FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

FACT SHEET

FOLATE, HEALTH AND FOOD SOURCES

Elizabeth Gollub[1]

Folate, vitamin B-9, is one of eight essential, water soluble B-vitamins. The B-vitamins were once thought to be a single nutrient because they tend to work together to support a variety of physiological processes that include energy production, cell growth and division, oxygen transport, and functions of the nervous system. However, each of the B-vitamins, which together might be referred to as the vitamin B-complex, has a unique structure, performs unique functions, and is required in unique amounts.

B-Vitamins	**DV* 4 years and older**	**DV* pregnant/breastfeeding**
Thiamin (B-1)	1.2 mg	1.4 mg
Riboflavin (B-2)	1.3 mg	1.6 mg
Niacin (B-3)	16 mg or equivalent	18 mg or equivalent
Pantothenic Acid (B-4)	5 mg	7 mg
Pyridoxine (B-6)	1.7 mg	2 mg
Biotin (B-7)	30 µg	35 µg
Folate (B-9)	**400 µg or equivalent**	**600 µg or equivalent**
Cobalamin (B-12)	2.4 µg	2.8 µg

**DV = Daily Value, the reference value used for food/supplement labeling purpose. Source: NIH, Office of Dietary Supplements*

Folate, named from the Latin word folium (leafy), was originally isolated from spinach; it is present naturally in a variety of leafy greens and other fresh foods. The term folate is used interchangeably with the term folic acid, the form used for fortification of foods and as dietary supplements. Regardless of the source, folate is crucial for cellular division and function – particularly to support phases of accelerated growth and development (e.g. pregnancy, the embryonic/fetal stage, infancy…adolescence); it is vital for brain and nervous system development and function; it appears to play a role in mental and emotional health; and it is associated with the reduction of risk for cardiovascular diseases and other chronic diseases or conditions. This is why adequate consumption of folate is important for everyone, throughout life.

Function and Significance

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Metabolically, folate functions as a co-enzyme, facilitating the transfer of single-carbon groups from one molecule to another, most notably for synthesis of nucleic acids (DNA and RNA) and metabolism of several amino acids (methionine, cysteine, serine, glycine, and histidine). As such, folate is critical for cell division, proliferation, and differentiation. But folate, in association with other B-vitamins, likely plays a role in disease prevention as well. For example, folate and cobalamin (vitamin B-12) is needed for the synthesis of methionine from homocysteine. Inadequate availability of folate (or B-12) for this process, results in elevated circulating levels of homocysteine, which seems to be a risk factor for cardiovascular disease, dementia, and possibly other chronic diseases or conditions.

Clinically, severe folate (or vitamin B-12) deficiency can lead to megaloblastic anemia. This develops from impaired DNA synthesis, which for the rapidly dividing blood cells, results in fewer, larger red blood cells. (Division of white cells and platelets are also impaired). These abnormal red blood cells have a decreased capacity for oxygen transport. Symptoms of megaloblastic anemia include fatigue, weakness, shortness of breath, headaches, difficulty concentrating and heart palpitation.

Inadequate consumption of folate can result from:

- poor diet, which would likely affect status of other nutrients as well;
- poor nutrient absorption/utilization associated with malabsorptive disorders, certain medications, heavy smoking, or heavy alcohol consumption;
- increased needs, such as during pregnancy and times of rapid growth.

Folate and Health

Pregnancy and Fetal Development

Pregnancy is characterized by rapid growth of both maternal and fetal tissue. Folate deficiency during this period of extensive cell growth, division, and differentiation is associated with a host of undesirable outcomes, most seriously, fetal neural tube defects such as spinal bifida and anencephaly. Development of the central nervous systems begins in the embryonic stage, usually before a woman knows she is pregnant. So, folate is particularly critical for all women of childbearing age and capacity – both before and during pregnancy.

Though the mechanism is not completely understood, neural tube defects are reduced by approximately 70% among women consuming adequate amounts of folate. The evidence is so strong and significant for public health, that to ensure consumption of folic acid among women of childbearing age, many countries have mandated folate fortification of wheat and/or enriched grains.

Cardiovascular Diseases

The role of folate in cardiovascular diseases is less conclusive. The rationale is based on research that links high blood-homocysteine levels with increased risk for cardiovascular diseases; and links folate rich diets and/or folic acid (along with B-12) supplementation with reduced blood-homocysteine levels. Folic acid seems to play an effective role in vascular health and prevention of stroke. However currently, there is no clear evidence that folic acid reduces occurrence or recurrence of a heart attack.

Other Chronic Diseases or Conditions

The relationship between folate status and several types of cancers (e.g. colorectal, lung, pancreatic, prostate, breast, and bladder), cognition and Alzheimer's disease, and depression have been studied systematically. Folate appears to have some connection with these conditions. But the mechanism and the

degree remain ambiguous. It is clear, however, that folate is involved in an array of vital metabolic processes and that deficiency, or in some cases, inadequate intake, lead to an array of negative health outcomes.

Recommended Intake and Sources

Folate is obtained from food – naturally occurring or fortified, or from supplements. The dietary recommendation for folate is based on an assumption that a person will consume a diet of both fresh/unprocessed foods and processed/fortified foods. This is important because folic acid – the synthetic form of the vitamin, is more bioavailable (at ~85%) than naturally occurring folate (at ~50%). The bioavailability of folic acid from a dietary supplement (on its own; in the absence of food) is even greater such that:

1.0 µg naturally occurring food folate	=	**0.6 µg** folic acid from fortified foods	=	**0.5 µg** folic acid from dietary supplements (without food)

The Recommended Dietary Allowance (RDA) for folate is expressed in terms of Dietary Folate Equivalents (DFE).

Recommended Dietary Allowances (RDAs) for Folate

Age	Male	Female	Pregnancy	Lactation
Birth to 6 months*	65 **µg** DFE*	65 **µg** DFE*		
7–12 months*	80 **µg** DFE*	80 **µg** DFE*		
1–3 years	150 **µg** DFE	150 **µg** DFE		
4–8 years	200 **µg** DFE	200 **µg** DFE		
9–13 years	300 **µg** DFE	300 **µg** DFE		
14–18 years	400 **µg** DFE	400 **µg** DFE	600 **µg** DFE	500 **µg** DFE
19+ years	400 **µg** DFE	400 **µg** DFE	600 **µg** DFE	500 **µg** DFE

*Institute of Medicine, Food and Nutrition Board, Dietary Reference Intakes. *The folate recommendation is expressed in terms of Adequate Intake (AI).*

Food Sources

Varying amounts of folate occur naturally in many different foods. But good, concentrated sources of food folate tend to be found in dark green leafy vegetables, certain fruits/juices, legumes – peanuts and beans, and beef liver. The following table is not a complete list but provides examples of excellent and good food sources of folate. Note that fortified grains (not included in the table) can be significant sources of folic acid.

Examples of Excellent and Good Food Sources of Folate

Excellent Source An "excellent" source of a nutrient contains 20% or more of the Daily Value. A typical portion of the foods listed here should provide at least 80µg folate.	• Beef liver • Spinach • Leafy amaranth • Black-eyed peas • Asparagus • Brussel sprout • Lentils • Broccoli • Chickpeas • Endive • Lima beans • Strawberries • Beets
Good Source A "good" source of a nutrient contains 10-19% of the Daily Value. A typical portion of the foods listed here should provide at least 40µg folate.	• Peanuts • Avocado • Mustard greens • Green peas • Artichoke • Mango • Orange juice • Cabbage • Cantaloupe • Cauliflower • Okra • Papaya • Red bell pepper

Based on nutrient profiles, U.S. Department of Agriculture, Agricultural Research Service, FoodData Central.

Folate-rich foods also provide other key nutrients and factors that support long-term health and wellbeing. Most people could consume adequate amounts of folate from a diet that routinely incudes a variety of vegetables, fruits, whole grains – enriched and fortified, beans, legumes, and animal proteins. Yet, those with greater needs, particularly women of childbearing age, should diligently consume 400 µg dietary folate equivalents daily. If this cannot be achieved by diet alone, supplementation is recommended.

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