Vitamin B12: Vital Nutrient for Good Health

By Sally Fallon and Mary G. Enig, PhD

One of the most important nutrients we get from animal foods is vitamin B12. The vitamin is also the largest known biomolecule and the only nutrient with a stable carbon-metal bond. One molecule of cobalt lies at the center of each B12 molecule, which has the approximate (and awesome!) chemical formula of C$_{61-64}$H$_{84-90}$N$_{14}$O$_{13-14}$PCo. Isolated B12 is a crystalline compound with a bright red color, due to the presence of cobalt. One practitioner has referred to B12 as "those ruddy drops that cheer sad hearts and strengthen faint hearts."\(^1\)

Vitamin B12 works with folic acid in many body processes including synthesis of DNA, red blood cells and the insulation sheath (the myelin sheath) that surrounds nerve cells and facilitates the conduction of signals in the nervous system. Severe depletion manifests as pernicious anemia, which was invariably fatal until the discovery of B12 in liver. But long before anemia sets in, other conditions may manifest, most often neurological problems (numbness, pins and needles sensations, a burning feeling in the feet, shaking, muscle fatigue, sleep disorders, memory loss, irrational anger, impaired mental function and Alzheimer’s) or psychological conditions (dementia, depression, psychosis and obsessive-compulsive behavior). President Kennedy has been quoted as having said he would never have become president without injections of B12.\(^2\)

**ABSORPTION**

Absorption of vitamin B12 is a complex process, subject to problems at several points.

B12 from animal food enters the stomach as part of animal proteins and must first be liberated by pepsin and hydrochloric acid. Free B12 then attaches to R-protein, which is released from the salivary cells and parietal cells (the same cells that release hydrochloric acid). To be absorbed efficiently, B12 must attach to a protein called intrinsic factor (IF) which is also secreted in the stomach. This cannot happen until the R-protein complexes are broken down by pancreatic enzymes in the small intestine. B12 then binds with the intrinsic factor and proceeds through the gut to the lower portion of the small intestine, where the intrinsic factor-B12 complex attaches to cell receptors, a process that involves calcium.

Thus, deficiencies in pepsin, hydrochloric acid, R-protein, pancreatic enzymes, intrinsic factor, calcium and cell receptors can all lead to B12 deficiency through blocked absorption. Once in the bloodstream, transport proteins bind to B12 and deliver it to the cells. Within the cells, enzymes liberate B12 from the protein complex and convert it to its two coenzyme forms, methylcobalamin and adenosylcobalamin. Deficiency in the required enzymes can block this conversion.

Because the absorption process is so complicated, and therefore subject to various blocks, many people--particularly the elderly--may develop deficiencies even though they are taking in plentiful B12 in their food. Fortunately, the body absorbs about 1-5 percent of free B12 by a process of passive diffusion. Thus supplementation with large doses of crystalline B12 or with foods extremely rich in B12 can successfully treat deficiencies caused by compromised protein digestion or lack of R-protein, intrinsic factor or pancreatic enzymes. Supplementation with the
coenzyme forms methylcobalamin and adenosylcobalamin (the forms found in the cells) can overcome B12 deficiency in the cells caused by lack of, or malfunction of, conversion enzymes.

VEGETARIANS

B12 is found almost exclusively in animal foods such as liver, kidney, meat, fish, shellfish, milk products and eggs but the original source of B12 in nature is bacteria, the only creatures able to manufacture this vitamin. In humans and animals, these bacteria produce B12 in the colon; however, little if any is absorbed across the colon wall so we must get our B12 from animal foods. Bivalves such as clams, mussels and oysters contain high levels of B12 because they siphon large quantities of vitamin B12-synthesizing microorganisms from the sea. Production of B12 supplements involves fermentation procedures similar to those used for penicillin and other antibiotics. Interestingly, while eggs contain B12, they also contain substances that block absorption, a fact that leaves only milk as a good source of B12 for vegetarians. Some studies indicate that B12 is better absorbed from milk than from meat. However, one source indicates that B12 in milk is destroyed by boiling. Analysis of B12 in pasteurized milk reveals only a 10 percent loss; however pasteurization deforms the milk proteins that aid in B12 absorption.

Interestingly, some sources claim that fermentation of yoghurt from milk lowers B12 levels, although food tables indicate similar levels in commercial milk and yoghurt.

The vitamin B12 molecule is resistant to temperatures in excess of the boiling point, unless exposed to an alkaline medium. The molecule breaks down at 250° C. Thus B12 is destroyed on the surface of grilled meat, but not in the interior. Eight percent of B12 in liver is lost by boiling for five minutes. Thus gentle braising or cooking steaks to rare or medium-rare best preserves B12 in meat.

Until recently, vegetarian and vegan literature claimed that certain plant foods could provide B12—seaweeds, fermented soybeans, spirulina, even unwashed vegetables that have been fertilized with manure. Proponents of vegetarianism pointed to inhabitants of India, who did not seem to exhibit signs of B12 deficiency in spite of very low levels of animal foods in the diet. Yet as early as 1974, an American study found that 92 percent of vegans, 64 percent of lactovegetarians, 47 percent of lacto-ovovegetarians and 20 percent of semi-vegetarians have blood levels below normal, that is, below the low range that marks the onset of pernicious anemia. Today, most vegetarian literature does warn about the very real possibility of depletion and recommends routine supplementation with B12. We now know that a source of B12 in the tropical, mostly vegetarian diet in India was insect excrement and parts in stored grains and legumes. These would have been an unavoidable feature of traditional diets in hot climates until the advent of modern sterilization and storage techniques.

Plant foods said to be sources of B12 actually contain B12 analogs (called cobamides)—substances that block the uptake of true B12 and increase the body’s need for the nutrient. A surprising source of cobamides is bacterial overgrowth in the small intestines, which can produce B12 analogs. The use of antibiotics, or a diet high in refined carbohydrates, can encourage the proliferation of bacterial overgrowth and lead to B12 deficiencies.
Yet another area for concern is multivitamin products! The late Victor Herbert, a noted B12 researcher, maintains that many multivitamin products contain spurious and even dangerous analogs of B12 possibly formed when crystalline B12 interacts with other nutrients in multivitamin products, such as vitamin C, iron and copper.14

High levels of folic acid can accelerate neuropsychiatric complications in persons with B12 deficiency.15 Since folic acid intakes of vegetarians tend to be high (from green vegetables and from grain products that have been fortified with folic acid), those following a vegetarian lifestyle may be at increased risk of neurological and psychological problems.

The body stores considerable B12 in the liver. Thus a delay of 5-10 years may separate the beginning of a vegetarian diet (or absorption problems) and the onset of deficiency symptoms. Interestingly, the body can recycle over 75 percent of the B12 it uses.16 Used B12 is excreted in bile and then reabsorbed in the small intestine by the same complex process described earlier. Some people have a more efficient recycling system than others and hence can go longer on a vegetarian diet without signs of deficiency. However, more B12 is excreted in the presence of high levels of fiber, a common feature of vegetarian diets.17 Vegan and vegetarian diets present a real danger for growing children because their stores are very low, especially if their mothers avoided animal foods during pregnancy and lactation. The scientific literature contains numerous case studies describing severe anemia, dramatic growth retardation, irritability and delays in the acquisition of motor skills in B12-deficient children from vegetarian families.

In a recent study, researchers assayed cognitive development in 72 young people raised on diets free of all animal products until at least the age of six and then on a diet containing milk and eggs. When compared with children who had eaten normal mixed diets (including meat) all their lives, they scored substantially lower on tests measuring spatial ability, short-term memory and "fluid intelligence," that is, the capacity to solve complex problems, abstract thinking ability and the ability to learn.18

MEASURING B12 DEFICIENCY

American medical opinion defines blood levels lower than 200 pg/mL as an indication of deficiency. This number is based on the level associated with the most severe manifestation of deficiency, pernicious anemia. In contrast, the lower limit in Japan and some European countries is 500-550 pg/mL, the levels associated with psychological and behavioral manifestations such as dementia and memory loss. Physicians in these countries consider blood levels of 500-1300 to be the normal range.19

According to Dr. John Domnisse, an expert in B12 deficiency, the acceptance of high levels as normal in Japan, and the willingness to readily treat psychiatric symptoms with B12 explains the low rates of Alzheimer’s dementia in that country--as well as the reason for the very high rates of Alzheimer’s in the US.20

Even with the very low cutoff currently considered the risk point, large numbers of Americans are deficient. In the ongoing Framingham Offspring Study, involving 3000 men and women in the town of Framingham, Massachusetts, researchers found that 39 percent had B12 levels in the so-called "low normal" range, that is below 258.21 Had the
researchers chosen the optimal range of 1100-1300 as a measure of B12 status, very few would have qualified as B12 replete.

One of the most surprising findings of this study was the fact that the youngest group (26 to 49 years old) had about the same B12 status as the oldest group (65 and up), an indication that deficiencies are becoming more common.

PERNICIOUS ANEMIA

Pernicious (that is, "deadly") anemia occurs when a person lacks the intrinsic factor and cannot absorb B12. The most common underlying cause of pernicious anemia is an autoimmune reaction that attacks and destroys the stomach cells that produce intrinsic factor. The disease is characterized by immature, abnormally large red blood cells (macrocytes), which are very inefficient at carrying oxygen, and by white blood cells with abnormal nuclei.

Early symptoms of pernicious anemia include paleness, weakness and fatigue; severe anemia causes shortness of breath, dizziness and a rapid heart rate.

Those suffering from pernicious anemia require very high levels of B12 to overcome the lack of intrinsic factor. The traditional treatment was one pound per day of calf’s liver, providing almost 200 micrograms B12. Today doctors prescribe injections or oral supplements of even higher doses.

SYMPTOMS OF AGING

B12 deficiency mimics many of the features of old age--ataxia (shaky movements and unsteady gait) muscle weakness, spasticity, incontinence, slowed reactions, memory loss, disorientation, depression and confusion can all occur when B12 levels are low.

Whether or not Alzheimer’s disease constitutes a condition of B12 deficiency is the subject of considerable debate among physicians. A recent and fascinating study of a family in Wales provides convincing evidence that low levels of B12 and Alzheimer’s are linked. Researchers evaluated members of a family with a genetic predisposition towards Alzheimer’s disease. They found that four out of six (67 percent) family members with confirmed Alzheimer’s disease had abnormally low blood levels of vitamin B12, compared to one out of 12 (8 percent) who were at equal genetic risk for developing Alzheimer’s but did not. The researchers speculated that a vitamin B12 deficiency could result in impaired methylation reactions in the central nervous system, a characteristic feature of Alzheimer’s, as well as the possibility that the genetic predisposition to Alzheimer’s may actually be related to a genetic impairment in the ability to absorb B12.

Investigators have found vitamin B12 deficiency in 3-42 percent of persons aged 65 and older. In a recent study of geriatric patients, 43 percent had levels below 295 pmol/L. Should a higher point be used as bench mark, it is likely that almost all seniors would be diagnosed as deficient.

Current medical practice has fixated on cholesterol as the marker for good health, using expensive lifelong drugs and soul-numbing diets to bring cholesterol levels as low as possible--a
policy that has resulted in untold misery for millions and a huge financial burden on the medical system. How much more felicitous and cost effective to test everyone who reaches age 50 for B12 levels instead. For a fraction of the cost, old age could be transformed into a period of peace and contentment, instead of one of heartbreaking suffering for the elderly and their families.

Research shows tremendous potential for B12 to reverse mental decline in elderly patients. In one study, 61 percent of patients with mental impairment had complete recovery with supplementation; investigators speculate that those that did not recover had suffered from deficiency so long that damage to the nervous system had become irreversible. Supplementation results in little improvement for those who have had full blown Alzheimer’s symptoms for greater than six months. Thus, routine early testing for B12 has the potential to prevent mental decline in the vast proportion of the elderly. By the time Alzheimer’s is conclusively diagnosed, it may be too late for supplementation to be effective.

HEART DISEASE

It was Dr. Kilmer McCully who elucidated high blood homocysteine levels as a marker for heart disease. Homocysteine is formed in the body from the amino acid methionine in a process that can be blocked by folic acid and vitamins B6 and B12. High homocysteine levels can result in endothelial dysfunction (a narrowing of the arteries) which in turn is believed to be a precursor of atherosclerosis. Researchers in Taiwan now report that homocysteine-induced endothelial narrowing can be avoided or at least reduced by supplementing with folic acid and vitamins B6 and B12. Ironically, the American Heart Association and government agencies have demonized B12-rich foods like liver and raw milk (which is also an excellent source of B6).

CANCER

Since B12 helps repair DNA that is damaged by radiation or oxidation, it plays a role in protection against cancer. Low levels of B12 are associated with cancer of the cervix and the breast in human studies.

But research on B12 and cancer is contradictory. In one study, high levels of vitamin B12 were associated with an up to 3-fold increase in risk of developing prostate cancer.

One explanation for these disparities lies in the fact that cancer cells develop receptors that allow them to absorb huge amounts of B12. In fact, researchers are looking at cancer drugs that combine B12 with cellular toxins such as nitric oxide. Inside the tumor cell, the nitric oxide component of the targeted drug is released, triggering cellular events leading to up-regulation of genes causing apoptosis—or programmed cell death.

Yet, a recent study found that injections of large doses of methylcobalamin were non-toxic and suppressed tumor growth in mice fed a diet deficient in B12.

Furthermore, holistic physicians have reported good results giving B12 to cancer patients. Dr. Max Gerson, who treated terminal cancer patients with extraordinary success, gave his patients liver injections, often combined with additional B12.

NERVOUS DISORDERS
One condition that would seem obviously correlated with B12 deficiency is multiple sclerosis (MS), a disease characterized by demyelination of the central nervous system. Yet many studies indicate that those with MS have normal blood levels of the vitamin. Japanese researchers have found that in MS patients, there is a decrease in the binding capacity of B12, thus inhibiting the transport of B12 into the cells, even in patients with normal levels in their blood. Even so, they were able to achieve some improvement with high-dose supplementation.

The benefit of B12 for depression may be due to B12’s ability to activate a substance called tetrahydrobiopterin (BH4), a compound which in turn helps activate "feel good" neurotransmitters like serotonin and dopamine. Surprisingly, B12 has also proven successful in treating diabetic neuropathy, possibly because the condition of diabetes deranges B12 metabolism.

Recurrent seizures may be a manifestation of B12 deficiency. One study found that individuals who suffered from seizures had low B12 levels.

Other neurological problems associated with B12 deficiency include urinary incontinence and migraine headaches. In one case history, B12 worked better than steroids as a treatment for Bell’s palsy. Another case study reports that shaky leg syndrome responds well to B12 injections.

**FERTILITY**

B12 plays a critical role in cellular replication so it is no surprise that deficiency can manifest as low sperm count. High doses are key to successful treatment. In one study, 27 percent of men with sperm counts less than 20 million given 1000 mcg per day of vitamin B12 were able to achieve a total count in excess of 100 million; in a study in which men were given 6000 mcg per day, 57 percent of men with low sperm counts demonstrated improvement.

As pernicious anemia often leads to infertility, B12 supplements can allow a woman to conceive. Traditional societies considered foods rich in B12 as important for fertility. B12 plays a key role in the development of new tissue; thus women who are deficient may not ovulate, or a fertilized egg may not develop, resulting in miscarriage. Prolonged B12 deficiency results in infertility. In one study, a woman who had suffered seven miscarriages before discovering her B12 deficiency went on to have three children once the problem was corrected.

**OTHER DISEASES**

- Osteoblast activity in the bones depends on B12 and bone metabolism is affected by deficiency. Low B12 is associated with osteoporosis and B12 supplements can help remineralize the bones.
- B12 deficiency occurs in 10-35 percent of all patients tested positive for HIV, attributed to various factors such as low intake, reduced absorption and depletion by drugs like AZT. B12 deficiency exacerbates neurological symptoms of AIDS. Most interesting is the fact that B12 inhibits the replication of the HIV virus. Thus B12 can serve as both a therapy against increased viral load and as nutritional support for the common symptoms of AIDS.
- B12 has been shown to be an effective treatment for asthma, especially for those whose asthma stems from sulfite sensitivity.
Researchers in Germany have reported using B12 as part of the successful treatment of a variety of skin conditions, such as hives, seborrhea, dermatitis, eczema, shingles and lupus. One journal article describes a successful treatment for psoriasis. Huge doses were needed--30 injections of 1000 micrograms each. B12 has been used to treat both hypopigmentation (vitiligo) and hyperpigmentation.

The carbohdrate disruption of diabetes may indicate B12 deficiency, and B12 has been used as a useful adjunct for the diabetic.

The Russians have pioneered the treatment of glaucoma with B12, observing improvement in half of a group of 46 patients receiving 1/10 milligram dose of B12 daily, and a Japanese physician found that B12 injections improved various vision problems.

Deafness is associated with B12 deficiency; supplements have been useful in treating tinnitus and noise-related hearing loss.

B12 deficiency in pregnant women has been implicated as a factor in neural tube defects such as spina bifida in offspring. This raises real concerns about the contraceptive pill, which depletes B12. Women who have been taking the contraceptive pill should have their levels tested and supplement as necessary before becoming pregnant.

B12 may be necessary for antibody response; low levels are associated with impaired immunity and increased infections.

Mycotoxins from molds interfere with B12 function, which explains why a common reaction to molds is neurological problems. Pesticides and chemicals also deplete vitamin B12. High doses of B12 can protect against these xenotoxins.

B12 injections have been beneficial in treating viral hepatitis.

Finally, treatment with B12 can help with sleep disorders as the nutrient is involved in the production of melatonin.

AN EXCEPTION TO OUR RULE

In these pages, we have consistently advised obtaining vitamins from food (including superfoods) rather than with vitamin supplements. One good reason to avoid supplements derives from research indicating that they can interfere with B12 uptake, exacerbate the symptoms of B12 deficiency or even cause the creation of B12 analogs that increase the body’s need for B12.

However, when it comes to B12 itself, supplementation with isolated B12 is often necessary and appropriate. The many factors in our modern lifestyle that block the complicated uptake pathways of this important nutrient--from nutrient deficiencies to exposure to toxins to factors in processed foods that cause reduced stomach acid, autoimmune disease and enzyme disruption--make it difficult to obtain sufficient quantities from our normal diet; and since vitamin B12 in supplements is produced in exactly the same way as B12 in nature, that is, by bacterial fermentation, the danger of high doses in most cases is negligible.

B12 supplements have the potential of making life better for a large portion of the population, and not just the elderly. Regular testing and treatment with supplements as needed is an important step in the transition from the modern diet back to a nutrient-dense traditional one, when, after a generation or two, supplements of any kind will no longer be needed.

The authors wish to acknowledge the contribution of Lee Clifford, MS, CCN, for providing her extensive files on vitamin B12.
SIGNS OF B₁₂ DEFICIENCY

Poor growth/failure to thrive in infants
Inflamed tongue
Premature grey hair
Disturbed carbohydrate metabolism
Fatigue
Weakness
Weight loss
Constipation
Infertility
Vision problems
Loss of hearing and tinnitus
Numbness and tingling in the hands and feet
Alcoholism
Impotence
Incontinence
Hyperpigmentation and hypopigmentation
(dark and light patches in the skin)
Neuralgia, neuritis and bursitis
Anemia, including pernicious anemia
Spinal cord degeneration
Psoriasis and other skin problems
Brain degeneration
Insomnia
Irrational or chronic anger
Violent behavior
Lack of balance/abnormal gait
Combat fatigue
Any emotional disorder up to and including insanity

TESTING FOR B₁₂ DEFICIENCY

The first step in determining B12 deficiency is a test of B12 levels in the blood. However, many doctors believe that blood levels are an unreliable indicator of deficiency and that tissue levels of B12 may be quite low even though blood levels are normal. They recommend also testing for elevated levels of homocysteine and methylmalonic acid (MMA), two precursors to the metabolic reactions controlled by B12. Since homocysteine levels can be elevated by a number of conditions (folic acid deficiency, B6 deficiencies, renal failure, hypothyroidism and certain genetic defects), doctors consider elevated MMA levels to be the more reliable indication of B12 deficiency.

Other tests include the Schilling test, in which a tiny dose of radioactive B12 is given by mouth and the amount absorbed measured. If vitamin B12 is absorbed only when given with intrinsic factor, the diagnosis of pernicious anemia is confirmed.
Because testing is so complicated, the levels considered normal in dispute, and disruption possible at numerous levels, many physicians have come to the conclusion that the only reliable way to assess the effects of subtle B12 deficiency on the blood, especially in older patients, is to observe changes (especially psychological changes) after treatment and determine empirically the best amount of supplementation for the individual patient. Since B12 is not toxic, except perhaps at extremely high levels, the empirical use of large doses to treat patients poses no danger.

**AVOIDING B₁₂ DEFICIENCY**

Get a plentiful amount in your food. Liver or shellfish eaten at least once a week is the the best way to ensure that you are taking in adequate amounts.

Avoid overconsumption of foods that block vitamin B12 intake or increase the body’s need for the vitamin, such as soy foods and spirulina.

Avoid antacids and drugs that lower stomach acid levels: acid-suppressing drugs such as Tagamet, Zantac and Losec can lead to serious B₁₂ deficiency (Koop H. Aliment Pharmacol Ther 1992;6:399-406 [review]; Marcaurd SP and others. Ann Intern Med 1994;120:211-215).

Avoid diabetes drugs such as Glucophage which also interfere with B₁₂ absorption (Archives Int Med 2002 Feb 25;162:484-85).

Consume plenty of calcium. Calcium is involved in the absorption of B₁₂ from the lower small intestine. Best sources are raw dairy products and bone broths. (Bone broths also help heal intestinal inflammation that could cause absorption problems.) Dolomite powder can also be used as a calcium source.

Take coconut oil and consume lacto-fermented foods: these help fight against pathogens such as helicobacter pylori, which is associated with B₁₂ deficiency. Eradication of the organism often clears up B₁₂ deficiency. (Archives of Internal Medicine, May 8, 2000 160:1349-53)

Avoid foods fortified with folic acid. Taking folic acid without B₁₂ can mask signs of B₁₂ deficiency in red blood cells but will not protect against deficiencies in the nervous system. Folic acid and B₁₂ work together and any supplementation program should include both of these nutrients (Institute of Medicine. Food and Nutrition Board. Dietary Reference Intakes: Thiamin, riboflavin, niacin, vitamin B₆, folate, vitamin B₁₂, pantothenic acid, biotin, and choline. National Academy Press. Washington, DC 1998).

Avoid taking excess vitamin C, especially for long periods. The ability of vitamin C to destroy B₁₂ has been observed by several researchers--although this is disputed by others. Small amounts of natural vitamin C are a better choice than large amounts of synthetic vitamin C. (Herbert V and Das KC. Folic acid and vitamin B₁₂. In: Shils ME, Olson JA, Shike M, eds. Modern Nutrition in Health and Disease. 8th ed. PhiladelphiaL Lea & Febiger, 1994:404.)

Take extra B12 before and after surgery. Nitrous oxide anesthesia during surgery can deplete B12, a fact that may explain many cases of post-operative depression (Marie RM and others. *Arch Neurol* 2000 Mar;57(3):380-2).

Avoid vaccinations containing thimerosol and other mercury-containing compounds. Vitamin B12 is depleted by mercury (*J Molecular Psychiatry* Apr 2004).


Take B12 supplements if you have any conditions that might interfere with B12, such as celiac disease, Crohn’s disease and similar intestinal disorders, especially if you are elderly or exhibit any of the symptoms of B12 deficiency.

**B12 SUPPLEMENTATION--SHOTS OR PILLS?**

The standard treatment for B12 deficiency involves injections, which deliver B12 quickly into the bloodstream and bypass any defective components of the absorption mechanism. Injections are indicated in cases of extreme deficiency, when B12 stores must be replenished very quickly. The standard protocol is 1000 micrograms daily for three days, then weekly for a month, then one injection per month indefinitely.

However, shots are unpleasant and expensive, requiring regular visits to the doctor’s office unless the patient is able to self administer. For all but the most urgent situations, a growing body of medical opinion supports the use of oral supplementation, especially sublingual tablets. Practitioners are now recommending a dose of 100-250 micrograms per day for maintenance purposes. Those with absorption problems may need 1000 -2000 micrograms per day. Such doses are safe because cobalamin has no known toxic effects. Those with absorption problems will absorb only a fraction of the dose (through a process of diffusion across the gut wall) but studies indicate that consistent use of oral supplementation will correct deficiency in most patients with malabsorption. In fact, a recent study showed that oral supplementation with 2000 micrograms per day was three times as effective as injections in increasing B12 levels in pernicious anemia patients (*Journal of the American Geriatrics Society*, January 1997 45(1):124).

Dr. John Dommisse recommends very high dose lozenges (2000/2500 mcg) taken after one or two meals daily, as effective as injections in maintaining serum B12 levels in the ideal range ([www.johndommisse.com/b12.html](http://www.johndommisse.com/b12.html)).

Nasal gel preparations have also been found to be capable of maintaining ideal serum B12 levels, although this method of supplementation remains controversial. Another possible delivery method, recommended by Dr. Joseph Mercola, is delivery through the skin by mixing B12 with DMSO ([www.mercola.com/2000/aug27/vitamin_b12_deficiency.htm](http://www.mercola.com/2000/aug27/vitamin_b12_deficiency.htm)).
The most commonly used form of B12 for treatment in the US is cyanocobalamin. Only two forms are active in the body, however, methylcobalamin and adenosylcobalamin. Cyanocobalamin must be converted in the body to either methyl or adenosyl cobalamin by the enzymatic removal of a cyanide molecule. (The amount of cyanide produced during this process is very small but still could be problematical); whereas the body can immediately use supplements of methylcobalamin (the only active form of vitamin B12 commercially available in the US). In a study that looked at the ability of vitamin B12 to extend life in mice with cancer, methylcobalamin led to significant increases in survival time while cyanocobalamin had no effect (Tsao CS and Myashita K. Pathobiology 1993;61(2):104-8).

THE PATIENT WHO WEPT FOR SIX MONTHS

From Your Nutrition Prescription by Dr. H.L. Newbold

Several years ago a seventy-six-year-old woman was brought to my office by her daughter, who stated that the mother had been weeping uncontrollably for the past six months and had recently become so incapacitated that she was unable to do her housework. She had been to see five physicians who had treated her in five different ways, mostly with antidepressants and tranquilizers. One doctor had given her injections of multiple vitamins, which had not helped either.

In spite of her normal B12 level, I gave her a trial injection of 1000 mcg of vitamin B12. I told myself that unless she quickly improved, she would need antidepressants. If the antidepressants didn’t help her a great deal within a month, she would need electroconvulsive therapy.

When she returned to my office three days later, she was considerably improved. She was no longer crying, and reported that she felt much stronger and had slept throughout the night for the first time in many months.

At the time of her next visit three days later, she looked happy and told me she could do her housekeeping again.

During subsequent visits the daughter was taught to administer the injections to her mother twice a week, or more frequently if she seemed in greater need of the vitamin. When she returned several weeks later, the elderly lady told me that she could feel herself becoming depleted of the vitamin every three or four days, and always felt completely restored after receiving another injection. At the time of that visit she was feeling the way she had felt ten years earlier, and was busy with all the household chores which she, like so many good German housewives of her generation, immensely enjoyed.

She was instructed to take the injections more often. If the injection gave her a lift, then she had waited too long.

This woman is a good example of a vitamin-dependent individual. I am sure we had elevated her serum vitamin B12 level to enormous heights. It would have been a waste of money to retest her.
Perhaps she was one of those people whose enzyme functions gradually fade with age. But this patient was restored to normal by giving her massive amounts of vitamins. It is even possible that certain metabolic pathways, not normally employing vitamin B12, switched pathways, and made use of this invigorated set of enzymes. At any rate, a few injections of B12 turned a crying, shuffling old woman into a bright-eyed, merry, elderly housewife who could once more take an active role in life and enjoy her remaining years.

Such transformations are what chemistry and nutrition are all about.

**VITAMIN B₁₂ AND THE NOBEL PRIZE**

The discovery, description, isolation and synthesis of B12 is a good example of science at its best and has resulted in four Nobel prizes, three in chemistry and one in medicine.

1934: Whipple (California), Minot and Murphy (Massachusetts) won the Nobel Prize in physiology and medicine for the discovery of the "anti-pernicious anemia factor" in liver.

1964: Dorothy Crowfoot Hodgkin (Oxford) won the Nobel Prize in chemistry for her crystal structure analysis of B12 crystal, using new X-ray techniques.

1965: R. B. Woodward (Harvard), working with B12, won the Nobel Prize in chemistry for outstanding achievements in the art of organic synthesis.

1981: K. Fukui (Kyoto) and R. Hoffman (Cornell), working with B12, won the Nobel Prize in chemistry for quantum mechanical studies of chemical reactivity.

**SOURCES OF VITAMIN B₁₂**

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<thead>
<tr>
<th>Source</th>
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### VITAMIN B₁₂

#### RECOMMENDED DAILY ALLOWANCE

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<tr>
<td>Pregnancy</td>
<td>2.6 micrograms</td>
</tr>
<tr>
<td>Lactation</td>
<td>2.8 micrograms</td>
</tr>
</tbody>
</table>

### About the Authors

**Sally Fallon** is the author of *Nourishing Traditions: The Cookbook that Challenges Politically Correct Nutrition and the Diet Dictocrats* (with Mary G. Enig, PhD), a well-researched, thought-provoking guide to traditional foods with a startling message: Animal fats and cholesterol are not villains but vital factors in the diet, necessary for normal growth, proper function of the brain and nervous system, protection from disease and optimum energy levels. She joined forces with Enig again to write *Eat Fat, Lose Fat*, and has authored numerous articles on the subject of diet and health. The President of the Weston A. Price Foundation and founder of [A Campaign for Real Milk](https://www.realmilk.com), Sally is also a journalist, chef, nutrition researcher, homemaker, and community activist. Her four healthy children were raised on whole foods including butter, cream, eggs and meat.

**Mary G. Enig, PhD** is an expert of international renown in the field of lipid biochemistry. She has headed a number of studies on the content and effects of *trans* fatty acids in America and Israel, and has successfully challenged government assertions that dietary animal fat causes cancer and heart disease. Recent scientific and media attention on the possible adverse health effects of *trans* fatty acids has brought increased attention to her work. She is a licensed nutritionist, certified by the Certification Board for Nutrition Specialists, a qualified expert witness, nutrition consultant to individuals, industry and state and federal governments, contributing editor to a number of scientific publications, Fellow of the American College of Nutrition and President of the Maryland Nutritionists Association. She is the author of over 60 technical papers and presentations, as well as a popular lecturer. Dr. Enig is currently working on the exploratory development of an adjunct therapy for AIDS using complete medium chain saturated fatty acids from whole foods. She is Vice-President of the Weston A Price Foundation and Scientific Editor of