Vitamin B12

Vitamin B12, also known as cobalamin, is an essential vitamin required by the body (1). Vitamin B12 is the most structurally complicated and largest vitamin of all the B's. Imagine that vitamin B12 is shaped like a ring, and that this ring is made out of something called corrin. In the centre of the ring, sits the biochemically rare element, cobalt. Vitamin B12 is thus a generic descriptor referring to a collection of cobalt and corrin molecules which share similar functions in the human body. All the substrates from which B12 is made must be synthesised by bacteria. This means that any one person's vitamin B12 status is partially dependent on the health of their gut microbiome. After bacterial synthesis, the human body converts any form of B12 into an active form that it can use.

Vitamin B12 has an important role in cellular metabolism, as one of two "active" forms – methylcobalamin and 5-deoxyadenosylcobalamin. The function of vitamin B12 is closely linked with vitamin B9 (folate). You could think of these two vitamins as being very good friends because they do almost everything together! Adequate levels of vitamin B12 and folate are required to convert homocysteine to methionine (2).

A deficiency in either B12 or folate can cause this cycle to become "jammed" and homocysteine can build up in the blood. Elevated levels of homocysteine are associated with increased risk of stroke, cardiovascular disease, Alzheimer's Disease and birth defects (13-16). Vitamin B12, again working alongside folate, is essential for the synthesis of DNA and the production of red blood cells (which carry oxygen around the body) (1). Vitamin B12 also has a separate role in the nervous system to help produce the myelin sheath surrounding nerve cells, which protects them and increase the speed of communication (1).

The absorption of vitamin B12 in the human body is by far the most complicated out of all vitamins and minerals. It relies on proper enzymatic function at the stomach, the intestine and the cellular level. A dysfunction at any one of these critical points can lead to a deficiency in B12.

B12 deficiency can prevent you from Food Freedom

Deficiencies in B12 are usually caused by malabsorption. However, as animal proteins are the main source of vitamin B12, vegans and vegetarians are at a significantly greater risk to develop a deficiency in vitamin B12 (4). Older adults are also at an increased risk due to a reduction in the production of stomach acid as a result of ageing. Additionally, certain conditions such as pernicious anaemia, lead to massive dysfunction at one of the critical B12 absorption points, causing a deficiency. Finally, there are many commonly prescribed medications that interfere with the absorption of B12, including proton pump inhibitors (hypertensive medications), metformin (for diabetes or weight management), nitrous oxide anaesthesia and some epileptic medications. If you can identify with any of the higher risk categories for vitamin B12 deficiency outlined here, it is recommended that you speak to a health professional about preventing or managing a deficiency.

Vitamin B12 deficiency symptoms are often mistaken for other conditions because they tend to be common and may even feel "normal".

Symptoms include weakness, fatigue, loss of appetite, hazy memory and difficulty concentrating (5, 6). The onset of a vitamin B12 deficiency is usually quite gradual and frequently misdiagnosed, because the liver can store large amounts of B12 - this will last for several years. Due to its utter importance in nerve function, an unmanaged B12 deficiency can lead to neurological disorders, including peripheral neuropathy – numbness and tingling in feet that can lead to amputation and loss of vision (7).

With consideration that vitamin B12 and folate do almost everything together, an excessive intake of folic acid (the synthetic form of folate, found in fortified foods and supplements) can mask a B12 deficiency. When B12 concentrations become low, folic acid can "takeover" to prevent anaemia and mask many symptoms that would otherwise indicate a deficiency in B12. This may sound like folic acid is picking up the slack for its good friend B12, but what it really means is that B12 concentrations continue to fall lower and lower without the person affected being aware. While this is happening, homocysteine concentrations rise and neurological damage begins. One way to "catch" this is with a simple blood test. Ask your medical doctor to test for serum homocysteine levels. If your serum homocysteine levels are elevated, your doctor should suspect a potential vitamin B12 deficiency at the cellular level – in combination with your signs and symptoms – even if your serum vitamin B12 is within "normal" range.

Studies have suggested that low vitamin B12 levels are associated with obesity and being overweight (9). Other studies have also shown that adequate vitamin B12 status can improve insulin resistance (10). Additionally, vitamin B12 is needed for the production of serotonin, a chemical responsible for regulating mood. Research shows that vitamin B12 deficiency was associated with twice the risk of severe depression in older women (11) and vitamin B12 supplements may help improve mood and depression in people with an existing deficiency (12).

Nevertheless, all individuals should aim for at least the recommended daily intake (see below) of vitamin B12 every day. The idea that certain clinical populations may benefit from increased amounts of vitamin B12 for therapeutic benefit is a promising area of science that requires more research.

How much do you need?

The recommended daily intake (RDI) for B12 has been set to prevent megaloblastic anaemia and to maintain adequate serum vitamin B12 concentrations. For both men and women, the RDI is 2.4 micrograms per day, increasing to 2.6 micrograms per day for pregnant women and 2.8 micrograms per day for lactating women (13).

Dietary Sources of B12

Vitamin B12 is synthesised by bacteria in the gastrointestinal tract of animals and is then absorbed by the host animal. It is found concentrated in animal tissues, hence why vitamin B12 is found only in foods of animal origin.

Food	Vit B12 (mcg)/100 g
Liver	18.0
Sardines	8.9
Mackerel	6.9
Salmon	4.3
Tuna	3.0
Lamb	2.6
Chicken	0.4
Egg, whole	0.8
Cheese, brie	1.7
Cheese, cheddar	1.1
Yoghurt, plain	0.4
Mushrooms	<0.1
Hemp milk	0.6

This table highlights the importance of vegetarians possibly needing to increase their intake of eggs and milk to have a better chance of reaching vitamin B12 requirements. Moreover, vegans can receive a small amount of vitamin B12 from mushrooms and fortified food products (e.g., hemp milk), but will require additional supplementation as guided by their health professional.

References

1. O'Leary F, et al. Vitamin B12 in health and disease. Nutrients 2010;2:299–316.
2. Klee GG. Cobalamin and folate evaluation: measurement of methylmalonic acid and homocysteine vs vitamin B(12) and folate. Clin Chem 2000;46(8 Pt 2):1277–1283.
3. Gibson R.S. Principles of Nutritional Assessment. 2nd ed. New York, NY, USA: Oxford University Press, 2005.
4. Heyssel R M, et al. Vitamin B12 turnover in man. The assimilation of vitamin B12 from natural foodstuff by man and estimates of minimal daily requirements. Am J Clin Nutr 1966;18:176–18.
5. Herbert V. Vitamin B12 in Present Knowledge in Nutrition. 17th ed. Washington, DC: International Life Sciences Institute Press, 1996.
6. Combs G. Vitamin B12 in The Vitamins. New York: Academic Press, Inc., 1992.
7. Clarke R. B-vitamins and prevention of dementia. Proc Nutr Soc 2008;67:75-81.
8. Scalabrino G. The multi-faceted basis of vitamin B-12 (cobalamin) neurotrophism in adult central nervous system: Lessons learned from its deficiency. Prog Neurobiol 2009;88:203–220.
9. Baltaci D, et al. Association of vitamin B12 with obesity, overweight, insulin resistance and metabolic syndrome, and body fat composition; primary care-based study. Med Glas 2013;10: 203–210.
10. Setola E, et al. Insulin resistance and endothelial function are improved after folate and vitamin B12 therapy in patients with metabolic syndrome: relationship between homocysteine levels and hyperinsulinemia. Eur J Endocrinol 2004;151:483 – 9.
11. Penninx BWJH. Vitamin B12 Deficiency and Depression in Physically Disabled Older Women: Epidemiologic Evidence From the Women's Health and Aging Study. Am J Psychiatry. 2000;157:715–21.
12. Hintikka J, et al. High vitamin B12 level and good treatment outcome may be associated in major depressive disorder. BMC Psychiatry. 2003;3:17.

13. National Health & Medical Research Council. Nutrient Reference Values Vitamin B12. Canberra, ACT: Commonwealth of Australia. c2009 [accessed 1 Jul 2011] Available from: http://www.nrv.gov.au/nutrients/vitamin%20b12.htm