**FOLIC ACID/FOLACIN (Vitamin B-9)**

**General:** water-soluble; “smoker's vitamin”

- A conglomerate compound comprised of PABA (para-aminobenzoic acid), glutamic acid & the organic pigment pterin;
- First isolated from 4 tons of spinach leaf & named after Latin name for leaf: folium;
- Folic acid comes from dietary sources & is also made by healthy intestinal bacteria, that use dietary PABA as a precursor;
- **History:** yeast & liver extract cures macrocytic anaemia in 1931; name suggested in 1941; folate cures megaloblastic anaemia in 1945; requirement for humans estimated in 1962;

**Nutrition**

- **Sources:** best: liver, dark green leafy vegetables, dry beans & peas, wheat germ, yeast; good: egg yolk, broccoli, orange juice, peanuts, almonds, whole grains, Brussels sprouts; intestinal bacteria;
- **Supplements:** folate, B-complex, multi-vitamin & multi-mineral-vitamin formulations;
- **Absorption:** from small intestine; about 30 to 50% absorbed; circulates freely in blood;
- **Improved by:** presence of other vitamins & minerals;
- **Antagonized by:** alcohol; mal-absorption; the “pill” & other drugs; stomach disorders;
- **Stability:** destroyed by heat & oxygen; at room temperature, up to 70% of folate from vegetables is lost within 3 days; up to 95% may be lost in cooking water;
- **Storage:** mainly (6 months supply) in liver;
- **Excretion:** excreted through urine
- **Metabolism:** works with B- 12; associated with glutamic acid, that is split off in intestinal wall before folacin is absorbed; healing, hyperthyroidism, haemolytic anaemia & pregnancy require increased amounts;
- **Interactions:** folic acid need increased by drugs, alcohol, oral contraceptives, antibiotics; sulpha drugs interfere with bacterial synthesis of folacin; aminopterin & streptomycin destroy folacin; high doses of folic acid may slow zinc metabolism;

**Functions of Folic Acid**

- Involved in all cells; indirectly affects all protein & enzyme metabolism;
- Necessary to convert phenylalanine into tyrosine & to oxidize & decarboxylate tyrosine;
- Required to form part of haemoglobin (porphyrin);
- Required for metabolism of long-chain fatty acids in brain;
- Involved in all biological reactions that involve transfer of methyl (CH3) groups: includes formation of methionine, serine, choline (from ethanolamine); synthesis of histidine; preparation of niacin for excretion; synthesis of all DNA & RNA bases;
- Especially important in the functions of rapidly dividing cells: red & white blood cells, tongue, intestinal wall, developing foetus;
- Co-enzyme in: forming red blood cells; synthesizing enzymes that control cell division; regulating embryonic development of nerve cells; amino acid metabolism; maintaining healthy cells in nervous system, sex organs, intestinal tract & blood;
- Essential for optimal functioning of nervous system & bone marrow;
- Involved in production of HCl;
- Essential for mental & emotional health; helps liver function (mobilizes fat from liver);
• Required to convert toxic homocysteine into the essential amino acid methionine;
• Pregnancy increases demand for folacin, for neural development of foetus;
• Synergies by: vitamin C & other B-complex vitamins;
• Antagonized by: alcohol, contraceptives, antibiotics, many drugs; stress & pregnancy;

**Quantities**

• **Measurement:** micrograms; milligrams;
• **Optimum:** (SONA) averages 300 to 1,000 µg/day;
• **Individual** optimum must be individually determined; especially important during pregnancy & foetal growth to prevent neural tube defects, cleft lip, cleft palate; supplementation during pregnancy recommended; requirement increases with rapid cell growth (pregnancy, hyperthyroid, haemolytic anaemia), size & metabolic rate;
• **Minimum:** (DRI) set at 400 µg/day (600 µg/day during pregnancy);
• **Less than RDA:** in excess of 10% of population, according to a U.S. government survey; clinical estimates suggest 70% of population may need more than they get;
• **Deficiencies** of folacin can result from: inadequate intake; impaired absorption due to low HCl (which requires folacin for its production), destroyed intestinal mucousa; increased requirement (leukemia, Hodgkin’s); increased losses;
• **At risk:** alcoholic; low socio-economic status: adolescents, pregnant adolescents, infants, prematures, young children & elderly; infants fed unfortified milk; women on the “pill”; people with stomach disorders; patients on drug treatments (cholestyramine, anti-epileptic drugs, sulphasalazine, anticancer drugs, phenobarb); people on haemodialysis or parenteral nutrition; poor, lonely people;
• **Symptoms include:** brain damage, learning disorders, retarded development of the newborn infant; effects on pregnant mother include: toxaemia of pregnancy, postpartum haemorrhaging, & iron-resistant (megaloblastic) anaemia;
• First symptoms of folic acid deficiency include poor memory from faulty nucleic acid synthesis, apathy, irritability, slowed intellectual processes; cracked lips & mouth corners, such as found in B-2 deficiency;
• **Chronic deficiency** results in anaemia’s — megaloblastic, pernicious & macrocytic;
• In the elderly poor cell growth, greying hair, impaired digestion;
• Toxicity: none associated with folacin; 100 times RDA is safe; 10 mg/day for 5 years without adverse effects; 15 mg/day produces no toxic effects;
• High folacin intake can mask vitamin B- 12 deficiency (folic acid corrects anaemia symptoms but not neurological damage of B- 12 deficiency);
• Reversed by: folate & B-12 administered together;

**Therapy**

• Supplemental levels of folic acid (400 to 1,000 µg/day) reverse deficiency symptoms & reduces incidence of neural tube defect in children of normal women & also women on anti-epileptic drugs;
• Beneficial in treating diarrhoea, sprue, dropsy, stomach problems, leg ulcers, glossitis;
• Can improve circulation of people with atherosclerosis & diabetes;
• Folacin, + PABA, B-12 & B-5 may prevent greying of hair;
• 5 to 10 mg/day of folacin increased capillary blood flow, warms extremities, lowers atherogenic homocysteine levels; benefits atherosclerotics;
• 10 mg/day reduces abnormal cells in oral contraceptive users with cervical dysplasia;
• 10 mg/day folacin + 500 µg/day B-12 decreases abnormal cells in smokers with bronchial dysplasia;
• Oral intake of folic acid decreases chromosome breakages in human cells;

**VITAMIN C (Ascorbic Acid)**

**General** water-soluble; anti-scurvy factor;

• Saturated adult human body contains about 5,000 mg; 1,500 mg on 100 mg/day intake; lost at rate of 3% per day; signs of scurvy begin at 300 mg body content;
• Made by almost all plants; most animals make Vitamin C in liver or kidneys on need;
• Due to a mutation millions of years ago, humans & a few other species lack enzyme needed to convert glucose to vitamin C & depend on dietary sources;
• Scurvy prevented by less than 100 mg/day; need for optimum health fluctuates widely;
• Vitamin C dependency can be seen as “potentially fatal inborn (genetic) error in glucose metabolism” (genetic condition like albinism, sickle cell anaemia & haemophilia) requiring between 1,500 and 4,500 mg/day for other important functions in the body;
• 150 pounds (adult human weight) of rat, mouse, housefly, dog, squirrel, goat, cow, mountain lion, etc. make between 2,000 & 15,000 mg/day & 4 or 5 times that much during periods of injury, stress or prolonged physical activity;
• Diets recommended for captive monkeys provide 4,000 to 5,000 mg/day of ascorbic acid per 150 pounds of body weight; human should have similar requirements (cell biochemistry is similar);
• **History:** scurvy described by Hypocrates in 400 B.C.; limes to British sailors in 1747 prevents scurvy (“scourge of the navy”) deaths on sea voyages & “limeys” rule the seas for 200 years; structure identified in 1932; synthesized in 1934; world-wide attention in 1970;

**Nutrition**

• **Sources:** best: black currant, sweet pepper, parsley; good: cauliflower, potato, sweet potato, broccoli, Brussels sprout, strawberry, citrus, guava, mango, fresh vegetables, fresh fruit; C content increases with matured development of plant; adrenal glands of freshly killed animals;
• **Supplements:** acid, mineral salts & effervescent powders; tablet, timed release tablet; capsule, multi-vitamin & multi-mineral-vitamin formulations;
• **Absorption** from duodenum & small intestine, both passive diffusion & Na-dependent active transport; circulates freely; low concentrations (30 - 60 mg) 100% absorbed; absorption: 90 mg dose = 80%; 1,500 mg = 49%; 3,000 mg = 36%; 12,000 mg = 16%; unabsorbed vitamin C continues into bowel, draws water by osmotic effect & makes watery stools;
• **Improved by:** frequent small doses absorbed better than few large doses;
• **Antagonized by:** smoking, stress, high fever, antibiotics, cortisone, inhalation of DDT or petroleum fumes, aspirin;
• **Stability:** destroyed by heat, light & oxygen; destroyed by long storage (15% /month) & cooking (30 - 50%); 50% lost within 1 week of irradiation (potatoes); C loss from broccoli: microwaved = 15%; pressure cooked =20%; steamed = 30%; boiled = 55%; destroyed by baking soda;
• **Storage:** throughout the body; highest (50x) concentration in adrenals; elevated (3 - 10x) in kidneys, lung, liver, placenta; also high in pituitary, white blood cells, brain, thymus & eye lens; muscles hold about 600 mg; foetal plasma is 2 - 4x higher than adult;
• **Excretion:** oxidized form excreted through kidneys within few hours after consumption; also lost through sweat;