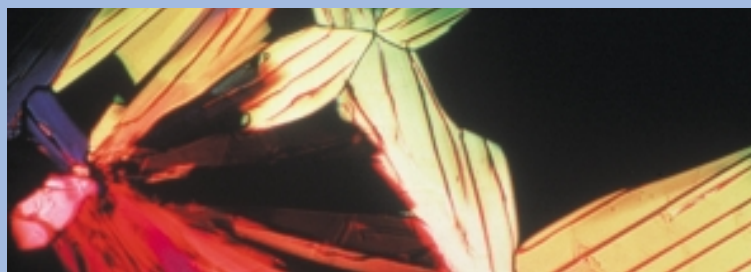
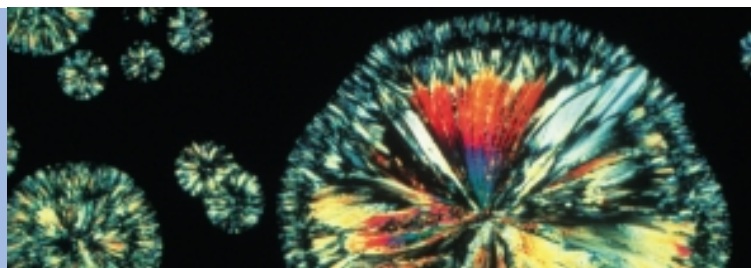


B-Vitamins

Dietary Reference Intakes DRI (US Food and Nutrition Board)



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A Summary of the Panel Report

This report has been elaborated by the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes and its Panel on Folate, other B-vitamins, and Choline and the Subcommittee on Upper Reference Levels of Nutrients, US Food Nutrition Board (FNB) with active involvement of Health Canada (1). It established a set of science-based reference values for the B-vitamins and choline to replace the previously published Recommended Dietary Allowances (RDAs) for the USA and the Recommended Nutrient Intakes (RNIs) for Canada.

This summary covers all B-vitamins and is based on the respective US FNB Panel report.

1. Definition and scope of Dietary Reference Intakes (DRI)

DRIs are reference values that are quantitative estimates of nutrient intakes to be used for planning and assessing diets for healthy people. They include a set of up to four values:

Estimated Average Requirement EAR

a daily nutrient intake value that is estimated to meet the requirement of half the healthy individuals in a group.

Recommended Dietary Allowances RDA

the average daily dietary intake level that is sufficient to meet the nutrient requirement of nearly all (97 to 98 %) healthy individuals in a particular life stage (age, pregnancy, lactation) and gender group.

Adequate Intake AI

a recommended daily intake value based on observed or experimentally determined approximations of nutrient intake by a group (or groups) of healthy people that are assumed to be adequate. The AI is a goal for the nutrient intake of individuals.

Tolerable Upper Intake Level UL

the highest level of daily nutrient intake that is likely to pose no risk of adverse health effects to almost all individuals in the general population. As intake increases above the UL, the risk of adverse effects increases.

General procedure to set Dietary Reference Intakes

The *Recommended Dietary Allowance RDA* is being mathematically derived from the Estimated Average Requirement EAR under consideration of the variability in requirement. Is the standard deviation SD of the EAR available and the requirement for the particular nutrient is normally distributed the

$$\mathbf{RDA = EAR + 2 SD_{EAR}}$$

If data are insufficient with regard to variability of requirement (which is mostly the case for the vitamins) an estimated coefficient of variation for the EAR of usually 10 percent (niacin 15%) is assumed and the

$$\mathbf{RDA = 1.2 \times EAR}$$

The *Estimated Average Requirement EAR* as the basis for calculating the RDA is being set following a careful review of the available scientific data base and the selection of *one specific criterion of adequacy* chosen for each of the nutrients. This includes the scientific evaluation of the data base for many health parameters as well as contemporary concepts of the reduction of disease risk.

In case sufficient scientific evidence is not available to derive an Estimated Average Requirement EAR and thus an RDA cannot be calculated, an *Adequate Intake AI* is set instead of an RDA. The AI can be considered as a surrogate of the RDA.

Tolerable Upper Intake Levels for Nutrients UL have been evaluated due to the increased interest and availability of fortified food and

increased use of dietary supplements. ULs are based on total chronic daily intake of a nutrient from food, fortified foods, and supplements. If adverse effects have been associated with intakes from food supplements or fortified foods *only*, the UL is based on nutrient intake from those sources only, and not on total intake. The UL is developed to be applied to almost all individuals in the general healthy population including sensitive individuals. The UL is not meant to apply to individuals who are treated with the nutrient under medical supervision.

The ULs are being derived by applying the framework of risk assessment adopted for nutrients. Risk assessment is a systematic means of evaluating the probability of occurrence of adverse health effects in humans from excess exposure to an environmental agent, in this particular case, a nutrient. The steps of risk assessment as applied to nutrients are:

- hazard identification: determination of adverse health effects caused by high intakes of the nutrient.
- dose response assessment: determines the relationship between nutrient intake/dose and adverse effect (incidence and severity). The derivation of a UL is based on the use of scientific judgement to select the appropriate no-observed-adverse-effect level (NOAEL) for the chosen adverse health effect. The NOAEL is the highest intake of a nutrient at which no adverse effects have been observed. In case, available data are inadequate to demonstrate a NOAEL, the lowest-observed-adverse-effect level (LOAEL) may be used. The LOAEL is the lowest dose at which an adverse effect



could be identified. The UL is preferentially derived from the NOAEL (or the LOAEL) by introduction of an uncertainty factor UF which deals with uncertainties in data (methodology, design of studies, analytical determination procedures, extrapolation from experimental animal data to humans, lack of data on chronic exposure, etc) and with incomplete knowledge regarding expected variability in response within the population. The UFs for nutrients are typically between 1-10, and they are lower with higher-quality data and when adverse effects are extremely mild and reversible. Thus, in general the UL is being derived by dividing the NOAEL by a single UF that incorporates all relevant uncertainties. If there are no data available on adverse effects no UL is being set.

$$UL = NOAEL / UF_1 \quad \text{or} \quad UL = LOAEL / UF_2$$

with $UF_2 > UF_1$

For specific age groups such as infants and children due to lack of data ULs were determined by extrapolating from the UL for adults (if there is one) based on body weight differences.

- Intake assessment: evaluates the range and the distribution of overall intakes of the nutrient for the population. If the UL only pertains to supplements, the assessment is directed to intake from supplements only.
- Risk characterization: estimates the risk of the fraction of the population, if any, with chronic intakes greater than the UL and evaluates the degree of excess intake exceeding the UL

The risk assessment does not make any recommendations for reducing a potential risk; these are the tasks of risk management (government; regulatory authorities).

2. Application and use of Dietary Reference Intakes (DRI)

DRI and Intake

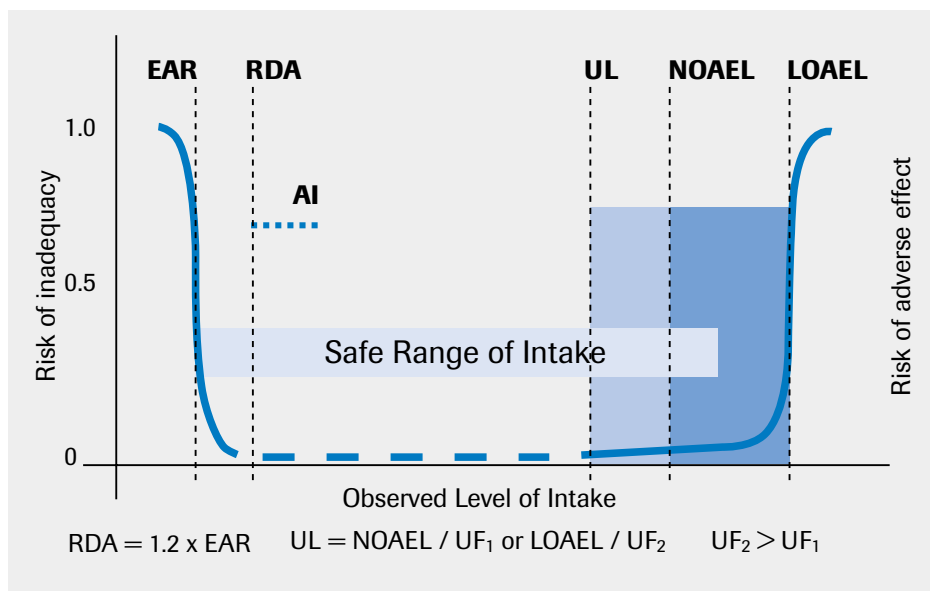


Fig.1: Dietary Reference Intakes (EAR; RDA; AI; UL), no-observed-adverse-effect (NOAEL), and lowest-observed-adverse-effect (LOAEL) intake levels. The Estimated Average Requirement (EAR) is the intake at which the risk of inadequacy is 0.5 (50%) to an individual. The Recommended Dietary Allowance (RDA) is the intake at which the risk of inadequacy is very small (about 2-3 %). At intakes between the RDA and the Tolerable Upper Level of Intake (UL) the risks of inadequacy and of excess are both close to zero. Above the UL and the NOAEL the risk of adverse effects gradually increase.

In the past, Recommended Dietary Allowances (RDAs) were the only values available to health professionals for planning and assessing the diets of individuals and groups and for making judgements on excessive intake. The newly developed Dietary Reference Intakes (DRI) are considered a more complete set of values and each value of the DRIs has a specific use. A separate Committee within the DRI process at the US Food and Nutrition Board, Institute of Medicine, is dealing with these aspects and reports will be made available after the deliberations. At this stage only the general use of Dietary Reference Intakes for healthy individuals and groups is summarized.

Use of DRIs for Planning of Diets

For the Individual

RDA: aim for that intake

AI: use as guide for intake in absence of a RDA

UL: use as guide that higher intakes may increase risk of adverse effects

For a Group

EAR: used in a way that approx 2-3% of the group have a lower intake than the group mean of requirement (EAR)

AI: use for formulation of tentative goals for mean intake of specific population group

UL: use to ensure that goals for mean intakes of a specific population group do not place an individual in this group at risk of adverse health effects due to over-consumption

Fig 2: Uses of Dietary Reference Intakes for Groups of Healthy Individuals

3. Criteria used for estimating the requirement

Use of DRIs for Assessment of Diets

For the Individual

EAR: use to examine the possibility of nutrient inadequacy; evaluation of true status requires biochemical, clinical, and/or anthropometric data

UL: use to examine the possibility of overconsumption and risk of adverse effects

For a Group

EAR: use in the assessment of prevalence of inadequate intakes within a group

In addition to the use of DRIs in planning and assessing of diets, these scientifically derived values will also be considered as basis of the so-called labeling RDAs (Daily Reference Value DRV) which will be determined by the regulatory bodies, in the USA by the FDA.

The establishment of DRIs follows these methodological steps: definition and selection of the nutrients to be assessed; selection and validation of indicators to be used; assessment of efficacy, and finally setting the DRIs, starting with the Estimated Average Requirement. There is a large number of factors which could possibly influence the determination of requirement:

- physiological factors (gender, age, body size and composition)
- health status (pregnancy, lactation, diabetes, asthma, chronic infections)
- life style (smoking, dieting, alcohol ingestion)
- occupational factors
- environmental conditions (ambient temperature, altitude, UV exposure)
- genetic / biological variations (specific phenotypes of enzymes)

The indicators considered and the respective indicator(s) finally used for the assessment of the Estimated Average Requirement (EAR) are summarized for the B-vitamins (Table I):

Table I: B-vitamins: Indicators evaluated and actually used for the assessment of Estimated Average Requirements (EAR)

Nutrient	Indicators evaluated	Indicators used for EAR/RDA assessment
Vitamin B ₁	Erythrocyte transketolase activity, urinary thiamin excretion, metabolic and depletion/repletion experiments	No currently available indicator provides an adequate basis; used a combination of erythrocyte transketolase activity, urinary thiamin excretion and others
Vitamin B ₂	Erythrocyte glutathione reductase activity coefficient, urinary riboflavin excretion, occurrence of signs of clinical deficiency, erythrocyte flavin concentration	Maintenance or restoration of riboflavin status by using biochemical indicators
Vitamin B ₆	Plasma, blood cells, urine vitamin concentration; urinary 4-pyridoxic acid excretion; relation to protein intake; erythrocyte aminotransferase saturation; try load test; homocysteine plasma concentration	Plasma 5'-pyridoxal phosphate value of at least 20 nmol/L
Niacin (nicotinic acid amide; nicotinic acid)	Biochemical and clinical end points of niacin deficiency such as daily urinary excretion of methyl-metabolites, ratio of urinary metabolites, erythrocyte pyridine metabolites; oral dose uptake tests; erythrocyte NAD; plasma pyridone derivatives	Urinary excretion of niacin metabolites, preferentially N ¹ -methyl nicotinic acid amide of 1.0 mg/day; intake required to meet this excretion calculated from experimental human studies

Table I: B-Vitamins: Indicators evaluated and actually used for the assessment of Estimated Average Requirements (EAR)

Nutrient	Indicators evaluated	Indicators used for EAR/RDA assessment
Folate	Urinary, plasma, erythrocyte folate concentration; plasma homocysteine concentration; results from metabolic studies; studies on maintenance and restoration of folate status; kinetic estimation of body pool size and turnover; indicators of hematological status; reduction of risk of neural tube defects, vascular disease, certain cancer, psychiatric and mental disorders	Combination of erythrocyte folate together with plasma folate and homocysteine concentration; risk reduction of neural tube defects
Vitamin B ₁₂	Maintenance of hematologic status (MCV, Hb, erythrocyte count, hematocrit, reticulocyte count); serum vitamin B ₁₂ / methyl malonic acid concentrations; homocysteine plasma levels; FIGLU excretion after histidine load; plasma B ₁₂ -binding proteins	No single indicator considered adequate; combination of adequate hematologic status (primary indicator), B ₁₂ daily turnover data and estimate of maintenance of body stores; dietary B ₁₂ intake corresponding to serum B ₁₂ and methyl malonic acid concentrations
Biotin	Clinical observations of patients receiving biotin-free intravenous nutrition; data from individuals with inborn errors of metabolism; consumption of large amounts of egg white; data from experimentally induced biotin deficiency; limited data from biotin availability and pharmacokinetic studies; excretion of 3-OH-valerianic acid	Evidence concerning biotin requirement is considered minimal and does yet not justify setting an EAR; Adequate Intake (AI) is being estimated on current dietary intake data and on an extrapolation from the AI for infants exclusively breast-fed
Pantothenic acid	Urinary excretion and blood levels of pantothenic acid; erythrocyte concentration	Primary criterion used to estimate an Adequate Intake (AI): intake to replace urinary excretion

4. Dietary Reference Intakes (EAR, RDA, AI) for various age groups for B-vitamins

Table II: DRI values for **Infants (0-6 months)**
(B-vitamins and Choline panel report 2000).

Nutrient	EAR	RDA	AI
Vitamin B ₁	-	-	0.2 mg
Vitamin B ₂	-	-	0.3 mg
Niacin	-	-	2 mg NE
Vitamin B ₆	-	-	0.3 mg
Folate	-	-	65 µg DFE*
Vitamin B ₁₂	-	-	0.4 µg
Pantothenic acid	-	-	1.7 mg
Biotin	-	-	5 µg

*DFE = dietary folate equivalents = 1 µg food folate = 0.5 µg synthetic folic acid on empty stomach = 0.6 µg synthetic folic acid with meals

Table IV: DRI values for **Children (1-3 years)**
(B-vitamins and Choline panel report 2000).

Nutrient	EAR	RDA	AI
Vitamin B ₁	0.4 mg	0.5 mg	-
Vitamin B ₂	0.4 mg	0.5 mg	-
Niacin	5 mg NE	6 mg NE	-
Vitamin B ₆	0.4 mg	0.5 mg	-
Folate	120 µg DFE*	150 µg DFE*	-
Vitamin B ₁₂	0.7 µg	0.9 µg	-
Pantothenic acid	-	-	2 mg
Biotin	-	-	8 µg

*DFE = dietary folate equivalents = 1 µg food folate = 0.5 µg synthetic folic acid on empty stomach = 0.6 µg synthetic folic acid with meals

Table III: DRI values for **Infants (7-12 months)**
(B-vitamins and Choline panel report 2000).

Nutrient	EAR	RDA	AI
Vitamin B ₁	-	-	0.3 mg
Vitamin B ₂	-	-	0.4 mg
Niacin	-	-	4 mg NE
Vitamin B ₆	-	-	0.3 mg
Folate	-	-	80 µg DFE*
Vitamin B ₁₂	-	-	0.5 µg
Pantothenic acid	-	-	1.8 mg
Biotin	-	-	6 µg

*DFE = dietary folate equivalents = 1 µg food folate = 0.5 µg synthetic folic acid on empty stomach = 0.6 µg synthetic folic acid with meals

Table V: DRI values for **Children (4-8 years)**
(B-vitamins and Choline panel report 2000).

Nutrient	EAR	RDA	AI
Vitamin B ₁	0.5 mg	0.6 mg	-
Vitamin B ₂	0.5 mg	0.6 mg	-
Niacin	6 mg NE	8 mg NE	-
Vitamin B ₆	0.5 mg	0.6 mg	-
Folate	160 µg DFE*	200 µg DFE*	-
Vitamin B ₁₂	1.0 µg	1.2 µg	-
Pantothenic acid	-	-	3 mg
Biotin	-	-	12 µg

*DFE = dietary folate equivalents = 1 µg food folate = 0.5 µg synthetic folic acid on empty stomach = 0.6 µg synthetic folic acid with meals

Table VI: DRI values for **Children (9-13 years)**
(B-vitamins and Choline panel report 2000).

Nutrient	EAR	RDA	AI
Vitamin B ₁	0.7 mg	0.9 mg	-
Vitamin B ₂	0.8 mg	0.9 mg	-
Niacin	9 mg NE	12 mg NE	-
Vitamin B ₆	0.8 mg	1.0 mg	-
Folate	250 µg DFE*	300 µg DFE*	-
Vitamin B ₁₂	1.5 µg	1.8 µg	-
Pantothenic acid	-	-	4 mg
Biotin	-	-	20 µg

* DFE = dietary folate equivalents = 1 µg food folate = 0.5 µg synthetic folic acid on empty stomach = 0.6 µg synthetic folic acid with meals

Table VII: DRI values for **Adolescents (14-18 years)**
(B-vitamins and Choline panel report 2000).

Nutrient	EAR	RDA	AI
Vitamin B ₁	1.1 / 0.9 mg ^o	1.2 / 1.0 mg ^o	-
Vitamin B ₂	1.1 / 0.9 mg ^o	1.3 / 1.0 mg ^o	-
Niacin	12 / 11 mg NE ^o	16 / 14 mg NE ^o	-
Vitamin B ₆	1.1 / 1.0 mg	1.3 / 1.2 mg ^o	-
Folate	330 µg DFE*	400 µg DFE*	-
Vitamin B ₁₂	2.0 µg	2.4 µg	-
Pantothenic acid	-	-	5 mg
Biotin	-	-	25 µg

* DFE = dietary folate equivalents = 1 µg food folate = 0.5 µg synthetic folic acid on empty stomach = 0.6 µg synthetic folic acid with meals

^o males / females

Table VIII: DRI values for **Adults (19-50 years)**
(B-vitamins and Choline panel report 2000).

Nutrient	EAR	RDA	AI
Vitamin B ₁	1.0 / 0.9 mg ^o	1.2 / 1.1 mg ^o	-
Vitamin B ₂	1.1 / 0.9 mg ^o	1.3 / 1.1 mg ^o	-
Niacin	12 / 11 mg NE ^o	16 / 14 mg NE ^o	-
Vitamin B ₆	1.1 mg	1.3 mg	-
Folate	320 µg DFE*	400 µg DFE*	-
	520 µg DFE*	600 µg DFE*	-
	(pregnancy)**	(pregnancy)**	
Vitamin B ₁₂	2 µg	2.4 µg	-
Pantothenic acid	-	-	5 mg
Biotin	-	-	30 µg

* DFE = dietary folate equivalents = 1 µg food folate = 0.5 µg synthetic folic acid on empty stomach = 0.6 µg synthetic folic acid with meals

** in addition to dietary folate 400 µg of folic acid as supplement is recommended for women capable of becoming pregnant to reduce the risk of neural tube defects

^o males/females

5. Criteria used for the establishment of Tolerable Upper Levels of Intake (UL)

Table IX: DRI values for Adults (51 and older)
(B-vitamins and Choline panel report 2000).

Nutrient	EAR	RDA	AI
Vitamin B ₁	1.0 / 0.9 mg ^o	1.2 / 1.1 mg ^o	-
Vitamin B ₂	1.1 / 0.9 mg ^o	1.3 / 1.1 mg ^o	-
Niacin	12 / 11 mg NE ^o	16 / 14 mg NE ^o	-
Vitamin B ₆	1.4 / 1.3 mg	1.7 / 1.5 mg ^o	-
Folate	320 µg DFE*	400 µg DFE*	-
Vitamin B ₁₂	2.0 µg**	2.4 µg**	-
Pantothenic acid	-	-	5 mg
Biotin	-	-	30 µg

* DFE = dietary folate equivalents = 1 µg food folate = 0.5 µg synthetic folic acid on empty stomach = 0.6 µg synthetic folic acid with meals

** adults > 51 years are advised to obtain most of this amount by consuming foods fortified with vitamin B₁₂ or vitamin B₁₂ – containing supplements

^o males / females

A nutrient can produce more than one adverse health effect (or endpoint) and the no-observed-adverse-effect (NOAEL) and lowest-observed-adverse-effect (LOAEL) levels for these different effects will be different. The Committee decided to use that critical endpoint (adverse effect) with the lowest NOAEL (or LOAEL). The use of the most sensitive endpoint for the derivation of the Tolerable Upper Level of Intake (UL) (using a single uncertainty factor UF) will ensure protection against all other adverse health effects which may occur with higher overall chronic intakes. For some nutrients within the B-vitamin group there were inadequate data to identify the intake where a risk may be associated or data demonstrating no adverse effects with the highest dosages used; in these cases no UL could be derived (see Tables XI and XII). For infants ULs could not be determined for any of the B-vitamins because of lack of data and adverse effects in this age group. When possible ULs for infants and children were determined by extrapolation from the UL for adults based on body weight differences.

Table X: Parameters (adverse health effects) used for the identification of NOAEL/LOAEL as basis for the derivation of Tolerable Upper Levels of Intake (UL) for B-vitamins in adults.

Vitamin	Criteria for NOAEL	Criteria for LOAEL	Comments
B ₁	No adverse effects known from food or supplements	No data to set a NOAEL; no adverse effect known	
B ₂	No adverse effect known from food or supplements	No adverse effects known from food or supplements	
B ₆	Sensory neuropathy	Sensory neuropathy	Dalton and Dalton data NOT considered
Folate	No data to set a NOAEL for folate and folic acid	Precipitate/exacerbate neurological complications; folic acid only	Individuals at risk for B ₁₂ deficiency may be at increased risk of neurological disorders with high folic acid intakes
B ₁₂	No adverse effect known from food or supplements	No adverse effects known from food or supplements	
Niacin	Vasodilatory effect / flushing; data not adequate	Vasodilatory effect caused by nicotinic acid only	No adverse effects from foods; UL for nicotinic acid based on flushing is considered protective against potential adverse effects of nicotinamide
Biotin	Daily oral doses up to 200 mg caused no toxicity		
Pantothenic acid	No adverse effect known from food or supplements	No adverse effect known from food or supplements	

Table XI: No-observed-adverse-effect (NOAEL) and lowest-observed-adverse-effect (LOAEL) intake levels, and uncertainty factors (UF) used for determination of Tolerable Upper Levels of Intake (UL) for B-vitamins in adults.

Vitamin	NOAEL	UF ₁	LOAEL	UF ₂	UL for Adults
B ₁	none; can not be determined due to absence of known toxic effects by ingestion		none; can not be determined due to absence of known toxic effects by ingestion		none
B ₂	none; no adverse effects associated with B ₂ consumption from food or supplements		none; no adverse effects associated with B ₂ consumption from food or supplements		none
Niacin	no evidence of adverse effects from consumption of niacin (nicotinic acid; nicotinamide) in food; data on intake of niacin as a supplement, food fortification or pharmacological agent are not adequate to identify a NOAEL		50 mg niacin as nicotinic acid/day*	1.5	35 mg/day*
B ₆	200 mg/day	2**	500 mg/day, but not used as basis for UL		100 mg/day

Table XI continued: No-observed-adverse-effect (NOAEL) and lowest-observed-adverse-effect (LOAEL) intake levels, and uncertainty factors (UF) used for determination of Tolerable Upper Levels of Intake (UL) for B-vitamins in adults.

Vitamin	NOAEL	UF ₁	LOAEL	UF ₂	UL for Adults
Folate from food	none; no adverse effects have been associated with the consumption of excess folate from foods				no UL for intakes of folate from food
Folic acid in fortified foods, supplements	none; data not available to set an NOAEL for synthetic folic acid using progression of neurological disorders in patients with pernicious anemia and subsequent vitamin B ₁₂ deficiency		5 mg/day at doses > 5mg/day there were more than 100 reported cases of neurological progression; doses less than 5mg/day showed only 8 well documented case reports	5***	1 mg/day
B ₁₂	none; no adverse effects have been associated with excess vitamin B ₁₂ intake from food and supplements				none
Pantothenic acid	in absence of known toxic effects by ingestion a NOAEL cannot be determined		in absence of known toxic effects by ingestion a LOAEL cannot be determined		none
Biotin	no reported adverse effects in animals and humans are known; daily oral doses up to 200 mg/day and up to 20 mg/day intravenously caused no toxicity				none

Footnotes to Table XI:

- * due to the transient nature of the flushing effect, a small UF_2 of 1.5 was selected. A smaller UF_2 was not appropriate because it is to be applied to a LOAEL rather than a NOAEL; indicator used is flushing; nicotinamide NOT to be associated with flushing effects, but a UL for nicotinic acid based on flushing is considered protective against potential adverse effects of nicotinamide

- ** an UF_1 of 2 was selected based on the limitations of the data involving pyridoxine doses of less than 500 mg/day; the LOAEL was not used for the calculation of an UL

- *** the selection of a relatively large UF_2 is based primarily on the severity of the neurological complications and on the use of a LOAEL rather than a NOAEL. The UF_2 is set not larger than 5 based on the uncontrolled observation that millions of people have been exposed to self treatment with about one-tenth of the LOAEL (about 400 $\mu\text{g}/\text{day}$) without reported adverse effects and harm

6. Values for No-Observed-Adverse-Effect (NOAEL), Lowest-Observed-Adverse-Effect (LOAEL) levels, and Tolerable Upper Levels of Intake (UL) for B-vitamins for adults

Table XII: NOAEL, LOAEL, and UL for B-vitamins in adults (19-50 years)

Vitamin	NOAEL	LOAEL	UL
B ₁	No adverse effect	No adverse effect	None
B ₂	No adverse effect	No adverse effect	None
B ₆	200 mg/day	500 mg/day	100 mg/day
Niacin	None for parameter (flushing)	50 mg/day *	35 mg/day *
Folate from food	No adverse effect	No adverse effect	None
Folic acid synthetic	No data available	5 mg/day	1 mg/day
B ₁₂	No adverse effect	No adverse effect	None
Biotin	No adverse effect	No adverse effect	None
Pantothenic acid	No adverse effect	No adverse effect	None

* Parameter for endpoint determination used is flushing; nicotinamide NOT to be associated with flushing effects, but the UL for nicotinic acid based on flushing is considered protective against any potential adverse effects of nicotinamide



7. Reported dietary and supplement intakes of B-vitamins in the USA

Table XIII: Dietary and supplement intake for adults in the USA

Vitamin	Dietary Intake/Day		Supplement Intake/Day; 50 percentile	
	Men	Women	Men	Women
B ₁ mg/day *	2	1.2	2.4	3.2
B ₂ mg/day **	2	1.5	1.9	2.9
B ₆ mg/day *	2	1.5	2.2	2.2
Niacin mg/day * +	17 - 20		20	30
Folate µg/day **	220 ***		400 ++	
B ₁₂ µg/day *	4-5	3	5	6
Biotin µg/day **	40		No data	
Pantothenic acid mg/day	Not determined in surveys		No data	

* median intake

** mean intake

+ reported as preformed niacin; no addition made for conversion of tryptophan to niacin

++ as folic acid

*** as of Jan 1998 enriched cereal grain is to be fortified with 1.4 mg/kg grain

Estimated that the mandatory fortification will increase folate intake by at least 80 µg/day (136 µg dietary folate equivalents)



8. Results from the panel on B-vitamins and major perspectives

The overall recommendations can be summarized as follows:

- Recommendation for folate was increased
- A concept for the use of folate equivalents was introduced
- Recommendations were made to use supplementation with selected vitamins
 - Folate and reduction of risk of neural tube defects in women capable of becoming pregnant
 - Intake of vitamin B₁₂ as supplements to overcome reduced absorption capacity in elderly people
- Recommendations for several B-vitamins no longer linked to energy intake
- Data on the variability of the requirement to calculate a standard deviation were considered to be insufficient for all assessed B-vitamins and therefore a coefficient of variation of 10 % was generally used (niacin 15 %)
- For almost all B-vitamins no EAR/RDA set for infants, rather than an AI due to lack of data
- The scientific basis for several B-vitamins was evaluated for their risk reduction potential of certain chronic diseases (folate/homocysteine and cardiovascular disease; folate and certain cancers), but more data are required on the respective endpoint and relevant selected biomarkers
- Introduction of the concept of Tolerable Upper Levels of Intake (UL) as a yardstick for the safety of nutrients, but for several B-vitamins no UL was set due to the observation of no adverse effects with high dose intakes

9. B-vitamin panel recommendation for future research

The FNB Panel has identified gaps in scientific data which would allow to have the overall recommendations for DRIs supported by a broader scientific base. These recommendations are summarized below according to B-vitamin:

Vitamin B₁

- Priority should be given to studies for setting Estimated Average Requirements (EAR) for children, adolescents, pregnant or lactating women, and the elderly
- Eventual studies with high doses should be designed in a way to provide data on potential adverse effects

Vitamin B₂

- Priority should be given to studies for setting Estimated Average Requirements (EAR) for children, adolescents, pregnant or lactating women, and the elderly
- Development of another functional test for determination of riboflavin status
- Examination of the effects of physical activity on the requirement

Vitamin B₆

- Priority should be given to studies for setting Estimated Average Requirements (EAR) for children, adolescents, pregnant or lactating women, and the elderly

Niacin

- Priority should be given to studies for setting Estimated Average Requirements (EAR) for children, adolescents, pregnant or lactating women, and the elderly

- Means to assess nicotinamide adenine dinucleotide (NAD) needs for increased ribolysation resulting from oxidative DNA damage
- Develop sensitive and specific blood measures for nicotinamide/nicotinic acid status

Folate

- Determination of the mechanisms and magnitude of relationship of folate intake with risk reduction for the occurrence of neural tube defects (NTD), and vascular disease and the influence of related factors on these relationships, including genetic polymorphism
- Estimation of folate requirement in high-risk groups by using newly identified folate status indicators that are linked to metabolic function and indices of folate status (target groups: children, adolescents, pregnant women by trimester, and lactating women)
- Development of more precise and reproducible methods for analysis for the estimation of both blood and food folate and for estimation of folate bioavailability
- Identification and quantification of adverse effects of high intakes (of folic acid) from supplements and fortified foods on onset and progression of vitamin B₁₂ deficiency
- Determination of the effect of folate fortification on folate intake and occurrence of NTD and vascular disease
- Determination of whether folate status affects the risk of birth defects other than NTDs and of chronic disease other than vascular disease, such as certain cancers



10. Reference

Vitamin B₁₂

- Data on the prevalence of vitamin B₁₂ deficiency as diagnosed by biochemical, neurological, or hematological abnormalities
- Improved and economical, and sensitive methods to evaluate the vitamin B₁₂ status resulting from malabsorption or vegetarian diets
- Studies on malabsorption of food-bound vitamin B₁₂ in the elderly to get information on forms and amount of vitamin B₁₂ that can normalize and maintain vitamin B₁₂ body stores
- For vegetarians information is needed about the absorption of vitamin B₁₂ from dairy products and fortified foods

Biotin

- There is a lack of data which would be useful for setting Estimated Average Requirement (EAR) for biotin (human requirement, intake, bioavailability, adverse effects/toxicity, metabolism and metabolic effects)

Pantothenic acid

- Priority research is on requirements of different age groups, especially infants, children, and the elderly
- Data on bioavailability of pantothenic acid from different foods and mixed diets
- Data on the contribution of synthesis by intestinal bacteria and its contribution to requirement
- Analytical method for determination of the content of pantothenic acid in foods

Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B₆, Folate, Vitamin B₁₂, Pantothenic Acid, Biotin, and Choline. A report by the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes and its Panel on Folate, other B Vitamins and Choline; Food and Nutrition Board, Institute of Medicine, National Academy Press, Washington, D.C., 2000 (<http://www.nap.edu>)





Vitamins

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