

vitamin B

FACT SHEET



The vitamin B complex comprises eight essential water-soluble micronutrients: thiamin (B₁), riboflavin (B₂), niacin (earlier known as B₃/B₄), pantothenic acid (earlier known as B₅), pyridoxine (B₆), biotin (earlier known as B₈ and vitamin H), folate (earlier known as B₉) and cobalamin (B₁₂). [For details on folate, see separate information sheet].

Importance for health

The B vitamins act as coenzymes (helpers) in numerous biochemical reactions in the body. They are therefore essential for the proper growth, maintenance and functioning of all cells, tissues and organs. They are needed for the production and release of energy, hormones, neurotransmitters, blood cells and antibodies. Some B vitamins are important for the optimal functioning of others: B₂, for example, is needed for the conversion of B₆ and folate into their active forms, B₂ and B₆ for the synthesis of niacin from the amino acid tryptophan. B₁₂ and folate are jointly involved in homocysteine lowering. B₁₂ is important for two key steps in fatty acid and amino acid metabolism. B vitamins are part of many enzymes involved in energy

production using carbohydrates, fatty acids and amino acids as a fuel for the body's endogenous energy source (ATP). Inadequate levels of B vitamins may, for example, lead to loss of appetite, fatigue, irritability, lack of concentration, dry skin, tingling sensations, muscle cramps and anemia.

Heart health

High blood levels of homocysteine increase the risk for cardiovascular disease. Adequate levels of the vitamins B₂, B₆, B₁₂ and folic acid are needed to remove homocysteine efficiently from the body. Studies have shown that supplementation with these vitamins can lower homocysteine levels significantly.^{1,2}

Protection against cancer

B vitamins are important for protein synthesis. Niacin, for example, influences the tumor suppressor protein p53³, and has been shown to lower the incidence of cancer of the mouth and esophagus.^{4,5} Another study linked high blood levels of B₁₂ in women with a lower incidence of breast cancer.⁶

Food sources

B vitamins are found in most foods, but only in small amounts. An exception is vitamin B₁₂, which is only found in foods of animal origin (e.g. meat, eggs, milk). Most B

vitamins are relatively unstable when exposed to heat, light and oxygen (exceptions are niacin and biotin). Considerable losses can occur during processing, storage and cooking.

Table 1: Food sources of B vitamins^{7,8}

Food	Portion size	% of average daily dietary requirements provided by one portion					
		B ₁	B ₂	N*	PA**	B ₆	B ₁₂
Milk	100 ml	4	12	1	8	2	>20
Eggs	1 (50 g)	3	15	<1	15	5	30
Potatoes	100 g	10	1.5	10	10	15	0
Bread, wholewheat	1 slice (30 g)	10	4	7	3	3	<1
Legumes (beans, peas, lentils)	100 g	18	7	7-10	4-10	7-14	0
Pork, ham	100 g	35-75	18	30	18	30	35
Beef	100 g	8-12	12	25	8	25	>95
Beef liver	100 g	>100	>100	>100	>100	70	>100
Orange juice, fresh	100 ml	1	2	2	4	3	0
Breakfast cereals (fortified)	100 g	80	80	100	100	80	80

*Niacin, **Pantothenic Acid

1 Bronstrup A, Hages M, Prinz-Langenohl R, Pietrzik K. Effect of folic acid and combinations of folic acid and vitamin B12 on plasma homocysteine concentrations in healthy young women. *Am. J. Clin. Nutr.* 1998; 68: 1104-1110.
2 Bronstrup, A Hages, M Pietrzik, K Lowering of homocysteine concentrations in elderly men and women. *Internat. J. Vit. Nutr. Res.* 1999;69: 187-193.

3 Jacobson EL, Shieh WM, Huang AC. Mapping the role of NAD metabolism in prevention and treatment of carcinogenesis. *Mol Cell Biochem.* 1999;193(1-2):69-74.

4 Negri E, Franceschi S, Bosetti C, et al. Selected micronutrients and oral and pharyngeal cancer. *Int J Cancer.* 2000;86(1):122-127.
5 Franceschi S, Bidoli E, Negri E, et al. Role of macronutrients, vitamins and minerals in the aetiology of squamous-cell carcinoma of the oesophagus. *Int J Cancer.* 2000;86(5):626-631.

6 Wu K, Helzlsouer KJ, Comstock GW, Hoffman SC, Nadeau MR, Selhub J. A prospective study on folate, B12, and pyridoxal 5'-phosphate (B6) and breast cancer. *Cancer Epidemiol Biomarkers Prev.* 1999;8(3):209-217
7 USDA National Nutrient Database for Standard Reference, Release 16.
8 Linus Pauling Institute Micronutrient Information Center. (2003).

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Recommended intakes

Recommended intakes for adults are shown in Table 2. Daily requirements of vitamin B₁ are affected by energy intake, those of vitamin B₆ by protein intake. The B vitamins have a high turnover rate in the body, and most are not stored in any appreciable amounts, making regular

intake essential. An exception is vitamin B₁₂, which is efficiently reabsorbed from the intestines and stored mainly in the liver. This explains why a B₁₂ deficiency can take years to develop even in vegans.

Table 2: Recommended daily intakes of B vitamins for men/women ⁹

Country/organisation	B ₁ (mg)	B ₂ (mg)	N(mg)	PA(mg)	B ₆ (mg)	Biotin(µg)	B ₁₂ (µg)
Belgium, 2000	1.1/0.9	1.6/1.3	18/14	3-12	1.7/1.2	15-100	1.4
France, 2001	1.3/1.1	1.6/1.5	14/11	5	1.8/1.5	50	2.4
DACH*, 2000	1.2/1.0	1.4/1.2	16/13	6	1.5/1.2	30-60	3.0
Ireland, 1999	1.1/0.9	1.6/1.3	18/14	-	1.5/1.1	-	1.4
Netherlands, 2000	1.1	1.5/1.1	17/13	5	1.5	-	2.8
Nordic countries, 1996	1.4/1.1	1.8/1.3	19/15	-	1.5/1.2	-	2.0
Portugal, 1982	1.5/1.2	1.6/1.4	18/14	-	2.2	-	3.0
Spain	1.2/0.9	1.8/1.4	20/15	-	1.5	-	2.0
United Kingdom	1.0/0.8	1.3/1.1	17/13	3-7	1.4/1.2	10-200	1.5
EU Reference Labelling Values	1.1	1.4	16	6	1.4	50	2.5

* Recommendations for Germany, Austria and Switzerland

N - Niacin, PA - Pantothenic Acid

Current intakes

Recent surveys in Austria,¹⁰ Germany,¹¹ Ireland,¹² the Netherlands,¹³ and the UK¹⁴ provide an indication of current intake of B vitamins. In Germany, men generally meet national recommendations for intake of B vitamins. However, a significant number of women do not meet intake requirements for vitamins B₁ and B₂. In the UK, the proportion of those not meeting current UK national recommendations for B vitamins does not generally exceed 10%. More recent recommendations (France, DACH and SCF) have proposed a requirement of 50 µg/day for biotin, an intake that is not met by 74% of men and 90% of women in the UK, although recommendations for biotin remain vague. Likewise in Ireland, the mean intake for most B vitamins is generally higher than recommended intakes, although for biotin and pantothenic acid, a significant proportion of men and women would not meet recent SCF recommendations for these vitamins. In Austria, by

contrast, certain population groups were shown to be deficient in B₁, B₂ and B₆. Women under the age of 25 and aged between 35 and 45 years did not meet requirements for B₁, B₂ and B₆. Among Austrian men, only those aged 46-55 years met requirements for B₂ and insufficient intake of B₆ was demonstrated for those aged between 36 and 45 years and over 56 years.

Comparative data illustrating trends in intake do not show consistent patterns for all B vitamins. Average intake of vitamin B₁₂ in the Netherlands dropped by over 15% between 1987 and 1997. However, intake from vitamin B₆ increased in excess of 10%. Similarly in the UK, average intake of all B vitamins increased by up to 20% (B₁ intake in women) between 1987 and 2001 with the exception of vitamin B₁₂ which decreased by around 5% in both men and women.

⁹ EC Scientific Committee on Food. Opinion of the Scientific Committee on Food on the revision of reference values for nutrition labelling. (2003)
¹⁰ Institut für Ernährungswissenschaften, Österreichischer Ernährungsbericht (1998).

¹¹ Robert Koch Institut, Was essen wir heute?: Beiträge zur Gesundheitsberichterstattung des Bundes. (2002).

¹² Irish Universities Nutrition Alliance (IUNA), The North-South Ireland Food Consumption Survey (2001).
¹³ Gezondheidsraad, Enkele belangrijke ontwikkelingen in de voedselconsumptie (2002).

¹⁴ UK Office for National Statistics, The National Diet & Nutrition Survey (NDNS): adults aged 19 to 64 years (2003).

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Food supplements

B vitamins are generally formulated as a combination (B-complex) or included in multivitamin supplements. Single supplements of vitamin B₆ and nicotinamide are also common.

A Gallup survey¹⁵ of 6 European countries in 1999 showed that 23% of the population use food supplements. Of these users, 12% claim to take a vitamin B-complex supplement. On average, food supplements provide 1.7%-3.7% of total niacin intake, 3.6%-7.7% of total B₆ intake, 2.7%-6.4% of folate intake and 3.2%-6.1% of pantothenic acid intake.¹²

Findings from Germany suggest that food supplements significantly enhance the likelihood of meeting dietary requirements for B vitamins, but that for certain B vitamins, even regular food supplement users do not meet these requirements. In Germany, 48% of food supplement users do not meet national recommendations for biotin compared to 66% of non-users. One traditional concern about food supplements is that they may 'replace' the diet and reduce consumer intake of micronutrients from foods. Bietz et al. compare the dietary intake from food sources

of regular users and non-users of food supplements. Although intake from food sources alone is sometimes greater in users of food supplements (as is the case for B₂, B₆, B₁₂) and sometimes less (B₁, B₁₂ and niacin), the difference in intake from food sources is marginal (<2% in all cases except B₁₂ which is 5% lower in food supplement users than non-users).¹⁶

Intake of B vitamins remains relatively low, even for regular users of food supplements. Only between 1% (vitamin B₁₂) and 7% (vitamin B₁) of regular user of food supplements exceeded 150% of the national recommendations for these vitamins.¹⁶ Sub-RDA levels of B vitamins even among food supplement users indicate patterns of irregular use of food supplements among users.

Table 3 provides a review of the range of B vitamin content in food supplements currently sold freely in the EU, i.e. those that the consumer can find on the shelves of supermarkets and health stores (including products that in some countries may be registered as medicines). Food supplements sold in pharmacies and subject to specific controls are not included.

Table 3: Range of B vitamins in food supplements on free sale (via health stores and supermarkets) in the major EU markets¹⁷

Country	B ₁ (mg)	B ₂ (mg)	B ₁₂ (µg)	Biotin (µg)	Niacin (mg)	PA (mg)	B ₆ (mg)
Low dose (across EU)	1.1	1.4	1.4	50	15	5	2
High dose							
Denmark	250	100	9	2500	100	90	200
Finland	75	75	500	600	35	35	75
Germany	12.2	16	10	5000	54	23	10
Ireland	100	200	25	500	450	500	50
Netherlands	50	200	3000	2500	500	550	200
Portugal	100	100	1000	1000	100	140	250
UK	100	100	2000	2000	250	140	100

¹⁵ Gallup European Consumers Awareness and Behaviour Survey on Vitamin and Mineral Supplements and Fortified Foods (Roche Vitamins Europe, 1999).

¹⁶ Bietz R et al., Vitamins - dietary intake and intake from dietary supplements in Germany. European Journal of Clinical Nutrition 56 (2002).

¹⁷ Market survey undertaken by the European Responsible Nutrition Alliance in 2001-2003.

Food fortification

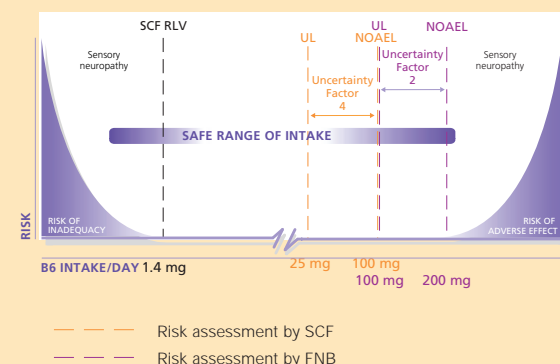
A range of B vitamins are currently added to foods in Europe at levels which vary depending on national legislation. Breakfast cereals, biscuits, dairy products and beverages may all have added B vitamins. In certain groups of the population breakfast cereals make an important contribution to the intake of a number of B vitamins e.g. around 15% of total vitamin B₁ and around 20% of vitamin B₂ intake in teenagers in the UK and Ireland. Some breakfast cereals also provide vitamins B₆

and B₁₂ along with niacin.¹⁴ In the UK the restoration of flour and bread with vitamin B₁ provides 15% of the total daily intake for some older adults. In Germany enriched beverages have made an important contribution to the B vitamin intake of adolescents. In accordance with EU legislation B group vitamins are added as defined to specific foodstuffs for particular nutritional use, for example, formulae milks, meal replacers and dietetic supplement drinks.

Safety

After assessing the B vitamins, the European Scientific Committee on Food (SCF) concluded that there is not enough data to establish a Tolerable Upper Intake Level (UL) for B vitamins with the exception of B₆ and niacin (see folate information sheet for findings on folate). No risk is associated with high intake of other B vitamins. Both the SCF and the Food and Nutrition Board of the Institute of Medicine were therefore unable to set ULs, as no adverse effect level could be identified.^{18, 19, 20, 21, 22} The SCF set a NOAEL (No Observed Adverse Effect Level) of 100mg/day for vitamin B₆ taking into account the results of a study by Dalton and Dalton.²³ A UL of 25 mg/day was established by dividing the NOAEL by an uncertainty factor of 4 (to take into account nature of intake data and uncertainties in the database.) Combined intake from foods and food supplements is generally below this level. However, supplements available in some countries contain higher amounts. Neurotoxicity has been reported only after prolonged periods of treatment at extremely high doses (at least 500 mg daily for more than a year). Minor neurological symptoms have been recorded at lower doses (above 100 mg daily for more than a year). The symptoms were always reversible.²⁴ The FNB in the USA recently set the adult UL for B₆ at 100 mg/day²⁵. They excluded the report by Dalton and Dalton from their calculations, because they considered the study had methodological weaknesses.

Niacin occurs in two forms, nicotinamide and nicotinic acid. High doses of free nicotinic acid (1-3 g/day for treatment of high blood cholesterol levels) are associated with flushing, gastrointestinal problems and abnormal liver function. Nicotinamide, the form of niacin generally used in vitamin supplements and for addition to foods, does not have such effects. The SCF has therefore set the adult UL for nicotinic acid at 10 mg/day, and the adult UL for nicotinamide at 900 mg/day. The UL for free nicotinic acid was derived from data on flushing following administration of a single oral dose. Flushing has not been reported for the bound forms of nicotinic acid present in foods.²⁶ The FNB did not make distinct risk assessments for niacin and nicotinamide and set a UL of 35mg/day to cover the use of niacin and nicotinic acid from supplements and fortified foods.²⁵



18 EC Scientific Committee on Food, Opinion of the Scientific Committee on Food on the Tolerable Upper Intake Level of Vitamin B1, (2001).
 19 EC Scientific Committee on Food, Opinion of the Scientific Committee on Food on the Tolerable Upper Intake Level of Vitamin B2 (2000).

20 EC Scientific Committee on Food, Opinion of the Scientific Committee on Food on the Tolerable Upper Intake Level of Biotin (2001).
 21 EC Scientific Committee on Food, Opinion of the Scientific Committee on Food on the Tolerable Upper Intake Level of Pantothenic Acid, (2002).
 22 EC Scientific Committee on Food, Opinion of the Scientific Committee on Food on the Tolerable Upper Intake Level of Vitamin B12, (2000).

23 Dalton K, Dalton MJT. Characteristics of pyridoxine overdose neuropathy syndrome. Acta Neurol Scand 76: 8-11. (1987).
 24 EC Scientific Committee on Food, Opinion of the Scientific Committee on Food on the Tolerable Upper Intake Level of Vitamin B6 (2000).

25 Institute of Medicine, Food and Nutrition Board, Dietary Reference Intakes for Thiamine, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic acid, Biotin and Choline. (2000).
 26 EU Scientific Committee on Food, Opinion of the Scientific Committee on Food on the Tolerable Upper Intake Levels of Nicotinic Acid and Nicotinamide (Niacin) (2002).