

Why is vitamin B₁₂ important?

Vitamin B₁₂ is an essential nutrient, required for DNA synthesis (and ultimately cell division), maturation of red blood cells, and the synthesis of myelin sheaths around nerves in the body.

Sources of vitamin B₁₂:

Vitamin B₁₂ is of special interest to vegetarians, particularly total vegetarians, since it is found only in animal-based products including red meats, poultry, seafood, dairy products and eggs. While plant-based foods are typically not a source of vitamin B₁₂, significant levels can be found in some foods fortified with the vitamin such as fortified ready-to-eat breakfast cereals, fortified plant beverages (made from soy, rice, almond, coconut, oats, hazelnut, or cashew), fortified vegetarian meat analogs (canned and frozen), or fortified nutritional yeast (such as Red Star®). It is also available as a B₁₂ supplement and as part of many multivitamin supplements. It is important to note that inactive analogs of vitamin B₁₂ may be present in some foods such as spirulina, seaweed, and fermented foods such as tempeh. While food labels may claim the presence of vitamin B₁₂ in these foods, they do not provide any significant level of active vitamin B₁₂ (cobalamin) useful for the body.

Digestion and absorption of vitamin B₁₂:

The digestion of vitamin B₁₂ begins in the stomach, where gastric secretions split vitamin B₁₂ from proteins. Vitamin B₁₂ is then free to bind to R-factor found in saliva. Pancreatic secretions partially degrade the R factor, and vitamin B₁₂ is then tightly bound to intrinsic factor, a glycoprotein secreted by the stomach. Intrinsic factor (with the B₁₂ attached to it) binds to special receptors at the lower end of the small intestine (ileum)¹. This binding facilitates the absorption of vitamin B₁₂ into the bloodstream, a process that is about 50% efficient. From here vitamin B₁₂ is carried by a transport protein (holotranscobalamin II or TC2) to the liver, where it is stored.

The good rate of absorption, combined with low daily requirements and the body's efficient reabsorption of B₁₂ secreted into the intestinal tract, enables the body to survive a long time, often years, on a low intake of the vitamin before a deficiency is clinically shown or manifested. It is estimated that intestinal absorption is saturated at about 1.5–2.0 µg per meal, so that vitamin B₁₂ sources should be taken at each meal². Vitamin B₁₂ absorption from food decreases drastically when the capacity of intrinsic factor is exceeded (at 1–2 µg of vitamin B₁₂). Vitamin B₁₂ appears to be more bioavailable from dairy than from eggs or other animal products⁽³⁾.

Since vitamin B₁₂ in meat, fish, dairy products, and eggs comes attached to the protein in food, its digestion can be inefficient in the elderly due to diminished gastric secretions. The vitamin B₁₂ in supplements and that added to fortified foods is more efficiently absorbed since it occurs in an unbound form not requiring digestion⁴. Hence, it is recommended that anyone over 50 should obtain a significant amount of their dietary B₁₂ from foods fortified with B₁₂, or else they will need to take a regular supplement. For efficient absorption, a B₁₂ tablet must be chewed rather than swallowed. Only about 1-2% of a large supplement is absorbed by passive diffusion, a mechanism different from that described above⁵. In dietary supplements, vitamin B₁₂ is usually present as cyanocobalamin, a form that the body readily converts to the active forms. It is not necessary to consume a more expensive

form of the supplement, methyl cobalamin. Furthermore, there is no difference in absorption between oral tablets and the sub-lingual preparations.

What are the Signs of Vitamin B₁₂ deficiency?

Vitamin B₁₂ is a nutrient of concern for all vegetarians as its deficiency is not uncommon. In one British study involving 689 men, it was found that vegans (total vegetarians) had mean serum B₁₂ levels that were 33% lower than the lacto-ovo-vegetarians. 52% of vegans and 7% of vegetarians were vitamin B₁₂ deficient⁶. The statistics would have shown higher percentages of deficiency if a higher, more traditional cut-off value was used to define deficiency (200 pg/ml rather than 160 pg/ml, i.e. 148 pmol/L rather than 118 pmol/L). Elimination of animal products from the diet typically produces a lower B₁₂ status of the individual. An assessment of the B₁₂ status of 340 SDA ministers in Australia in 1997 revealed that the 53% of the lacto-ovo-vegetarians and vegans had vitamin B₁₂ deficiency largely due to a low dietary intake of the vitamin⁽⁷⁾.

Since both folate deficiency and B₁₂ deficiency are associated with macrocytic anemia, it is possible that B₁₂ deficiency can be masked by a high intake of folic acid. The folate may correct the macrocytic anemia, but if B₁₂ deficiency exists, it could go undetected until neurological symptoms appear. There are multiple manifestations of B₁₂ deficiency. Hematological complications of B₁₂ deficiency include macrocytic anemia (in which there are large immature red blood cells), neutropenia (an abnormally low level of white blood cells), and thrombocytopenia (low platelet count). All these signs are reversible with B₁₂ supplements.

Vitamin B₁₂ deficiency can also lead to the demyelination of peripheral nerves, the spinal cord, cranial nerves and the brain, resulting in nerve damage and neuropsychiatric abnormalities. Neurological symptoms of vitamin B₁₂ deficiency include numbness and tingling of the hands and feet, difficulty in walking with a loss of balance, memory loss, dementia, depression, general weakness and psychosis. Unless detected and treated early, these symptoms may be irreversible⁽¹⁾.

An infant born to a vegan mother, who has followed her dietary practices for some time without B₁₂ supplementation or fortified foods, can be at considerable risk of becoming vitamin B₁₂ deficient. If the mother's B₁₂ stores are low and her B₁₂ intake is very low, the fetus will not obtain sufficient vitamin during fetal development and the infant will not get sufficient vitamin from mother's milk. Within months the child can show signs of B₁₂ deficiency such as developmental delay or regression, failure to thrive, seizures, loss of reflexes, lethargy, and anemia⁽⁸⁾.

Vitamin B₁₂ is important for aiding osteoblasts, the bone-forming cells. In the Framingham Offspring Osteoporosis study, those with lower vitamin B₁₂ levels (less than 200 pg/mL or 148 pmol/L) had lower-than-average bone mineral density compared with participants who had vitamin B₁₂ levels above 200 pg/mL⁽⁹⁾.

Causes of vitamin B₁₂ deficiency¹

- Inadequate dietary intake:
 - Following a restrictive diet. Some vegetarian diets (especially a vegan diet) without supplementation or use of B₁₂ -fortified foods
- Inadequate absorption or impaired utilization
 - Loss of gastric acid and/or pepsin (major contributor to B₁₂ deficiency) in the elderly. This is independent of the diet pattern followed by the elderly person.

- Lack of intrinsic factor
- Gastritis and the partial or total surgical removal of the stomach
- Ileal disease or ileal resection (secondary to Crohn's disease)
- Use of medications commonly used to treat elevated blood pressure (ACE inhibitors), diabetes (metformin), Parkinson's disease (levodopa), and for suppression of gastric acid secretion such as proton-pump inhibitors (Prilosec)
- Gastric infection with *Helicobacter pylori*
- Increased requirements
 - During pregnancy and lactation

How can you avoid vitamin B₁₂ deficiency?

Careful food selection is necessary to ensure adequate vitamin B₁₂ intake. The recommended daily intake of vitamin B₁₂ for adolescents and adults is 2.4 µg¹⁰. This amount can be achieved by lacto-ovo-vegetarians by selecting from a variety of low-fat dairy products and eggs as well as using B₁₂-fortified foods. Vegans must consume B₁₂-fortified foods or B₁₂ supplements on a daily basis. This is particularly important for women during pregnancy and lactation, especially for total vegans^{2,11}. A supplement of 500 µg B₁₂ three to four times a week is recommended for those with a low dietary intake. The B₁₂ supplement should be thoroughly chewed for good absorption. Alternatively a sub-lingual form is very effective¹². Vitamin B₁₂ has a low potential for toxicity. No adverse effects have been observed in people taking 1000 µg daily for 5 years.

Seaweed (such as nori and the blue-green algae, Spirulina), fermented soy (such as tempeh and miso) should not be relied upon as valid sources of active B₁₂. The amount of vitamin B₁₂ produced in the mouth is also an insignificant amount, insufficient to begin to meet your daily needs. B₁₂ is produced in the large bowel of humans by certain bacteria residing in the large intestine. However, this production occurs beyond the ileum (the lower end of the small intestine), where active B₁₂ absorption takes place. Small amounts of vitamin B₁₂ are found in white button mushrooms, but they cannot be relied upon as a significant dietary source⁽¹³⁾.

Years ago, Adventists were given the counsel that the time would come to discard milk and eggs¹⁴ (which are good sources of B₁₂). In most Western countries, fortified soy and similar beverages and other B₁₂-fortified foods (mentioned earlier) are now readily available, thus removing the necessity of using dairy and egg. However, in many other countries, these B₁₂ fortified foods and beverages are not available, necessitating a daily food source of B₁₂ (or a regular B₁₂ supplement) for good health. Removing dairy from the diet without an appropriate substitute to provide a regular supply of B₁₂ could lead to a serious unwanted B₁₂ deficiency (described earlier). Ellen White warned that some people in abstaining from milk and eggs fail "to supply the body with proper nourishment and as a consequence become weak and unable to work"⁽¹⁴⁾. Such a result only brings the health reform into disrepute¹⁴. She warns that "we are not to advocate extremes in health reform"¹⁴. While a balanced vegan diet has been shown to be safe and healthy in North America and other Western countries having B₁₂ fortification readily available¹², it may not support optimal health in other countries without diligent efforts to obtain a regular B₁₂ intake.

Why is B₁₂ fortification of a plant diet necessary today if the original diet was ideal and ensured optimal health? We don't know. In past centuries, B₁₂-synthesizing intestinal flora may have inhabited the small intestine of humans making B₁₂ absorption in the ileac region a distinct possibility. Changes in the gut flora of humans over time could have occurred making B₁₂ production to occur lower down in the colon, and hence unavailable for absorption. Also, ideally, natural contamination of foods and water with vitamin B₁₂ could

have occurred in the conditions of creation. These conditions have changed with the human actions towards foods (i.e. thermal treatments during food processing among others). Furthermore, we are unaware of the nutritional content of the fruit from the tree of life in the Garden of Eden. The tree was removed from access to men and women after the Fall. We are sure of one thing. Long periods of no B₁₂ intake produce serious clinical signs of B₁₂ deficiency that impair our health.

Assessment of one's vitamin B₁₂ status

A vitamin B₁₂ deficiency can manifest itself with serious clinical symptoms (as described above). Hence, it is especially important that vegans have their B₁₂ status assessed annually to facilitate early intervention when necessary. Monitoring the vitamin B₁₂ status of pregnant vegans and young vegan children should be considered especially important¹¹. Measuring blood levels of methylmalonic acid (MMA) provides the easiest and most accurate form of assessment. An elevated level is an indication of vitamin B₁₂ deficiency. Typically, healthcare professionals measure only serum levels of vitamin B₁₂. For the most reliable approach to diagnose vitamin B₁₂ deficiency it is recommended to measure at least two biomarkers, such as cobalamin and MMA (15)

The range of values for serum vitamin B₁₂ that are accepted as normal varies between different countries and between different labs. Typically in the USA, the accepted normal levels of vitamin B₁₂ range between 200 to 900 pg/mL (148 pmol/L to 664 pmol/L). Values less than 200 pg/mL (148 pmol/L) are generally considered to indicate a vitamin B₁₂ deficiency. However, many believe that B₁₂ adequacy can only be achieved with a serum level of no less than 350 pg/mL (258 pmol/L). This is based upon the fact that neurological changes have been observed in individuals with serum B₁₂ levels between 200 and 350 pg/ml (16), even though blood cell abnormalities were absent.

The General Conference Nutrition Council recommends that the total vegetarian should regularly consume foods fortified with vitamin B₁₂ or else use a 500 µg supplement of vitamin B₁₂ 3-4 times a week. This would be especially important for a pregnant or breast-feeding woman. Elderly, total vegetarians, and lacto-ovo-vegetarians with decreasing consumption of dairy and eggs should have their vitamin B₁₂ status checked regularly, at least on an annual basis.

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