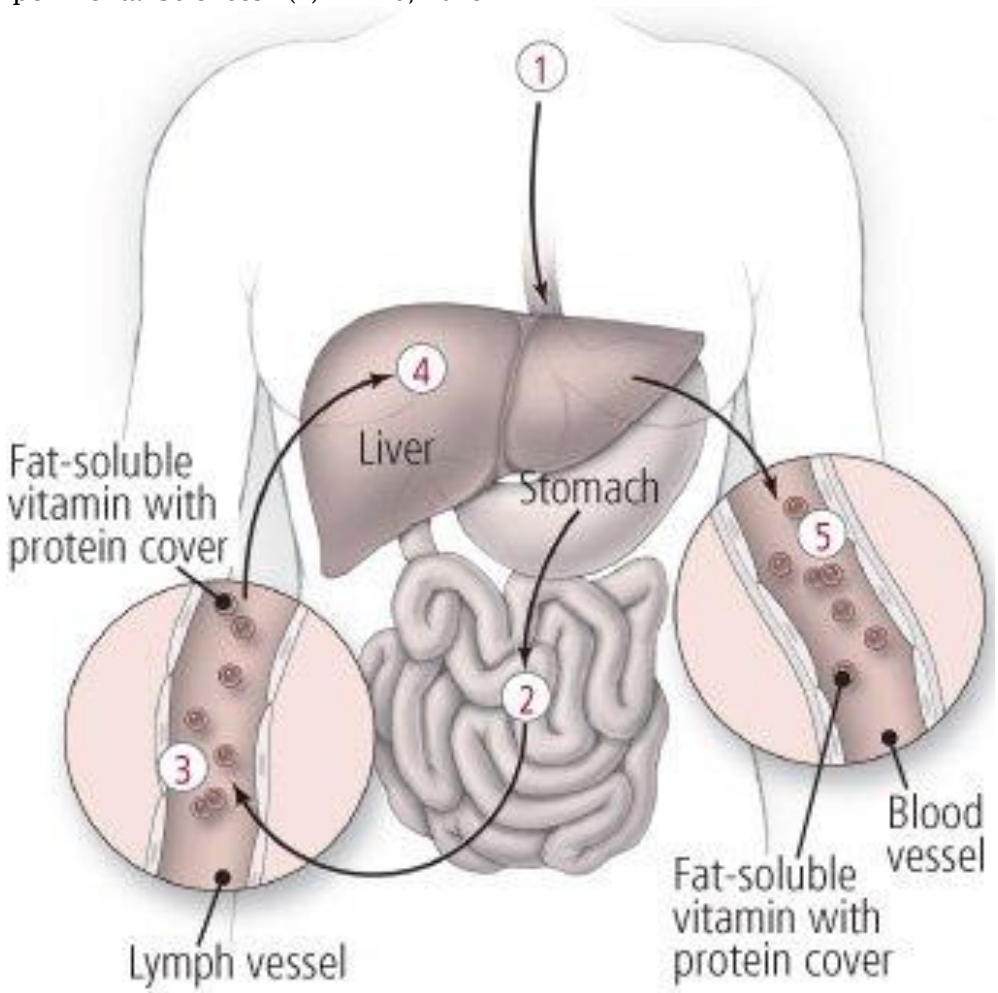

Fig. 1: Food containing fat-soluble vitamins is ingested.

The food is digested by stomach acid and then travels to the small intestine, where it is digested further. Bile is needed for the absorption of fat-soluble vitamins. This substance, which is produced in the liver, flows into the small intestine, where it breaks down fats. Nutrients are then absorbed through the wall of the small intestine.

Upon absorption, the fat-soluble vitamins enter the lymph vessels before making their way into the bloodstream. In most cases, fat-soluble vitamins must be coupled with a protein in order to travel through the body.

These vitamins are used throughout the body, but excesses are stored in the liver and fat tissues. As additional amounts of these vitamins are needed, your body taps into the reserves, releasing them into the bloodstream from the liver. Fatty foods and oils are reservoirs for the four fat-soluble vitamins. Within your body, fat tissues and the liver act as the main holding pens for these vitamins and release them as needed [9].

To some extent, you can think of these vitamins as time-release micronutrients. It's possible to consume them every now and again, perhaps in doses weeks or months apart rather than daily, and still get your fill. Your body squirrels away the excess and doles it out gradually to meet your needs.

Each of the vitamins listed below has an important job in the body. A vitamin deficiency occurs when you do not get enough of a certain vitamin. Vitamin deficiency can cause health problems. Not eating enough fruits, vegetables, beans, lentils, whole grains and fortified dairy foods may increase your risk for health problems, including heart disease, cancer, and poor bone health (osteoporosis). Vitamin A helps form and maintain healthy teeth, bones, soft tissue, mucous membranes, and skin.

Vitamin B6 is also called pyridoxine. Vitamin B6 helps form red blood cells and maintain brain function. This vitamin also plays an important role in the proteins that are part of many chemical reactions in the body. The more protein you eat the more pyridoxine your body requires. Vitamin B12, like the other B vitamins, is important for metabolism. It also helps form red blood cells and maintain the central nervous system. Vitamin C, also called ascorbic acid, is an antioxidant that promotes healthy teeth and gums. It helps the body absorb iron and maintain healthy tissue. It is also essential for wound healing. Vitamin D is also known as the "sunshine vitamin," since it is made by the body after being in the sun. Ten to 15 minutes of sunshine 3 times a week is enough to produce the body's requirement of vitamin D for most people at most latitudes. People who do not live in sunny places may not make enough vitamin D. It is very hard to get enough vitamin D from food sources alone. Vitamin D helps the body absorb calcium. You need calcium for the normal development and maintenance of healthy teeth and bones. It also helps maintain proper blood levels of calcium and phosphorus.

Vitamin E is an antioxidant also known as tocopherol. It helps the body form red blood cells and use vitamin K.

Vitamin K is needed because without it, blood would not stick together (coagulate). Some studies suggest that it is important for bone health. Biotin is essential for the metabolism of proteins and carbohydrates, and in the production of hormones and cholesterol. Niacin is a B vitamin that helps maintain healthy skin and nerves. It also has cholesterol-lowering effects at higher doses.

Folate works with vitamin B12 to help form red blood cells. It is needed for the production of DNA, which controls tissue growth and cell function. Any woman who is pregnant should be sure to get enough folate. Low levels of folate are linked to birth defects such as spina bifida. Many foods are now fortified with folic acid [10].

Pantothenic acid is essential for the metabolism of food. It also plays a role in the production of hormones and cholesterol. Riboflavin (vitamin B2) works with the other B vitamins. It is important for body growth and the production of red blood cells.

Thiamine (vitamin B1) helps the body cells change carbohydrates into energy. Getting enough carbohydrates is very important during pregnancy and breastfeeding. It is also essential for heart function and healthy nerve cells. Choline helps in normal functioning of the brain and nervous system. Lack of choline can cause swelling in liver. Carnitine helps the body to change fatty acids into energy [10].

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