

Vitamins



Vitamins: Functional aspects, Deficiency disorders and its metabolism

The vitamins are natural and essential nutrients, required in small quantities and play a major role in growth and development, repair and healing wounds, maintaining healthy bones and tissues, for the proper functioning of an immune system, and other biological functions. These essential organic compounds have diverse biochemical functions.

There are different types of vitamins, and all are required for the metabolic processes. The discovery of the vitamins was begun by a Polish American biochemist **Casimir Funk**. Based on his research and discoveries on vitamins, their sources, functions, and deficiency disorders, he is considered as the father of vitamins and vitamin therapy.

Like minerals, vitamins cannot be synthesized by our body. Therefore, we need to get them from the food we consume or in extreme cases supplements to keep ourselves healthy.

Types of Vitamins: Based on the solubility, Vitamins have been classified into two different groups:

1. Fat-Soluble Vitamins.
2. Water-Soluble Vitamins.

Fat-soluble vitamins: Fat-soluble vitamins are stored in the fat cells and as the name suggests, these vitamins require fat in order to be absorbed. Vitamin A, D, E and K are fat-soluble vitamins.

Vitamins	Physiological effect	Effect of deficiency
Vitamin A (Retinol)	Formation of vision pigments, Differentiation of epithelial cells	Night-blindness, continued deficiency can lead to complete blindness.
Vitamin D (Cholecalciferol)	Increase the body's ability to calcium and phosphorus, Transfer of calcium from blood to bones	Softening of bones called Rickets .
Vitamin E (Tocopherol)	Fat-soluble antioxidant	Damage to skin and decrease in the rate of gamete production (sterility)
Vitamin K (Phylloquinone)	Formation of prothrombin (a key enzyme in blood clotting)	Delay in blood clotting

Few important points regarding fat-soluble vitamins:

1. **β -carotene (pro-vitamin A)**, abundantly present in carrot) and vitamin E are fat-soluble antioxidant molecules, which prevent ROS-mediated (reactive oxygen intermediates) cell or DNA damage and delay the aging process.
2. **Vitamin D** exists in two possible forms i.e., **vitamin D₂ (ergocalciferol)** and **vitamin D₃ (1,25-dihydroxycholecalciferol)**. Usually, the metabolic activity of both vitamin D₂ and D₃ are the same but, studies say that vitamin D₃ is maintained at a higher level in serum for a greater duration than D₂.
3. **Vitamin K** is involved in the formation of coenzyme **menaquinone**, which is usually involved in the transfer of carboxyl groups or electrons in various reactions.

The best sources of fat-soluble vitamins include:

1. **Vitamin A:** Found in potatoes, carrots, pumpkins, spinach, beef and eggs.
2. **Vitamin D:** Found in fortified milk & other dairy products, Shark and fish liver oil and *synthesized somewhat in the skin in the presence of sunlight.*
3. **Vitamin E:** Found in fortified cereals, leafy green vegetables, seeds, and nuts.
4. **Vitamin K:** Found in dark green leafy vegetables and in turnip or beet green.

Water-soluble vitamins: Water-soluble vitamins are **not stored in our body** as their excess gets excrete through the urine. Therefore, these vitamins need to be replenished constantly. Most water-soluble vitamins are present in the form of **coenzymes (organic cofactors of proteins/enzymes)** in our body. Vitamin B complex and C are water-soluble vitamins.

Water-soluble vitamin	Present as the coenzyme	The function of the coenzyme	Deficiency disorder
Vitamin B₁ (thiamine)	Thiamine pyrophosphate (TPP)	Decarboxylation reactions	Beri-beri
Vitamin B₂ (riboflavin)	Flavin mononucleotide (FMN) and Flavin adenine dinucleotide (FAD)	Redox reactions involving proton (H ⁺)	Cheilosis
Vitamin B₃ (niacin)	Nicotinamide adenine dinucleotide (NAD) and Nicotinamide adenine dinucleotide phosphate (NADP)	Redox reactions involving proton (H ⁺)	Pellagra
Vitamin B₅ (pantothenic acid)	Coenzyme A (CoA)	Carrier of acyl group	Burning foot syndrome
Vitamin B₆ (Pyridoxine)	Pyridoxal phosphate	Transfer of amino group	Anemia, Depression
Vitamin B₇ (biotin)	Biotin	Carboxylation reactions	Hair loss, brittle nails
Vitamin B₉ (folic acid)	Tetrahydrofolate (THF)	Carrier of one carbon unit like formyl group	Megaloblastic anemia
Vitamin B₁₂ (cyanocobalamin)	Methylcobalamin or deoxyadenosylcobalamin	Intramolecular rearrangement	Pernicious anemia
Vitamin C (ascorbic acid)	None	N/A	Scurvy

Few important points regarding water-soluble vitamins:

1. **Vitamin C** is an **antioxidant**, as it is essential in healing injury and wound and for the **formation of collagen**, a protein found in fibrous connective tissues like tendons, ligaments etc.
2. Excess of **Vitamin B₃ (Niacin)** can cause liver injury.
3. **Transketolase** is an enzyme of both the **pentose phosphate pathway** in all organisms and the **Calvin cycle of photosynthesis**. The deficiency of **Vitamin B₁ (Thiamine)** decreases the efficiency of the transketolase enzyme.

The best sources of water-soluble vitamins include:

1. **Vitamin B1 or Thiamine:** Found in pork chops, ham, enriched grains and seeds (**especially rice**).
2. **Vitamin B2 or Riboflavin:** Found in whole grains, enriched grains and dairy products.
3. **Vitamin B3 or Niacin:** Found in mushrooms, fish, poultry, and whole grains.
4. **Vitamin B5 or Pantothenic Acid:** Found in chicken, broccoli, legumes and whole grains.
5. **Vitamin B6 or Pyridoxine:** Found in fortified cereals and soy products.
6. **Vitamin B7 or Biotin:** Found in many fruits like fruits and meats.
7. **Vitamin B9 or Folic Acid:** Found in leafy vegetables.
8. **Vitamin B12 or Cyanocobalamin:** Found in fish, poultry, meat and dairy products.
9. **Vitamin C or ascorbic acid:** Found in citrus fruits and juices, such as lemon, oranges and grapefruits.

Vitamin metabolism: The liver is a major site for vitamin metabolism and vitamin storage. It produces bile for absorption of fat-soluble vitamins (A, D, E, K). Larger quantities of the fat-soluble vitamins than of water-soluble ones can be stored in the body. Vitamins A, D, and K are stored chiefly in the liver; however, most of the stored vitamin E is found in body fat.

The water-soluble vitamins are absorbed in the intestine and are passed directly to the blood from which they are carried to the tissues in which they will be utilized. Vitamin B₁₂ requires a substance known as an intrinsic factor in order to be absorbed. Water-soluble vitamins are generally excreted in the form of urine. Thiamin, riboflavin, vitamin B₆, vitamin C, pantothenic acid, and biotin appear in urine as free vitamins. Products (also called metabolites) that are formed during the metabolism of thiamin, niacin, and vitamin B₆ also appear in the urine. Excretion of these vitamins is low when intake is sufficient for proper body function. If intake begins to exceed minimal requirements, excess vitamins are stored in the tissues and, as the tissues become saturated, the rate of excretion increases sharply. However, vitamin B₁₂ is excreted solely in the feces.

CSIR NET

Life Science 2022

A Foundation Course

Complete Prep of Life Science for June 2022 Aspirants

Why take this course?

- 400+ Hrs Live Classes & Doubt Sessions for complete conceptual clarity
- 3000+ Practice Questions covering all levels of difficulty
- 20+ Unit Wise Study Modules & Mind Maps
- 50+ Full Mock Tests, Chapter Wise Mock Tests, PYQs Mock Tests

