

Vitamin A

Essential Nutrient Functions

Vitamin A refers to a wide range of fat-soluble nutrients, some referred to as preformed (retinol and derivatives), and those generally deemed vitamin A precursors (beta-carotene and other carotenoids). Ultimately, the isomers of the final bioactive form of vitamin A, called retinoic acid (RA), act as nutrigenomic “hormones” that alter gene expression and influence various physiological processes. Vitamin A is best known for its role in retinal function and vision, especially night vision, but is also well known for its effects on immune function.

Intake Guidelines

Recommended Dietary Allowances (RDAs) for Vitamin A

Age	Males mcg /day (IU/day)	Females mcg /day (IU/day)	Pregnancy	Lactation
0-6 months	400 (1,333 IU)	400 (1,333 IU)		
7-12 months	500 (1,667 IU)	500 (1,667 IU)		
1-3 years	300 (1,000 IU)	300 (1,000 IU)		
4-8 years	400 (1,333 IU)	400 (1,333 IU)		
9-13 years	600 (2,000 IU)	600 (2,000 IU)		
14-18 years	900 (3,000 IU)	700 (3,000 IU)		
19+ years	900 (3,000 IU)	700 (3,000 IU)	770 (2,567 IU)	1,300 (4,333 IU)
18 & younger			750 (2,500 IU)	1,200 (4,000 IU)

Note: IU calculated as retinol

How is it measured?

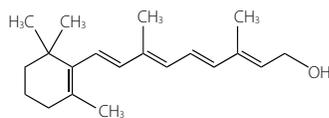
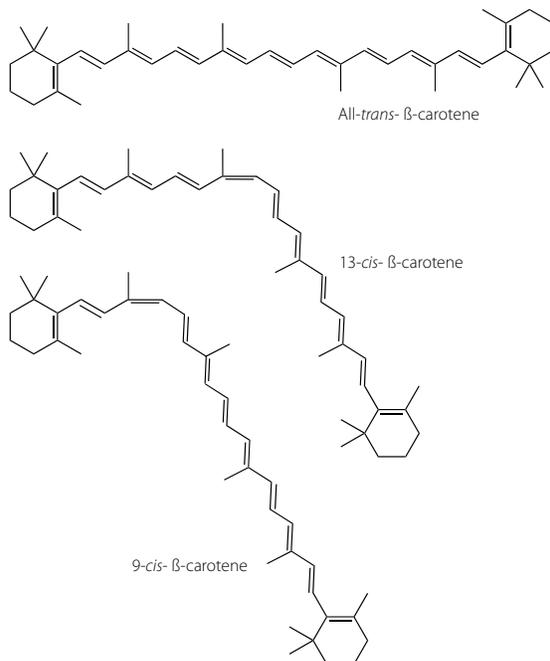
Unlike most vitamins, measuring vitamin A is complex; making it complicated for consumers by the conversion to international units (IU) on most Supplement Facts boxes. The basic unit of measurement, however, is micrograms (mcg) of retinol activity equivalents (RAE), with one mcg of retinol equal to one RAE, and one RAE equal to 3.33 IU of vitamin A. Note the RDA levels are listed in mcg of RAE, not in IU. This is important because dietary and supplemental sources of vitamin A differ in their retinal activity. This results in the following conversions:

- One IU retinol = 0.3 mcg RAE
- One IU beta-carotene from dietary supplements = 0.15 mcg RAE
- One IU beta-carotene from food = 0.05 mcg RAE
- One IU alpha-carotene or beta-cryptoxanthin = 0.025 mcg RAE

A RAE cannot be directly converted into an IU without knowing the source(s) of vitamin A. For example, the RDA of 900 mcg RAE for adolescent and adult men is equivalent to 3,000 IU if the food or supplement source is preformed vitamin A (retinol). However, this RDA is also equivalent to 6,000 IU of beta-carotene from supplements, 18,000 IU of beta-carotene from food, or 36,000 IU of alpha-carotene or beta-cryptoxanthin from food. So a mixed diet containing 900 mcg RAE provides between 3,000 and 36,000 IU of vitamin A, depending on the foods consumed.

General Levels of Deficiencies in the U.S.

NHANES data (2003 – 2006) shows the percent of Americans over the age of two with dietary intake below the EAR is about 75%. This is reduced, but not eliminated, when considering intake from fortification (45%) and supplementation (34%). Patients taking Orlistat are known to have reduced ability to absorb dietary vitamin A.

Retinol**Beta Carotene Structures****Natural and Supplemental Forms**

The major forms of supplemental vitamin A are either retinol esters (retinyl palmitate or acetate) or beta-carotene. While retinol forms are found in some dietary sources—highest in animal or fish livers, lower amounts in eggs—the majority of dietary vitamin A comes from beta-carotene and other carotenoids. After ingestion, β -carotene is metabolized in the mucosa of small intestine by β -carotene dioxygenase into two retinyl molecules, which are then reduced to vitamin A (retinol).

There is also a synthetic form of beta carotene used in food fortification, dietary supplements and, unfortunately, in a number of widely publicized clinical trials. The synthetic form differs from natural beta-carotene in that it contains only a single isomer (all-*trans* retinol), while natural beta-carotene contains several *cis*-isomers along with the all-*trans* isomer.

In the past few decades a natural beta-carotene source from the algae species *Dunaliella*, which is both adequately priced and highly concentrated with an approximately 50:50 blend of all-*trans* and 9-*cis*-isomers has become widely available. Limited animal and human studies show mixed results related to bioavailability between this natural form and the all-*trans* synthetic form of beta-carotene. While this form is more expensive than the synthetic beta-carotene alternative, the fact that it also contains several other carotenoid compounds, sometimes labeled as “mixed

carotenoids,” with health benefits unrelated to their conversion to vitamin A alone, we recommend using this form by itself, or in combination with preformed retinol (retinyl palmitate) for use in dietary supplements.

Potential for Toxicity

The potential for toxicity is different for preformed vitamin A and beta-carotene forms. Since both are fat-soluble and stored in the body, excess beta-carotene can be stored without full conversion to active retinol forms, though excess beta-carotene can turn skin a shade of yellow. Long-term intake of preformed vitamin A in doses above 15,000 IU should be avoided; however, short-term higher doses may be appropriate, under clinical supervision, for certain individuals with low immune function. Clinicians using high-dose retinol therapies should be familiar with signs of hypervitaminosis A. Acute vitamin A toxicity is relatively rare; symptoms include nausea, headache, fatigue, loss of appetite, dizziness, dry skin, desquamation and cerebral edema. Signs of chronic toxicity include dry and itchy skin, desquamation, loss of appetite, headache, cerebral edema, and bone and joint pain.

References:

- Vitamin A Page of Linus Pauling Institute Website: <http://lpi.oregonstate.edu/infocenter/vitamins/vitaminA/>.
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- Ben-Amotz A, Levy Y. Bioavailability of a natural isomer mixture compared with synthetic all-*trans* beta-carotene in human serum. *Am J Clin Nutr.* 1996 May;63(5):729-34.
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