



Vitamins in Metabolism

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Objectives

At the end of the lecture student should be able to;

- give the classification of vitamins
- understand the role of vitamins in metabolism

Vitamins

- Chemically unrelated organic compounds
- Essential: cannot be synthesized by body in adequate amounts
- Supplied by the diet
- Need in minute quantities
- Required for normal metabolism

Terminology

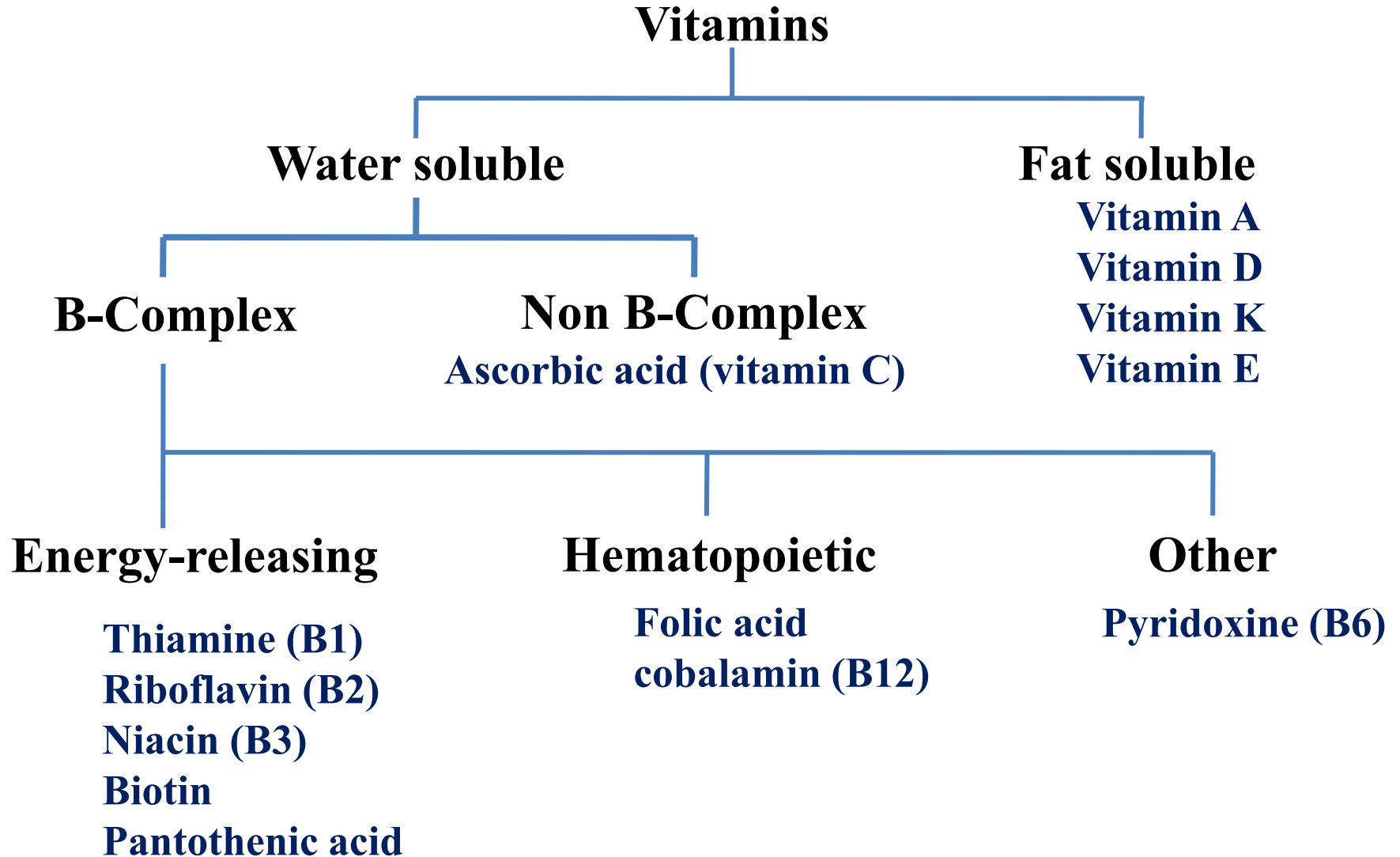
Pro-vitamins

a precursor of a vitamin convertible into the vitamin in an organism. E.g. Beta carotene

Vitamers

different biologically active forms of the same vitamin. E.g. Retinol, Retinoic acid

Vitamins - Classification



Fat Soluble Vitamins

	Other name	Function
A	Retinol/ β -carotene	phototransduction
D	cholecalciferol	bone remodeling
E	α -tocopherol	antioxidant
K	phytylmenaquinone	coagulation
	ubiquinol	bone remodeling

Water Soluble Vitamins

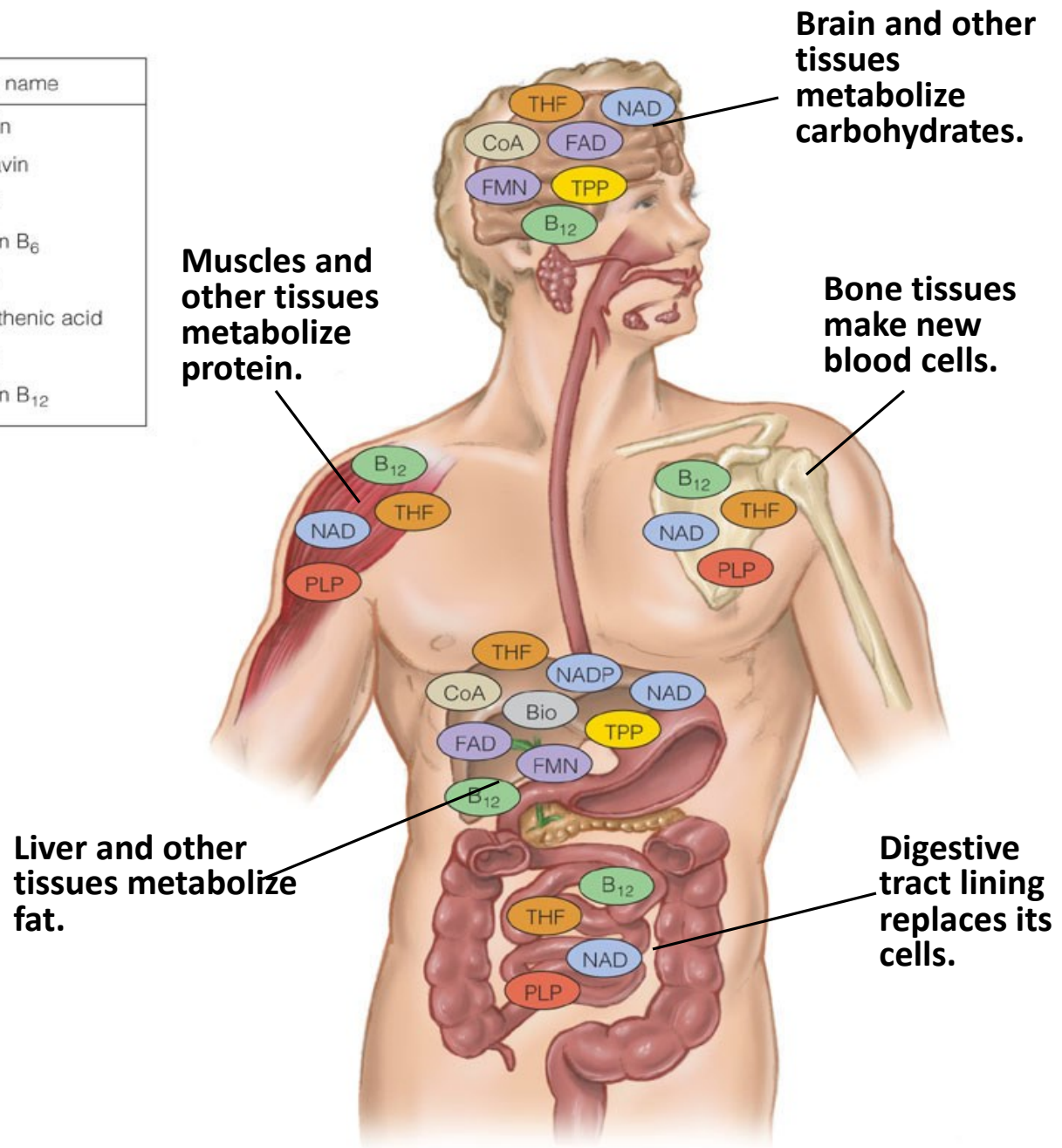
	Other name	Coenzyme name	Function
B1	Thiamine	Thiamine pyrophosphate (TPP)	Carbohydrate metabolism
B2	Riboflavin	Flavin mononucleotide (FMN) Flavin adenine dinucleotide (FAD)	redox, respiration
B3	niacin	Nicotinamide adenine dinucleotide (NAD ⁺) Nicotinamide adenine dinucleotide phosphate (NADP ⁺)	redox
B5	Pantothenic acid	Coenzyme A (CoA) ACP	TCA, FA and Cholesterol

Water Soluble Vitamins

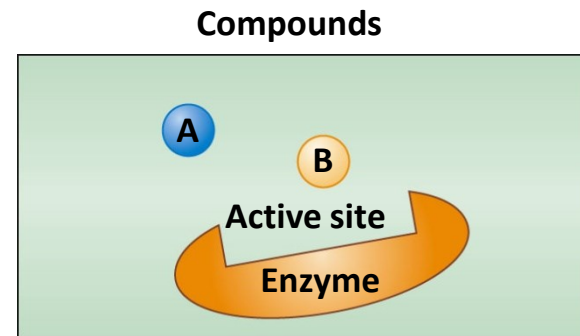
	Other name		Function
B6	Pyridoxine, pyridoxal pyridoxamine	Pyridoxal Phosphate	AA metabolism, Glycogenolysis
B7	Biotin	Enzyme bound Biotin	gluconeogenesis, TCA, FA,AA
B9	Folic acid	Tetrahydrofolate	1C metabolism
B12	Cobalamin	Methylcobalamin Deoxyadenosyl cobalamin	1C&H metabolism
C	Ascorbic acid	Ascorbic acid	hydroxylation

Key:

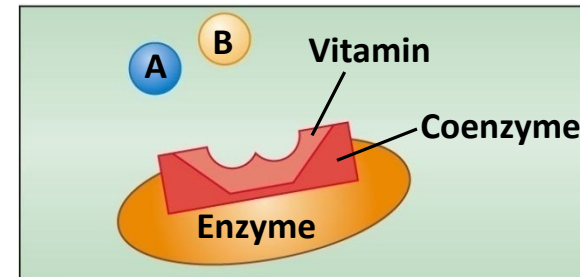
Coenzyme name		Vitamin name
TPP	=	thiamin
FAD	=	riboflavin
FMN	=	riboflavin
NAD	=	niacin
NADP	=	niacin
PLP	=	vitamin B ₆
THF	=	folate
CoA	=	pantothenic acid
Bio	=	biotin
B ₁₂	=	vitamin B ₁₂



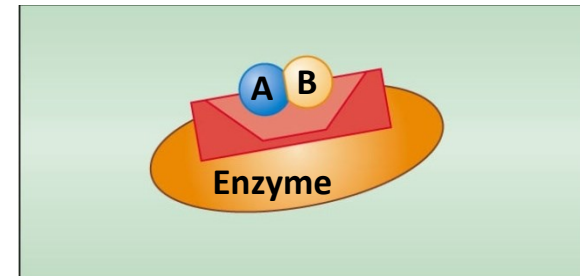
Without the coenzyme, compounds A and B don't respond to the enzyme.



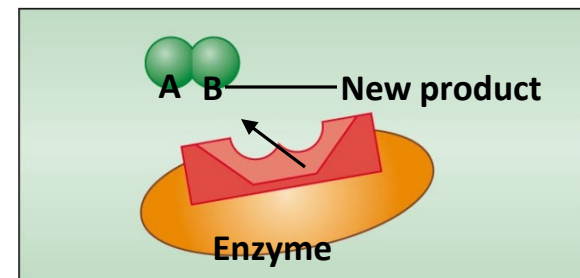
With the coenzyme in place, compounds A and B are attracted to the active site on the enzyme, and they react.



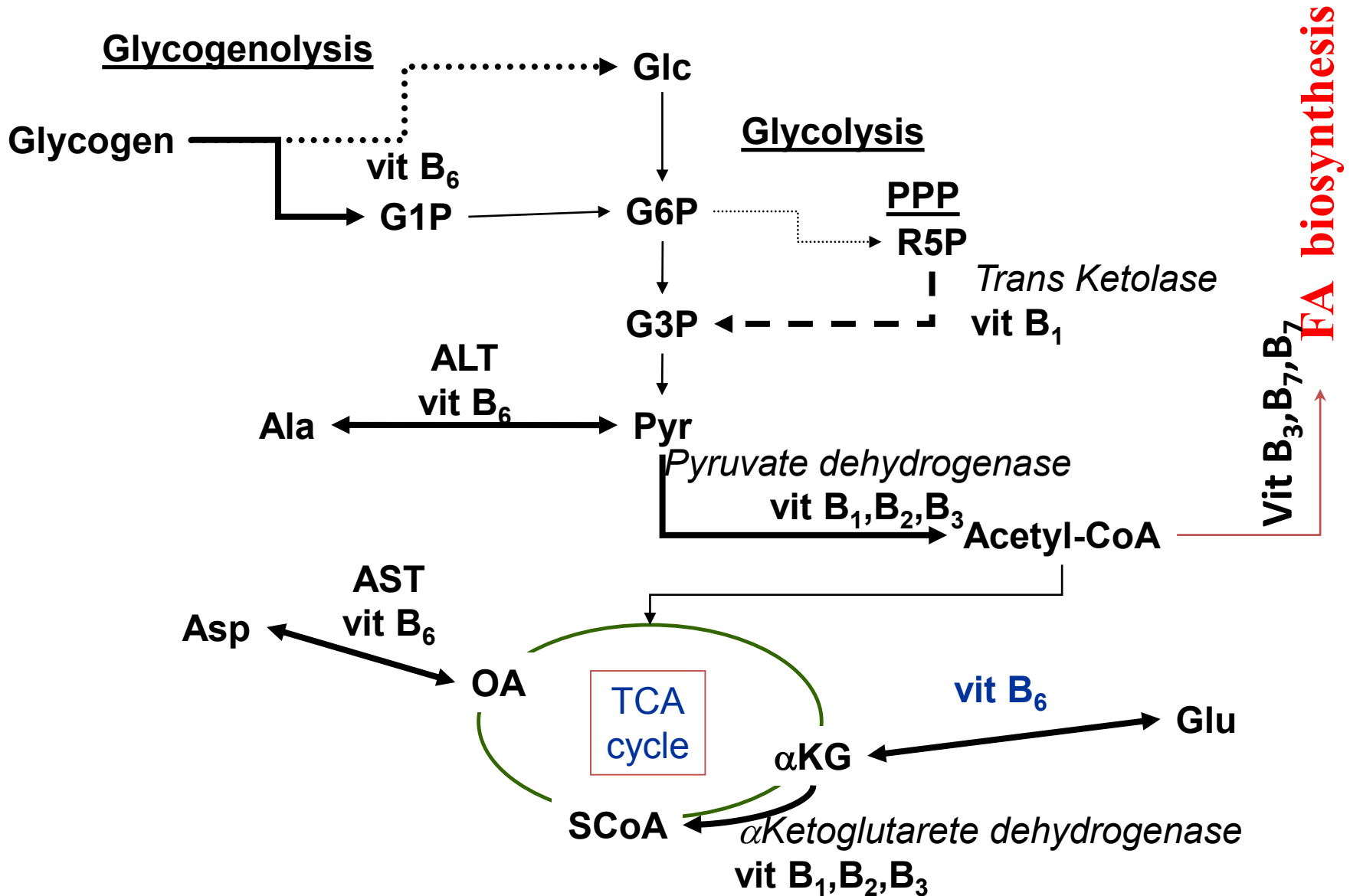
The reaction is completed with the formation of a new product. In this case, the product is AB.



The product AB is released.



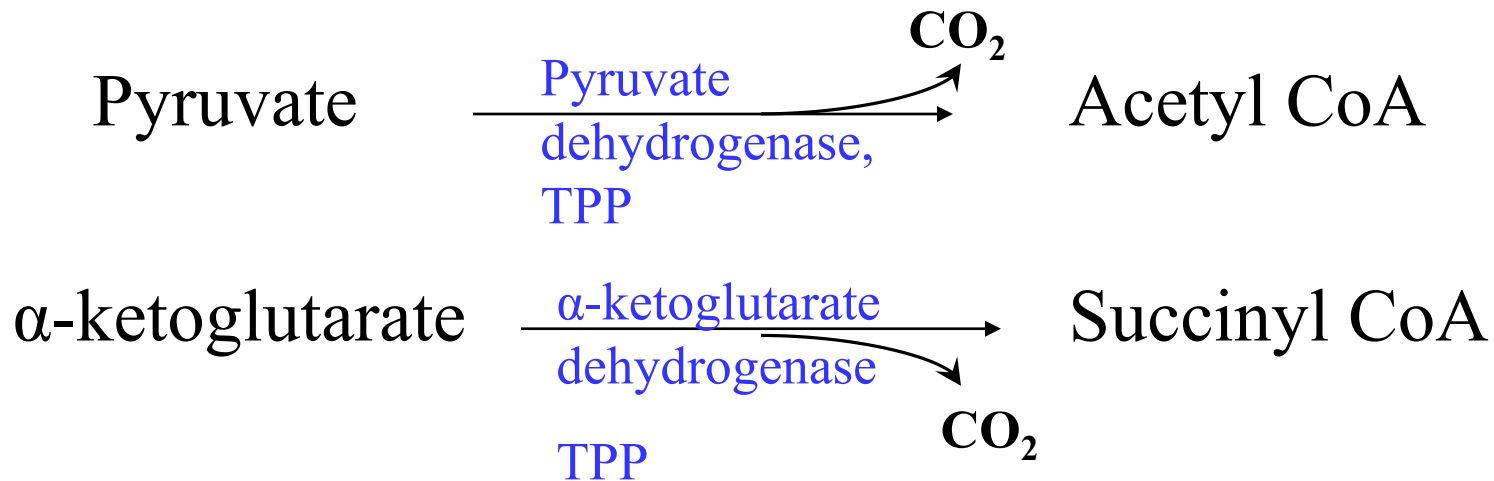
Role in Pathways - Overview



Thiamine – B1

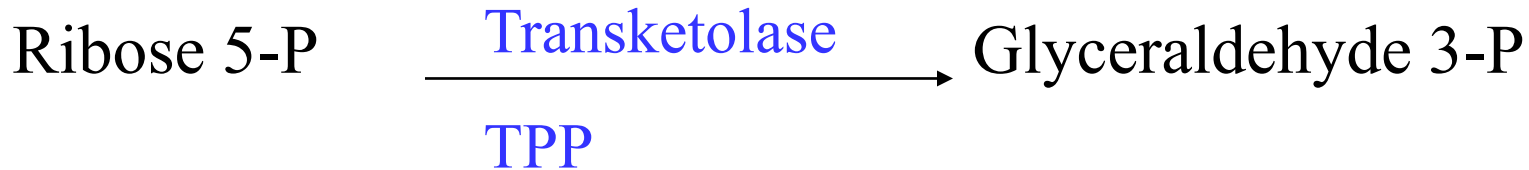
- Biologically active form : Thiamine pyrophosphate(TPP)
- Function : coenzyme in carbohydrate metabolism

1) Oxidative decarboxylation of α -keto acids



Thiamine – B1 ctd..

2) Formation or degradation of α -ketols by transketolase



Deficiency: Beriberi

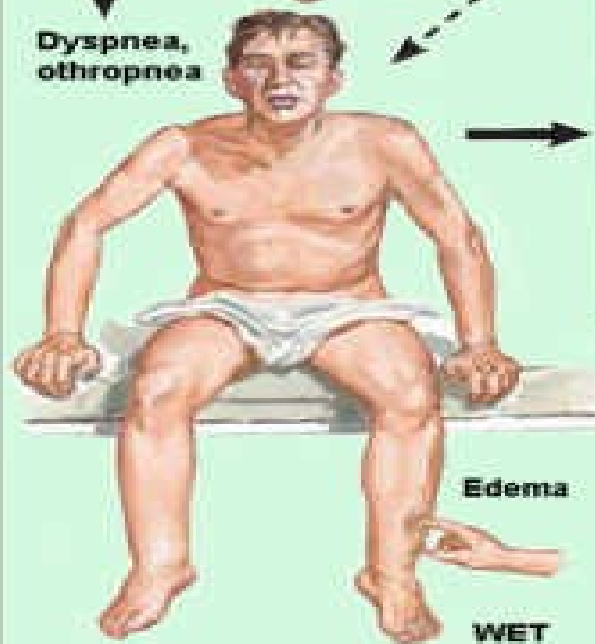
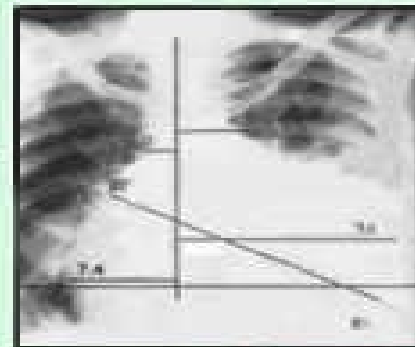
Symptoms: Tachycardia, Vomiting, Convulsions

Deficiency can be due to both insufficient intake and poor habits
e.g. Wernicke-Korsakoff syndrome : chronic alcoholics are likely
to be Thiamin deficient
Worsens with high glucose intake or infusion

THIAMINE DEFICIENCY (Beriberi)

DRY BERIBERI

Common early manifestations



Wernicke's Syndrome

Ophthalmoplegia
→ Confusion
→ Coma
→ Death



Riboflavin – B2

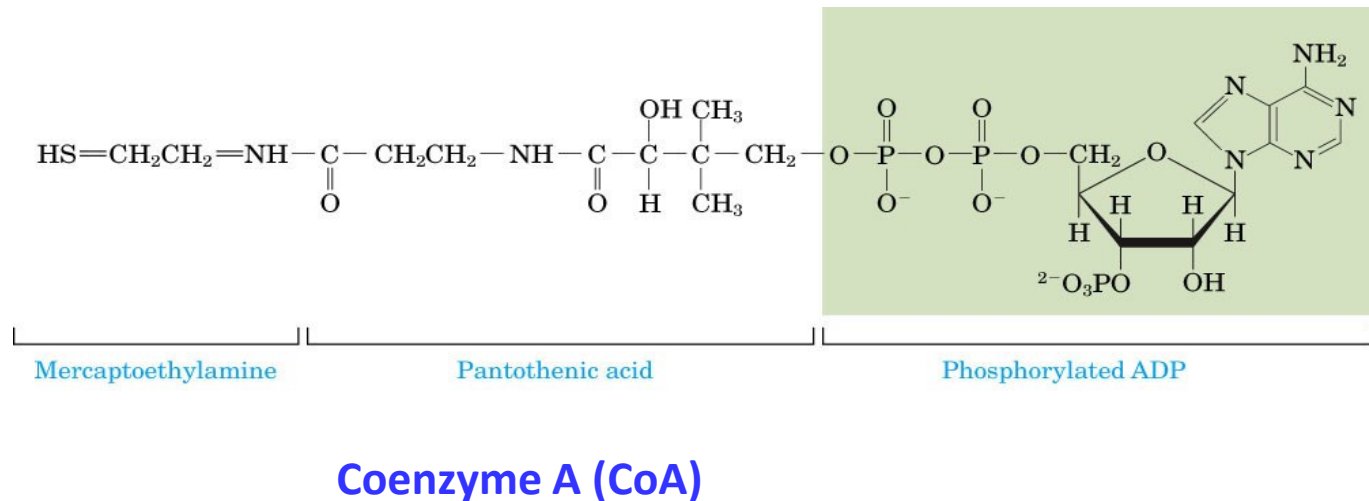
- Biologically active form/s: i. Flavin mononucleotide (FMN)
ii. Flavin adenine dinucleotide (FAD)
- Proteins with FAD/FMN → "flavoproteins"
- Functions:
 1. Coenzymes involved in oxidation-reduction reactions
Eg: Succinate dehydrogenase
xanthine oxidase
 2. Component of electron transport chain
- Deficiency: Rare

Niacin – B3

- Biologically active form/s:
 - Nicotinamide adenine dinucleotide (NAD^+)
 - Nicotinamide adenine dinucleotide phosphate (NADP^+)
- Functions:
 1. Serve as coenzymes in oxidation-reduction reactions- numerous dehydrogenases
Eg: Enzymes that need NAD^+
 2. Coenzyme assists with the metabolism of carbohydrates (PPP) and fatty acids
Eg: Enzymes that need NADP^+
- Deficiency: Pellagra
- Symptoms: Dermatitis, Diarrhea, Dementia

Pantothenic acid – B5

- Biologically active form/s: Coenzyme A
- Functions: required for the metabolism of CHO, fats and proteins
 1. Component of Coenzyme A – function in transfer of acyl groups

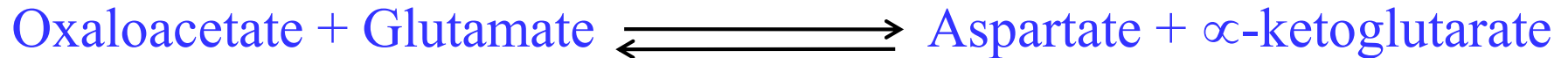


2. Component of fatty acid synthase (ACP domain)

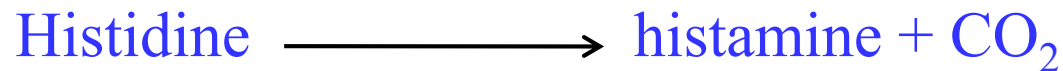
Pyridoxine – B6

- Biologically active form : pyridoxal phosphate (PLP)
- Functions: Coenzyme for reactions in amino acid metabolism

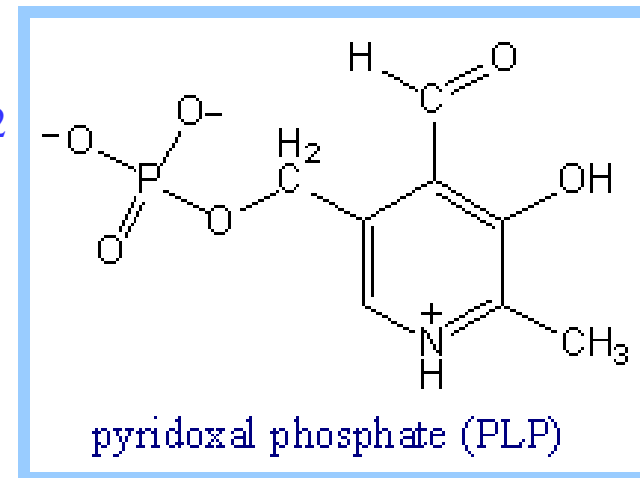
1. Transamination



2. Decarboxylation

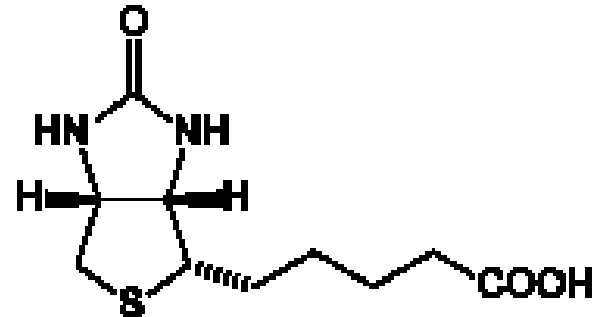


- Deficiency: Rare



Biotin – B7

- Biologically active form : Enzyme bound Biotin
- Functions:
 1. CH and FA metabolism



Eg: Coenzyme in carboxylation reactions – acts as carrier of activated CO₂

Pyruvate

Oxaloacetate

Pyruvate carboxylase
→

Acetyl CoA

Malonyl CoA

Acetyl CoA carboxylase
→

- Deficiency: Rare

Folic acid – B9

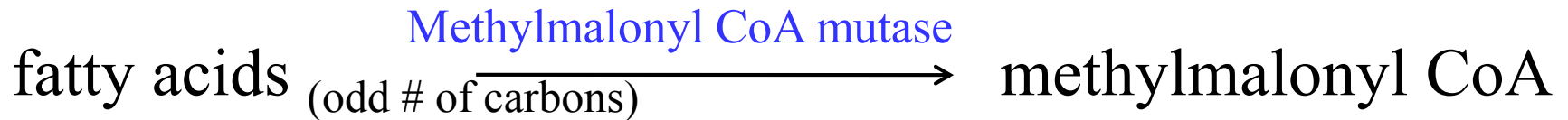
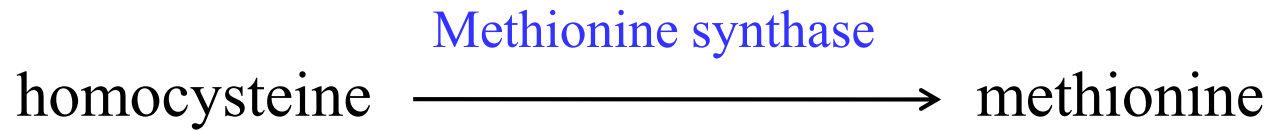
- Biologically active form: **Tetrahydrofolic acid (H₄F)**
- Plays a key role in one carbon unit (-CH₃, -CH₂OH, -CHO, ...) transfer during,
 - Biosynthesis of amino acids: serine, methionine, glycine, ...)



- Biosynthesis of purines & thymidine
- Deficiency: Megaloblastic anemia
Neural tube defects
- Symptoms : Anemia, Birth defects

Cobalamin – B12

- Active form: Methylcobalamin deoxyadenosyl cobalamin
- Required in 2 reactions



- Part of coenzymes for RBC formation
- Deficiency: **Pernicious anemia**

Ascorbic acid – C

- Active form: Ascorbic acid
- Functions
 1. In collagen synthesis - A coenzyme in hydroxylation of proline and lysine
 2. Serve as a reducing agent in a number of different reactions
 Cu^+ in monooxygenases, Fe^{2+} in dioxygenases
 3. Antioxidant activity
 4. Facilitate dietary iron absorption
- Deficiency: Scurvy, slow-healing wounds
- Symptoms :Scurvy: Sore spongy gums, loose teeth, fragile blood vessels, swollen joints