

Vitamins and their role in metabolism and transfer of 1C residues

1st week

Vitamin deficiency

- **decrease of intake**
- **defects of absorption** - diseases of intestinal mucosa
 - decreased bile secretion
- **effects of drugs** - antivitamins
 - suppression of intestinal bacterial flora
- **liver diseases** - decreased storage capacity
 - decreased activation
- **increased requirement and utilization** - pregnancy
 - lactation
 - growth
 - infections diseases
 - alcoholism

Water soluble vitamins

Ascorbate – scurvy, fragility of bones and capillaries

B-complex

Energy releasing

Thiamine (B₁) – Beri-beri, inflammation of nerves, degeneration of nerves, muscle pains, seizures, **THIAMINASES** (coffee, tea)

Riboflavin (B₂)

Niacin (B₃) – pellagra
three D - dermatitis, dementia, diarrhea

Biotin

Pantothenic acid

Hemopoetic

Folic acid (B₉) – megaloblastic anaemia
in pregnancy – developmental defects

Cobalamin (B₁₂) - megaloblastic anaemia
defects of CNS

AA metabolism

Pyridoxine (B₆) –
skin inflammation,
increased excitability,
seizures

Lipid soluble vitamins

Hypovitaminoses

- Retinol (A)** - night blindness, anaemia
- Retinal**
- Retinoic acid** - increased ceratinization
- defects in regeneration of skin and mucosae
→ infections
- Cholecalciferol (D)** - rickets
- Tocopherol (E)** - newborns: fragility of capillaries, hemolytic anaemia
- adults: erythrocytes and muscles damage
- Vitamin K** - bleeding

Lipid soluble vitamins

Hypervitaminoses

Vitamin A

- skin, liver
- intracranial pressure increase
- congenital malformations

Cholecalciferol (D)

- lack of appetite, diarrhea, vomiting
- soft tissues calcification
(vessels, kidneys)

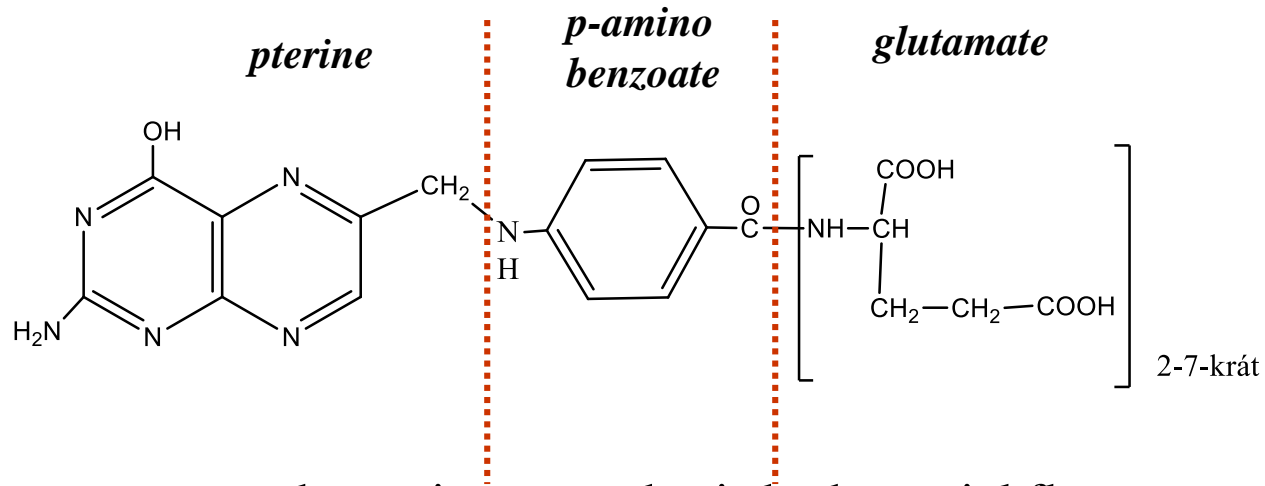
		Metabolism of		
vitamin	active form	Carbohydrates	Lipids	Amino acids
B₁	TDP	pyruvate dehydrogenase complex		branched-chain α -keto acid oxidation
		α -ketoglutarate dehydrogenase complex		
		transketolase (PPP)		
B₂	FAD	pyruvate dehydrogenase complex		branched-chain α -keto acid oxidation
		α -ketoglutarate dehydrogenase complex succinate dehydrogenase		
			acylCoA dehydrogenase	
	FMN			amino acid oxidases

		Metabolism of		
vitamin	active form	Carbohydrates	Lipids	Amino acids
B₃	NAD⁺	pyruvate dehydrogenase complex		branched-chain α -keto acid oxidation
		α -ketoglutarate dehydrogenase complex		
		glyceraldehyde-3P dehydrogenase	hydroxyacylCoA dehydrogenase	glutamate dehydrogenase
		lactate dehydrogenase		
		malate dehydrogenase isocitrate dehydrogenase		
	NADP⁺	glucose-6P-dehydrogenase (PPP)	malic enzyme	
		(PPP) 6-phosphogluconolactonate-dehydrogenase		
	NADPH		cytochrome P ₄₅₀ reductase ketoacyl-reductase enoyl-reductase HMG-CoA-reductase	

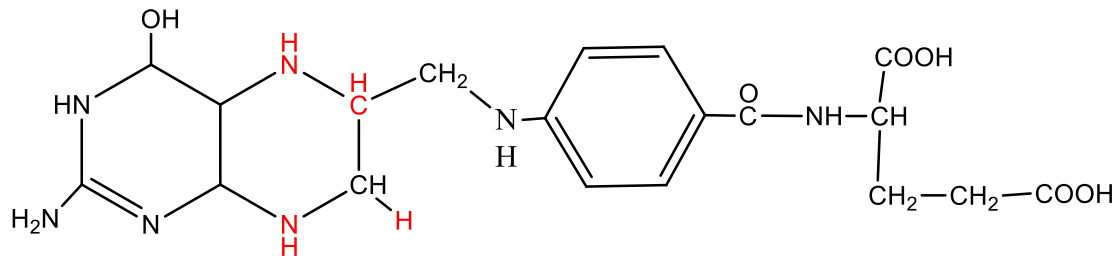
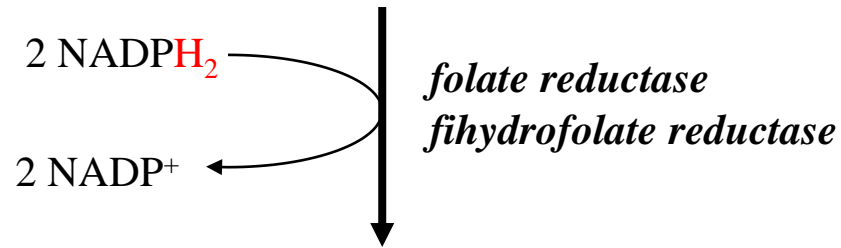
		Metabolism of		
vitamin	active form	Carbohydrates	Lipids	Amino acids
B₅	CoA	acetylCoA		
		succinylCoA		
			acylCoA	
H (B₇)	biotin	pyruvate carboxylase	acetylCoA carboxylase	
			propionylCoA carboxylase	
B₆	pyridoxal phosphate (PLP)	glycogen phosphorylase		transaminases
				serine dehydratase
				cystein desulfhydrase
				decarboxylases of AA

Folic acid

coenzyme form: **tetrahydrofolate**

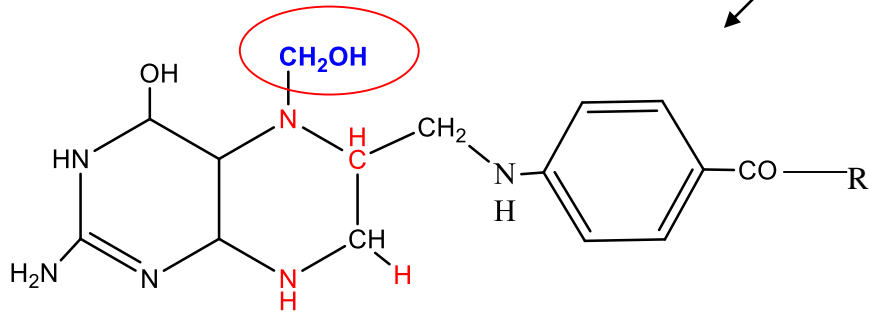
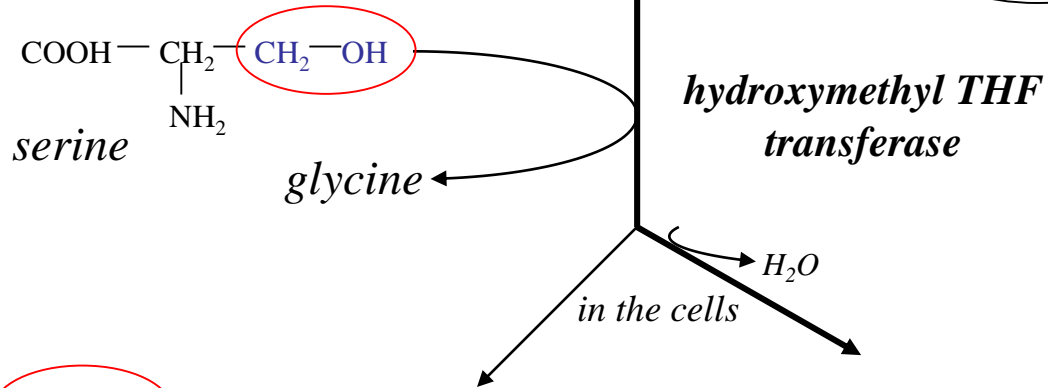
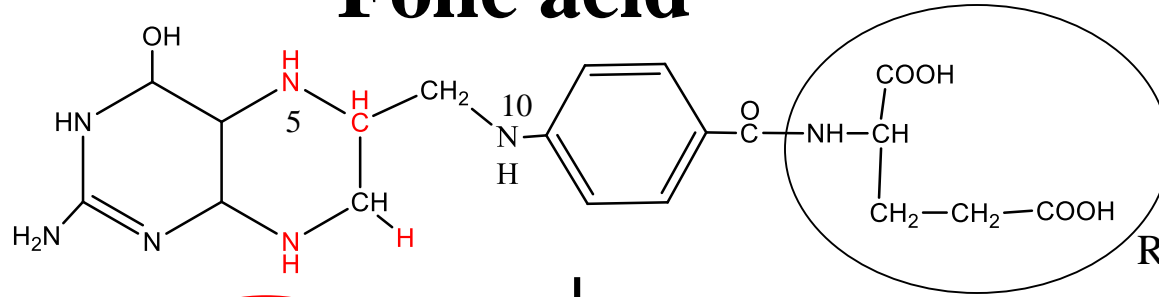


absorption + synthesis by bacterial flora

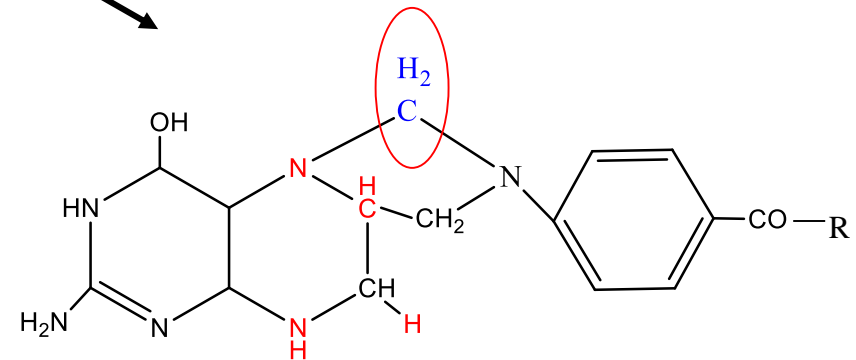


tetrahydrofolate

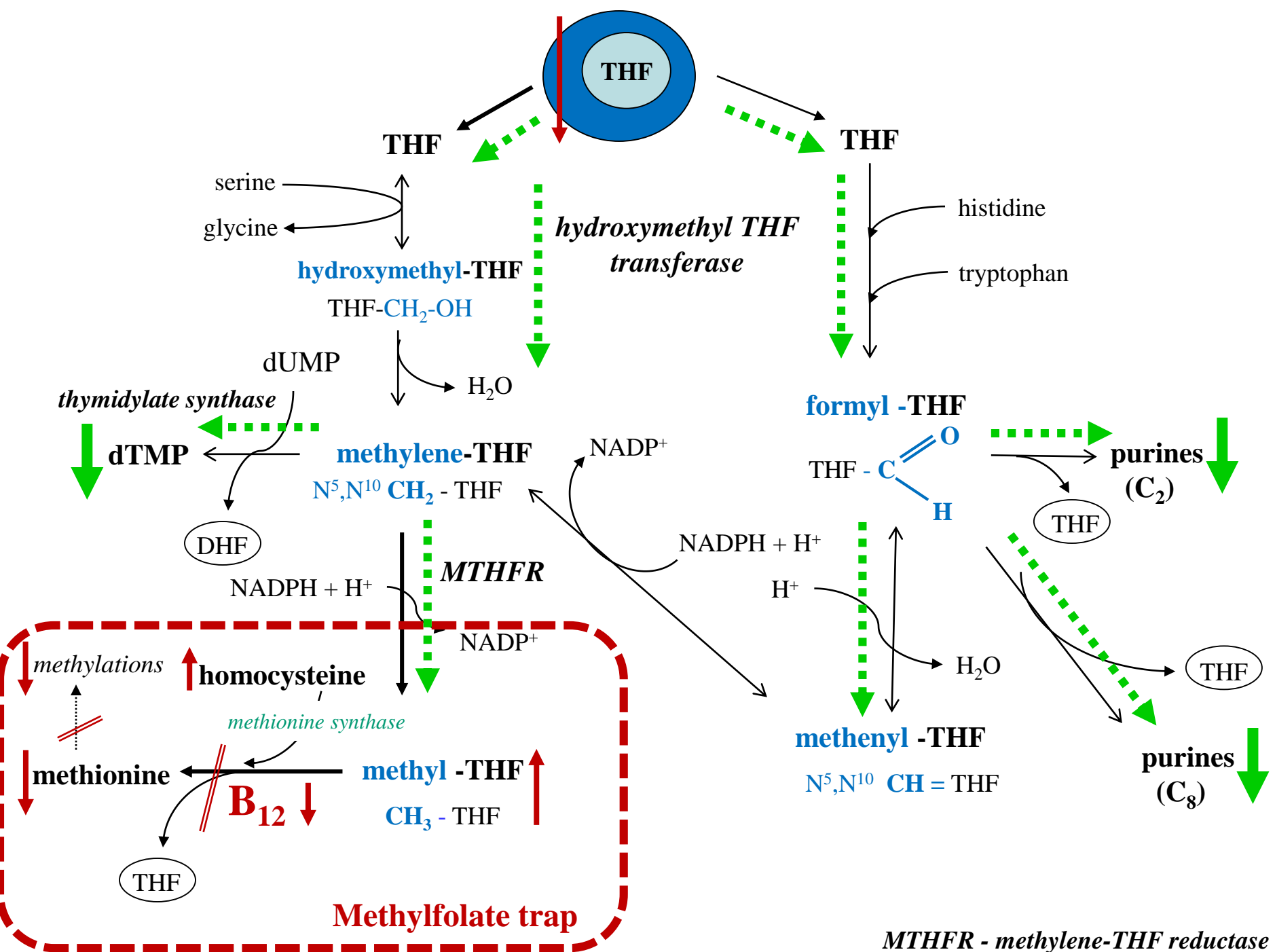
Folic acid



N^5 -hydroxymethyl-THF
or N^{10} -hydroxymethyl-THF



N^5,N^{10} -methylene-THF

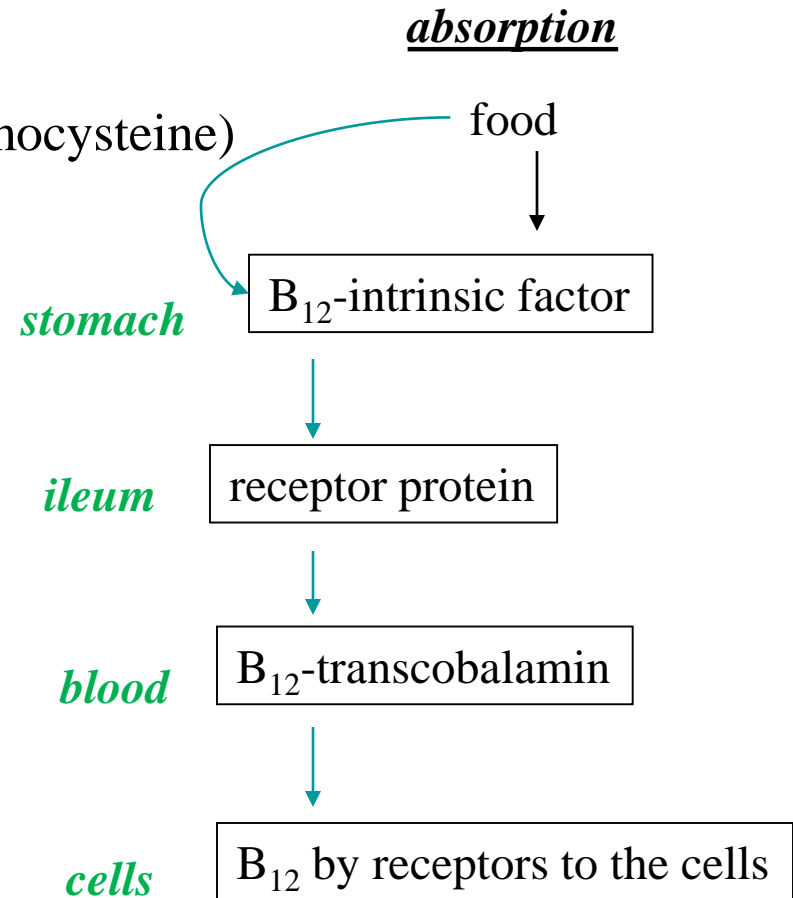
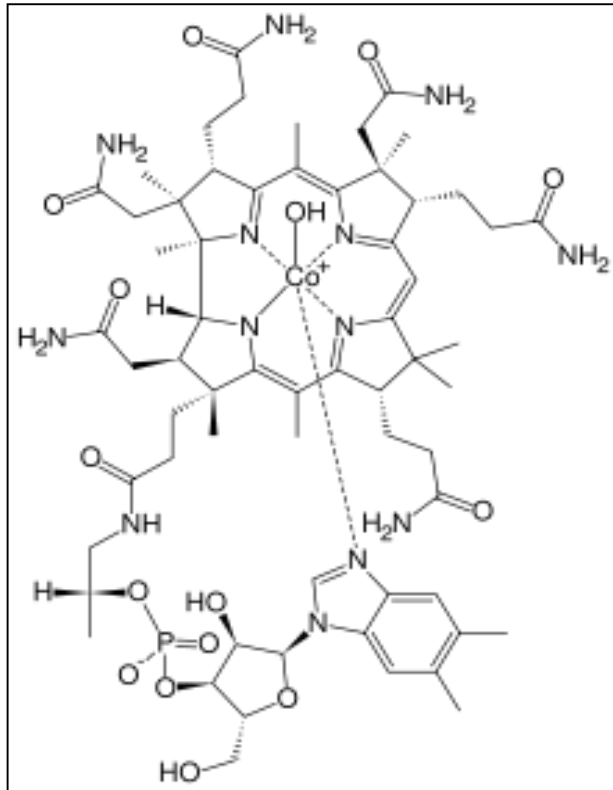


Vitamin B₁₂

coenzyme form: **cobalamin**

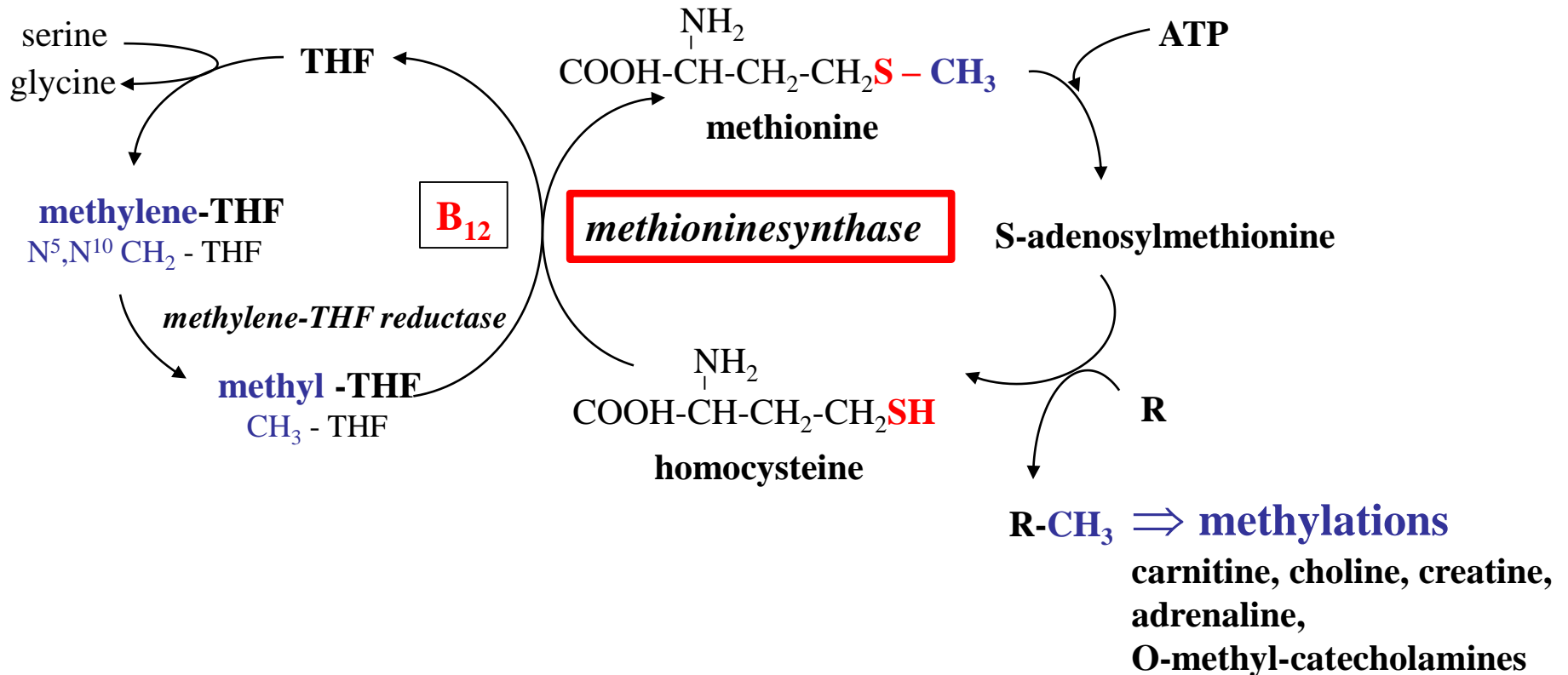
coenzyme: - methylmalonyl-CoA mutase

- methioninesynthase (from homocysteine)

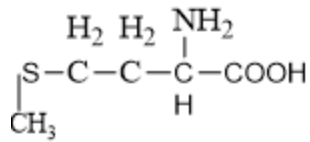


Deficiency: mainly caused by deficiency of intrinsic factor ⇒ pernicious anaemia

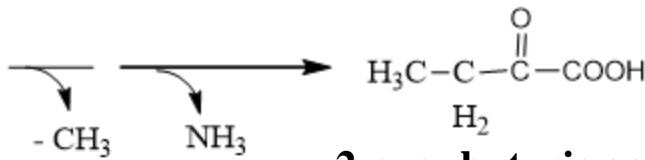
Vitamin B₁₂



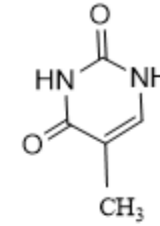
Vitamin B₁₂



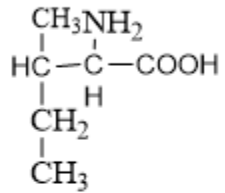
methionine



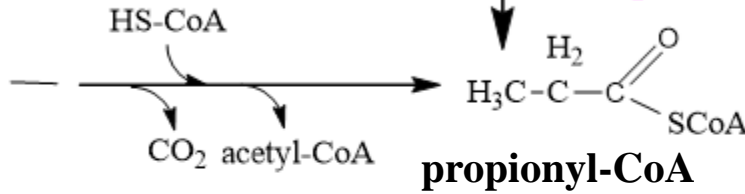
2-oxo-butyric acid



Thymine



isoleucine

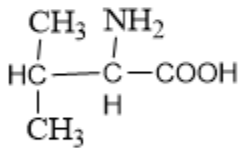


propionyl-CoA

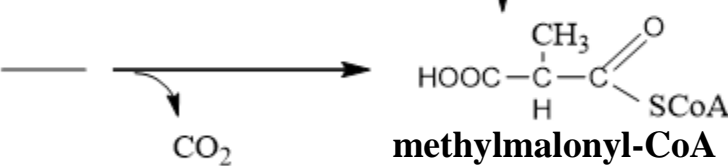
Cholesterol

CO_2
biotin
propionyl-CoA carboxylase

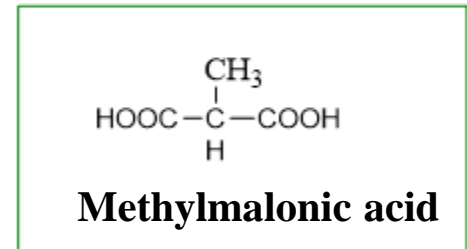
**carboxylic acids with
an odd number of C**



valine

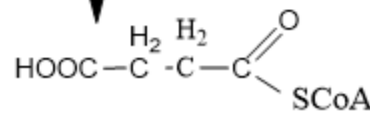


methylmalonyl-CoA



Methylmalonic acid

\downarrow **B₁₂** **methylmalonyl-CoA mutase**



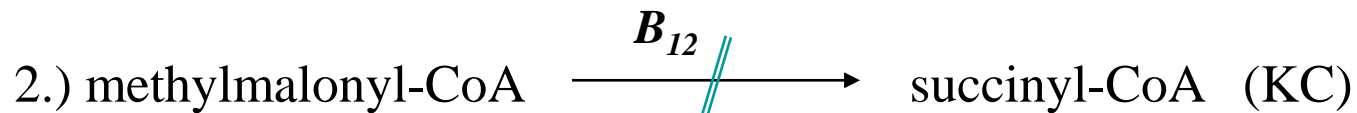
succinyl-CoA

\downarrow
blood

\downarrow
urine

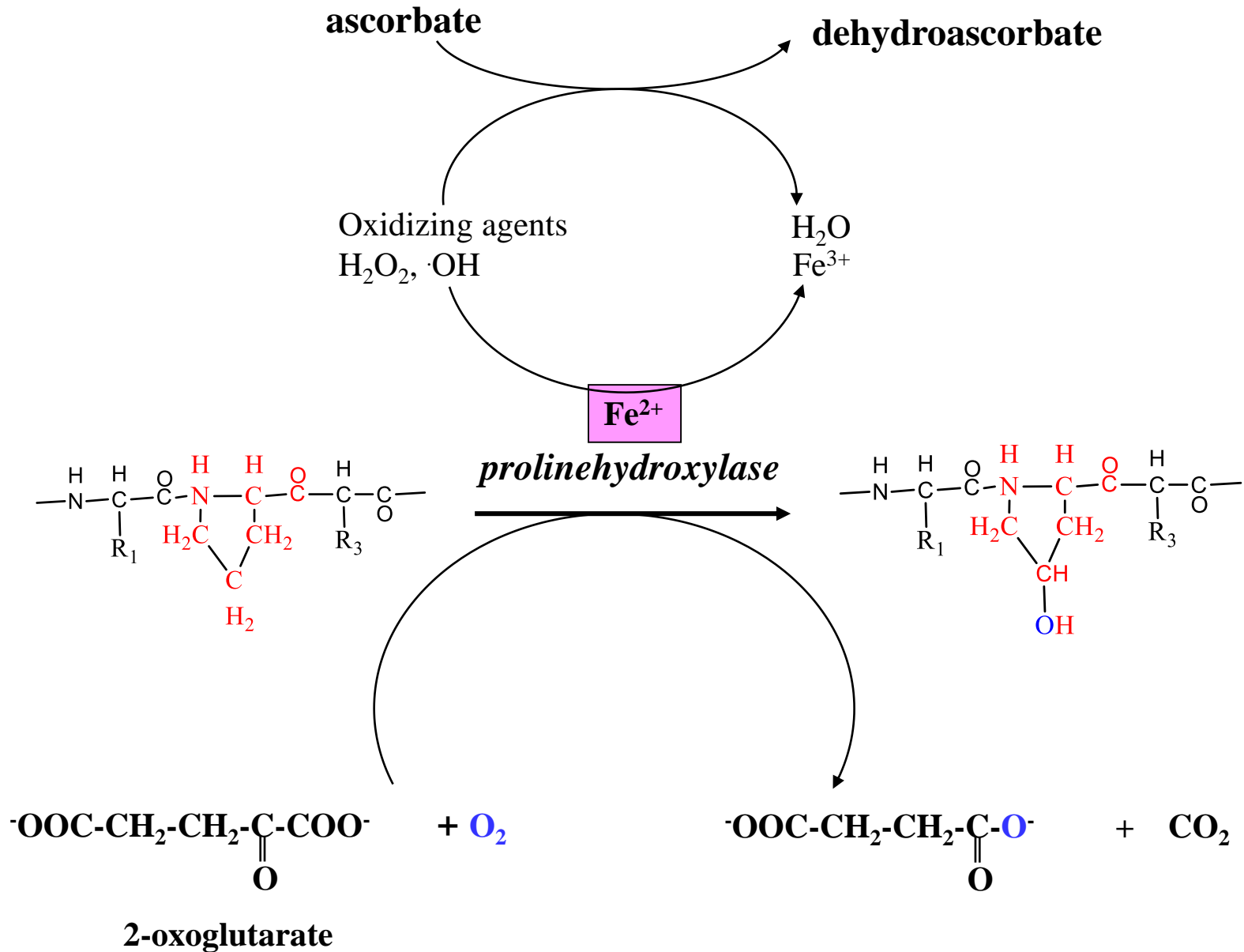
Hypovitaminoses: folic acid, B₁₂

- 1.) methylfolate-Trap: decreased synthesis of purines „de novo“
 - decreased methylation of dUMP on dTMP
 - increased homocysteine and decreased methionine
- **megaloblastic anemia (large Ery, full of hemoglobin, but a small number)**
 - ⇒ **weakness, fatigue**
- **bioch. finding: increased serum and urine homocysteine, increased urine methylmalonate**
- **Leu and Thromb. decrease**
- **inflammations, mucous membranes ulcerations (cell division decrease)**
- **Methionine decrease ⇒ choline decrease ⇒ reduced acetylcholine production**
- **hyperhomocysteinemia**



- **CNS disorders: much methylmalonyl-CoA ⇒ competition with malonyl-CoA at FA synthesis ⇒ branched FA (demyelination?)**
- **cardiovascular system: blood homocysteine increase – storage in walls vessels ⇒ arteriosclerosis (especially with elevated cholesterol)**

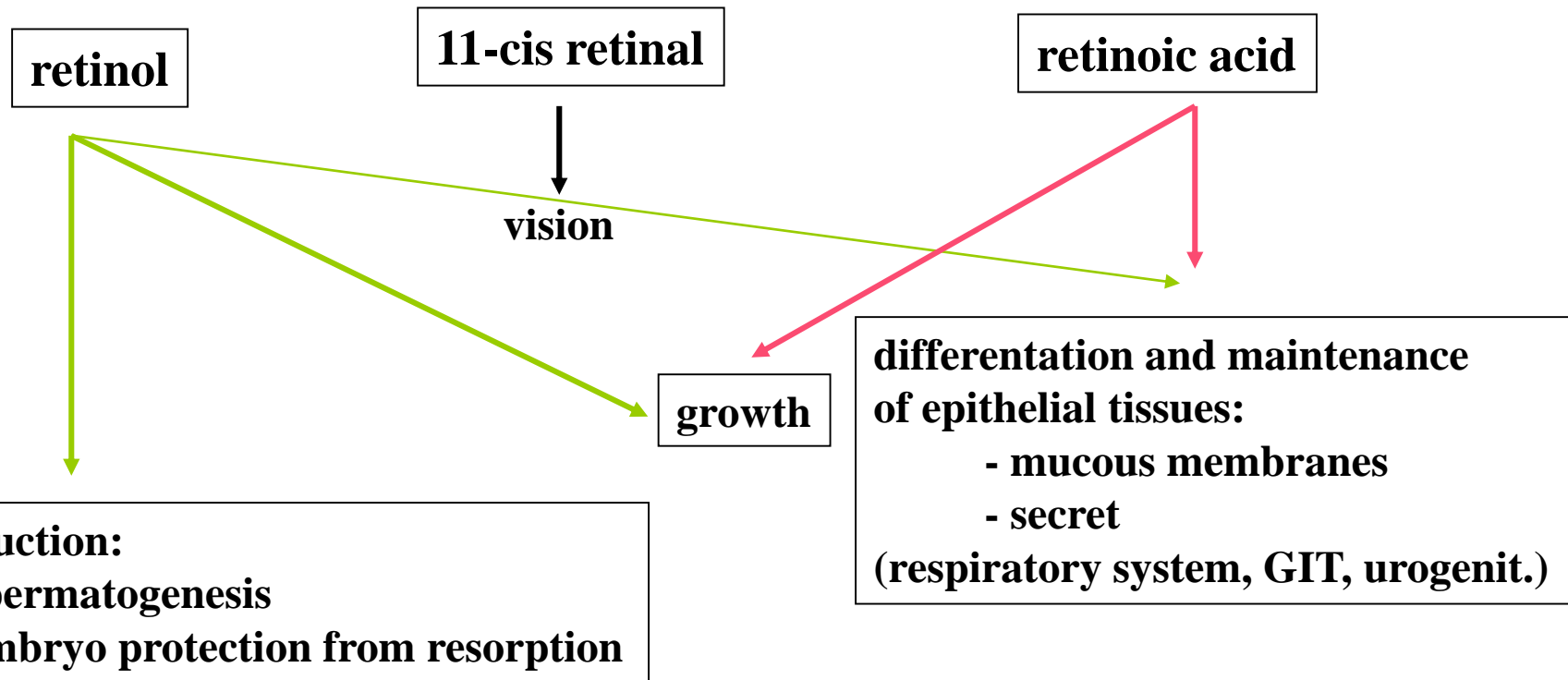
Vitamin C



Vitamin A

resources: - retinol esters – animal (liver, kidney)
- β -carotene – plants (less than 20%) \longrightarrow retinal

function: - cancer protection
- β -carotene (antioxidative effects)
- vitamin A (growth regulation)



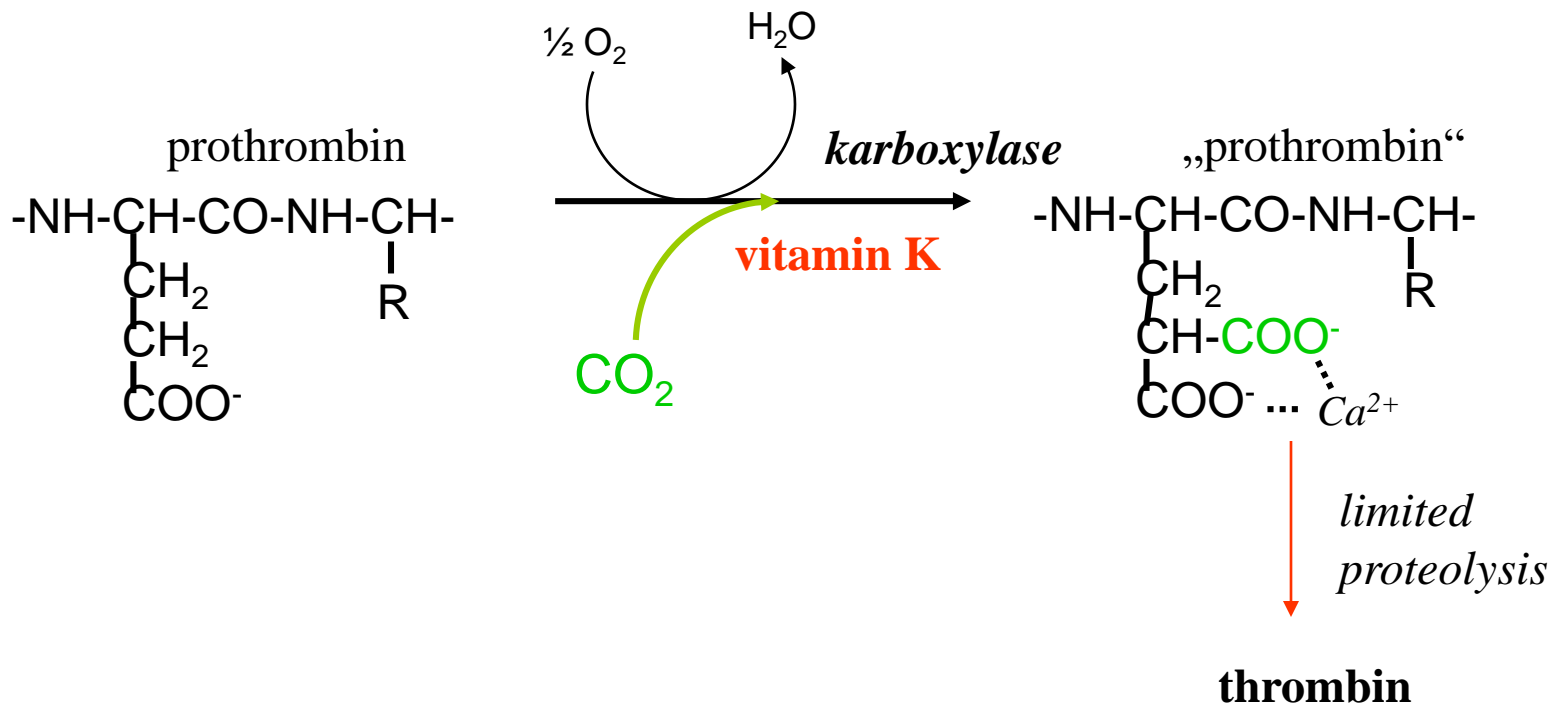
Vitamin K

function: - **blood clotting regulation**

- liver prothrombin production and secretion

- participates in the activation of prothrombin to thrombin

(vitamin K- dependent carboxylation of glutamic acid in the liver ER)



By the same mechanism (glutamic acid γ -carboxylation) it activates osteocalcin production together with vitamin D. The osteocalcin is necessary for Ca^{2+} binding in bones.

Vitamins and oral health

Vitamin A - ensures the integrity of mucous membranes, salivary glands, teeth and bones

- deficiency → xerostomia (dry mouth), increased infectious diseases, disturbed tooth growth
- excess → exfoliative cheilitis (inflammation of the lips associated with peeling skin), impaired healing and gingivitis

Vitamin D - important in the process of synthesis and mineralization of dentin and bone tissue

- protects against chronic gingivitis

Vitamin K - it participates in the process of calcium storage and mineralization of bones and teeth together with vitamin D

Vitamin C - important in the process of collagen and dentin formation, keeps it strong and healthy connective tissues of the gums

- deficiency → scurvy: gingivitis and bleeding gums, tooth loss

Vitamins of B-complex - angular cheilitis (corners inflammation), glossitis, aphthae, gingivitis and periodontitis