INE INSTITUTE OF NUTRITIONAL ENDOCRINOLOGY

Micronutrients: Vitamin B6

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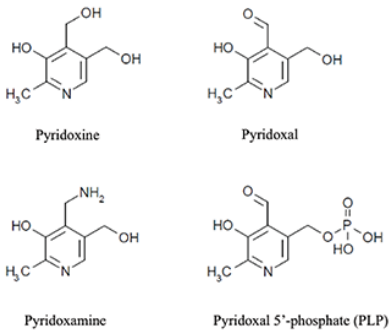
Medical Disclaimer: The information in this presentation is not intended to replace a one-on-one relationship with a qualified health care professional and is not intended as medical advice. It is intended as a sharing of knowledge and information from the research and experience of Dr. Ritamarie Loscalzo, drritamarie.com, and the experts who have contributed. We encourage you to make your own health care decisions based upon your research and in partnership with a qualified health care professional.

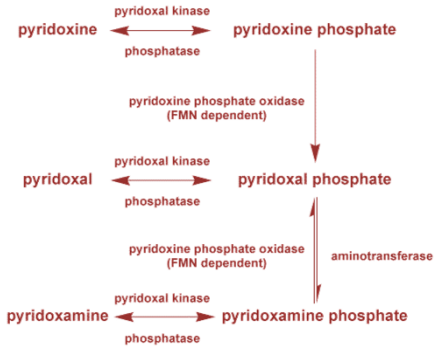
Vitamin B6 General Info

- ✓Vitamin B6 is a water-soluble vitamin
- ✓First isolated in the 1930s
- ✓6 common forms
  - ➢Pyridoxal
  - ➢Pyridoxine (pyridoxol)
  - ➢Pyridoxamine
  - ➢Their phosphorylated forms
- ✓Pyridoxal 5'-phosphate (PLP)
  - ➢The bioactive coenzyme form

Vitamin B6 Chemical Structure



Vitamin B6 Forms Relationships

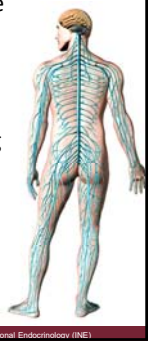


Vitamin B6 Roles

- ✓ Essential to over 100 enzymes, mostly involved in protein metabolism
- ✓ Helps make several neurotransmitters, including serotonin and norepinephrine
- ✓ Involved with brain development and function
- ✓ Helps make melatonin
- ✓ Helps control the levels of homocysteine
- ✓ Helps absorb vitamin B12
- ✓ Important for hemoglobin synthesis

Vitamin B6 and Nervous System Function

- ✓ The PLP-dependent enzyme aromatic L-amino acid decarboxylase catalyzes the synthesis of
  - Serotonin from tryptophan
  - Dopamine from L-3,4-dihydroxyphenylalanine (L-Dopa)
- ✓ PLP-dependent enzymes catalyze synthesis of neurotransmitters, including glycine, D-serine, glutamate, histamine, and GABA

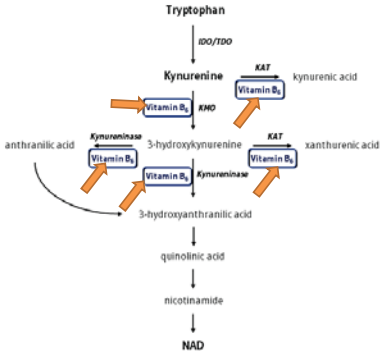


http://www.ncbi.nlm.nih.gov/pubmed/16763894

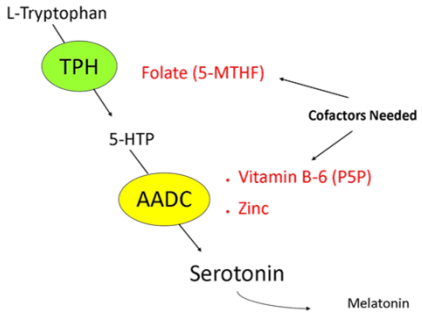
Vitamin B6 and Tryptophan

- ✓ Plays a major role in converting tryptophan to niacin
  - ➢ Co-enzyme PLP
  - ➢ Responsible for helping the enzyme kyneureninase to transport kyneurin into the niacin pathway
  - ➢ Without vitamin B-6, this PLP pathway can get diverted into another amino acid pathway, preventing the formation of niacin
- ✓ Vitamin B-6 also works with iron and riboflavin during this conversion process

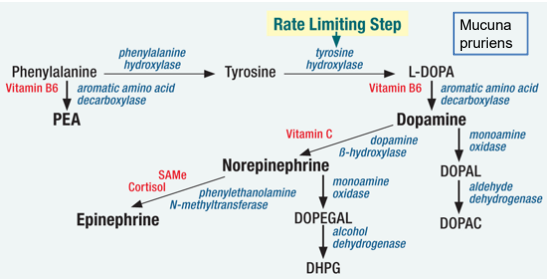
Vitamin B6 and Tryptophan



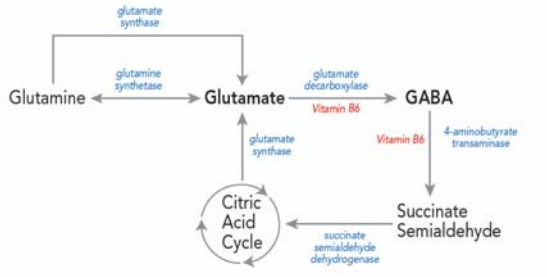
Vitamin B6, Serotonin and Melatonin

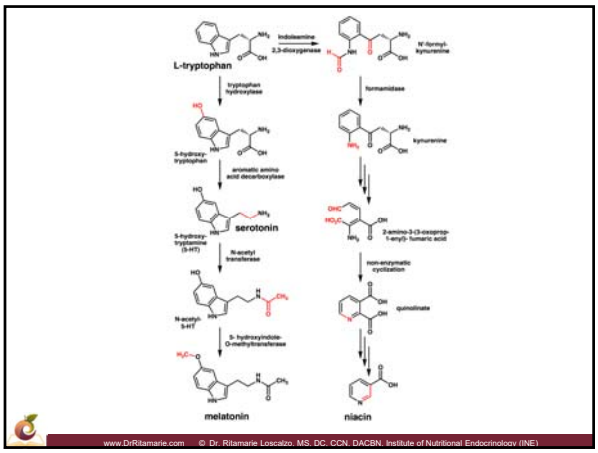


Vitamin B6, Dopamine and Stress

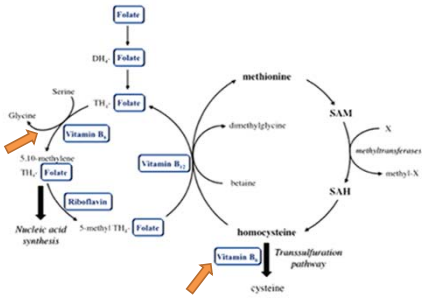


Vitamin B6 and GABA





Vitamin B6 and Methylation



SAM, S-adenosylmethionine; SAH, S-adenosylhomocysteine; TH4-folate, tetrahydrofolate.

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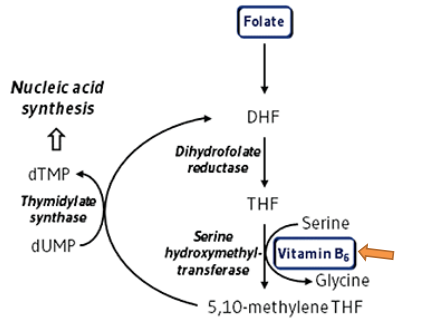
Vitamin B6 and Folate Metabolism



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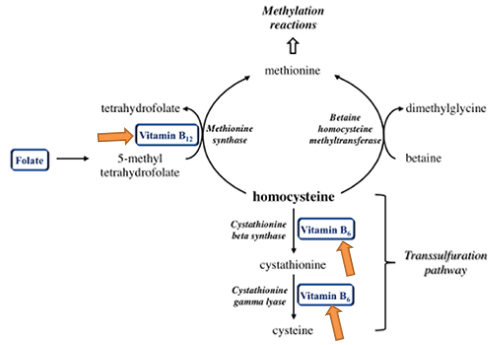
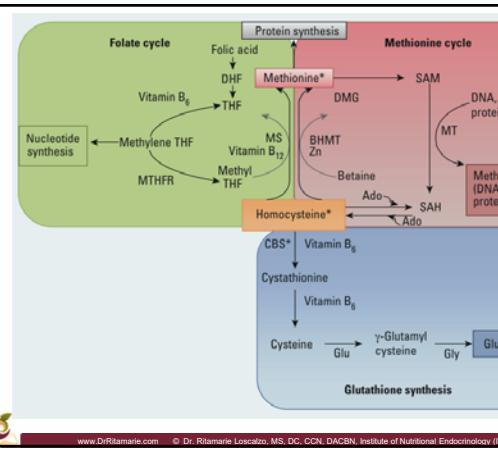
Vitamin B6 and Homocysteine





Vitamin B6 and Hemoglobin Synthesis

- PLP is a coenzyme of 5-aminolevulinic acid synthase
  - Involved in the synthesis of heme
- Pyridoxal and PLP
  - Able to bind to the hemoglobin molecule and affect its ability to pick up and release oxygen

Vitamin B6 and Inflammation

- ✓Deficiency correlated with elevated CRP and fibrinogen (related to cardiovascular inflammation)
- ✓Inflammation can deplete Vitamin B6
- ✓Possibly linked to cognitive decline

Vitamin B6 and Nucleic Acid

- ✓Supports metabolism by facilitating nucleic acid synthesis
- ✓Plays an important role in protein synthesis
- ✓PLP serves as a coenzyme for SHMT, which catalyzes the simultaneous conversions of serine to glycine and tetrahydrofolate (THF) to 5,10-methylene THF

Vitamin B6 Absorption

- ✓Absorbed in the small intestine
- ✓Before absorption, a phosphate group must be removed, allowing B6 to be a free molecule
- ✓Absorbed by passive diffusion from the intestine into the blood - without the need of energy

Influences on Vitamin B6 Absorption

Decreases Absorption

- ✓ Oral estrogens
- ✓ Hydrazine
- ✓ Tetracycline

Increases Absorption

- ✓ Increased intake
- ✓ Decrease alcohol consumption
- ✓ Maintain digestive health

Things That Deplete Vitamin B6

- ✓ Oral contraceptives
- ✓ Anti-Inflammatory medications
  - ➢ Hydrocortisone
  - ➢ Prednisone
- ✓ Antibiotics
  - ➢ Isoniazid
- ✓ Asthma medications
  - ➢ Aminophylline
  - ➢ Theophylline
- ✓ Cardiovascular medications
  - ➢ Hydralazine
- ✓ Diuretics
  - ➢ Bumetanide
  - ➢ Ethacrynic Acid
  - ➢ Furosemide
  - ➢ Torsemide

Nutrient Interactions with Vitamin B6

- ✓ Folate and vitamin B12
  - ➢ Related to vitamin B6 in their core biochemical pathways
  - ➢ More deficiencies of these two
  - ➢ Prone to absorption problems
- ✓ Magnesium
  - ➢ Vitamin B6 uses as a co-factor
- ✓ Diets high in protein
  - ➢ Increases risk of vitamin B6 depletion

Vitamin B6 Interactions

- ✓ Can reduce the effectiveness of levodopa therapy
  - ➢ Used to treat Parkinson's disease
- ✓ Penicillamine
  - ➢ Used to treat Wilson's disease
  - ➢ Lead poisoning
  - ➢ Kidney stones
  - ➢ Arthritis
- ✓ Estrogenic herbs may interact with vitamin B6
  - ➢ Hops, black cohosh, red clover, soybeans, licorice, green tea and coffee beans

Vitamin B6 RDA

Life Stage	Age	Males (mg/day)	Females (mg/day)
Infants	0-6 months	0.1 (AI)	0.1 (AI)
Infants	7-12 months	0.3 (AI)	0.3 (AI)
Children	1-3 years	0.5	0.5
Children	4-8 years	0.6	0.6
Children	9-13 years	1.0	1.0
Adolescents	14-18 years	1.3	1.2
Adults	19-50 years	1.3	1.3
Adults	51 years and older	1.7	1.5
Pregnancy	all ages	-	1.9
Breast-feeding	all ages	-	2.0

Vitamin B6 Deficiency

- ✓ Severe deficiency is uncommon because it is present in so many foods
- ✓ Secondary deficiency most often results from:
  - ➢ Protein-energy undernutrition
  - ➢ Malabsorption
  - ➢ Alcoholism
  - ➢ Use of pyridoxine-inactivating drugs (e.g., anticonvulsants, isoniazid, cycloserine, hydralazine, corticosteroids, penicillamine)
  - ➢ Excessive loss
- ✓ Rarely, secondary deficiency results from increased metabolic demand (e.g., in hyperthyroidism)
- ✓ Rare inborn errors of metabolism can affect pyridoxine metabolism

Impact of Vitamin B6 Deficiency

- ✓ Peripheral neuropathy
- ✓ A pellagra-like syndrome – niacin co-factor
- ✓ Seborrheic dermatitis
- ✓ Glossitis – inflammation of the tongue
- ✓ Cheilosis – cracks in the corner of the mouth
- ✓ Depression
- ✓ Confusion
- ✓ EEG abnormalities
- ✓ Seizures
- ✓ Normocytic, microcytic, or sideroblastic anemia can also develop

Clinical Uses of Vitamin B6

- ✓ Morning sickness – 25mg per day
- ✓ PMS - up to 100 mg/day
- ✓ Carpal Tunnel - 100-200 mg/day of vitamin B_6 for several months
- ✓ Depression – with amino acids – 25-50 mg P5P
- ✓ Inflammation
- ✓ Anxiety – Pyroluria – with zinc – 25-75mg P5P or 100-200 mg pyridoxine HCl

Impact of Vitamin B6 Excess

- ✓ Sensory changes
- ✓ Difficulty coordinating movements
- ✓ Difficulty balancing
- ✓ Allergic skin reactions and numbness
- ✓ Loss of appetite
- ✓ Nausea
- ✓ Stomach pain
- ✓ Sensitivity to sunlight

*** side effects often improve within six months of discontinuing the use of vitamin B-6 if supplementation is stopped as soon as the symptoms appear. However, if nerve damage occurs, it may be permanent, according to the University of Florida.*

Assessing Status of Vitamin B6

- ✓Indirect functional: low liver enzymes AST, ALT, GGT
- ✓Blood: Ratio of PLP (P5P) to PA (pyridoxic acid)
- ✓Blood: PLP only
- ✓Spectracell
- ✓Organic Acids
- ✓Urine
  - ➢4-pyridoxic acid
  - ➢Xanthurenic acid

Food Sources of Vitamin B6

- ✓Tuna
- ✓Turkey
- ✓Beef
- ✓Chicken
- ✓Salmon
- ✓Sweet potatoes
- ✓Sunflower seeds
- ✓Spinach
- ✓Bananas

Food Sources of Vitamin B6

World's Healthiest Foods ranked as quality sources of vitamin B6

Food	Serving Size	Cals	Amount (mg)	DRI/DV (%)	Nutrient Density	World's Healthiest Foods Rating
Tuna	4 oz	147.4	1.18	69	8.5	excellent
Spinach	1 cup	41.4	0.44	26	11.3	excellent
Cabbage	1 cup	43.5	0.34	20	8.3	excellent
Bok Choy	1 cup	20.4	0.28	16	14.5	excellent
Bell Peppers	1 cup	28.5	0.27	16	10.0	excellent
Turnip Greens	1 cup	28.8	0.26	15	9.6	excellent
Garlic	6 cloves	26.8	0.22	13	8.7	excellent
Cauliflower	1 cup	28.5	0.21	12	7.8	excellent
Turkey	4 oz	166.7	0.92	54	5.8	very good
Beef	4 oz	175.0	0.74	44	4.5	very good
Chicken	4 oz	187.1	0.68	40	3.8	very good
Salmon	4 oz	157.6	0.64	38	4.3	very good
Sweet Potato	1 cup	180.0	0.57	34	3.4	very good
Potatoes	1 cup	160.9	0.54	32	3.6	very good
Banana	1 medium	105.0	0.43	25	4.3	very good
Winter Squash	1 cup	75.8	0.33	19	4.6	very good

Herbs High In Vitamin B6

- ✓Alfalfa
- ✓Catnip
- ✓Oat straw

Vitamin B6 Supplementation

- ✓Pyridoxine hydrochloride
- ✓Pyridoxal-5-phosphate (P5P aka PLP)

References

- ✓ Advanced Nutrition and Human Metabolism – Gropper, Smith and Groff
- ✓ Dakshinamurti S, Dakshinamurti K. Vitamin B6. In: Zempleni J, Rucker RB, McCormick DB, Suttie JW, eds. Handbook of Vitamins. 4th ed
- ✓ http://examine.com/supplements
- ✓ Galluzzi L, Vacchelli E, Michels J, et al. Effects of vitamin B6 metabolism on oncogenesis, tumor progression and therapeutic responses. Oncogene
- ✓ McCormick DB. Vitamin B6. In: Bowman BA, Russell RM, eds. Present Knowledge in Nutrition. Vol. I
- ✓ Da Silva VR, Russell KA, Gregory JF 3rd. Vitamin B6. In: Erdman JW Jr., Macdonald IA, Zeisel SH. Present Knowldege in Nutrition. 10th ed
- ✓ Eliot AC, Kirsch JF. Pyridoxal phosphate enzymes: mechanistic, structural, and evolutionary considerations. Annu Rev Biochem
- ✓ Linus Pauling Institute - http://lpi.oregonstate.edu/mic/vitamins/B6