

Vitamin A :

Source :

Cod liver oil and halibut liver oil are rich sources of vitamin A. Vitamin A is also found in good quantities in egg yolk, butter, ghee etc. They may also be derived from β -carotene in green leafy vegetables and yellow fruits especially carrot, papaya etc. β -carotene is the precursor of vitamin A.

Daily requirement :

750 μ g in adults. The requirement is increased in children, pregnancy and lactation.

Functions :

- 1) Vitamin A forms part of the visual pigment essential for night vision.
- 2) Vitamin A maintains the health of epithelial tissues and the skin.
- 3) Vitamin A affords protection from infections.

Deficiency symptoms :

- 1) **Eye changes :**
 - a) The earliest sign of vitamin A deficiency is *night blindness* and appearance of *Bitot's spots* which are greyish, raised areas on the conjunctiva.
 - b) Dryness of conjunctiva and cornea (*xerophthalmia*)
 - c) In severe cases, the cornea may soften and slough out. This is called *keratomalacia*.
- 2) **Skin changes :**

The skin becomes rough, dry and scaly due to hyperkeratinisation. This is called *phrynoderma* (toad skin).
- 3) Epithelial cells in the respiratory tract, gastrointestinal tract and urinary tract are affected with thickening and hyperkeratinisation. As a result, infections are common with diarrhoea and formation of urinary stone.

Prevention :

Vitamin A deficiency and night blindness are very common in the poorer sections of the community. Oral vitamin A supplementation in

high doses (2,00,000 I.U. every 6 months) should be given to preschool children to prevent vitamin A deficiency.

Vitamin D :

Source :

Fish, fish liver oil, butter, eggs, meat, milk and milk products. Ultraviolet rays in sunlight can produce vitamin D in the skin from 7-dehydro-cholesterol.

Daily requirement :

300 I.U. of vitamin D (7.5 μ g) in adults. Children, lactating and pregnant women require more.

Function and deficiency symptoms :

See vitamin D₃ (p. 450)

Vitamin E :

Source :

Green leafy vegetables, meat, eggs, milk. Vitamin E is available in a wide range of foods. Hence, deficiency of this vitamin is rare in humans.

Daily requirement :

About 10-30 mg/day of vitamin E.

Functions :

Vitamin E is one of the important antioxidants in the body. It removes free radicals from the body and prevents formation of harmful oxidation products in the tissues.

Deficiency symptoms :

As already told, deficiency of vitamin E is rare in humans. However, in exceptional circumstances e.g. malabsorption of fat, vitamin E deficiency may occur. The symptoms include loss of reflexes, gait disturbances, defects in proprioception and vibration sense etc. along with degeneration of posterior columns of spinal cord.

Vitamin K :

Source :

Green leafy vegetables, fruits etc. A major source of vitamin K is intestinal bacteria which synthesise this vitamin in the gut.

Functions :

γ -carboxylation of glutamic acid residues in vitamin K-dependent clotting factors (p. 98).

Deficiency symptoms :

Causes of vitamin K deficiency have been mentioned in p. 80. Inactivation of vitamin K-dependent clotting factors in vitamin K deficiency lead to coagulation disorder with increased clotting time but normal bleeding time.

Vitamin B₁ (Thiamine) :

Source :

Cereals, pulses, fruits, yeast, meat, fish etc. Thiamine is present in large quantities in the outer covering of cereals. Polishing removes this vitamin from rice and cereals.

Daily requirement :

1-1.5 mg in adults.

Function :

- 1) Thiamine acts as a coenzyme in oxidative decarboxylation of α -keto acids e.g. pyruvic and α -ketoglutaric acids.
- 2) It also takes part in the transketolase reaction in the pentose phosphate pathway.
- 3) It may have some specific functions in neurons.

Deficiency symptoms :

Thiamine deficiency leads to a disease complex known as *beri-beri*. It may be manifested as :

- a) **Wet beri-beri**, where the cardiovascular system is mainly involved. There is marked peripheral vasodilatation with arteriovenous shunt, reduced circulation time, tachycardia, increased cardiac output and marked venous congestion. High output cardiac failure may be present. There is also water retention and oedema. An acute attack may even lead to cardiovascular collapse and death.
- b) **Dry beri-beri** presents with predominant neuronal involvement. Three different types present as follows :

(1) Presenting with *peripheral neuropathy* showing loss of reflexes, sensory and motor symptoms accompanied by degeneration of myelin sheath.

(2) As *Wernicke's encephalopathy* presenting with vomiting, nystagmus, paralysis of eye muscles, ataxia and mental confusion.

(3) As *Korsakoff's syndrome* presenting with characteristic retrograde amnesia (failure to recall past events) and confabulation (to make up for the memory loss by concocted, false statements)

Prevention :

- a) By replacing milled or polished cereals with undermilled cereals.
- b) Thiamine supplementation in the diet.

Riboflavin (Vitamin B₂) :

Source :

Liver, fish, milk, milk products, green leafy vegetables, germinating seeds etc.

Daily requirement :

1-2 mg/day.

Function :

This vitamin is part of the coenzymes FAD (Flavine adenine dinucleotide) and FMN (flavin mononucleotide) which take part in oxidation-reduction reactions in the body.

Deficiency symptoms :

These include sore throat, cheilosis, angular stomatitis, glossitis, seborrhoeic dermatitis and normochromic, normocytic anaemia.

Prevention :

Adequate intake of the vitamin in the diet.

Niacin (Vitamin B₃) :

Source :

Liver, meat, fish, egg, cereals, pulses, green vegetables. Niacin can be synthesised from tryptophan in the body. Hence, it is not a true vitamin.

Daily requirement :

10-15 mg/day. Requirement varies with tryptophan content in the diet.

Function :

Niacin or nicotinic acid is a component of coenzymes NAD (nicotinic adenine dinucleotide) and NADP (Nicotinic adenine dinucleotide phosphate). Both these coenzymes play an important role in various oxidation-reduction reactions in the body.

Deficiency symptoms :

Niacin deficiency leads to *pellagra*, a disease which previously affected a sizeable population in many parts of the world. Consumption of maize as the principal cereal together with milling of the grain seemed to contribute to this disease.

The symptoms of pellagra are summarised as the three 'D's. These are *dermatitis*, *dementia* and *diarrhoea*. Kept untreated, they may lead to death. Glossitis, achlorhydria due to damage of the gastric epithelium, stomatitis, vaginitis may also coexist.

Prevention :

Niacin, in adequate amounts in the diet, prevents pellagra.

Pyridoxine (Vitamin B₆) :**Source :**

It is widely distributed in meat, fish, liver, eggs, cereals, green leafy vegetables.

Daily requirement :

15 mg/day

Functions :

- 1) It acts as a cofactor in the metabolism of many amino acids.
- 2) It is required for the synthesis of δ -amino levulinic acid, the precursor of haem.
- 3) It is also believed to play a role in neuronal excitability.

Deficiency symptoms :

As pyridoxine is widely available in food, pure pyridoxine deficiency is not seen. However, some drugs notably isoniazid, penicillamine, cycloserine etc. inactivate the function of this

vitamin as a cofactor. Supplementary pyridoxine added to the diet alongside the above medicines prevent deficiency symptoms.

Symptoms include convulsions, dizziness, irritability etc.

Prevention :

Vitamin B₆ should be supplemented with isoniazid, oral contraceptive and other drugs causing deficiency of this vitamin.

Pantothenic acid :**Source :**

Liver, fish, meat, eggs, yeast and vegetables.

Daily requirement :

10 mg/day, in adults.

Function :

Pantothenic acid is necessary for synthesis of coenzyme A.

Deficiency symptoms :

These include dermatitis, alopecia, enteritis etc.

Prevention :

Due to widespread occurrence in food, deficiency of this vitamin is rare.

Biotin :**Source :**

Widely distributed in food especially liver, egg yolk, tomatoes.

Daily requirement :

30-100 μ g.

Function :

It acts as a cofactor for the carboxylase enzyme.

Deficiency symptoms :

Deficiency may arise due to :

- a) ingestion of raw egg white which binds with biotin
- b) intravenous alimentation without biotin supplement
- c) deficiency of biotinidase enzyme which releases biotin from food.

Symptoms include alopecia, dermatitis, conjunctivitis, ataxia etc. Children may suffer from delayed development.

Folic acid :

Source :

Green leafy vegetable, fish, liver, eggs.

Requirement :

100 µg/day in adults. 300 µg/day in pregnancy and 150 µg/day in lactation.

Function :

- 1) Helps in DNA synthesis (p. 77)
- 2) It acts as a coenzyme for single carbon atom transfer.

Deficiency symptoms :

Megaloblastic anaemia (p. 77)

Vitamin B₁₂ :

Source :

Found exclusively in animal food e.g. liver, fish, meat, egg, milk etc. There is no vegetable source of Vitamin B₁₂.

Requirement :

1 µg/day in adults.

Function, deficiency symptoms and prevention:

(p. 78)

Vitamin C (Ascorbic acid) :

Source :

Amla is the richest source of vitamin C. Other sources include citrus fruits e.g. lemon, orange etc. guava, green leafy vegetable pulses.

In lower animals, vitamin C is synthesised from glucose. However, in primates, the required enzyme is deficient. So, man and other primates must obtain vitamin C from food.

Requirement :

40-50 mg in adults.

Function :

- 1) Vitamin C is a powerful reducing agent.

- 2) It also acts as an antioxidant and removes harmful free radicals.

- 3) It is involved in hydroxylation of procollagen. Proline is hydroxylated to hydroxyproline which is essential for collagen synthesis.

- 4) Vitamin C maintains active folic acid pool by preventing oxidation of tetrahydrofolate.

- 5) Vitamin C helps in reduction of Fe⁺⁺⁺ to Fe⁺⁺ form. This is required for absorption of iron.

Deficiency symptoms :

Vitamin C deficiency leads to *scurvy*, a dreaded disease of the past. Weaned children and old people lacking this vitamin in diet suffer from this disease most often. The manifestations are :

- a) bleeding gums
- b) delayed wound healing
- c) purpura and ecchymoses involving the back of legs
- d) haemorrhage in joints, nail beds and in muscles
- e) Anaemia of normochromic, normocytic type secondary to haemorrhage. Macrocytic anaemia may occur due to concomitant folate deficiency and also due to reduction in active folate pool (see above).

Prevention :

Provision of adequate amounts of vitamin C in the diet, especially of children and old people.