

# Vitamins

Vitamins are organic compound required by the body in small (tiny ) amounts for a variety of essential processes in the body. They are classified as micronutrients because they are normally required in small amounts: usually a few milligrams (mg) or micrograms ( $\mu\text{g}$ ) per day.

Most vitamins cannot be synthesised by the body so must be obtained by the diet. An exception is vitamin D which can be synthesised by the action of sunlight on the skin. Small amounts of niacin (a B vitamin) can be made from the amino acid, tryptophan.

Vitamins have a diverse range of functions in the body, including:

- 1- Co-factors in enzyme activity
- 2- Antioxidants (prevent damage from free radicals)
- 3- Pro-hormone (only vitamin D)

- If insufficient amounts of vitamins are available to the body because of a poor diet or some medical condition, such as malabsorption disorders or inborn errors of metabolism, a deficiency disease can develop.

There are two classes of vitamins:

- the fat-soluble vitamins (A, D, E, and K)
- the water-soluble vitamins (B and C).

Fat-soluble vitamins taken up in excess can be stored in the human body, whereas excess amounts of water-soluble vitamins are excreted

- This is why an excess uptake of fat-soluble vitamins can cause symptoms of toxicity?, which rarely occurs for water-soluble vitamins .

# Requirements and recommended dietary intakes

- The body requires different amounts of each vitamin because each vitamin has a different set of functions. Requirements vary according to age, sex and physiological state (for example pregnancy). They may also be influenced by state of health.

# Lipid-soluble vitamins (A, D, E and K)

hydrophobic compounds, absorbed efficiently with lipids, transport in the blood in lipoproteins or attached to *specific binding proteins*,

Fatsoluble vitamins are (1) absorbed, (2) transported, and (3) stored for longer periods of time than water soluble vitamin



- Vitamin A : serves many important functions in the body, with its role in vision being of particular significance.



# Chemical structure of Vitamin A

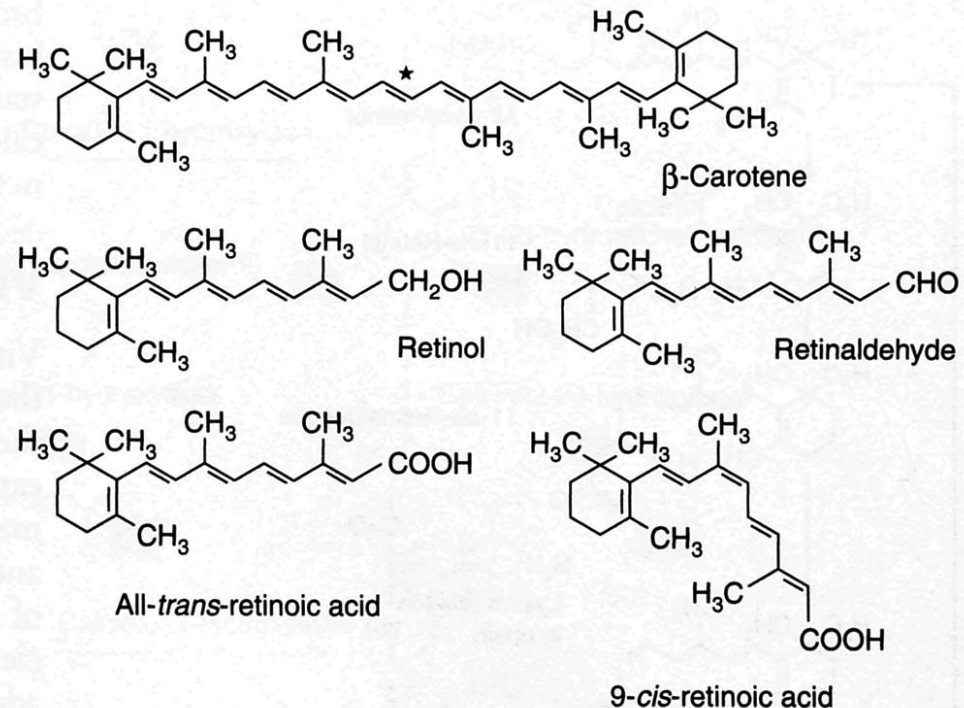
## Retinol

Biologically active forms - *retinoids*: retinol, retinal, retinoic acid.

Major vit. A precursors (provitamins) → plants *carotenoids*.

Foodstaf of animals origin contain most of vit. A in the form of esters (retinylpalmi-tates) – *retinol* and *long fatty acid*

Cyklohexan ring and isoprenoid chain



# Dietary source

from animal-derived food,

such as (1) liver, (2) other organ meats, and (3) fish oils.

Other sources are full cream milk.

The provitamin A carotenoids are obtained from yellow to orange pigment fruits and vegetables, and green leafy vegetables.

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# function

Vitamin A is essential to the normal structure and function of the skin and mucous membranes such as in the eyes, lungs and digestive system.

has a significant function in vision.

# ***Deficiency***

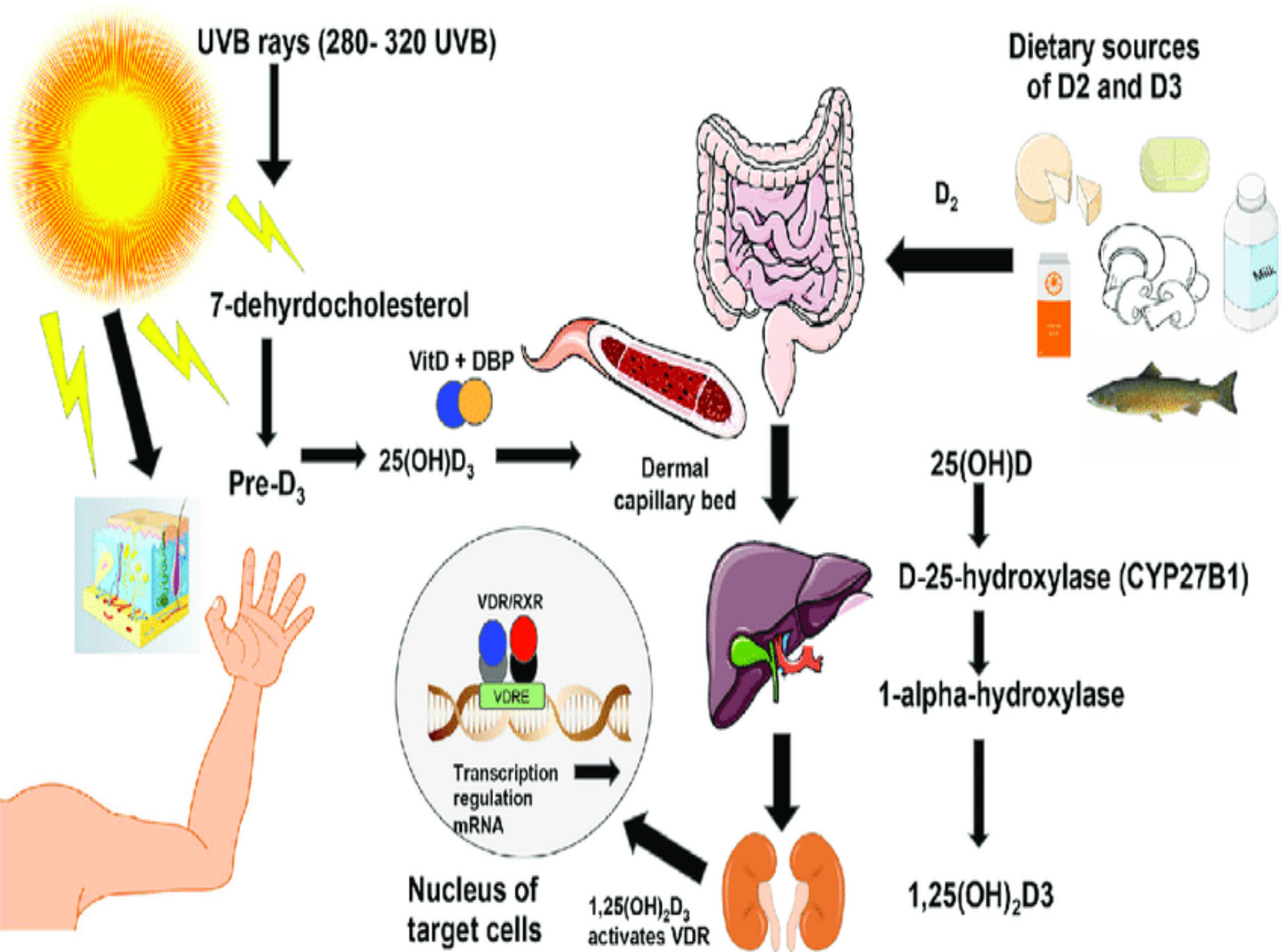
Vitamin A deficiency can lead to night blindness (impaired adaptation to low-intensity light) and eventually total blindness.

# Vitamin D



- There are two sources of vitamin D
  - 1) **Vitamin D** is produced endogenously by exposure of skin to sunlight
  - 2) **Vitamin D** is absorbed from foods.
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Vitamin D is metabolized first to its main circulating form, **D<sub>2</sub> (ergocalciferol)**, 25-hydroxyvitamin D [25(OH)D] then to its biologically active form, **D<sub>3</sub> (cholecalciferol)**, 1,25-dihydroxyvitamin D [1,25(OH)<sub>2</sub>D], a hormone regulating calcium and phosphate metabolism.





# Sources

Vitamin D may be acquired by exposure of skin to sunlight or ingestion of foods containing vitamin D or its metabolites.

Only a few foods, primarily

(1) fish liver oils, (2) fatty fish, (3) egg yolks, and (4) liver

The recommended daily allowance is 400 IU (10 µg), although higher requirements (800 to 1000 IU) may be needed in the elderly.

# Vitamin E

Vitamin E is an antioxidant that acts as a scavenger for molecular oxygen and free radicals. It also has a role in cellular respiration.

# Dietary Sources

The principal sources of dietary vitamin E are (1) oils and fats, particularly wheat germ oil and sunflower oil, (2) grains, and 3) nuts. Meats, fruits, and vegetables contribute little vitamin E.

# Functions Vitamin E

is considered necessary for (1) neurological and reproductive functions, (2) protecting the red cell from hemolysis, (3) prevention of retinopathy in premature infants, and (4) inhibition of free-radical chain reactions of lipid peroxidation.

# Requirements and Reference

Nutrient Intakes The daily requirement for •  
vitamin E is related to the cellular  
polyunsaturated fatty acid content. The  
minimum adult requirement for vitamin E is  
thought to be approximately 3 to 41ng/day

# Deficiency

Signs of deficiency include (1) irritability, (2) edema, and (3) hemolytic anemia

# Vitamin K

Vitamin K promotes clotting of the blood and is required for the conversion of several clotting factors and prothrombin, and is of growing interest in bone metabolism.

# Dietary Sources

The main dietary sources of the •  
phylloquinones are

(1) green vegetables, (2) margarines, and •  
(3) plant oils, whereas some  
menaquinones are obtained from

(1) cheese, (2) other milk products, and •  
(3) eggs.



# Requirements and Reference Nutrient

Dietary reference intakes for vitamin K have recently been revised by the Food and Nutrition Board of the US. Institute of Medicine, and are 120pg/day for men over 18 years and 90pg/day for women

# Deficiency

vitamin K deficiency in the adult is uncommon, the risk is increased in fat malabsorption states (bile duct obstruction, cystic fibrosis, and chronic pancreatitis) and liver disease. Hemorrhagic disease

# Water soluble vitamins

- Vitamin B<sub>1</sub> (thiamine)
- Vitamin B<sub>2</sub> (riboflavin)
- Vitamin B<sub>3</sub> or Vitamin P or Vitamin PP (niacin)
- Vitamin B<sub>5</sub> (panthotenic acid)
- Vitamin B<sub>6</sub> (pyridoxine and pyridoxamine)
- Vitamin B<sub>7</sub> or Vitamin H (biotin)
- Vitamin B<sub>9</sub> or Vitamin M and Vitamin B-c (folic acid)
- Vitamin B<sub>12</sub> (cobalamin)

# Vitamin B1

also known as thiamine-forms the coenzyme thiamine pyrophosphate (TPP). It is required for the essential decarboxylation reactions catalyzed by the pyruvate and 2-oxoglutarate complexes.



# Dietary Sources

present in most plant and animal tissue  
nervous tissue (including the brain).

# Requirements and Reference

2mg/day for adult males and 1.1 mg/day for females. Additional requirements are recommended for pregnancy and lactation.'

# Deficiency

Beriberi is the disease resulting from thiamine deficiency.



# Vitamin B<sub>2</sub> (riboflavin)

Yellow to orange-yellow natural dye slightly soluble in water.

Flavin coenzymes are electron carriers in oxidoreduction reaction.



# Dietary Sources

Rich sources of the coenzyme forms of the vitamin are liver, kidney, and heart. Many vegetables are also good sources.

# Vitamin B<sub>3</sub> – niacin (**nicotinic acid**)



Niacin is required for the release of energy from food (for the normal function of the skin and mucous membranes and for normal functioning of the nervous system).

# *Deficiency*

Deficiency of niacin results in the disease •  
pellagra. It is characterized by sun-  
sensitive skin producing effects similar to  
severe sunburn.

# ***Food sources***

Meat, wheat and maize flour, eggs, dairy products and yeast are all dietary sources of niacin.

# Vitamin B<sub>5</sub> – pantothenic acid

Co-enzyme A assists the following reactions: •

formation of sterols (cholesterol and 7-  
dehydrocholesterol).

formation of fatty acids. –

formation of keto acids such as pyruvic acid. –

Other reactions are acylation, acetylation, signal  
transduction deamination

# Vitamin B<sub>6</sub> (Pyridoxine)

It is essential for the formation of red blood cells and the metabolism and transport of iron.



# Vitamin B<sub>12</sub> (Cyanocobalamin)

Vitamin B<sub>12</sub> serves as a cofactor for enzymes involved in the normal function of the nervous system.

# ***Deficiency***

Deficiency results in the development of pernicious anaemia, in which red blood cells are enlarged (megaloblastic), and peripheral neurological damage develops.



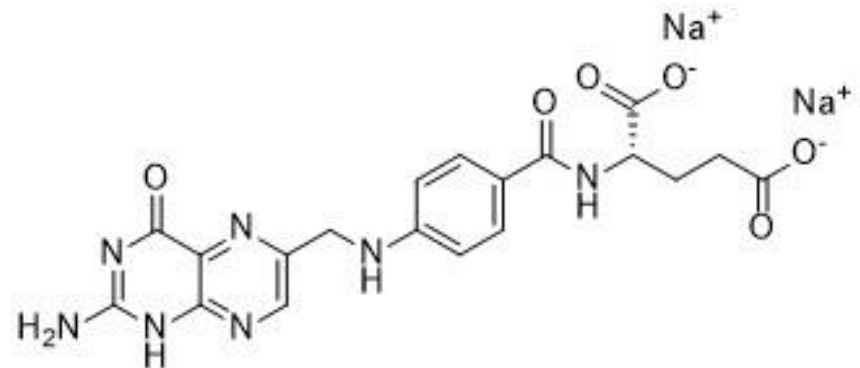
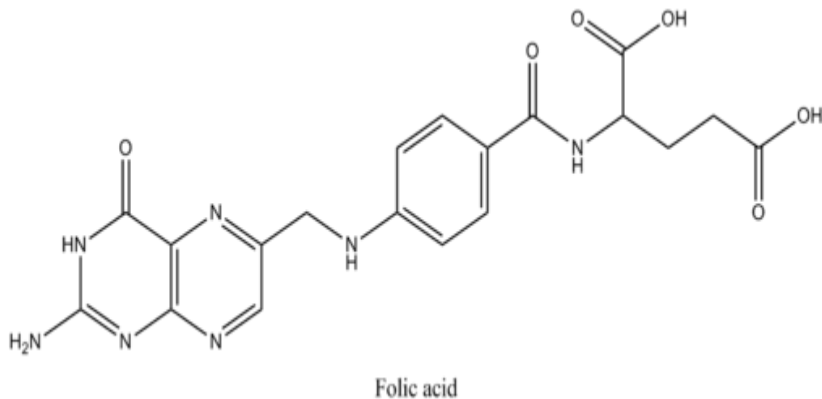
# ***Food sources***



Vitamin B<sub>12</sub> is found in almost all foods of animal origin. Meat, fish, milk, cheese, eggs, yeast extract and fortified breakfast cereals are all dietary sources.

# Vitamin B<sub>9</sub> or Vitamin M and Vitamin B- c (**Folate/folic acid**)

The term folate describes a group of derivatives of pteryl glutamic acid. Folic acid is the synthetic form of folate. It is used in supplements and for food fortification



Folate functions together with vitamin B<sub>12</sub> to form healthy red blood cells. It is also required for normal cell division,

# ***Deficiency***

Deficiency results in megaloblastic anaemia and may be due to poor diet or increased requirement, for example in pregnancy, There may also be a low white cell and platelet count in the blood.

# **Vitamin C (ascorbic acid)**

Vitamin C has antioxidant properties, potentially protecting cells from oxidative damage caused by free radicals.

# ***Deficiency***

Severe deficiency of vitamin C leads to scurvy. Deficiency is associated with fatigue, weakness, aching joints and muscles.

# ***Food sources***

Fresh fruits especially citrus fruits and berries; green vegetables, peppers and tomatoes are all sources of vitamin C. It is also found in potatoes (especially new potatoes).



# ***Food sources***

Green leafy vegetables, brown rice, peas, oranges, bananas and fortified breakfast cereals are sources of folate.

