

3. LIPIDS

- derivatives of fatty acids (>3 C)
- free fatty acids
- accompanying compounds

function

- main nutrients
- source of energy
- source of essential fatty acids
- solvent of important compounds (lipophilic vitamins)

content in foods (book 1, tab. 3.23)

production of fats and oils source (book 1, tab. 3.26)

plant oils	pressing	animal fats	melting
	extraction		extraction

plant fats and oils

refining

- deguming (hydratation),
plant gums, proteins, their complexes with water
- deacidification (neutralisation)
salts
- bleaching
carotenoids, chlorophylls
- deodoration
tocopherols, sterols

classification

in technological praxis

fats, oils, waxes, lecithin, fatty acids

according to consistence

- oils (liquid)
 - drying oil
 - semi-drying oil
- linseed oil
sunflower/soy

- | | |
|-----------------------------|---------|
| non-drying oil | olive |
| • fats (plastic) | lard |
| • waxes (hard, nongreasing) | bee wax |

according to polarity

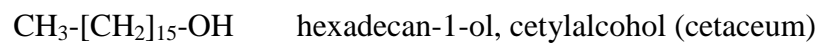
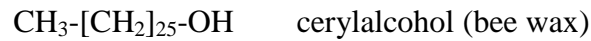
- neutral lipids
- polar lipids

according to structure

- | | |
|---|---|
| 1. fatty acids and their soaps | R-[CH ₂] _n -COOH |
| 2. homolipids (esters of fatty acids with alcohols) | |

2.1 monohydric alcohols (waxes)

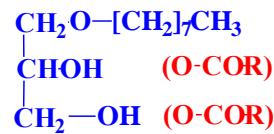
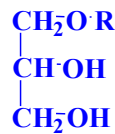
aliphatic (cerides)



alicyclic (sterides)

esters of sterols (cholesterol)

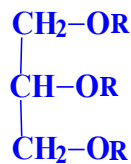
2.2 dihydric alcohols (glycols), alkoxylipids



1-alkoxypropane-2,3-diols
(glycerol ethers)

chimylalcohol
(shark fat)

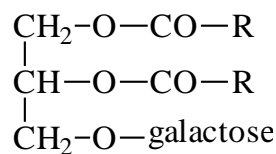
2.3 trihydric alcohol (glycerol)



fats and oils

2.4 polyhydric alcohols

sugars - glycolipids (galactose)



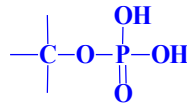
saccharose

1-3 FAs emulsifiers

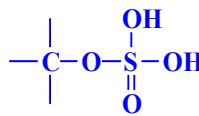
6-8 FAs low energy fats (OLESTRA)
 sorbitol (alcoholic sugar)
 emulsifiers

3. heterolipids 0,5-2%

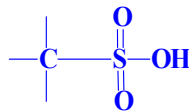
glycerol, FA, polar components
 phospholipids



lipid sulfates

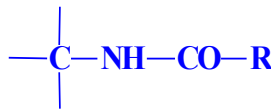


sulpholipids



lipamides

amides FA



4. komplex lipids

proteolipids (lipoproteins)
 glycolipids (cerebrosides)
 mucolipids (sialoglycosfingolipids = gangliosides)

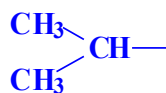
Fatty acids

saturated (book 1, tab. 3.1)

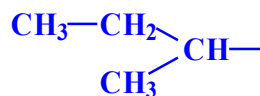


straight chain

branched chain (book 1, tab. 3.18)



iso-



anteiso-

even number of C atoms, odd number of C atoms

fats, oils

C₄ - C₂₂

waxes

C₂₂ - C₃₆

n = 4 butyric (butanoic)

6 caproic (hexanoic)

8 caprylic (octanoic)

10 caprinic (decanic)

12 lauric (dodekanic)

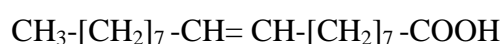
14 myristic (tetradekanic)

16 palmitic (hexadekanic)

18 stearic (octadekanic)

20 arachidic (eicosanoic)

unsaturated (monoenic) (book 1, tab. 3.2)



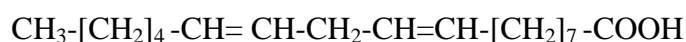
cis-octadec-9-enoic, (9*Z*)-octadec-9-enoic

oleic

18:1 Δ 9 *cis*

ω -9

dienoic (polyenic) (book 1, tab. 3.3)



cis, cis-9,12-oktadecadienic

linoleic

18:2 Δ 9,12 all-*cis*

ω -6

trienoic (book 1, tab. 3.3)



cis, cis, cis-9,12,15-oktadecatrienová

linolenic (α)

18:3 Δ 9,12,15 all-*cis*

ω -3

polyenoic (book 1, tab. 3.3)



eicosatetraenoic

arachidonic

20:4 Δ 5,8,11,14 all-*cis*

ω -6



docosapentaenic

clupanodonic

20:5 Δ 7,10,13,16,19 all-*cis*

ω -3

other fatty acids

- unsaturated in unusual positions

petroselinic

18:1 Δ 11 *cis*

erucic

22:1 Δ 13 *cis*

γ -linolenic

18:3 Δ 6,9,12 *cis*

- *trans*-fatty acids

content in animal fats (book 1, tab. 3.17)

elaidic

18:1 Δ 9 *trans*

alkenic, cyclic (kniha 1 tab. 3. 5), with *O*-functional group: hydroxy, oxo, epoxy, furans

occurrence (book 1, tab. 3.7, 3.8, 3. 9, 3.10, 3.11, 3.12, 3.13 3.14, 3.15, 3.16,3.19)

saturated C4-C10

butter (milk fat) (book 1, tab. 3.9)

saturated C12, C14

coconut, palm kernel oil (book 1, tab.3.7)

saturated C16, C18

palm oil, animal fats

branched C19, C20

butter (from chlorophyll, rumen mikroorganisms)

C18:1 (oleic) (book 1, tab. 3.13)

olive, rape, sunflower, groundnut, butter, lard, tallow

C22:1 (erucic)

rape seed oil

C 18:2 (linoleic) (book 1, tab. 3.14)

soy oil

C18:3 (α -linolenic) (book 1, tab. 3.15)

rape seed oil

Polyunsaturated: ω -3

fish oils book 1, tab.3.11.)

C18:3 (γ -linolenic)

primrose oil, borage seed oil

C20:4 (arachidonic)

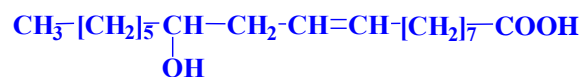
meat, liver, lard, eggs

***trans*-isomers** (kniha 1. tab. 3.17)

animal fats, hardening fats

hydroxy fatty acids (kniha 1. tab. 3.6)

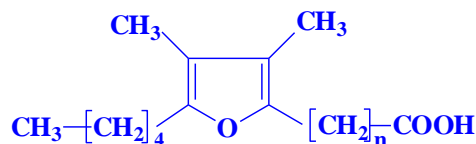
castor seed oil (for technical purposes)



(12*R*,9*Z*)-12-hydroxyoctadec-9-enoic (ricinoleic) acid

furan fatty acids

1-6 % cod liver oil, to 25 % sweet water fish



essential fatty acids

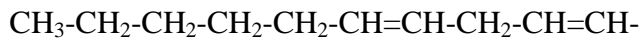
role of FA in nutrition

special function (vitagen F)

ω -3, ω -6 fatty acids

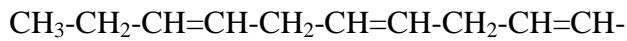
- active compound of membranes (fluidity, flexibility)
- control of H₂O permeability by skin
- regulation of synthesis and transportation of cholesterol

- precursors of icosanoids (e.g. prostaglandins)



linoleic

18:2 Δ 9,12 all-*cis*



linolenic (α)

18:3 Δ 9,12,15 all-*cis*

other acid in smaller quantity

~ 1% energy intake from fats

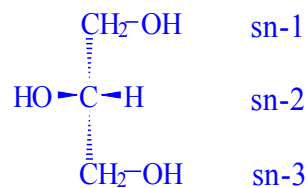
ω -3 prevention of cardiovascular diseases

2-10 g of C18:3 Δ 9,12,15 /day

ideal relation ω -6/ ω -3 = 5/1 (4-10/1)

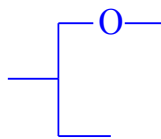
ordinary relation 25/1

glycerol esters

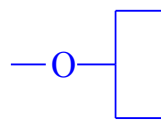


5 types of esters

monoacylglycerols (monoglycerides)

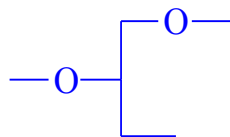


1-monoacyl-*sn*-glycerol

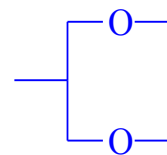


2- monoacyl-*sn*-glycerol

diacylglycerols (diglycerides)

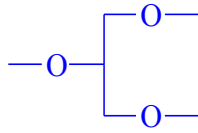


1,2-diacyl-



1,3-diacyl-

triacylglycerols (triglycerides)



1,2,3-triacyl-

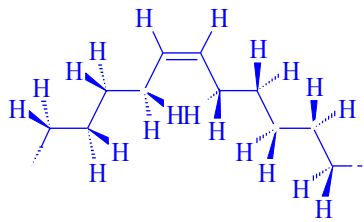
mixed, simple, optical activity, exactly defined (lard: U=outer position, otherwise interior)

fatty acid composition of refined oils and fats (book 1, tab. 3.7)

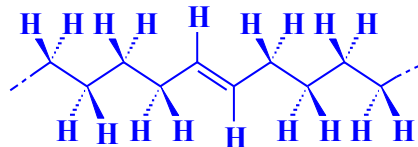
physical-chemical properties

melting point, thawing point, hardening point (in given range of temperature)

- structure of FA, TAG (number of C, multiple double bounds)
- configuration of crystals
- conformation of unsaturated fatty acid chain (lowers thawing point.)

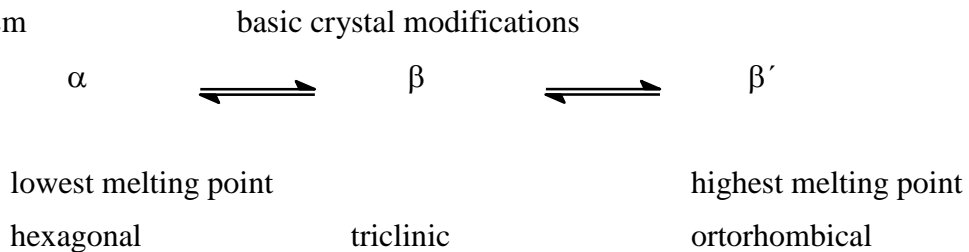


chain conformation of *cis*-monoenoic acid, (*Z*)-



chain conformation of *trans*-monoenoic acid (*E*)-

- polymorphism



β : lard, olive oil, cacao butter, β' : tallow, butter, rape seed oil

cocoa butter: 6 polymorphic forms of melting point from 17.3 to-36.4°C, predominates β -3, its melting point = 33.8°C (melting point of chocolate: 32-36°C)

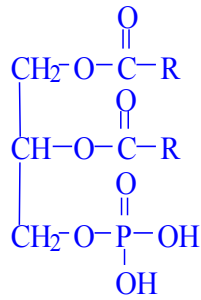
phospholipids

content book 1, tab.3. 32 a 3. 33)

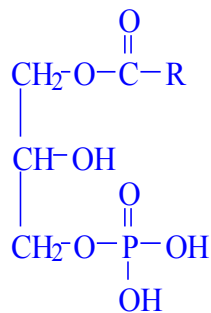
phosphatides and fospholipamides

stabilisation of emulsions

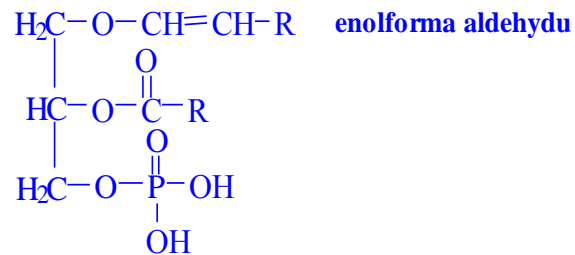
phosphatides (phosphatidyl derivatives, lyso phosphatidyl derivatives, plasmalogens)



phosphatidyl acid (phosphatidylcholine)



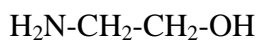
lysophosphatidyl acid (lysophosphatidylcholine)



plasmenoic acid (plasmenylcholine)



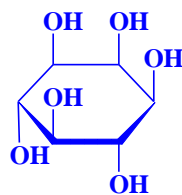
choline (lecithine)



ethanolamine (kefaline)

serine

inositol (*myo*-inositol)

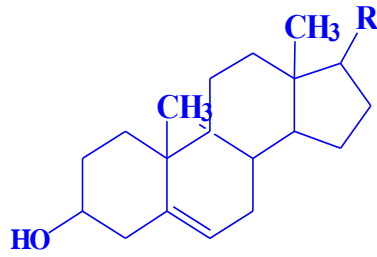


lipid accompanying compounds lipoides, unsaponifiable material

sterols (book 1, tab. 3.39) **zoosterols** (book 1, tab. 3.38)

fytoosterols (book 1, tab. 3.39 a 3.40, 3.41, 3.42, 3.45)

mycoosterols

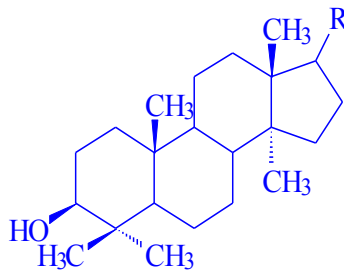


cholesterol, sitosterol, ergosterol

other terpenoids

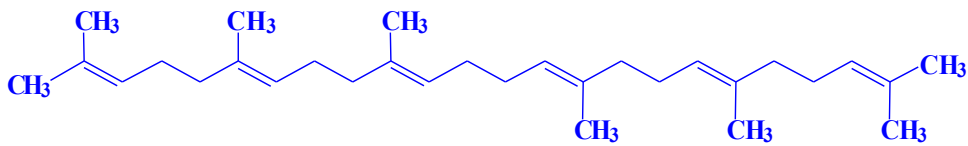
triterpenic alcohols

dimethylsterols



cycloartenol C30

hydrocarbons



squalen C30 (olive oil)

nonacosan C29 (apple wax)

other compounds

lipophilic vitamins (A, D, E, K)

lipophilic pigments (chlorophylls, carotenoids)