

Another measure, the Suggested Optimum Nutritional Allowance (**SONA**) is under consideration by the U.S. government. These are averages for optimum levels of health. Being higher than the RDA and the DRI, The **SONA** holds the promise of better health for most people.

Due to differences in inheritance, life style (food habits and activity levels), stage of life cycle, stress level and environmental factors, optimum intake of vitamins will vary for each individual with time. These factors necessitate a wide range of vitamin intakes to adequately provide for the nutritional well being of the entire population.

### ***VITAMIN A (Beta-Carotene, Retinol)***

**General** - oil-soluble; anti-xerophthalmic factor;

- Retinol (true vitamin A) - found in animal tissues;
- Beta-carotene (pro-vitamin A) - yellow-orange pigment of plants;
- Conversion of beta-carotene to vitamin A in animal tissues takes 6 to 7 hours & occurs only according to need, making carotene non-toxic;
- **History:** identified in 1913; structure defined in 1931 (Karrer) for Nobel Prize; synthesis 1946; identified as major source of infant mortality in Indonesia 1984;

### ***Nutrition***

- **Sources:** vitamin A: liver, egg yolk, fish (esp. fish liver oils), dairy cream & other animal products; lemon grass; beta carotene: carrots, yams, squash, apricots, red & dark green vegetables;
- **Supplements:** A + D, beta carotene, multi-vitamin, multi-mineral-vitamin formulations;
- **Absorption:** from upper small intestine, along with fats, takes about 3 to 5 hours; - vitamin A absorption is 2 to 4x more efficient than that of beta carotene, independent of amount present; toxicity possible for vitamin A; 10 to 50% of carotene is absorbed; absorption decreases if more is present in body;
- **Improved by:** edible fats & oils; taking with meals; vitamin E; bile salts;
- **Antagonized by:** excess protein, alcohol, iron, mineral oil, intense physical activity within 4 hours of ingestion, inflammatory bowel disease;
- **Stability:** vitamin A is destroyed by oxygen in the presence of sunlight; protected by vitamin E; carotene is stable during cooking, but also sensitive to oxygen & light; freezing protects vitamin A and carotene from deterioration;
- **Storage:** 90% of vitamin A in liver (1 to 2 years' supply = 500,000 IU); high concentrations in kidneys & lungs; some present in all cells; carotene stored in liver, fat tissue, & skin;
- **Antagonized by:** cirrhosis & liver degeneration;
- **Excretion:** through bile, through urine & broken down in metabolism;
- **Metabolism:** adequate protein & zinc required to release vitamin A from liver; hydrogenation destroys vitamin A& carotenes;
- **Interactions:** oral contraceptives;

### ***Functions of vitamin A***

- Necessary for health of all cells;
- Involved in vision, smell, hearing, taste, growth, bone development, cell differentiation & reproduction;

- Required for protein synthesis, RNA synthesis, cell division, cell membrane stability, production of light-sensitive visual pigments, mucus production, sexual & reproductive processes, sperm production, egg development, functions of adrenal & thyroid glands (metabolic rate, energy level, body temperature, growth rate), skin integrity, functions of inner lining of digestive tract, bone development & remodelling, liver function;
- Protects against infections in nose, throat, lungs, digestive tract, urinary tract;
- Involved in wound healing;
- Beta carotene (anti-oxidant) traps free radicals, protecting against damage from pollution & cigarette smoke; quenches singlet oxygen; protects skin from UV sunlight damage;
- Functions antagonized by: low thyroid may result in vitamin A depletion by slowing down conversion of beta-carotene; diabetes also interferes with conversion;

### *Quantities*

- **Measurement:** 1,000,000 micrograms ( $\mu\text{g}$ ) = 1,000 milligrams (mg) = 1 gram (g);
- 1  $\mu\text{g}$  of retinol (vitamin. A) = 1 retinol equivalent (RE), (new international standard);
- 1 RE = 1  $\mu\text{g}$  = 3.3 IU = 6  $\mu\text{g}$  beta-carotene = 12  $\mu\text{g}$  other pro-vitamin A carotenoids;
- **Optimum: (SONA)** average ranges from 800 to 2,000  $\mu\text{g}$  /day for vitamin. A, and 5 to 10 mg/day of beta-carotene;
- **Individual** optimum must be determined for each individual case; depends on nutritional status & body's need;
- **Minimum: (DRI)** set at 700/900 $\mu\text{g}$  (2300/2700 I.U.) /day, no RDA set for beta-carotene: suggested intake is 6 to 10 mg/day, or more;
- **Less than RDA:** 50% of population, according to a U. S. government survey;
- **Deficiency** of vitamin A results from lack in diet, poor absorption (inflammatory bowel disease, sprue, infection, parasites, diseases), mineral oil, excess or deficiency of protein, excess alcohol & iron, strenuous physical activity within 4 hours of a meal); inefficient conversion (thyroid deficiency, diabetes) or impaired storage (degenerative liver disease, cirrhosis, jaundice); cystic fibrosis; deficiency of fat (also protein) in diet; smoking; environmental pollution; increased need during pregnancy & lactation;
- **Symptoms** include: dry skin; lacklustre hair; dandruff; "goosy", bumpy hair follicles, esp. back of arms; poor nails; loss of sense of smell; softening of bones and teeth; drying & thickening of cornea (xerophthalmia); night blindness; blindness; stunted growth in children due to impaired hormone, membrane, & skeleton biochemistry; increased cell membrane permeability; skin & mucous membrane infections; respiratory disease; diarrhoea; parasitic & infectious diseases; reduced level of white blood cells; senility from oxidative damage to brain tissues; psoriasis; birth defects (cleft palate, congenital eye & heart defects); calcium phosphate kidney stones; precancerous changes in epithelial tissues of skin & lining of digestive tract (site of 50% of cancers); immune deficiency; cancer;
- **Toxicity** from intake of vitamin A is unusual; requires more than 10 times RDA;
- **Beta-carotene** produces orange-coloured skin, but is 100% non-toxic;
- **Vitamin A toxicity** requires more than 50,000 IU/day over an extended time;
- **Toxicity symptoms:** enlargement of liver & spleen; lethargy; headache, nausea, abdominal pain, diarrhoea; hair loss, dry skin; menstruation stops; bone re-ineralization;
- In infants: scaly dermatitis, weight loss, anorexia, skeletal pain;
- Toxicity reversed by stopping intake; recovery rapid & complete, often within 72 hours of stopping;

### ***Therapy with vitamin A***

- Usual therapeutic dose is 5,000 to 25,000 IU/day;
- Glaucoma, conjunctivitis, nearsightedness, crossed eyes, Betot spots (raised white patches of the white of the eyes);
- 10,000 IU of vitamin A plus 400 mg of vitamin B-2 may help reverse cataracts;
- Tinnitus; migraine headaches;
- 100,000 IU of vitamin A over 4 to 6 months lower high cholesterol, but do not alter normal cholesterol levels;
- Protection against carcinogenic agents; enhanced immunity;
- Helps treat acne & its lesions, psoriasis, dandruff, bedsores, burns, warts, eczema;
- Bronchial asthma, rhinitis, emphysema; nephritis; cirrhosis of the liver;
- Beta carotene used to enhance immune response (macrophages); and prevention of cancers, esp. lung & cervix;

### ***VITAMIN D (D-3: Cholecalciferol; D-2: Ergocalciferol)***

**General.** oil-soluble; rickets-preventive factor; sunshine vitamin; bone & tooth itamin;

- **D-3** (natural form) found in fish liver oils or produced by UV (sun) irradiation of 7-dehydrocholesterol (derivative of cholesterol obtained from lanolin) in the fatty layers of the skin; Vitamin D3 has recently been found to be up to 9 times more biologically active than the D2 form.
- **D-2** (vegetarian form) produced by UV irradiation of ergosterol, a compound derived from yeast;
- **History:** oil-soluble anti-rickets factor suggested in 1918; anti-rickets factor found present in cod liver oil (used since early 1800's) in 1920; crystallized in 1930; identified in 1937;

### ***Nutrition***

- **Sources:** fish livers, beef liver, egg yolks; sunshine on skin; milk (fortified with D);
- **Supplements:** A + D, multi-vitamin, multi-mineral-vitamin formulations;
- **Absorption:** upper part of small intestine; along with dietary fats; 80% of intake absorbed; skin-formed vitamin D absorbed into lymphatics; alpha-globulin 2 carries it in blood;
- **Improved by:** edible fats & oils; taking with meal;
- **Synergists:** Vitamins A & C prevent vitamin D oxidation; vitamins B-1 & B-3 increase tolerance for vitamin D; calcium controls bone formation;
- **Antagonized by:** cortisone, some anti-convulsants;
- **Stability:** destroyed by oxygen & light;
- **Storage:** mainly in liver; also in skin, spleen, bones;
- **Excretion:** in bile;
- **Metabolism:** D-3 & D-2 converted to calcidiol in liver; calcidiol converted to calcitriol (active form) in kidneys;
- **Interactions:** sedatives, tranquilizers, anti-convulsants turn vitamin D to inactive forms;