

C3181

Biochemie I

04-Koenzymy a vitaminy

FRVŠ **1647/2012**

Obsah

- Koenzymy a vitaminy. Koenzymy oxidoreduktáz (nikotinamid a NAD, flaviny, chinony, hemy, železosírné proteiny, lipoát,) transferáz (ATP, UDP, CDP, biotin, thiamin, koenzym A, THF, pyridoxalfosfát, vit B₁₂).
- Vitamin C, lipofilní vitaminy (A, D, K).

Typy kofaktorů

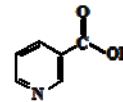
- Rozdělení podle reakcí
 - Někdy spadají do více skupin (THF)
- Jako prekurzory slouží vitaminy
 - Většinou, někdy jiné esenciální složky
 - Možnost syntézy z neesenciálních prekurzorů – hem
- Relativita pojmu
 - Kofaktor x druhý substrát (ATP)
 - Vazba kovů
 - Produkty přeměny aminoacylů – PQQ

Kofaktory oxidoreduktas

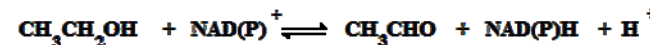
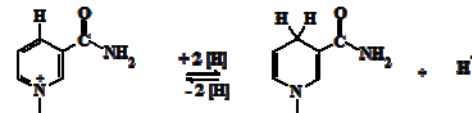
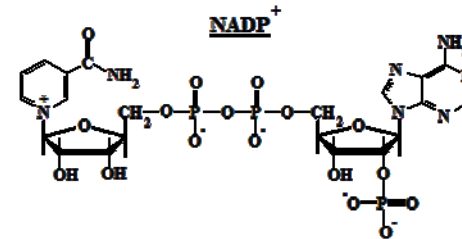
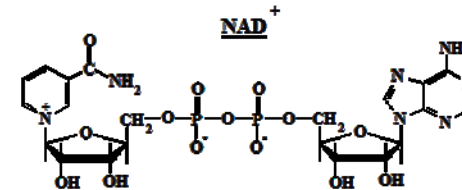
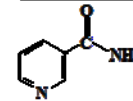
- Nikotinamidové
- Koenzymy
- Prekurzor niacin
- Disociabilní
- $2e^-$ redukce
- Přenos H^-
- NAD^+ - respirace
- $NADP^+$ - redukce
- Změna spektra
- $A_{340} = f(c)$

NIKOTINAMIDOVÉ KOENZYMY

k. nikotinová

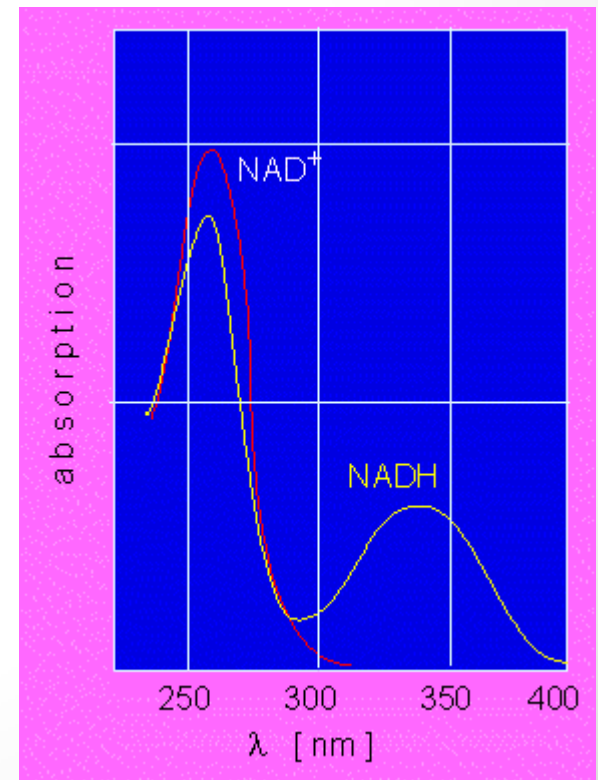
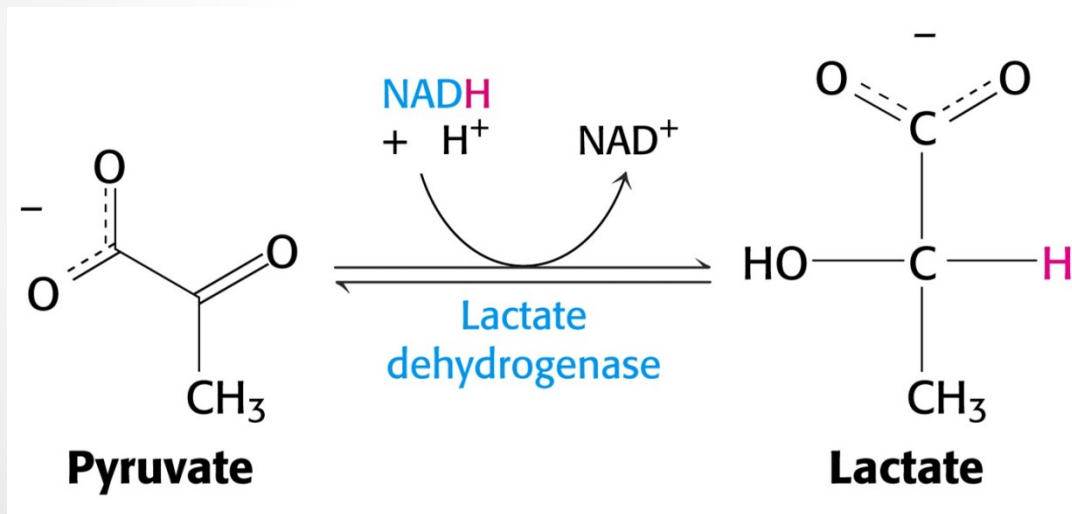


nikotinamid



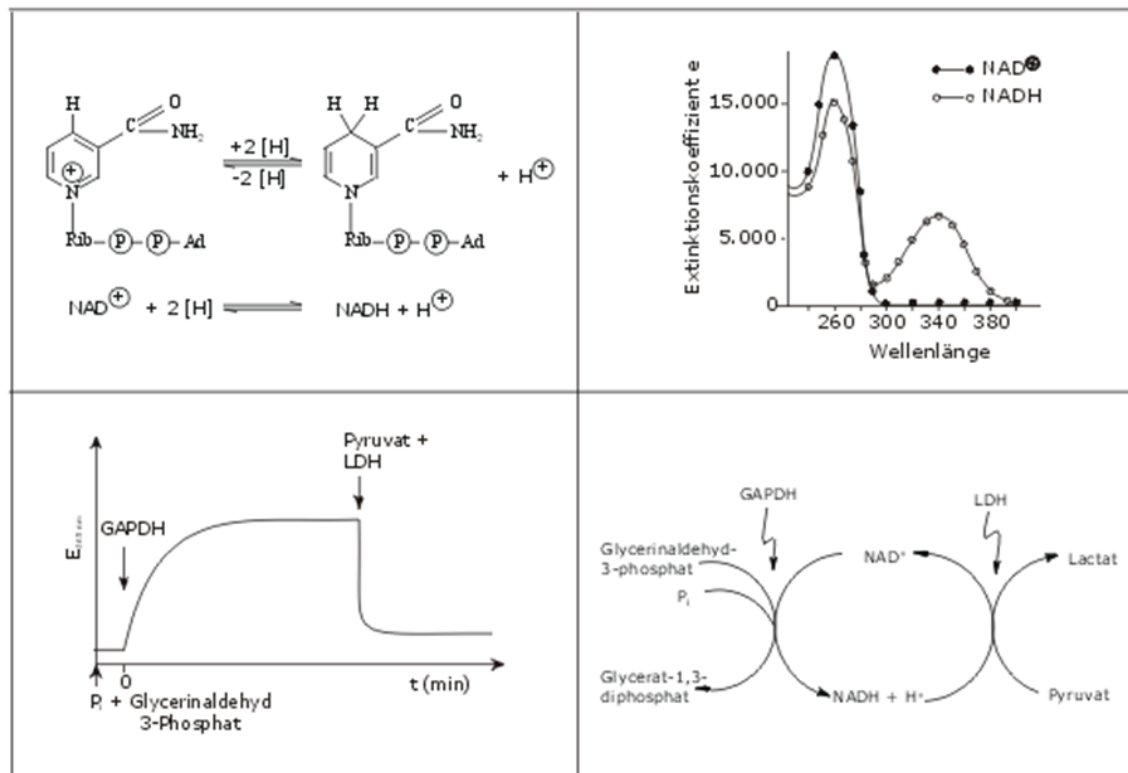
Kofaktory oxidoreduktas

- Warburgův optický test



Warburgův optický test

Prinzip des Optischen Tests nach WARBURG



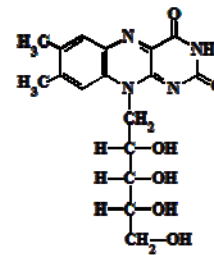
Folie 7.11

Kofaktory oxidoreduktas

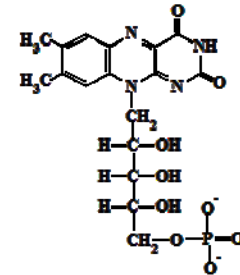
- Flavinové kofaktory
- Prekurzor riboflavin
- Prostetické skupiny
- 2 $1e^-$ kroky
- Semichinony, radikály (zdroj ROS)
- Změna A nevýrazná
- Žlutá (ox) x leukoforma (red)

FLAVINOVÉ KOENZYMY

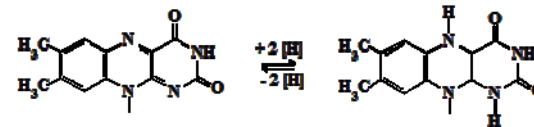
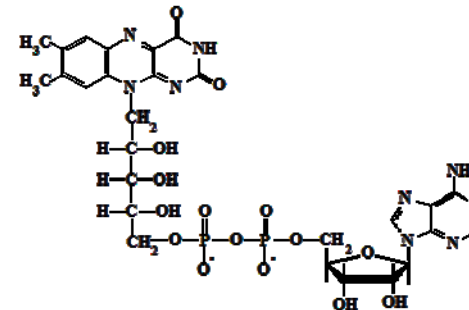
riboflavin



FMN

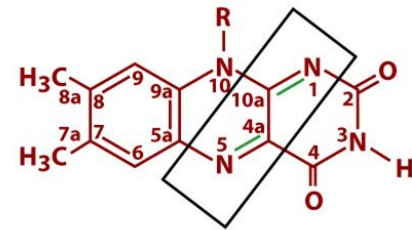


FAD

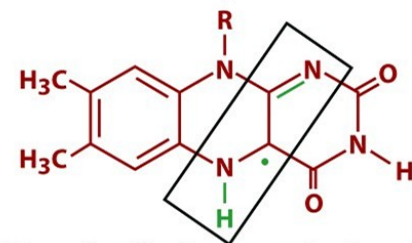


Kofaktory oxidoreduktas

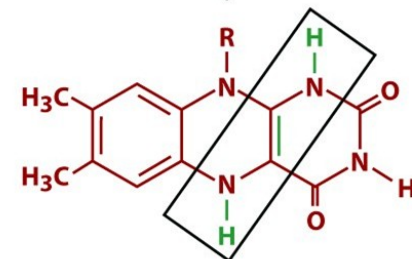
- Redukce FAD



**Flavin adenine dinucleotide (FAD)
(oxidized or quinone form)**



FADH• (radical or semiquinone form)

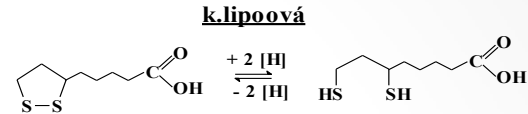


FADH₂ (reduced or hydroquinone form)

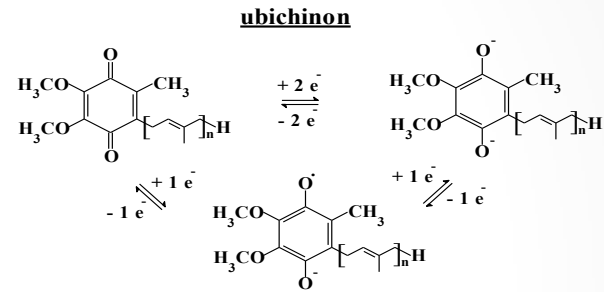
Figure 13-12 Fundamentals of Biochemistry, 2/e
© 2006 John Wiley & Sons

Kofaktory oxidoreduktas

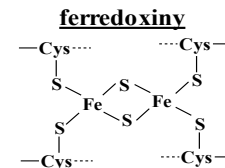
- Kys. lipoová (thioktová)
 - Vitamin
 - Vázán amidicky na apoprotein
 - Odtud lipoamid



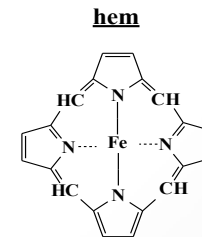
- Ubichinon, CoQ
 - Volná interakce
 - UQ-5n, CoQ_n, n = 6 – 10
 - Semichinony, radikály, ROS



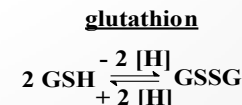
- Ferredoxinové typy
 - Nehemově vázané Fe, FeS proteiny
 - Klastry Fe-S různé struktury



- Hemově vázané Fe
 - Různé substituenty, též lipofilní
 - Různý způsob vazeb

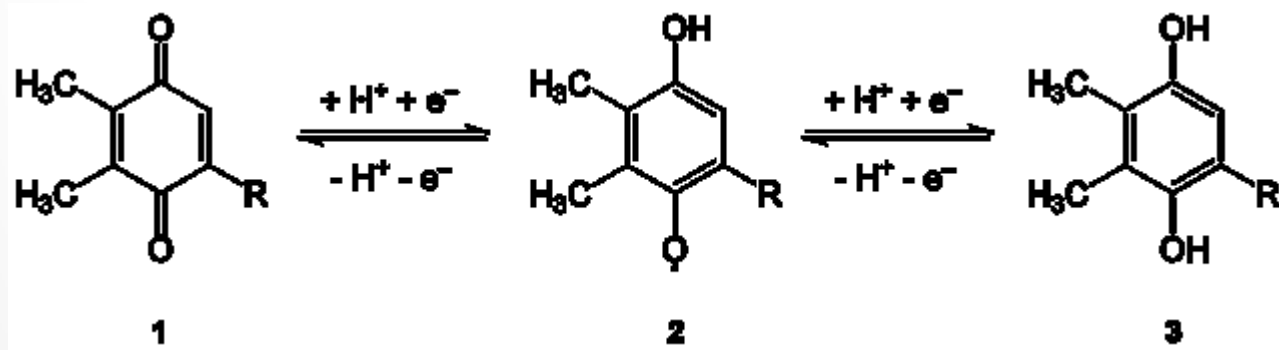
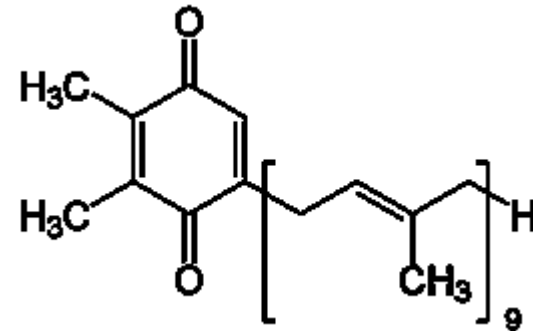


- GSH
 - Detoxikace, GSH peroxidasa x reduktasa
 - Též přenos skupin, xenobiotika



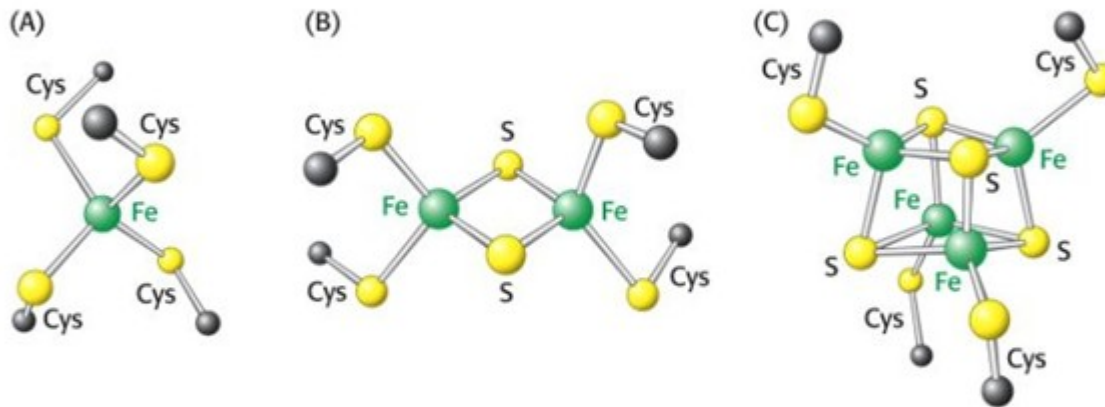
Kofaktory oxidoreduktas

- Plastochinon
 - Obdoba UQ u fotosyntézy
 - Redukce 2 x 1e⁻



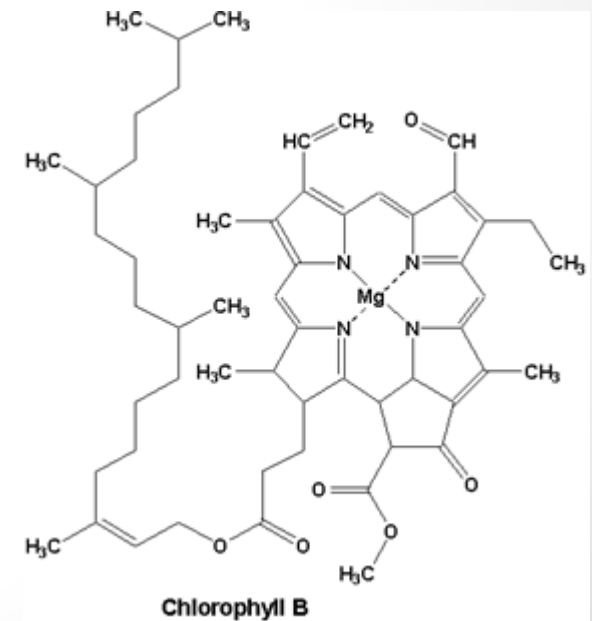
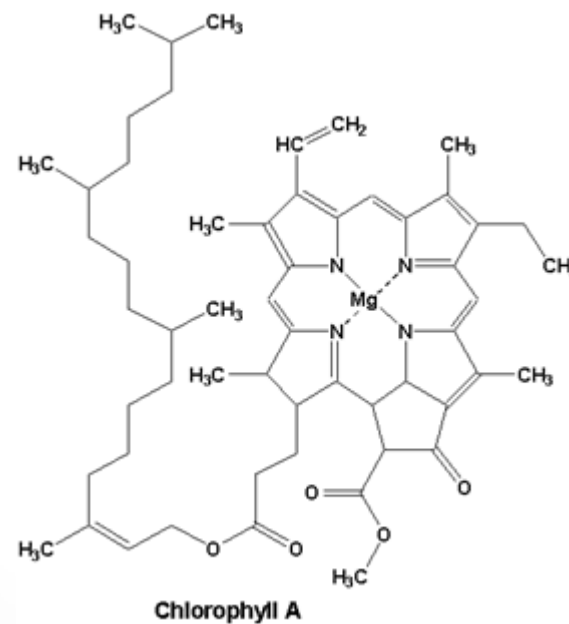
Kofaktory oxidoreduktas

- Fe-S klastry, příklady prostetických skupin bílkovin feredoxinového typu



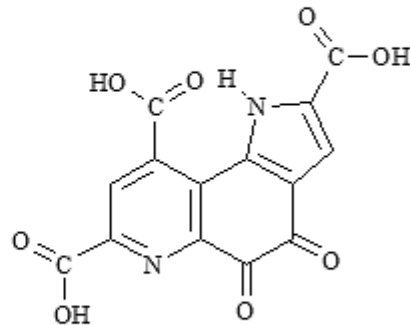
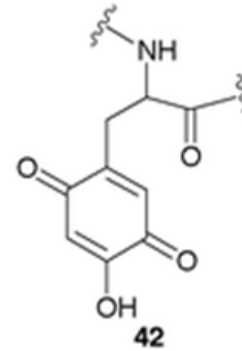
Kofaktory oxidoreduktas

- Chlorofyly
 - Porfyrinová struktura, lipofilní substituent
 - Mg^{2+}
 - Fotosyntéza – transport e^-

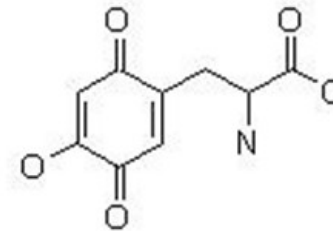


Kofaktory oxidoreduktas

- Přeměněné AK
 - Prostetické skupiny
 - Bílkovinný původ



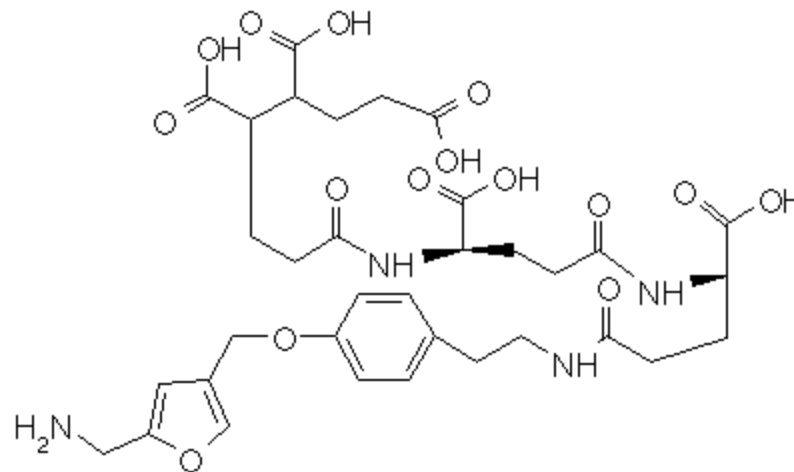
Pyrolochinolichinon
PQQ



TOPAchinon
TrihydrOxyPhenylAlanin

Kofaktory oxidoreduktas

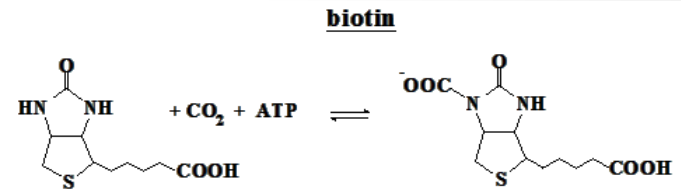
- Kofaktory metanogeneze



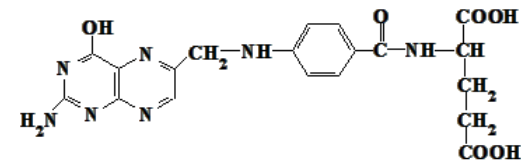
Metanofuran

Koenzymy transferas

- Biotin
 - Vitamin B
 - Vázán na Lys enzymu
 - Aktivní karboxyl
- THF – tetrahydrofolát
 - Z folátu
 - Disociabilní
 - Aktivní 1C metabolity
 - Syntézy nukleotidů - bazí
- TPP – tiamindifosfát
 - Aktivní aldehydy (2C)
 - Prostetická skupina

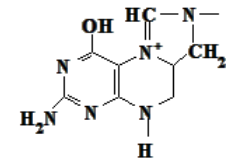
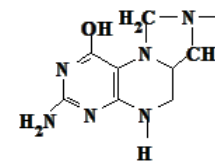


Kys. listová

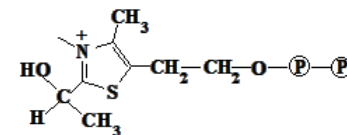
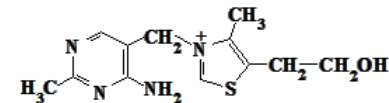


methylenetetrahydrolistová k.

methenyltetrahydrolistová k.



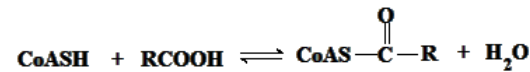
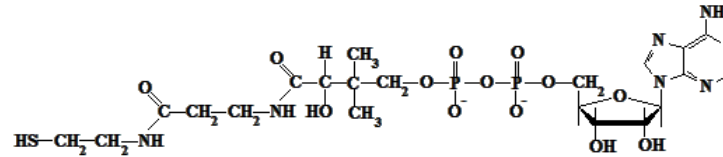
thiamin



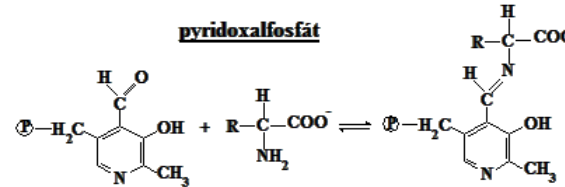
Koenzymy transferas

- Koenzym A
 - Z pantotenátu
 - Aktivní acyly
 - Spřaženo ATP = AMP + PP
- PALPO
 - Z pyridoxinu
 - Metabolismus aminů, AK
 - Tvorba Schiffovy báze
 - Úloha apoenzymu – typ reakce
- CDP – netřeba vitamin
- UDP - dtto
 - Aktivní monosacharidy
 - UTP + Glc-1-P = UDP-Glc + PP

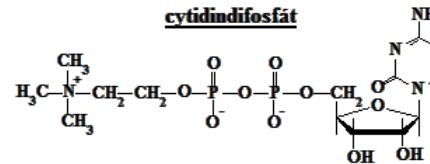
koenzym A - CoA - CoASH



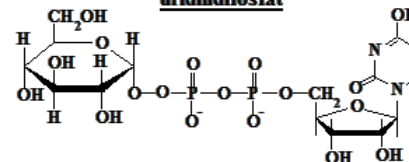
pyridoxalfosfát



cytidindifosfát

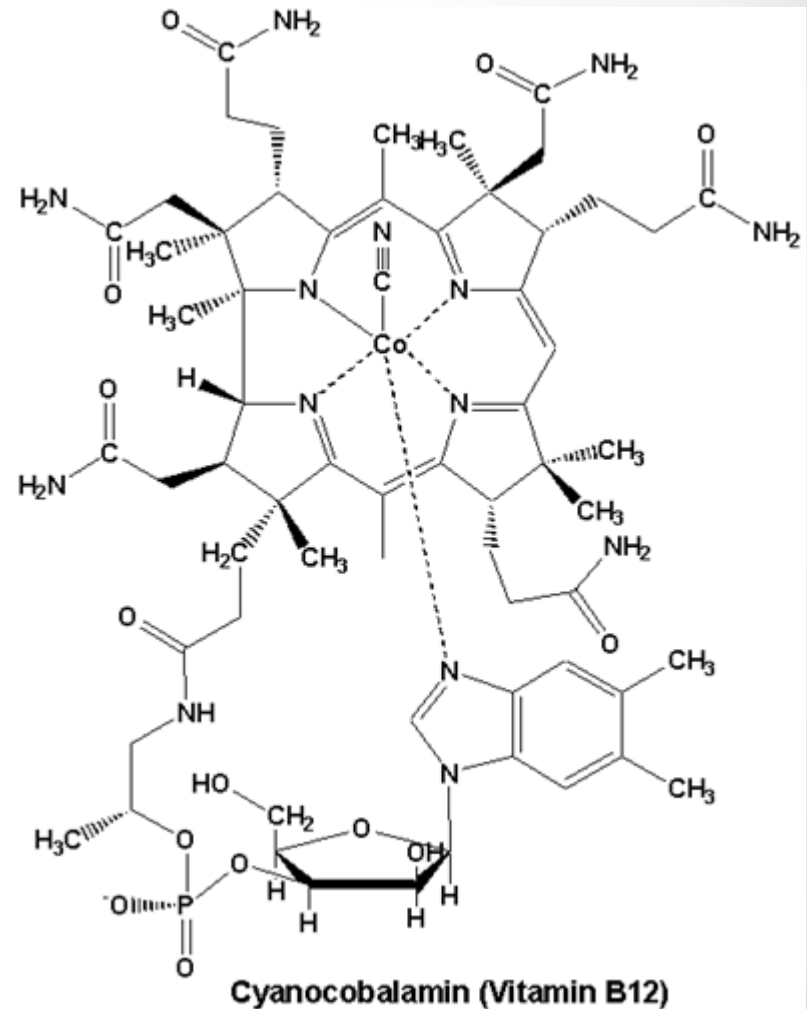


uridindifosfát



Koenzymy isomeras

- Vitamin B₁₂
 - Kobalamin
 - Korinoid + nukleotid
 - Ligandy
 - CN neúčinnější
 - Transkarboxylace
 - Krvetvorba
 - Perniciósní anemie
 - Aplikace
 - Perorální nespolehlivá
 - Vnitřní faktor pro vstřebávání
 - Biotechnologická produkce
 - Výkaly přežvýkavců
 - Aktivovaný kal



Vitaminy

- Vitaminy jako prekurzory kofaktorů
 - Většinou, některé nepotřebují
 - Některé jsou spíše metabolity (askorbát)
- Fyziologická role – zde druhořadé
- Výskyt – vlastnosti (polarita)
 - Rozpustné ve vodě – polární
 - Rozpustné v tucích – nepolární
 - Hledisko dietetické
- Následující přehled
 - Korelace struktur s kofaktory

Podrobnější přehled cs.wikipedia.org/wiki/Vitamín

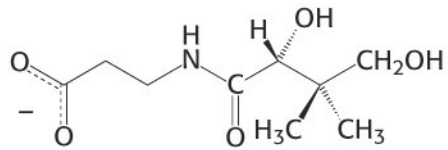
TABLE 8.9 Water-Soluble Vitamins

Vitamin	Coenzyme	Typical reaction type	Consequences of deficiency
Thiamine (B ₁)	Thiamine pyrophosphate	Aldehyde transfer	Beriberi (weight loss, heart problems, neurological dysfunction)
Riboflavin (B ₂)	Flavin adenine dinucleotide (FAD)	Oxidation–reduction	Cheliosis and angular stomatitis (lesions of the mouth), dermatitis
Pyridoxine (B ₆)	Pyridoxal phosphate	Group transfer to or from amino acids	Depression, confusion, convulsions
Nicotinic acid (niacin)	Nicotinamide adenine dinucleotide (NAD ⁺)	Oxidation–reduction	Pellagra (dermatitis, depression, diarrhea)
Pantothenic acid	Coenzyme A	Acyl–group transfer	Hypertension
Biotin	Biotin–lysine complexes (biocytin)	ATP-dependent carboxylation and carboxyl-group transfer	Rash about the eyebrows, muscle pain, fatigue (rare)
Folic acid	Tetrahydrofolate	Transfer of one-carbon components; thymine synthesis	Anemia, neural-tube defects in development
B ₁₂	5'-Deoxyadenosyl cobalamin	Transfer of methyl groups; intramolecular rearrangements	Anemia, pernicious anemia, methylmalonic acidosis
C (ascorbic acid)		Antioxidant	Scurvy (swollen and bleeding gums, subdermal hemorrhages)

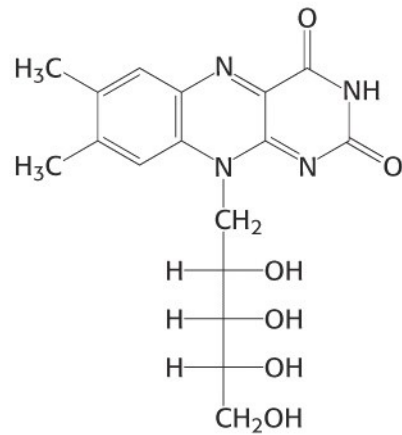
TABLE 8.10 Fat-soluble vitamins

Vitamin	Function	Deficiency
A	Antioxidant	Inhibition of sperm production; lesions in muscles and nerves (rare)
D	Regulation of calcium and phosphate metabolism	Rickets (children): skeletal deformities, impaired growth Osteomalacia (adults): soft, bending bones
E	Roles in vision, growth, reproduction	Night blindness, cornea damage, damage to respiratory and gastrointestinal tract
K	Blood coagulation	Subdermal hemorrhaging

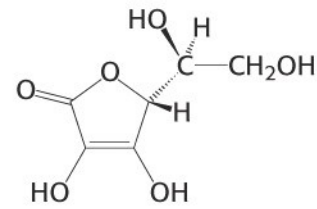
Chyba – A a E!?



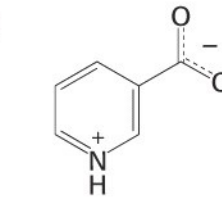
Vitamin B₅
(Pantothenate)



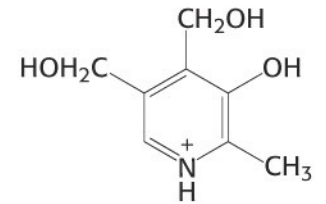
Vitamin B₂
(Riboflavin)



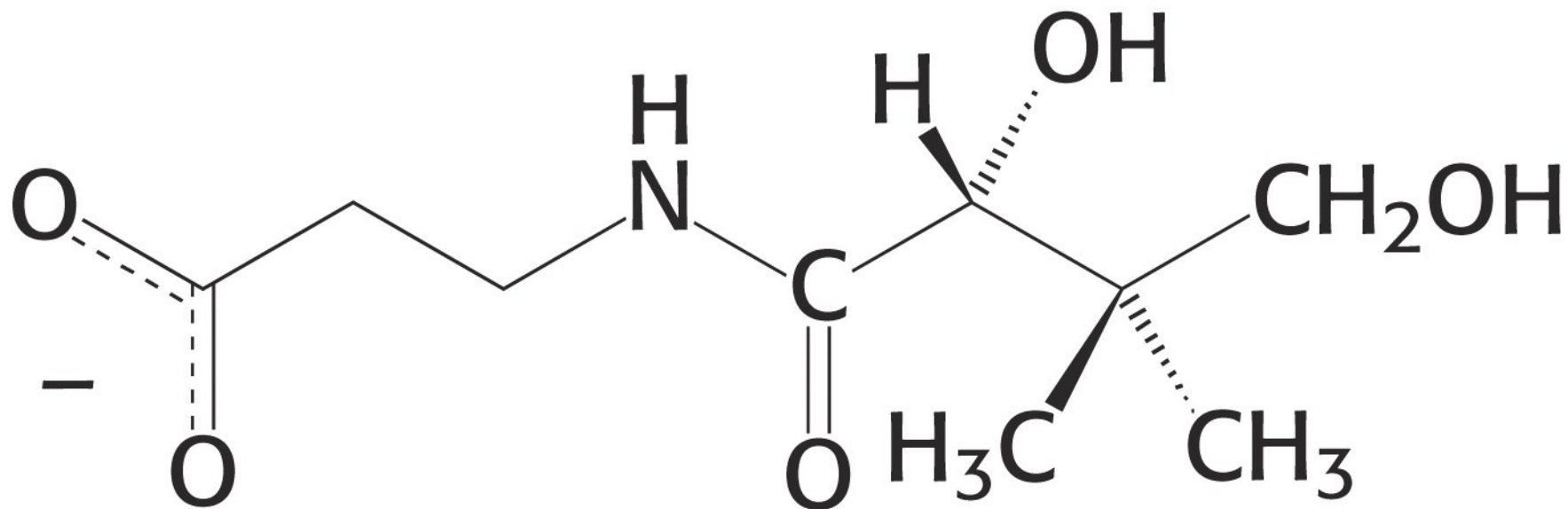
Vitamin C
(Ascorbic acid)



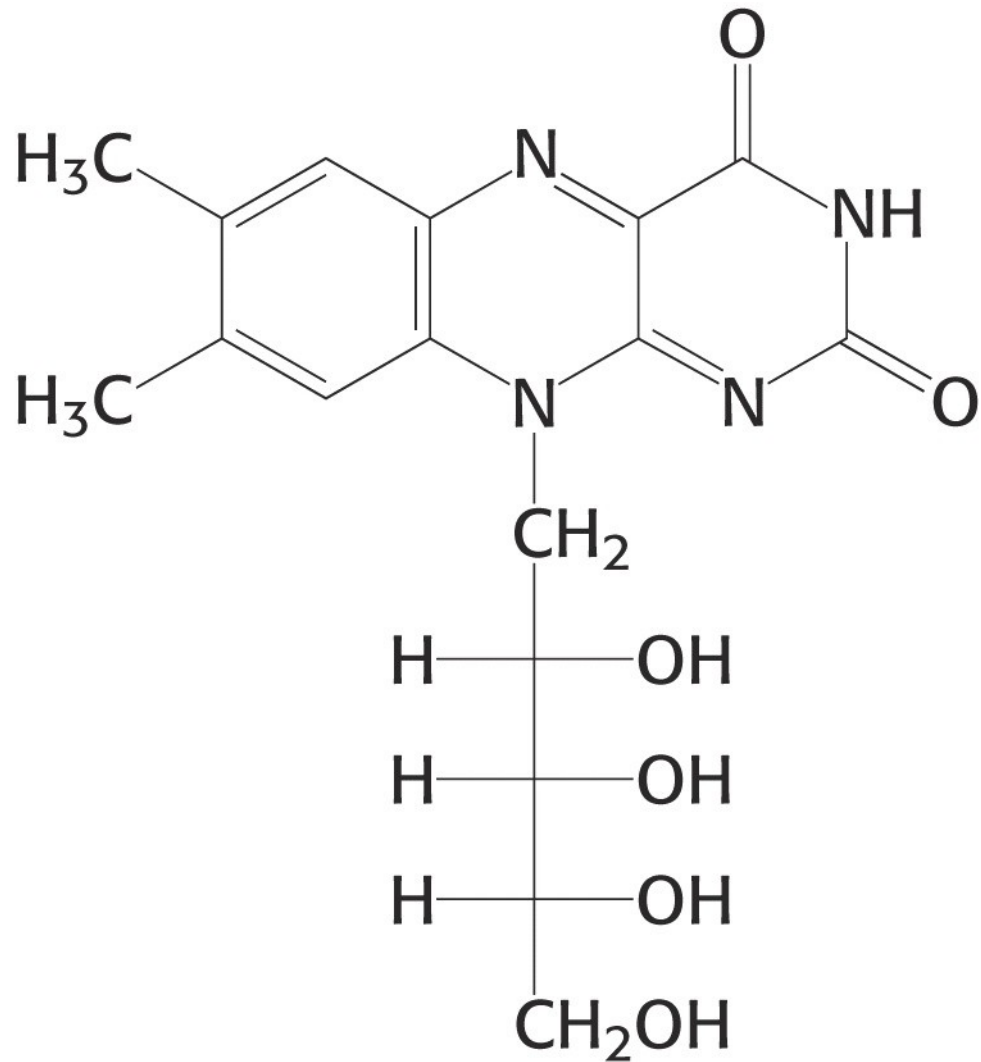
Vitamin B₃
(Niacin)



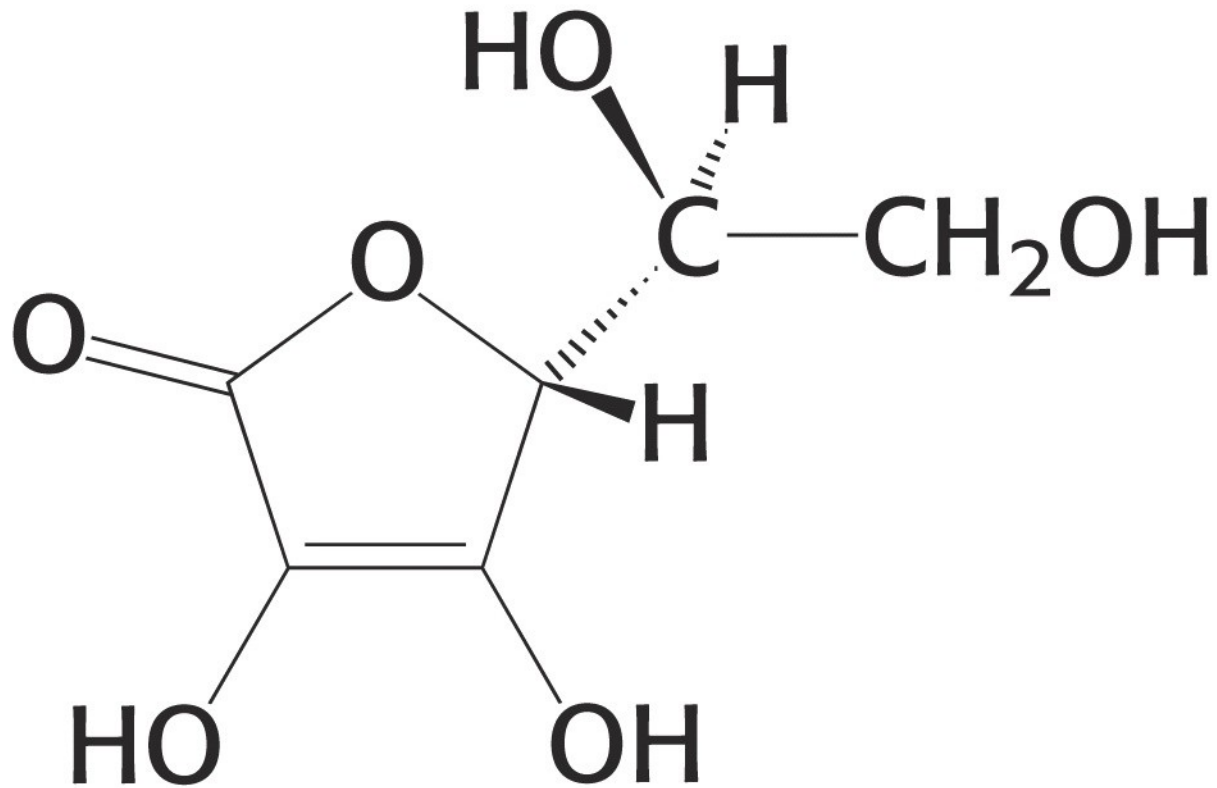
Vitamin B₆
(Pyridoxine)



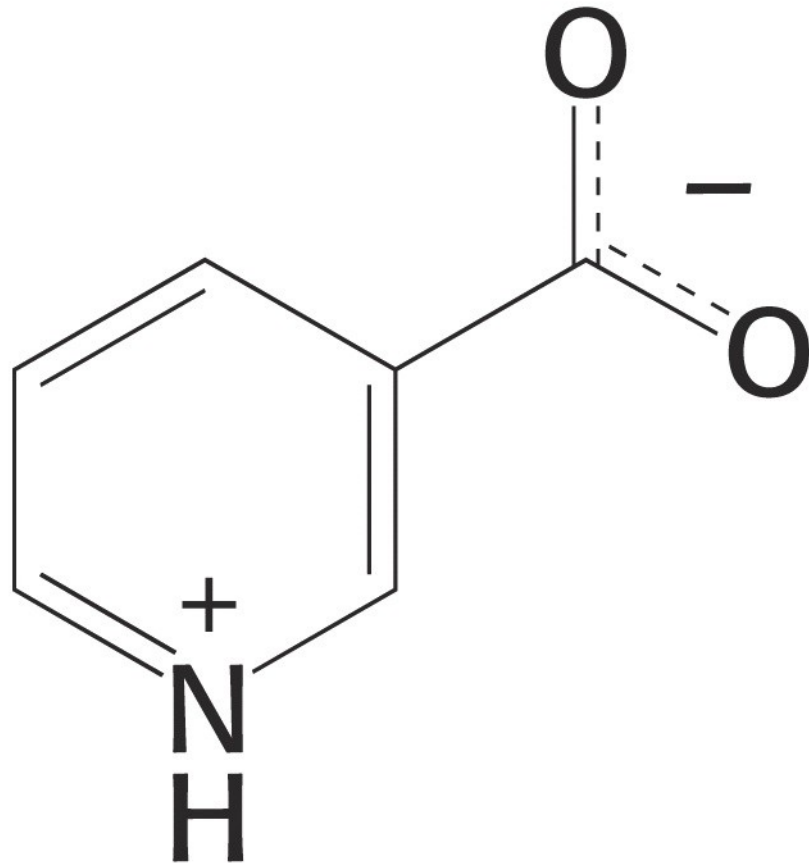
Vitamin B₅
(Pantothenate)



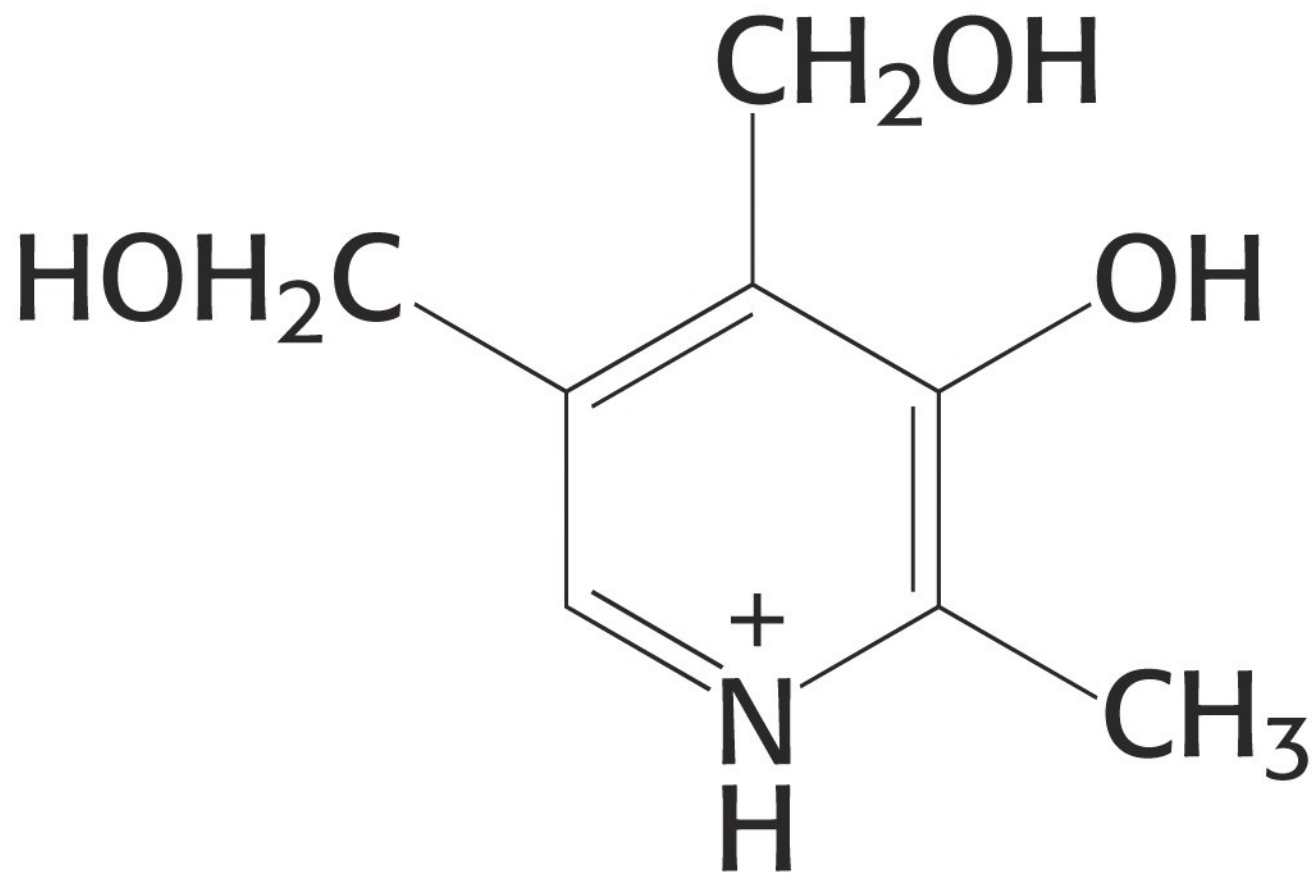
Vitamin B₂
(Riboflavin)



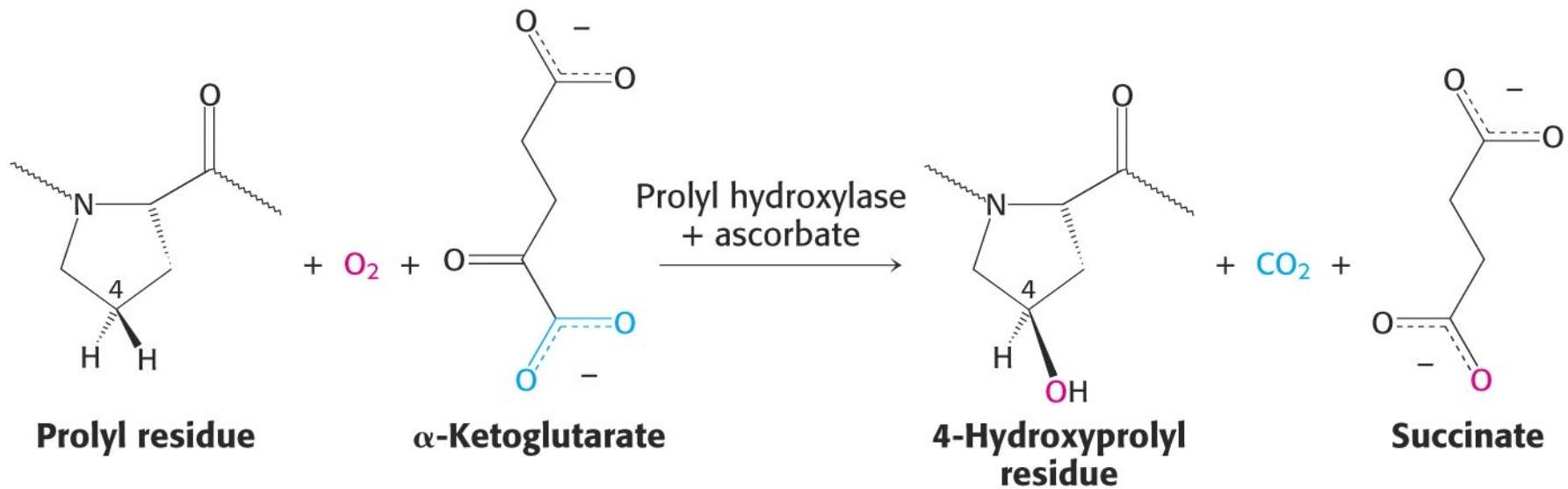
Vitamin C
(Ascorbic acid)

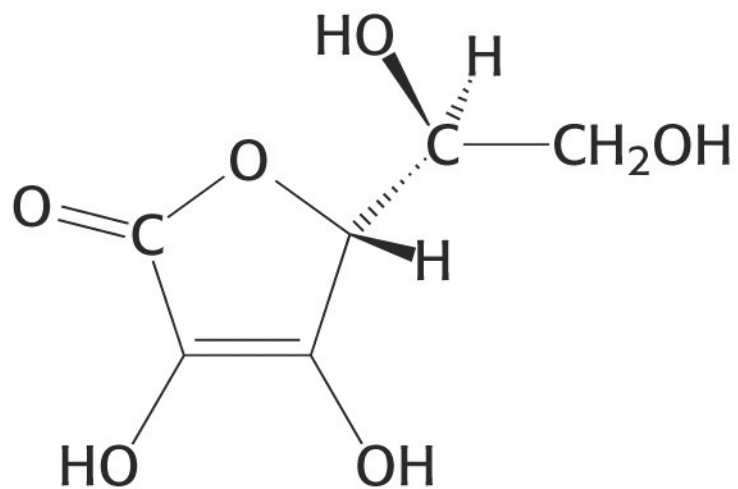


Vitamin B₃
(Niacin)

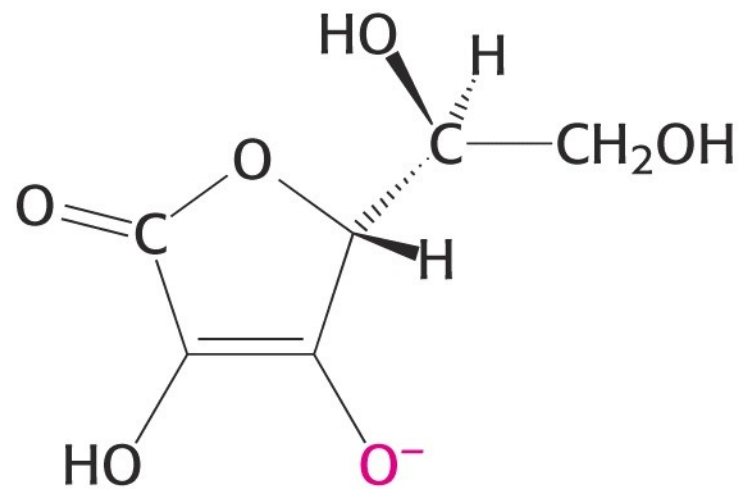


Vitamin B₆
(Pyridoxine)

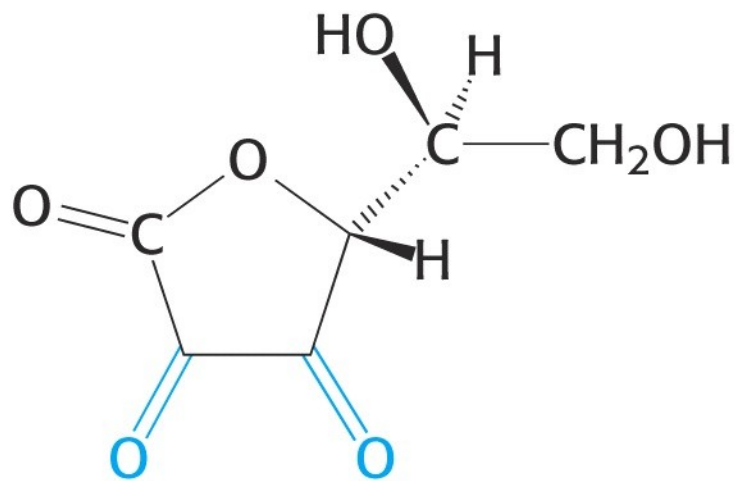




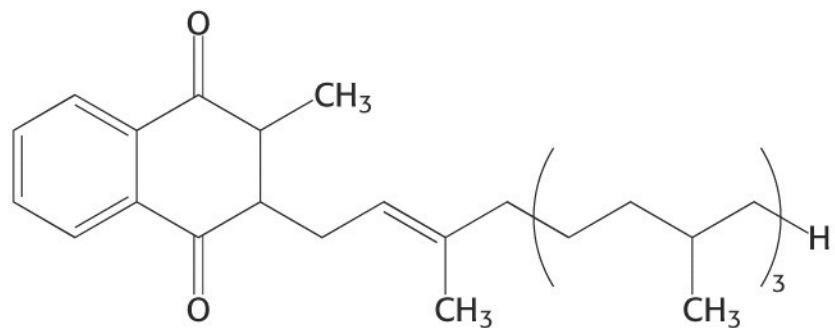
Ascorbic acid



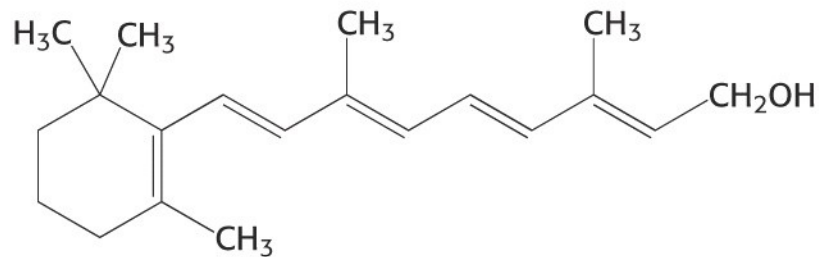
Ascorbate



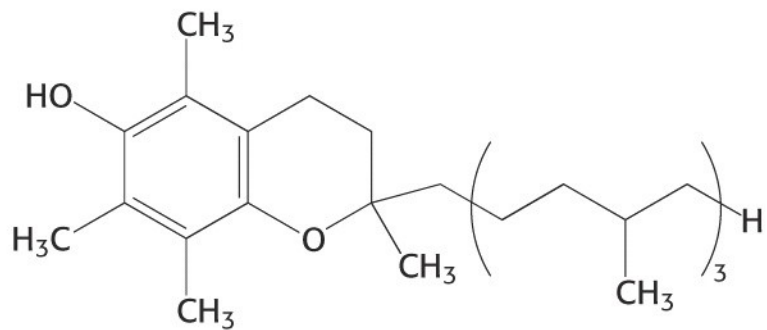
Dehydroascorbic acid



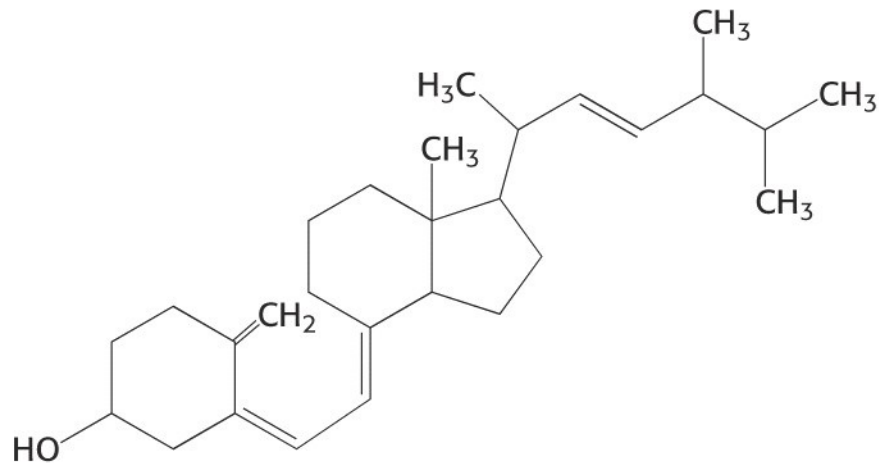
Vitamin K₁



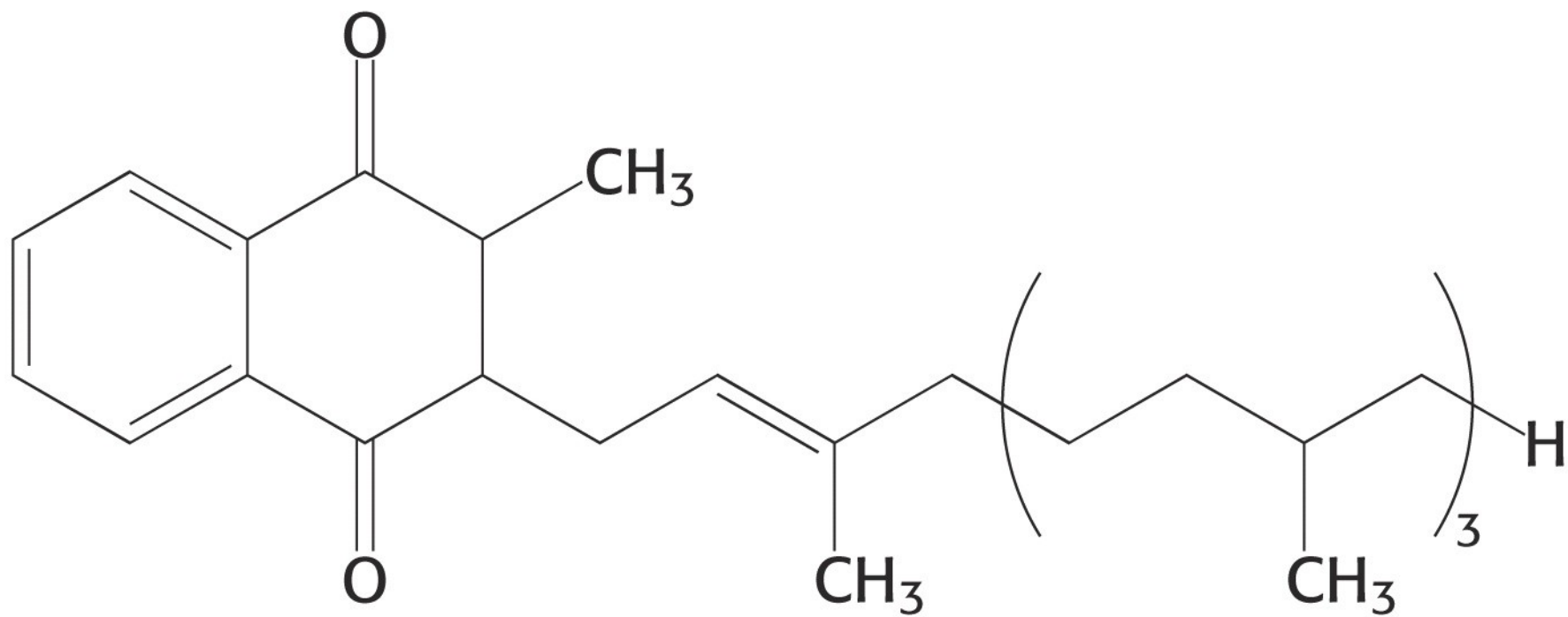
Vitamin A (Retinol)



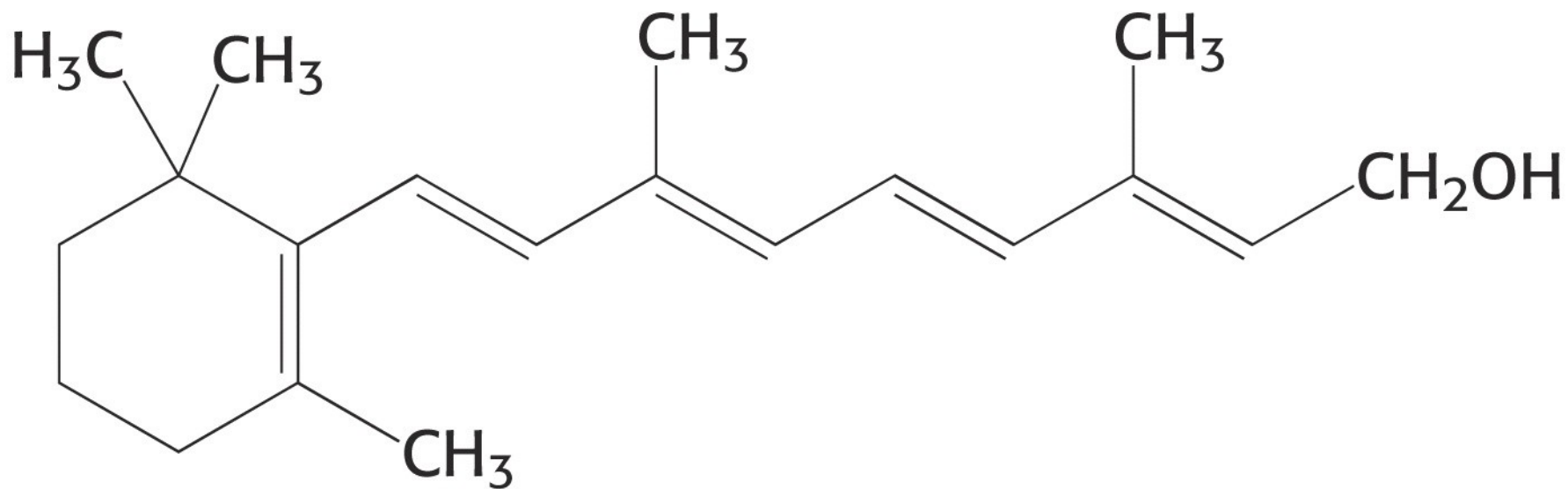
Vitamin E (α-Tocopherol)



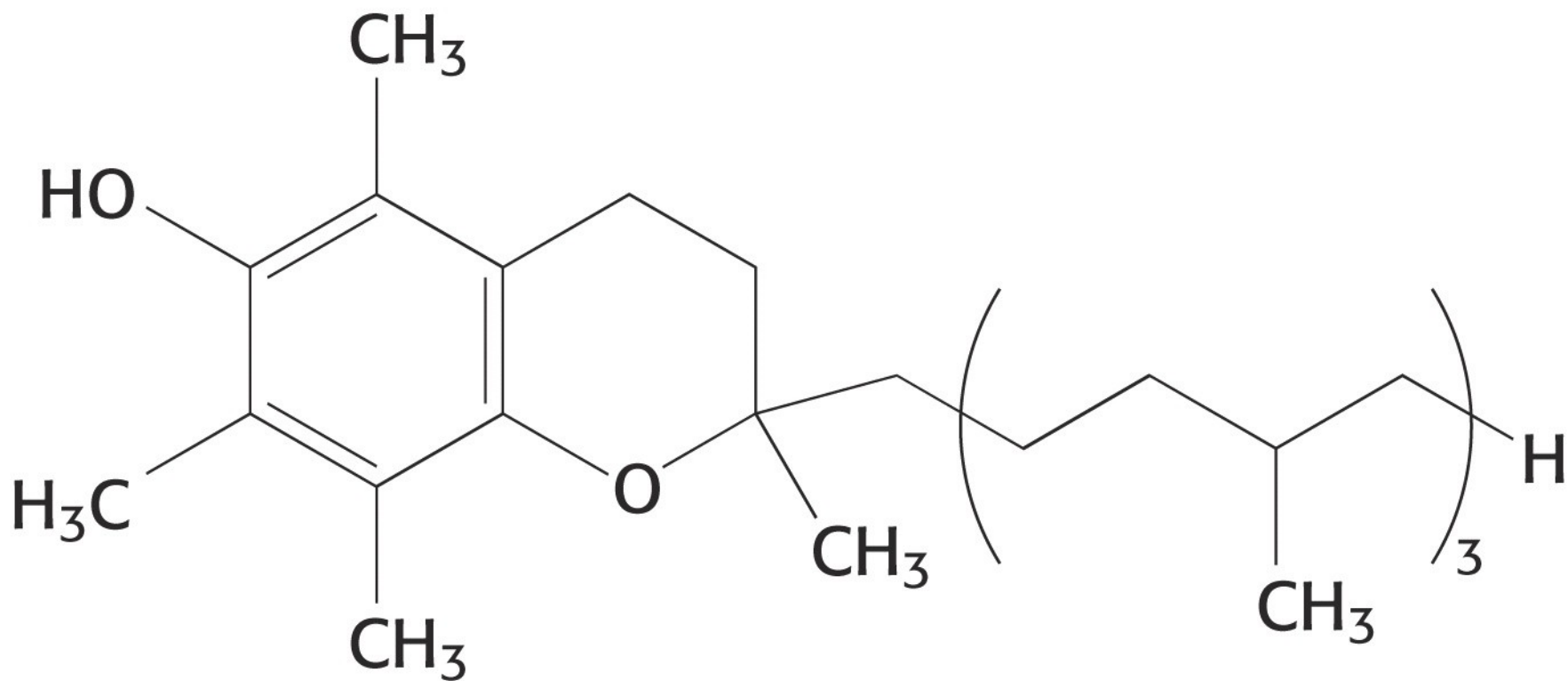
Vitamin D₂ (Calciferol)



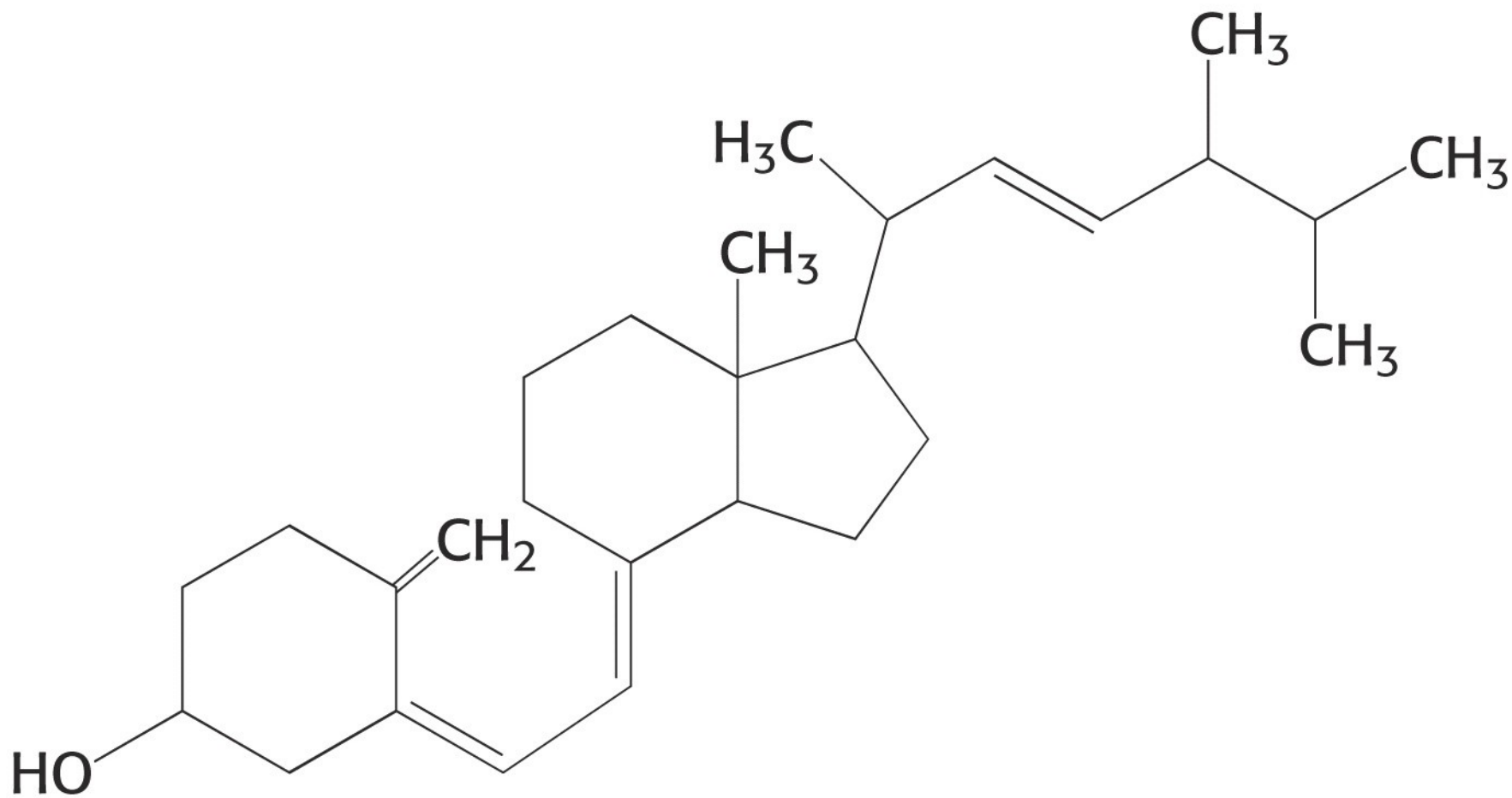
Vitamin K₁



Vitamin A (Retinol)



Vitamin E (α-Tocopherol)



Vitamin D₂ (Calciferol)