

B.Sc second year Zoology (Honours)

Paper- 4

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Vitamin A

The two main forms of vitamin A in the human diet are preformed vitamin A (retinol, retinyl esters), and provitamin A carotenoids such as beta-carotene that are converted to retinol. Preformed vitamin A comes from animal products, fortified foods, and vitamin supplements. Carotenoids are found naturally in plant foods. There are other types of carotenoids found in food that are not converted to vitamin A but have health-promoting properties; these include lycopene, lutein, and zeaxanthin.

Vitamin A also stimulates the production and activity of white blood cells, takes part in remodeling bone, helps maintain healthy endothelial cells (those lining the body's interior surfaces), and regulates cell growth and division such as needed for reproduction.

Recommended Amounts

Vitamin A is currently listed on the Nutrition Facts label measured in international units (IU). However, the Institute of Medicine lists the Recommended Dietary Allowances (RDA) of vitamin A in micrograms (mcg) of retinol activity equivalents (RAE) to account for different absorption rates of preformed vitamin A and provitamin A carotenoids. Under the Food and Drug Administration's (FDA) new food and dietary supplement labeling regulations, as of July 2018 large companies will no longer list vitamin A as IU but as "mcg RAE."

- **RDA:** The Recommended Dietary Allowance for adults 19 years and older is 900 mcg RAE for men (equivalent to 3,000 IU) and 700 mcg RAE for women (equivalent to 2,333 IU).
- **UL:** The Tolerable Upper Intake Level is the maximum daily intake unlikely to cause harmful effects on health. The UL for vitamin A from retinol is 3,000 micrograms of preformed vitamin A.

Vitamin A and Health

The evidence suggests that eating a variety of foods rich in vitamin A, especially [fruits and vegetables](#), is protective from certain diseases, though the health benefit of vitamin A supplements is less clear.

Food Sources

Many breakfast cereals, juices, dairy products, and other foods are fortified with retinol (preformed vitamin A). Many [fruits and vegetables](#) and some supplements contain beta-carotene, lycopene, lutein, or zeaxanthin.

- Leafy green vegetables ([kale](#), spinach, broccoli), orange and yellow vegetables (carrots, [sweet potatoes](#), pumpkin and other [winter squash](#), summer squash)
- Tomatoes
- Red bell pepper
- Cantaloupe, mango
- Beef liver
- Fish oils
- Milk

Signs of Deficiency

Deficiency. Also at risk are adults and children who eat a very limited diet due to poverty or self-restriction. Mild vitamin A deficiency may cause fatigue, susceptibility to infections, and infertility. The following are signs of a more serious deficiency.

- Xerophthalmia, a severe dryness of the eye that if untreated can lead to blindness
- Nyctalopia or night blindness
- Irregular patches on the white of the eyes
- Dry skin or hair

Vitamin D

Vitamin D is produced when sunlight (or artificial light, particularly in the ultraviolet region of 190-400nm wave lengths) fall on the skin and triggers a chemical reaction to a cholesterol based molecule, and converts it into calcidiol (adding one hydroxyl group, also called 25(OH)D technically) in the liver and into calcitriol (or 1,25 (OH)₂D in the kidney.

What it does

General

- Vitamin D is a fat-soluble vitamin that helps maintain calcium and phosphorus balance, promotes bone health, regulates immune function, and influences cell growth and development.
- Vitamin D can be made in the skin (upon exposure to ultraviolet B [UVB] radiation from the sun) and obtained from dietary and supplemental sources.

Immune-specific

- Vitamin D increases the expression of antibacterial proteins.
- Vitamin D limits certain aspects of the acquired immune response, playing a protective role and potentially reducing the risk of autoimmune disease and tissue transplant rejection.

What we know

- Low serum 25-hydroxyvitamin D₃ (a reliable measure of vitamin D status) is linked to a higher risk of upper respiratory tract infections.
 - Overall, randomized controlled trials indicate that daily supplementation with vitamin D may reduce the risk of upper respiratory tract infections.
- Low serum 25-hydroxyvitamin D₃ has been observed in individuals with autoimmune disease, including those with insulin-dependent (type 1) diabetes mellitus, multiple sclerosis (MS), systemic lupus erythematosus, and rheumatoid arthritis. In those with MS, lower vitamin D status is associated with increased disease activity and risk of relapse.
 - Living at higher latitude (and thus, exposed to less UVB radiation from the sun) and low vitamin D intake have been associated with an increased risk of developing MS.
 - Despite the well-documented association between low vitamin D status and multiple autoimmune diseases, few randomized controlled trials have been

conducted and the clinical efficacy of vitamin D supplementation in the prevention and treatment of autoimmune disease is not yet known.

HIGHLIGHT

- Vitamin D is notoriously difficult to obtain from food sources alone and national surveys indicate that 94% of the US population is not meeting the dietary requirement for vitamin D.
- The LPI recommends 2,000 IU (50 micrograms) of supplemental vitamin D daily for generally healthy adults.

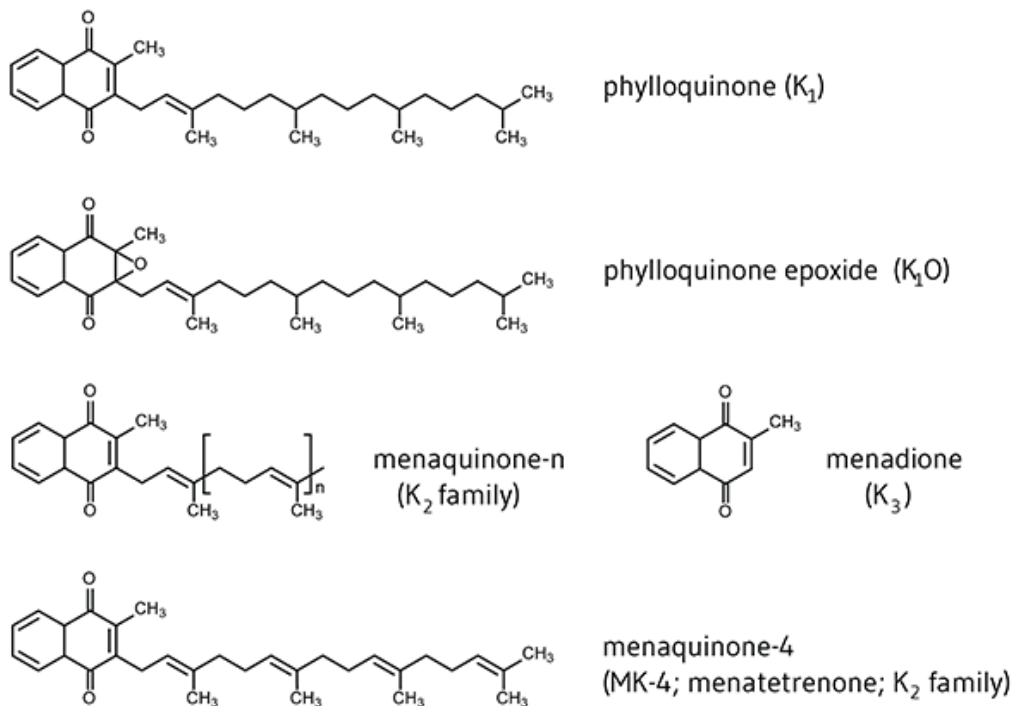
Vitamin K

Vitamin K is a [fat-soluble vitamin](#). Originally identified for its role in the process of blood clot formation ("K" is derived from the German word "koagulation"), vitamin K is essential for the functioning of several [proteins](#) involved in physiological processes that encompass, but are not limited to, the regulation of blood clotting ([coagulation](#)). Naturally occurring forms of vitamin K include phylloquinone (vitamin K₁) and a family of molecules called menaquinones (MKs or vitamin K₂).

Naturally occurring forms of vitamin K include a number of vitamers known as vitamin K₁ and vitamin K₂ (**Figure 1**). Vitamin K₁ or phylloquinone is [synthesized](#) by plants and is the predominant form in the diet. Vitamin K₂ includes a range of vitamin K forms collectively referred to as menaquinones. Most menaquinones are synthesized by human [intestinal](#)

[microbiota](#) and found in [fermented](#) foods and in animal products.

Figure 1. Chemical Structures



Menaquinones differ in length from 1 to 14 repeats of 5-carbon units in the side chain of the molecules. These forms of vitamin K are designated menaquinone-n (MK-n), where n stands for the number of 5-carbon units (MK-2 to MK-14). Widely used in animal husbandry, the synthetic compound known as menadione (vitamin K₃) is a provitamin that needs to be converted to menaquinone-4 (MK-4) to be active.

- With limited vitamin K storage capacity, the body recycles vitamin K in the vitamin K [oxidation-reduction](#) cycle in order to reuse it multiple times.
- Vitamin K is the essential [cofactor](#) for the [carboxylation](#) of glutamic acid residues in many vitamin K-dependent [proteins](#) (VKDPs) that are involved in blood [coagulation](#), bone [metabolism](#), prevention of vessel mineralization, and regulation of various cellular functions.
- [Vitamin K](#) deficiency increases the [risk](#) of excessive bleeding ([hemorrhage](#)). An injection of vitamin K is recommended to protect all newborns from life-threatening bleeding within the skull.
- The adequate intake ([AI](#)) level for vitamin K is set at 90 µg/day for women and 120 µg/day for men.
- Vitamin K deficiency may impair Vitamin K deficiency may impair the activity of VKDPs and increase the risk of [osteoporosis](#) and [fractures](#). Yet, [observational studies](#) have failed to isolate vitamin K intakes from overall healthful diets, thus warranting cautious interpretation of positive associations between vitamin K intakes and markers of bone health. Overall, [intervention trials](#) have been inconclusive regarding the role of

supplemental vitamin K in further reducing bone loss in otherwise [calcium](#)- and [vitamin D](#)-replete adults.

- Abnormal mineralization of blood vessels increases with age and is a major risk factor for [cardiovascular disease](#). Vitamin K inadequacy may inactivate several VKDPs that inhibit the formation of calcium precipitates in vessels.
- Phylloquinone is found at high concentrations in green leafy vegetables and certain plant oils, while most menaquinones are usually found in animal livers and [fermented](#) foods.
- Several drugs, including vitamin K [antagonists](#) (e.g., warfarin), are known to interfere with vitamin K absorption and metabolism.

Vitamin C

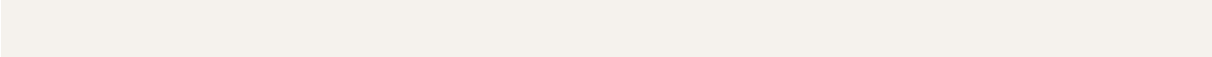
- Vitamin C (ascorbic acid) is a water-soluble vitamin that neutralizes a variety of **reactive oxygen species** and recycles important cellular **antioxidants**.
- Vitamin C is also a cofactor in numerous enzymatic reactions involved in the making of collagen, L-carnitine, and several neurotransmitters, and in the regulation of gene expression.

Immune-specific

- Immune cells generate reactive oxygen species to kill invading organisms; vitamin C may protect immune and nearby cells from damage by these substances.
- ***In vitro* studies** suggest that vitamin C may increase the production and function of certain immune cells that help engulf and kill foreign invaders.

What we know

- Immune cells accumulate and concentrate vitamin C and then quickly use it up during an active immune response.
- The scientific evidence regarding the effect of vitamin C supplementation on immune function is hampered by several methodological shortcomings. Important considerations for research studies on vitamin C and infections include:
 - the baseline vitamin C status of the study population. A beneficial effect of vitamin C supplementation on the immune system may occur only in those with low vitamin C intake and status to begin with.
 - the presence of modifying factors. Physical stress, **oxidative stress**, smoking, and disease may be accompanied by an increased demand for vitamin C.
- At this time, the scientific evidence is insufficient to advocate vitamin C supplementation in the prevention of pneumonia in the general population.
- Routine use of vitamin C supplements may have a mild, beneficial effect on the duration of the common cold in certain individuals.



The daily Recommend Dietary Allowance (RDA) of vitamin C for adults is 65 to 90 mg per day. We need vitamin C to help absorption of iron from food.

Food Sources: Gooseberry, orange, lemon, guava, bell peppers, bitter gourd, raw mango

Deficiency symptoms: Scurvy, Sore gums, Hemorrhages around the bones