

## Biological Functions of Vitamin B complex and effects on human health in both excess and deficiency levels

**Amarjeet Kaur**

Department of Pharmacy, Guru Ram Das (PG) Institute of Management & Technology,  
Dehradun, Uttarakhand, India.

*amarjeetkaur069@gmail.com*



### ABSTRACT

Vitamins are micronutrients and play vital role in healthy life. Body needs them in relatively small amounts, in comparison with other nutrients. Vitamins are two types on bases of their solubility viz. lipid soluble and water soluble. B vitamins or vitamin B complex are a group of water-soluble vitamins that play important roles in cell metabolism. These vitamins are chemically distinct vitamins that often coexist in the same foods. Individual B vitamin supplements are referred to by the specific name of each vitamin (e.g., B1, B2, B3, B5, B6, B7, B8, B9, B12 etc.). In general, supplements containing all eight vitamins are referred to as a vitamin B complex. B vitamins are found in whole unprocessed foods. Processed carbohydrates such as sugar and white flour tend to have a lower B vitamin than their unprocessed counterparts. Good sources for B vitamins include legumes (pulses or beans), whole grains, potatoes, banana, chilli peppers, tempeh, nutritional yeast, brewer's yeast, and molasses. The vitamin B12 is of note because it is not available from plant products, making B12 deficiency a legitimate concern for vegetarians. Deficiency of B vitamins causes various diseases. Their deficiency may cause diseases viz. Vit. B1-Beriberi; Vit B2-Ariboflavinosis; Vit B3-Pellagra; Vit B5-acne; Vit B6-microcytic anaemia; Vit B7-CNS disorders; Vit B9-leucopaenia, macrocytic anaemia; Vit. B12--Macrocytic anaemia, memory loss.

**Keywords:** Vitamin B, Deficiency, Sources, Doses

### INTRODUCTION

Vitamin B complex are one of the most essential group of vitamins and vital in maintaining the health of the nervous system, skin, eyes, hair, liver, brain function, muscle tone and gastrointestinal tract. These vitamins together are responsible for helping enzymes release from food, promote proper metabolism, give cells plenty of oxygen, detoxify organs, stabilize your nervous system functions, keep skin and hair healthy, prevent defective vision and have also been used in the treatment of debilitating conditions.<sup>[1]</sup>

### Ideal characteristics:

- Required in relatively small amount.
- Essential because certain chemical reactions cannot occur without them.
- Must be obtained in the diet because the body can't manufacture them or can't make adequate amounts.
- Must be eaten regularly because they are stored in limited quantities and are gradually lost.
- A deficiency results in at least one specific disorder.

### Sources of B vitamins and their routine doses

Vitamin	Major source	RDA	Deficiency
Vitamin B <sub>1</sub> [Thiamine]	Meats, leafy green vegetables, Grains, legumes	1.1 mg for women, 1.2 mg for men, 1.4 mg for breast feeding or pregnant women	Beri-beri
Vitamin B <sub>2</sub> [Riboflavin]	Present in wide variety of Foods, including milk, meats Grains.	1.1 mg for women, 1.3mg for men, mg for pregnant women, 1.6 for breast feeding women	Glossitis, cheilosis

Vitamin B <sub>3</sub> [Niacin]	Meats, leafy green vegetables, Potatoes, peanuts. May be synthesized in small amount from tryptophan.	14 mg for women 16 mg for men	Pellagra , dermatitis
Vitamin B <sub>5</sub> [pantothenic acid]	Grain, legume, egg yolk, &meat.also synthesized by intestinal Bacteria.	5 mg	Alopecia, degenerative change in CNS
Vitamin B <sub>6</sub> [Pyridoxine]	Present in meat from mammals, fish & poultry. Vegetables, tomatoes & potatoes	1.3 mg for men 1.5 mg for women 1.9 mg for pregnant women, 2.0 mg for breastfeeding women	Microcytic anaemia, Homocystinuria, Cystathioninurea
Vitamin B <sub>7</sub> [Biotin]	Egg yolk,legumes,nuts& liver. Also synthesized by intestinal bacteria.	30 µg	Graying of hair CNS Disorders
Vitamin B <sub>9</sub> [Folic acid]	Dark green, vegetables (spinach), Beef, eggs, whole grains, Also synthesized by intestinal bacteria.	400µg for women 600 µg for pregnant women 500 µg for breast feeding women	Leucopaenia, macrocytic anemia, Neurological disorders
Vitamin B <sub>12</sub> [Cyanocobalamin]	It is obtained almost exclusively from ingestion of animal products.	2.4 µg for men, 2.6 µg for pregnant women. 2.8 µg for breastfeeding women	Macrocytic anemia

**Vitamin B<sub>1</sub>[Thiamine]:** Discovered in 1912 by Casimir Funk, vitamin B1 is said to be good for circulation, carbohydrate metabolism, cognitive activity, brain function, and nervous system health.

**Vitamin B<sub>2</sub>[Riboflavin]:** Discovered in 1926 by Tishler and Williams. It is needed for the digestion and metabolism of protein, fats, and carbohydrates and is also necessary for cell respiration. vitamin B<sub>2</sub> is required for the formation of red blood cells and antibodies and benefits vision, healthy skin, nails and hair. It also aids growth and reproduction and helps in stressful situations.

**Vitamin B<sub>3</sub>[Niacin or vit P]:** Discovered in 1937 by Conrad Elvehjem. Niacin is said to be helpful in lowering serum cholesterol, reducing high blood pressure, preventing fatty buildup in the liver, maintaining the nervous system and helping to reduce depression. It is needed for proper circulation and healthy skin and thought to be better tolerated when taken with vitamin C( niacin has a tendency to cause flushing and warm, tingling sensation).

**Vitamin B<sub>5</sub>[Pantothenic acid]:** Vitamin B5 is said to be anti-stress vitamin and involved in the production of neurotransmitters. It also aids in vitamin utilization and helps to convert fats, carbohydrates and protein into energy. Pantothenic acid assist in cell building and required by all cells in the body. Vitamin B5 improves the body's resistance to stress and assist in the development of CNS. It is also said to help adrenal glands and to fight infections by building antibodies.

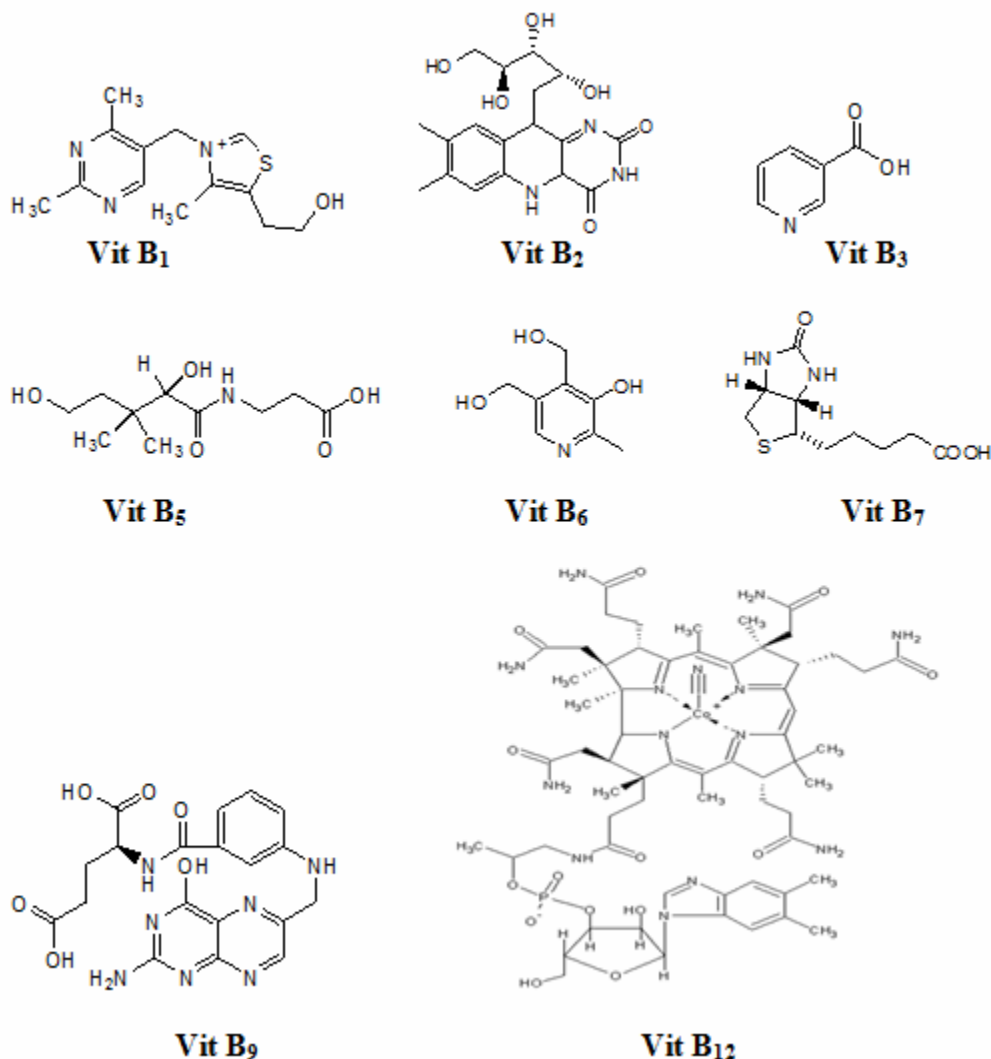
**Vitamin B<sub>6</sub>[Pyridoxine]:** Discovered in 1934 by Paul Gyorgy. Pyridoxine is said to be good for menstrual problems (removing excess fluid) and for reducing the risk of arteriosclerosis and stroke. Vitamin B6 aids in the formation of antibodies and in the fat and carbohydrate metabolism. It is necessary for the synthesis and breakdown of aminoacids ,the building blocks of protein. It also promotes healthy skin, reduces muscle spasms, carpal tunnel syndrome, leg cramp and numbing of the hands.

**Vitamin B<sub>7</sub>[ Biotin ] or [Vitamin H]:** Biotin is required by all organisms but can be synthesized only by bacteria, yeast, molds, algae and some plant species.

**Vitamin B<sub>9</sub> [folic acid] or [vit M]:** Discovered in 1933 by Lucy Wills, folic acid is necessary for DNA and RNA synthesis, which in turn, is essential for the growth and reproduction of all body cells. It is essential for the formation of red blood cells by its action on bone marrow and aids in the amino acid metabolism.

**Vitamin B<sub>12</sub> [cobalamin] or [cyanocobalamin]:** It is said to help in the formation and regeneration of red blood cells, helping to prevent anaemia. It is necessary for calcium absorption and carbohydrate, fat, and protein metabolism. It helps to maintain healthy nervous system, promotes growth in children and increase energy.

### STRUCTURES OF VITAMIN B COMPLEXES



### B vitamin molecular functions

Vitamins	Molecular Function
Vit B1 [Thiamin]	Thiamin plays a central role in the generation of energy from carbohydrates. It is involved in RNA and DNA production, as well as nerve function. Its active form is a coenzyme called thiamin pyrophosphate (TPP), which takes part in the conversion of pyruvate to acetyl coenzyme A (CoA) in metabolism. <sup>[2]</sup>
Vit B2 [Riboflavin]	Riboflavin is involved in the energy production for the electron transport chain, the citric acid cycle, as well as the catabolism of fatty acids (beta oxidation). <sup>[3]</sup>
Vit B3 [Niacin]	Niacin is composed of two structures: nicotinic acid and nicotinamide. There are two coenzyme forms of niacin: nicotinamide adenine dinucleotide (NAD) and nicotinamide

	adenine dinucleotide phosphate (NADP). Both play an important role in energy transfer reactions in the metabolism of glucose, fat and alcohol. <sup>[4]</sup> NAD carries hydrogens and their electrons during metabolic reactions, including the pathway from the citric acid cycle to the electron transport chain. NADP is a coenzyme in lipid and nucleic acid synthesis. <sup>[5]</sup>
Vit B5 [Pantothenic acid]	Pantothenic acid is involved in the oxidation of fatty acids and carbohydrates. Coenzyme A, which can be synthesised from pantothenic acid, is involved in the synthesis of amino acids, fatty acids, ketones, cholesterol, <sup>[6]</sup> phospholipids, steroid hormones, neurotransmitters (such as acetylcholine), and antibodies. <sup>[7]</sup>
Vit B6 [Pyridoxine]	Pyridoxine is usually stored in the body as pyridoxal 5'-phosphate (PLP), which is the co-enzyme form of vitamin B6. Pyridoxine is involved in the metabolism of amino acids and lipids; in the synthesis of neurotransmitters <sup>[8]</sup> and hemoglobin, as well as in the production of nicotinic acid (vitamin B3). <sup>[9]</sup> Pyridoxine also plays an important role in gluconeogenesis.
Vit B7 [Biotin]	Biotin plays a key role in the metabolism of lipids, proteins and carbohydrates. It is a critical co-enzyme of four carboxylases: acetyl CoA carboxylase, which is involved in the synthesis of fatty acids from acetate; propionyl CoA carboxylase, involved in gluconeogenesis; $\beta$ -methylcrotonyl CoA carboxylase, involved in the metabolism of leucine; and pyruvate CoA carboxylase, which is involved in the metabolism of energy, amino acids and cholesterol. <sup>[10]</sup>
Vit B8 [Inositol]	Inositol is a vitamin-like substance. It is found in many plants and animals. It can also be made in a laboratory. Inositol is used for diabetic nerve pain, panic disorder, high cholesterol, insomnia, cancer, depression, schizophrenia, Alzheimer's disease, attention deficit-hyperactivity disorder (ADHD), autism, promoting hair growth, a skin disorder called psoriasis, and treating side effects of medical treatment with lithium. Inositol is also used by mouth for treating conditions associated with polycystic ovary syndrome, including failure to ovulate; high blood pressure; high triglycerides; and high levels of testosterone. <sup>[11]</sup>
Vit B9 [Folic Acid]	Folic acid acts as a co-enzyme in the form of tetrahydrofolate (THF), which is involved in the transfer of single-carbon units in the metabolism of nucleic acids and amino acids. THF is involved in pyrimidine nucleotide synthesis, so is needed for normal cell division, especially during pregnancy and infancy, which are times of rapid growth. Folate also aids in erythropoiesis, the production of red blood cells. <sup>[12]</sup>
Vit B12 [Cyanocobalamin]	Vitamin B12 is involved in the cellular metabolism of carbohydrates, proteins and lipids. It is essential in the production of blood cells in bone marrow, and for nerve sheaths and proteins. <sup>[13]</sup> Vitamin B12 functions as a co-enzyme in intermediary metabolism for the methionine synthase reaction with methylcobalamin, and the methylmalonyl CoA mutase reaction with adenosylcobalamin. <sup>[14]</sup>

**B vitamins side effects:** Because water-soluble B vitamins are eliminated in the urine, taking large doses of certain B vitamins usually only produces transient side-effects. General side effects may include restlessness, nausea and insomnia. These side-effects are almost always caused by dietary supplements and not foodstuffs.

Vitamins	Tolerable Upper Intake Level	Harmful effects
Vit B <sub>1</sub> [Thiamine]	None	No known toxicity from oral intake. There are some reports of anaphylaxis caused by high-dose thiamin injections into the vein or muscle. However, the doses were greater than the quantity humans can physically absorb from oral intake. <sup>[15]</sup>
Vit B <sub>2</sub> [Riboflavin]	None	No evidence of toxicity based on limited human and animal studies. The only evidence of adverse effects associated with riboflavin comes from <i>in vitro</i> studies showing the production of reactive oxygen species (free

		radicals) when riboflavin was exposed to intense visible and UV light. <sup>[16]</sup>
Vit B <sub>3</sub> [Niacin]	35 mg/day from supplements, drugs or fortified food	Intake of 3000 mg/day of nicotinamide and 1500 mg/day of nicotinic acid are associated with nausea, vomiting, and signs and symptoms of liver toxicity. Other effects may include glucose intolerance, and (reversible) ocular effects. Additionally, the nicotinic acid form may cause vasodilatory effects, also known as flushing, including redness of the skin, often accompanied by an itching, tingling, or mild burning sensation, which is also often accompanied by pruritus, headaches, and increased intracranial blood flow, and occasionally accompanied by pain. <sup>[17]</sup> Medical practitioners prescribe recommended doses up to 2000 mg per day of niacin, usually in time release format, to combat arterial plaque development in cases of high lipid levels. <sup>[18]</sup>
Vit B <sub>5</sub> [Pantothenic acid]	None	No known toxicity
Vit B <sub>6</sub> [Pyridoxine]	100 mg/day from supplements, drugs or fortified food.	Intake of more than 1000 mg/day is associated with peripheral sensory neuropathy but adverse effects can occur with much less and, therefore, doses over 200 mg are not considered safe. Other effects are unconfirmed: dermatological lesions [causal association is unlikely]; B6 dependency in newborns [causal association is also unlikely]. <sup>[19]</sup> Recently there is a growing number of consumer reports indicating that B6 can cause severe toxicity and permanent disability, even at RDI levels. <sup>[20]</sup>
Vit B <sub>7</sub> [Biotin]	None	No known toxicity
Vit B <sub>9</sub> [Folic acid]	1 mg/day	Masks B12 deficiency, which can lead to permanent neurological damage. <sup>[21]</sup>
Vit B <sub>12</sub> [Cyanocobalamin]	None established	Acne-like rash [causality is not conclusively established]. <sup>[22,23]</sup>

**Related nutrients:** Many of the following substances have been referred to as vitamins as they were once believed to be vitamins. They are no longer considered as such, and the numbers that were assigned to them now form the “gaps” in the true series of B complex vitamins described above ( e.g., there is no vit B<sub>4</sub>). Some of them though not essential to humans, are essential in the diet of other organisms; others have no nutritional value and may even be toxic under certain conditions.

**Vitamin B<sub>4</sub> [6-Aminopurine]:** Adenine is a purine base of nucleic acids. Its status as a human vitamin is doubtful. It is widespread in animal and plant tissues. Its deficiency responds to various agents including adenine, arginine, cysteine, glycine and thymine. Its deficiency cause muscular weakness in rats & chicks.<sup>[24]</sup>

**Vitamin B<sub>8</sub> [Ergadenylic acid]:** It is obtained from yeast.<sup>[24]</sup> It has recently been approved by the U.S. FDA as an ingredient to block the bitter taste of artificial sweeteners in low calorie food.<sup>[25]</sup> Its deficiency decreases RNA, ADP and ATP synthesis, inhibits breakdown of food into energy, reduce hormone functions etc.<sup>[24]</sup>

**Vitamin B<sub>10</sub> [Pteroyl mono glutamic acid]:** It is also known as ‘Vitamin R’ and ‘factor R’ or feather factor. It is a growth and feather promoter in chickens, which corresponds to folic acid and vitamin B<sub>12</sub>.<sup>[24]</sup> Deficiency causes depressed growth and feathering in chickens.

**Vitamin B<sub>11</sub> [Pteroylhrpta–glutamic acid]:** It’s known as ‘Vitamin S’ or growth factor.<sup>[24]</sup> Its deficiency causes depressed growth and feathering in chickens.

**Vitamin B<sub>13</sub> [Orotic acid/ Pyrimidinecarboxylic acid]:** Orotic acid is obtained from whey , root vegetables etc. Orotic acid , a ‘mineral transporter’ is commercially available in the form of mineral orotates. Its vitamin status is unlikely due to it manufactured in the body by intestinal flora. Aspartic acid Colamine phosphate (calcium AEP)

are 'mineral transporter' and might have some claim as 'Vitamin B<sub>13</sub>'.<sup>[24]</sup> Deficiency may cause possibly multiple sclerosis.

**Vitamin B<sub>14</sub>:** It is obtained from yeast, grains, meat, wine etc. It is perhaps a substance isolated from wine that prevents Tumor or Cancer.<sup>[24]</sup> Deficiency may cause anaemia.

**Vitamin B<sub>15</sub>**[Pangamic acid / Pangametin]: It is obtained from yeast, apricot seeds, corn, etc. It is believed to be Dimethylglycine(DMG) and Gluconic acid, although mixtures vary. If DMG is responsible for the benefits often attributed to Pangamic acid, then Trimethylglycine(TMG) may be considered to have B<sub>15</sub> activity. Both DMG & TMG act as methylators, reduce homocystein in the blood, and good for liver health.<sup>[24]</sup>

**Vitamin B<sub>16</sub>:** It is a component of Pangamic acid.<sup>[25]</sup>

**Vitamin B<sub>17</sub>** [Amygdalin]: It is obtained from apricot seeds, buckwheat, millet, lima beans. Flax etc. Optimal intake is 25-100mg. It is supposed to be anti-cancer substance. Vitamin B<sub>17</sub> is a group of cyanide producing sugar known as 'cyanogenic glycosides' or 'nitrilosides' that release cyanide when acted upon by the enzyme B-glucosidase. Often taken in concentrated form of amygdalin, one particular glycoside, but soon after mixed with water, the chemical is subjected to epimerisation, so quality is poor when stored in water. Rodent research suggests anti- metastatic effect at high injectables doses. Is an unproven therapy for cancer.<sup>[24]</sup> Deficiency leads to possible increased incidence of cancer.

**Vitamin B<sub>22</sub>:** It is obtained from yeast and aloe vera.

**Vitamin B<sub>c</sub> [folic acid]:** It is obtained from green leafy vegetables, soyabeans, oranges etc. Optimal intake is 400-1000 mcg. It lowers the blood level of homocysteine, perhaps reducing heart diseases. It is a key factor in the prevention of many birth defects. Consuming too much may contribute to the development of colon Tumour or cancer. Also known as vitamin M. The deficiency may cause nutritional macrocytic anaemia.<sup>[24]</sup>

**Vitamin B<sub>h</sub> [Inositol]:** Its source are yeast, grapefruits, lecithin, peanuts etc. Optimal intake is 100-1000 mg. It is present in many B-complex formulas, and is probably best thought of as a B complex factor appearing with the B vitamins in many food and supplements, rather than an actual vitamin. It is a component of Lecithin with choline. Deficiency causes eczema.<sup>[24]</sup>

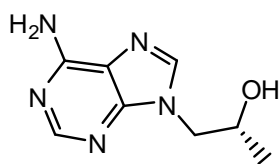
**Vitamin B<sub>p</sub>:** It is a factor used to treat perosis in chickens, a condition that responds to a mixture of choline and manganese.

**Vitamin B<sub>t</sub>:** It is obtained from chicken , fish, and red meats etc. Optimal intake is 500 mg. It has been promoted as a treatment for heart diseases. Its acetylated form has been promoted as good for brain health. Also known as insect growth factor.<sup>[24]</sup>

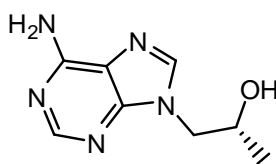
**Vitamin B<sub>x</sub> [PABA]:** It is obtained from sunflower seeds, yeast, wheat germ. Optimal intake is 10-100 mg It has been used topically as a sunscreen, although rarely used now. Like choline and inositol, it still appears in B complex formulas. It is an essential nutrient for some bacteria. The deficiency causes Greying of hair, eczema in animal.

**Vitamin B<sub>w</sub>:** It is obtained from yeast, soyabeans, egg yolk etc. Optimal intake is 300-1000 mcg & RDA -300 mg. A biotin deficiency is rare. Unless raw egg whites are eaten often (they contain a substance that binds biotin), we get ample biotin. Recently high dose biotin has been found to benefits Diabetes. Also known as Co enzyme R, factor W,S,H, and X & vitamin H.<sup>[24]</sup> The deficiency causes eczema, improper fat metabolism.

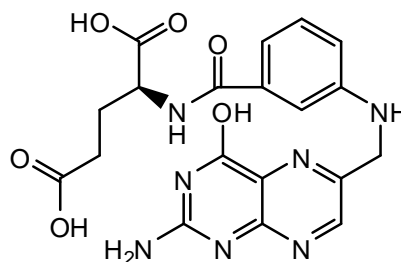
#### Structure



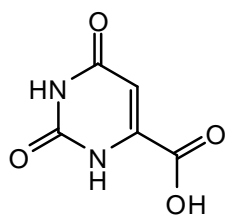
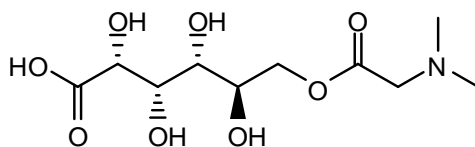
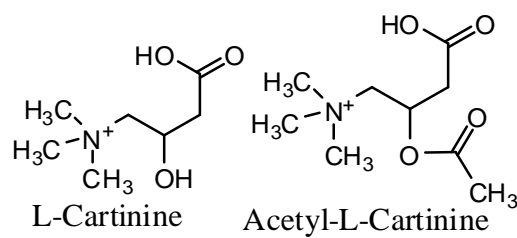
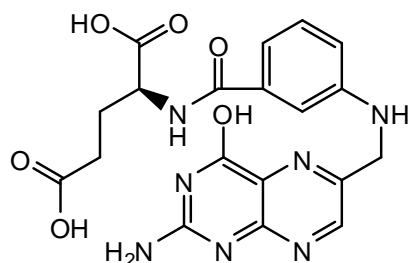
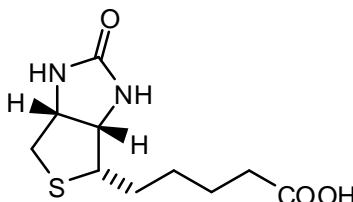
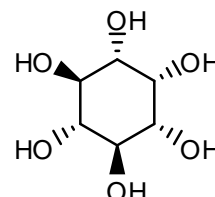
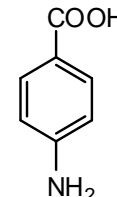
**Vit B<sub>4</sub>**



**Vit B<sub>10</sub>**



**Vit B<sub>11</sub>**

Vit B<sub>13</sub>Vit B<sub>15</sub>VitB<sub>t</sub>VitB<sub>c</sub>VitB<sub>w</sub>VitB<sub>h</sub> (Inosito)VitB<sub>x</sub>

## ↓ REFERENCES

1. Kumar P. Natural Products: A practical manual. Pharma Med Press Publications, 2009. ISBN: 978-81-88449-79- Page no. 83- 91.
2. Fattal-Valevski A. Thiamin (vitamin B1). J Evidence-Based Complement & Altern Med, 2011; 16 (1): 12–20.
3. Riboflavin. Alternative Medicine Review, 2008; 13 (4): 334–340.
4. Whitney N, Rolfes S, Crowe T, Cameron-Smith D, Walsh A. Understanding Nutrition. Melbourne: Cengage Learning, 2011.
5. National Academy of Sciences. Institute of Medicine. Food and Nutrition Board, ed. Chapter 6- Niacin. Dietary Reference Intakes for Thiamine, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin and Choline. Washington, D.C. National Academy Press, 1998.
6. University of Bristol. Pantothenic Acid. 2002, Retrieved 16 Sept 2012.
7. Gropper S, Smith J. Advanced nutrition and human metabolism. Belmont, CA: Cengage Learning, 2009.
8. University of Maryland Medical Center. Vitamin B6 (Pyridoxine), 2012. Retrieved 16 Sept 2012.
9. University of Bristol. Vitamin B<sub>6</sub> (Pyridoxine), 2002. Retrieved 15 Sept 2012.
10. University of Bristol. Biotin. 2012, Retrieved 17 Sept 2012.
11. Webmd.com Inositol overview.
12. National Academy of Sciences. Institute of Medicine. Food and Nutrition Board, ed. Chapter 8-Folate. Dietary Reference Intakes for Thiamine, Riboflavin, Niacin, Vitamin B<sub>6</sub>, Folate, Vitamin B<sub>12</sub>, Pantothenic Acid, Biotin and Choline. Washington, D.C.: National Academy Press, 2008.
13. University of Bristol. Vitamin B<sub>12</sub>. 2002, Retrieved 16 Sept 2012.
14. DSM. Vitamin B<sub>12</sub>. 2012, Retrieved 16 Sept 2012.
15. National Academy of Sciences. Institute of Medicine. Food and Nutrition Board., ed. Chapter 4- Thiamin. Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline. Washington, D.C.: National Academy Press. 1998, pp. 58–86. ISBN 0-309-06411-2. Retrieved 2009-06-17.
16. National Academy of Sciences. Institute of Medicine. Food and Nutrition Board., ed. Chapter 5-Riboflavin. Dietary Reference Intakes for Thiamine, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B<sub>12</sub>, Pantothenic Acid, Biotin, and Choline. Washington, D.C.: National Academy Press. 1998, pp. 87–122. ISBN 0-309-06411-2. Retrieved 2009-06-17.

17. National Academy of Sciences. Institute of Medicine. Food and Nutrition Board., ed. Chapter 6- Niacin. Dietary Reference Intakes for Thiamine, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline. Washington, D.C.: National Academy Press. 1998, pp.123–149. ISBN 0-309-06411-2. Retrieved 2009-06-17.  
18.<http://www.rxabbott.com/pdf/niaspan.pdf>
19. National Academy of Sciences. Institute of Medicine. Food and Nutrition Board., ed. Chapter 7-Vitamin B6. Dietary Reference Intakes for Thiamine, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline. Washington, D.C.: National Academy Press. 1998, pp.150–195. ISBN 0-309-06411-2. Retrieved 2009-06-17.  
20.[http://www.medhelp.org/posts/Nutrition/B<sub>6</sub>-Toxicity/show/2642?page=1](http://www.medhelp.org/posts/Nutrition/B6-Toxicity/show/2642?page=1)
21. National Academy of Sciences. Institute of Medicine. Food and Nutrition Board., ed. Chapter 8-Folate. Dietary Reference Intakes for Thiamine, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline. Washington, D.C. National Academy Press. 1998, pp.196–305. ISBN 0-309-06411-2. Retrieved 2009-06-17.
22. National Academy of Sciences. Institute of Medicine. Food and Nutrition Board., ed. Chapter 9-Vitamin B<sub>12</sub>. Dietary Reference Intakes for Thiamine, Riboflavin, Niacin, Vitamin B<sub>6</sub>, Folate, Vitamin B<sub>12</sub>, Pantothenic Acid, Biotin, and Choline. Washington, D.C.: National Academy Press. 1998, p. 346. ISBN 0-309-06411-2. Retrieved 2010-09-23.
23. Dupré A, Albarel N, Bonafe JL, Christol B, Lassere J. Vitamin B<sub>12</sub> induced acnes. *Cutis; cutaneous medicine for the practitioner*, 1979, 24(2): 210–1.
24. <http://www.lifeinyouryears.net/everyvitamin/> by David Bennett.
25. <http://www.rationalwiki.org/pseudovitamins>.