Vitamins

1. Which one of the following diseases is caused by the deficiency of niacin? [GPAT-2024]

(a) Night Blindness (b) Scurvy (c) Anemia (d) Pellagra

2. Match List I with List II [GPAT-2023 SHIFT-I]

LIST I NAME OF VITAMIN	LIST II FUNCTIONS OF VITAMINS
1. Riboflavin	[P] The electron acceptor for isocitrate dehydrogenase
2. Niacin	[Q] Decarboxylation of alpha-ketoglutarate dehydrogenase
3. Thiamine	[R] Part of coenzyme A
4. Pantothenic acid	[S] Cofactor for succinate dehydrogenase
	[T] Enzyme activity regular, such as for protein kinase C

Choose the correct answer from the options given below

(a) 1-[S], 2-[P], 3-[Q], 4-[R] (b) 1-[R], 2-[Q], 3-[S], 4-[T]

(c) 1-[P], 2-[R], 3-[S], 4-[Q] (d) 1-[Q], 2-[T], 3-[P], 4-[S]

3. Absorption of Vitamin B12, is facilitated by [GPAT-2023 SHIFT-II]

(a) Hydrogel (b) Pyridoxine (c) Nicotinic acid (d) Pantothenic acid

4. Mixed micelle of lipids with bile acids and lipid soluble vitamins are absorbed by [GPAT-2021]

(a) Pancreatic lipase (b) Apo lipoproteins

(c) Enterocytes (d) Chylomicrons

5. Riboflavin chemically is [GPAT-2020]

(a) 6, 7-dimethyl isoalloxazine (b) 6, 7-diethyl isoalloxazine

(c) 8, 9-dimethyl isoalloxazine (d) 8, 9-diethyl isoalloxazine

6. Thiamine is essential for [GPAT-2016]

(a) Pyruvate dehydrogenase (b) Isocitrate dehydrogenase

(c) Succinate dehydrogenase (d) Acetyl CoA synthetase

7. The most potent Vitamin D metabolite is [GPAT-2016]

(a) 25-Hydroxycholecalciferol
(b) 1,25-Dihydroxycholecalciferol
(c) 24, 25-Dihydroxycholecalciferol
(d) 7-Dehydrocholesterol

8. Thiamine deficiency causes decreased energy production because [GPAT-2016]

(a) It is required for the process of transamination
(b) It is a co-factor in oxidative reduction
(c) It is a co-enzyme for transketolase is pentose phosphate pathway
(d) It is a co-enzyme for pyruvate dehydrogenase & alpha ketoglutarate dehydrogenase

9. Beta ionone is starting material for synthesis of [GPAT-2015]

(a) Vitamin K (b) Vitamin B1 (c) Vitamin A (d) Vitamin D

10. Which of the following vitamin is present in Coenzyme A [GPAT-2014]

(a) Thiamine (b) Glycoprotein (c) Lipoprotein (d) Mucoprotein

11. Vitamin K is constituted of ring [GPAT-2013]

(a) Hydroquinone
(b) Naphthoquinone
(c) Benzopyrone
(d) Benzimidazole

12. Aminotransferases usually require the following for their activity [GPAT-2010]

(a) Niacinamide (b) Vitamin B12 (c) Pyridoxal phosphate (d) Thiamine

13. The compounds 2-Methyl-3-phytyl-1-1,4-naphthoquinone and 2-methyl 1-3-all-trans farnesyl geranyl -1,4-naphthoquinone one are commonly known as [GATE-2007]

(a) Vitamin D2 and D3
(b) Vitamin A1and A2
(c) Vitamin K1and K2
(d) Vitamin B1 and B2

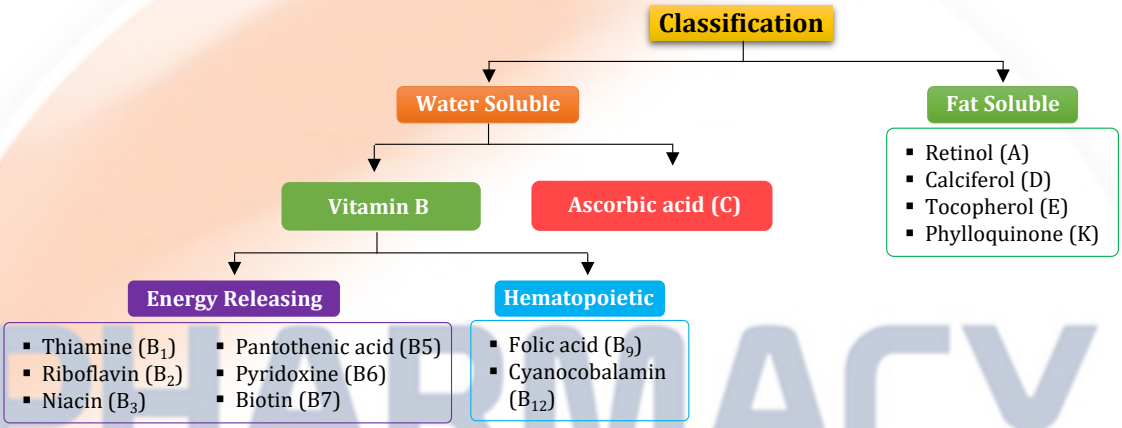
14. The metabolic function of Riboflavin involves the following [GATE-2003]

(a) FMN and FAD
(b) NADP and NADPH
(c) AMP and ATP
(d) Retinal and Retinene

Vitamins

Vitamins

- Vitamins are natural organic substances that our body needs in small amounts to stay healthy, grow properly, and carry out normal body functions.
- Since our body can't make enough of them, we must get them from food.



History

- In 1747, James Lind found that citrus fruits cured scurvy (a disease now known to be due to Vitamin C deficiency).
- In the 1890s, scientists found that beriberi was caused by eating only polished rice, which lacks Vitamin B1.
- Casimir Funk isolated an active principle (an amine) from rice polishings and, later in yeast, which could cure beri-beri in pigeons.
- In 1912, Casimir Funk first used the word "vitamine", meaning vital for life.
- Later the "e" was dropped when it was discovered that not all vitamins are amines.

Fat Soluble Vitamins

Vitamin	Year of Discovery	Discovered By	Key Milestones
A	1913 (identified), 1930s (structure), 1947 (synthesized)	McCollum & Davis (USA), Osborne & Mendel	Structure elucidated by 1930s; synthesized in 1947; linked to vision and immunity
D	1922 (effect found), 1931 (structure), 1935 (synthesized)	Elmer McCollum, Alfred Hess, Adolf Windaus	Nobel Prize (1928) to Windaus; known as the "sunshine vitamin"
E	1922 (discovered), 1936 (isolated), 1938 (synthesized)	Herbert Evans & Katherine S. Bishop	Named tocopherol (birth-bearing); antioxidant role identified
K	1929 (discovered), 1939 (structure), 1943 (Nobel)	Henrik Dam & Edward Doisy	Named “Koagulation” vitamin; Nobel Prize in 1943

Vitamin A - Retinal

Vitamin	Main Ring Structure	Main Functions	Main Sources	Coenzyme / Active Form	Main Deficiencies
Vitamin A	**β-ionone ring** with **polyisoprenoid chain** (fat-soluble)	• Forms **rhodopsin** for **night vision** • Maintains **epithelial integrity** (skin, mucosa) • Enhances **immunity** • Supports **cell growth, differentiation**, and **reproduction** • **Bone growth** in children • **Antioxidant** (as β-carotene)	• **Animal sources:** Liver, fish oil, dairy, egg yolk (retinol) • **Plant sources:** Carrots, spinach, sweet potato (β-carotene provitamin A)	• Retinal • Retinoic acid	• **Night blindness** • **Xerophthalmia** • **Bitot’s spots** • **Keratomalacia** • **Hyperkeratosis** • **Increased infections** (respiratory, GI tract)

☐ Vitamin D - Calciferol

Vitamin	Main Ring Structure	Main Functions	Main Sources	Coenzyme / Active Form	Main Deficiencies
Vitamin D	Secosteroid (Broken steroid ring)	• Regulates calcium & phosphate absorption • Promotes bone mineralization • Regulates PTH secretion	• Sunlight (UVB on skin) • Fish oil, liver, egg yolk • Fortified foods	1,25-dihydroxyvitamin D (Calcitriol)	• **Rickets** (children) • **Osteomalacia** (adults) • **Hypocalcemia, tetany** • **Secondary hyperparathyroidism**

☐ Vitamin E - Tocopherol

Vitamin	Main Ring Structure	Main Functions	Main Sources	Coenzyme / Active Form	Main Deficiencies
Vitamin E	**6-hydroxy chromane ring** (tocol) with **isoprenoid side chain**	• **Antioxidant:** Protects cell membranes, lipids, DNA from oxidative stress • Maintains **skin & eye health** • Strengthens **immunity** • Protects **RBCs** from hemolysis • Enhances **fertility**	• Vegetable oils (sunflower, wheat germ) • Nuts & seeds • Green leafy vegetables	**α-Tocopherol** (most active form)	• **Hemolytic anemia** (especially in infants) • **Neuromuscular disorders:** Ataxia,weakness • **Retinopathy** • **Reduced immunity**

☐ Vitamin K - Phylloquinone

Vitamin	Main Ring Structure	Main Functions	Main Sources	Coenzyme / Active Form	Main Deficiencies
Vitamin K	2-methyl-1,4-naphthoquinone core with isoprenoid chain (K1 & K2)	• **Blood coagulation:** Activates clotting factors II, VII, IX, X • **Bone health:** Activates osteocalcin • **Vascular protection:** Inhibits vascular calcification • Aids **wound healing**	• **K1 (Phylloquinone):** Green leafy vegetables • **K2 (Menaquinone):** Animal foods, gut flora • **K3 (Menadione):** Synthetic	K1, K2 (active forms in body)	• **Prolonged bleeding** • **Hemorrhagic disease of newborn** • **Easy bruising & nosebleeds** • **Bone fragility**

☐ Water Soluble Vitamins

Vitamin	Year of Discovery	Discovered By	Key Milestones
B1	1910 (isolated), 1926 (pure form)	Umetaro Suzuki, Casimir Funk	Synthesized in 1936; linked to carbohydrate metabolism
B2	1933 (isolated), 1935 (synthesized)	Richard Kuhn	Recognized as a growth factor; coenzyme FMN/FAD roles identified
B3	1937	Conrad Elvehjem	Tryptophan → Niacin pathway discovered
B5	1931	Roger J. Williams	Synthesized in 1940; known as "from everywhere" (pantothen)
B6	1934 (adermine), 1938 (isolated)	Paul György	Multiple forms (PN, PL, PM) identified
B7	1936 (named), 1940s (structure)	Paul György, W.G. Bateman	Avidin in egg white binds biotin, causing symptoms
B9	1941 (isolated), 1945 (synthesized)	Lucy Wills, Herschel Mitchell	Role in DNA synthesis and fetal neural tube development
B12	1948 (isolated), 1956 (structure)	Rickes, Smith & Parker; Dorothy Hodgkin	Largest vitamin; requires intrinsic factor for absorption
C	1928 (isolated), 1932 (role confirmed)	Albert Szent-Györgyi, James Lind (earlier)	Nobel Prize in 1937; antioxidant and collagen synthesis role

❑ Vitamin B1 – Thiamine

Vitamin	Main Ring Structure	Main Functions	Main Sources	Coenzyme / Active Form	Main Deficiencies
Vitamin B1	Pyrimidine + Thiazole ring linked by methylene bridge	• **Carbohydrate metabolism:** Coenzyme for PDH, α-KGDH, and transketolase • **Nerve conduction:** Maintains peripheral nerve health • **Energy production** from glucose • **Supports neurotransmitter synthesis (ACh)**	Whole grains, legumes, pork, nuts, enriched cereals	Thiamine Pyrophosphate (TPP) / TDP	• **Beriberi (Dry:** neuropathy; Wet: cardiac failure) • **Wernicke's Encephalopathy** (confusion, ataxia, eye movement disorder) • **Korsakoff's Syndrome** (memory loss, confabulation)

❑ Vitamin B2 – Riboflavin

Vitamin	Main Ring Structure	Main Functions	Main Sources	Coenzyme / Active Form	Main Deficiencies
Vitamin B2	**Isoalloxazine ring** attached to a **ribitol side chain** (yellow pigment)	• Coenzyme in redox reactions (oxidation–reduction) • Involved in **energy production** (ETC, TCA cycle) • Maintains **mucous membranes, skin, and eye health**	Milk, eggs, green leafy vegetables, meat, enriched cereals	**FMN** (Flavin mononucleotide) **FAD** (Flavin adenine dinucleotide)	• **Ariboflavinosis:** Cracks at mouth corners **(cheilitis), glossitis, seborrheic dermatitis,** sore throat

❑ Vitamin B3 – Niacin

Vitamin	Main Ring Structure	Main Functions	Main Sources	Coenzyme / Active Form	Main Deficiencies
Vitamin B3	**Pyridine ring** with carboxyl (nicotinic acid) or amide (nicotinamide) group	• **Redox reactions:** $NAD^+/NADP^+$ in >400 enzyme reactions • **ATP production** in glycolysis, TCA cycle, fatty acid metabolism • **DNA repair & gene expression** • **Antioxidant defense** via NADPH	Meat, fish, poultry, whole grains, legumes, enriched cereals	**NAD^+, $NADP^+$**	• **Pellagra:** 4 D's → **Dermatitis, Diarrhea, Dementia, Death**

❑ Vitamin B5 – Pantothenic acid

Vitamin	Main Ring Structure	Main Functions	Main Sources	Coenzyme / Active Form	Main Deficiencies
Vitamin B5	Made of Pantoic acid + β-alanine (water-soluble)	• **Energy metabolism:** Forms Coenzyme A (CoA) for TCA cycle • **Fatty acid synthesis/degradation:** Involved via CoA and ACP • **Synthesis of Acetyl-CoA** for cholesterol, steroids, ACh	Whole grains, meat, legumes, eggs, broccoli	Coenzyme A (CoA), part of ACP	• **Burning feet syndrome** (tingling, pain in feet) • **Rare** but seen in **malnutrition/alcoholism cases**

❑ Vitamin B6 – Pyridoxine

Vitamin	Main Ring Structure	Main Functions	Main Sources	Coenzyme / Active Form	Main Deficiencies
Vitamin B6	Pyridine ring with varying side chains	• **Amino acid metabolism:** Transamination, decarboxylation, deamination (via PLP) • **Neurotransmitter synthesis**: Serotonin, dopamine, GABA • **Heme synthesis** • **Glycogenolysis** via glycogen phosphorylase	Meat, fish, poultry, whole grains, bananas, legumes	**Pyridoxal-5′-phosphate (PLP)**	• **Neurological symptoms:** Irritability, depression, neuropathy • **Cheilitis, glossitis** • **Microcytic anemia** • **Convulsions (infants)**

☐ Vitamin B7 – Biotin

Vitamin	Main Ring Structure	Main Functions	Main Sources	Coenzyme / Active Form	Main Deficiencies
Vitamin B7	Ureido ring + tetrahydro-thiophene ring with valeric acid side chain	• **Coenzyme for carboxylases** (e.g., acetyl-CoA carboxylase) • **Fatty acid & amino acid metabolism** • **Gene regulation** (via histone • biotinylation) • **Supports skin, hair, nails**	Eggs (cooked), nuts, seeds, liver, whole grains, gut microbiota	**Free Biotin** (active form)	• **Raw egg whites** (avidin binding) • **Biotinidase deficiency** • **TPN without supplementation**

☐ Vitamin B9 – Folic acid

Vitamin	Main Ring Structure	Main Functions	Main Sources	Coenzyme / Active Form	Main Deficiencies
Vitamin B9	**Pteridine ring + PABA + Glutamic acid** (water-soluble)	• **DNA & RNA synthesis:** Required for purine/thymidine production • **Amino acid metabolism:** Converts homocysteine to methionine (with B12) • **Cell division & RBC formation** • **Neural tube development**	Leafy greens, legumes, citrus fruits, fortified cereals, liver	**Tetrahydrofolate (THF)**	• **Megaloblastic anemia** • **Neural tube defects (NTDs)** • **Glossitis, mouth ulcers** • **Fatigue, pallor** • **Elevated homocysteine**

☐ Vitamin B12 – Cyanocobalamin

Vitamin	Main Ring Structure	Main Functions	Main Sources	Coenzyme / Active Form	Main Deficiencies
Vitamin B12	Corrin ring with central cobalt atom (water-soluble)	• **DNA synthesis (with B9):** Converts methyl-THF to THF • **RBC formation:** Prevents megaloblastic anemia • **Neurological function:** Myelin synthesis • **Fatty acid & amino acid metabolism** • **Homocysteine → Methionine**	**Animal products:** Meat, fish, eggs, dairy, fortified foods	**Methylcobalamin** (cytoplasm) **Adenosylcobalamin** (mitochondria)	• **Pernicious anemia** (IF deficiency) • **Neurological symptoms:** Numbness, memory loss, spinal cord degeneration

☐ Vitamin C – Ascorbic Acid

Vitamin	Main Ring Structure	Main Functions	Main Sources	Coenzyme / Active Form	Main Deficiencies
Vitamin C	6-carbon lactone ring (glucose-like structure)	• **Collagen synthesis:** Cofactor for proline & lysine hydroxylation • **Antioxidant:** Regenerates Vitamin E • **Immune support:** Enhances WBC function • **Iron absorption ($Fe^{3+} \rightarrow Fe^{2+}$)** • **Wound healing** • **Neurotransmitter synthesis**	Citrus fruits, guava, strawberries, amla, green vegetables	**L-ascorbic acid** (active form) **Dehydroascorbic acid** (oxidized)	• **Scurvy:** Bleeding gums, loose teeth, petechiae, poor wound healing

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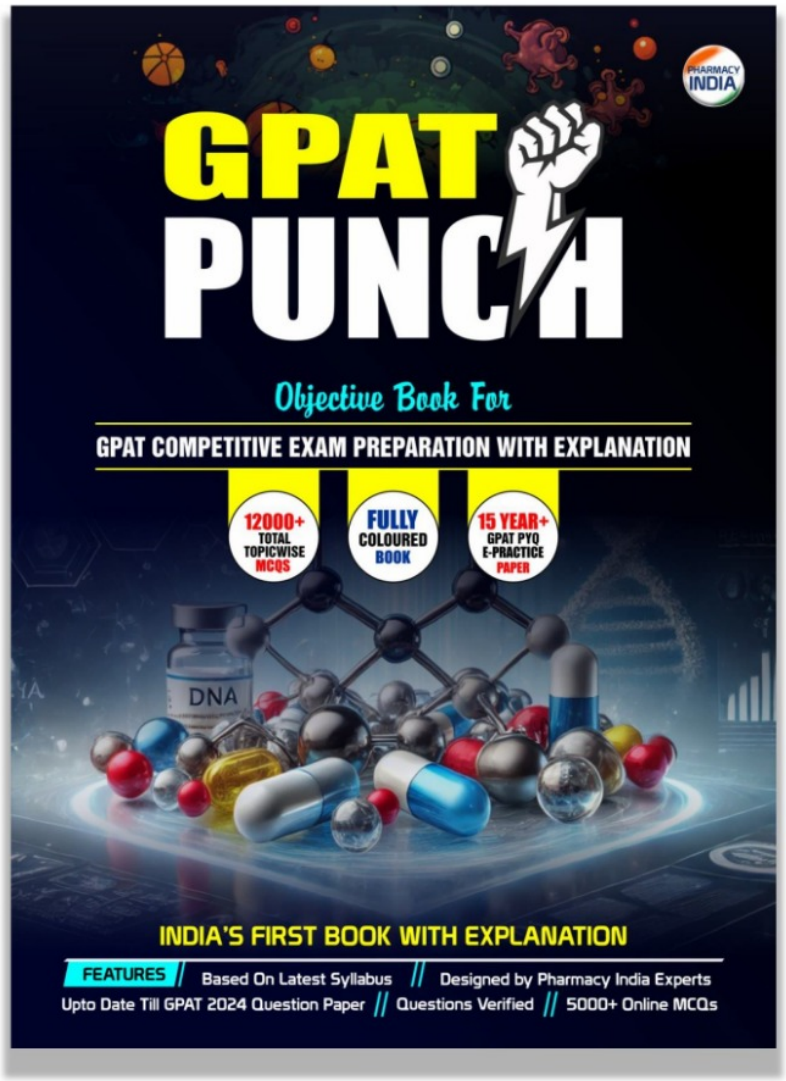

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