

## Water soluble vitamins

BCH 282 (Lec 13)

- The B vitamins and vit C are water-soluble vitamins. these vitamins found in the watery compartments of foods and distributed into the water compartments of the body.
- They can easily absorbed into the blood-stream and are easily excreted if their blood conc. rise too high.
- Then, these vitamins are less likely to reach toxic conc. in the body than the fat-soluble vitamins.
- Foods never deliver excessive amount of the water-soluble vitamins, but large doses of supplements can reach toxic levels.

### The B-Vitamins

1. B-vitamins do not give people energy like energy-yielding nutrients but help to burn this fuel or energy.
2. This class contain 8 B vitamins each work as a coenzyme.

So these vitamins must be present in every cell continuously for the cells to function properly.

Coenzyme: a small molecule that works with an enzyme to promote the enzymes activity.

Many coenzymes have vitamin B as part of their structure.

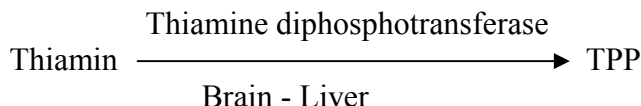
(CO = with)

1. Thiamin B<sub>1</sub>: Sources:

Plant: Whole grains (unrefined cereal grain), yeast, beans, peas.

Animal: Liver, heart, kidney, milk.

- Thiamin = vitamin B1
- Active form thiamin pyrophosphate (TPP) formed in the brain and liver by the specific enzyme.



Recommended intake: 1 – 1½ mg/day

Functions:

All cells use thiamine in their energy metabolism, specially nerve cell membranes.

1. TPP serves as coenzyme for pyruvate and  $\alpha$ -keto glutarate dehydrogenases catalyzed oxidative decarboxylation reaction:

↓

(3 enzymes; 5 coenzymes)

Reaction      (Pyruvate  $\rightarrow$  acetyl CoA)  
                   ( $\alpha$ KG  $\rightarrow$  Succinyl CoA)

2. Coenzyme in transketolase catalyzed reactions of pentosephosphate pathway (1 + MP shunt)
3. TPP plays an important role in the transmission of nerve impulse.

Deficiency:

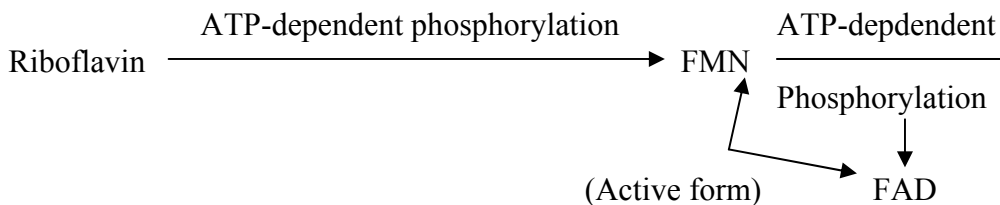
Beri Beri is thiamin-deficiency in th hands, feet and (peripheral neuropathy) and muscular weakness and abnormal heart action.

Dry Beri Beri: Advanced neuromuscular symptoms including atrophy, weakness of muscles.

Wet Beri Beri: The previous symptoms (dry beri beri) are coupled with oedema.

2. Riboflavin (B<sub>2</sub>):      Riboflavin = Vitamin B<sup>2</sup>

Riboflavin is the precursor for the coenzymes, s flavin mononucleotide (FMN) and flavin adenine dinucleotide (FAD)



Requirement: 1.2 – 1.7 mg/day

Functions:      FMN and FAD serve as sprothetic groups of oxidoreductase enzymes (Flavoprotein enzymes):

1. Oxidative decarboxylation of  $\alpha$ -KG).
2. Oxidative degradation of fatty acids (FAD is the prosthetic group of acyl CoA dehydrogenase).
3. Oxidative deamination of  $\alpha$ -amino acids:

FMN : Prosthetic group of L-a.a. oxidase

FAD : Prosthetic group of D-a.a. oxidase

4. Dehydrogenase of succinic acid in the citric acid cycle (succinate dehydrogenase with FAD as prosthetic group).
5. Like thiamine, B<sub>2</sub> facilitates energy production in the body.

The needs of infants, children, pregnant women rise rapidly during periods of active growth, support normal vision, skin health.

N.B.:

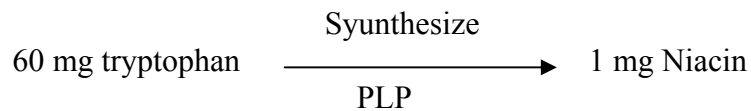
- B<sub>2</sub> is light sensitive, the UV rays of sun or fluorescent lamps can destroy it. For this reason, milk is sold in cardboard or opaque plastic containers to protect riboflavin in the milk from light.
- However, riboflavin is heat stable so the cooking does not destroy it.

Deficiency: cause riboflavinosis.

The main symptom is skin rash (seborrhea), dermatitis, ocular disturbance (photophobia), cheilosis, angular stomatitis, glossitis, vascularization of the cornea.

### 3. Niacin = Vitamin B<sub>3</sub>:

- Like other vitamins, it participates in the energy metabolism of the body.
- Niacin is unique among the B vitamins in that the body can make it from protein. The amino acid tryptophan can be converted to niacin in the body.



Synthesis of Niacin from tryptophan requires pyridoxal phosphate (PLP).

Recommended intakes are therefore, stated in Niacin equivalent (NE) reflecting the body's ability to convert tryptophan to Niacin.

N.B.: This conversion is inefficient and most people requires dietary sources of both tryptophan and Niacin.

Sources::

- Food stuff containing Niacin as B<sub>3</sub>.
- Tryptophan containing protein such as meat.

Functions:

Niacin:

- NAD<sup>+</sup> nicotinamide adenine dinucleotide
- NADP<sup>+</sup> nicotinamide adenine dinucleotide phosphate

NAD<sup>+</sup> and NADP<sup>+</sup> are coenzymes of many oxidoreductase enzymes in both cytosol and mitochondria.

NAD<sup>+</sup> linked dehydrogenases catalyze oxidation-reduction reactions in oxidative pathways in the citric acid cycle and glycolysis  $AH_2 + NAD^+ \rightarrow A + NADH + H^+$

- Ex
- Glyceraldehyde 3-P dehydrogenase
  - Malate dehydrogenases
  - Lactate dehydrogenases

NADP<sup>+</sup> linked dehydrogenase: Often found in the pathways concerned with reductive synthesis e.g. 1 + MP shunt.

- e.g.
- Glucose-6-P dehydrogenase
- also
- Glutathione reductase
  - Molic enzyme (NADP malate dehydrogenase)

Niacin is used as medication :

Physicians sometimes use diet, large doses of niacin to lower blood cholesterol and treat atherosclerosis.

Deficiency: Pellagra = Niacin deficiency disease

(Pellis = skin                      Agra = Seizures)

- Border line deficiencies are manifested by glossitis symptoms include “4 Ds” Diarrhea, Dermatitis, Dementia and ultimately Death.
- Dermatitis here is usually seen in skin areas exposed to sunlight and is symmetric, in the form of pigmentations and thickening of the skin.
- Several physiological conditions e.g. Hartnup disease and malignant carcinoid syndrome as well as certain drug therapy (isoniazid used in treatment of tuberculosis) can lead to niacin deficiency.
- In Hartnup disease tryptophan absorption is impaired and in malignant carcinoid syndrome tryptophan metabolism is altered.

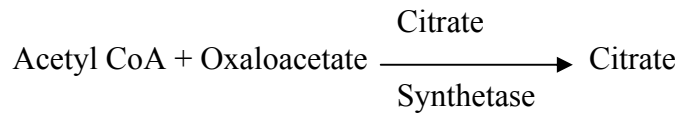
4. Pantothenic acid = Vitamin B<sub>5</sub> sources as B<sub>1</sub>

Functions: is also important in energy metabolism.

- Pantothenic acid is recognized as a substance that stimulates growth. pantothenic acid is involved in more than 100 different steps in the synthesis of lipids, steroid hormones and Hb.
- Active pantothenic acid is coenzyme A (CoA) and acyl carrier protein of fatty acid synthetase.

The SH Group of both CoA and ACP acts as a carrier of acyl group (R-COL<sup>-</sup>) in enzymatic reaction involved in:

1. Fatty acid oxidation and synthesis.
2. Oxidative decarboxylation of  $\alpha$ - keto acids.
3. Formation of citric acid in citric acid cycle



4. Cholesterol synthesis

Deficiency:

There is no evidence of pantothenic acid deficiency disease in man because it is very widespread in natural food.

5. Biotin: Also important in energy metabolism sources as B<sub>1</sub>.

The active form of biotin is biocytin.

Function: Involved in carboxylation reactions i.e. carriers CO<sub>2</sub>

- e.g.
- Acetyl CoA carboxylase in FA synthesis
  - Pyruvate carboxylase in gluconeogenesis (synthesis of glucose from non carbohydrate sources)
  - Propionyl-CoA carboxylase

Propionyl CoA → succinate → citric acid cycle

Deficiency: is rare because it is found in numerous food and is synthesized by intestinal bacteria.

Deficiency of biotin is generally seen only:

1. After long antibiotic therapy which deplete intestinal flora.
2. Following excessive consumption of raw eggs, due to the affinity of the egg white protein, avidin, for biotin preventing intestinal absorption of biotin.