D.PHARM • SECOND YEAR

Biochemistry & Clinical Pathology

CHAPTER 4

Lipids



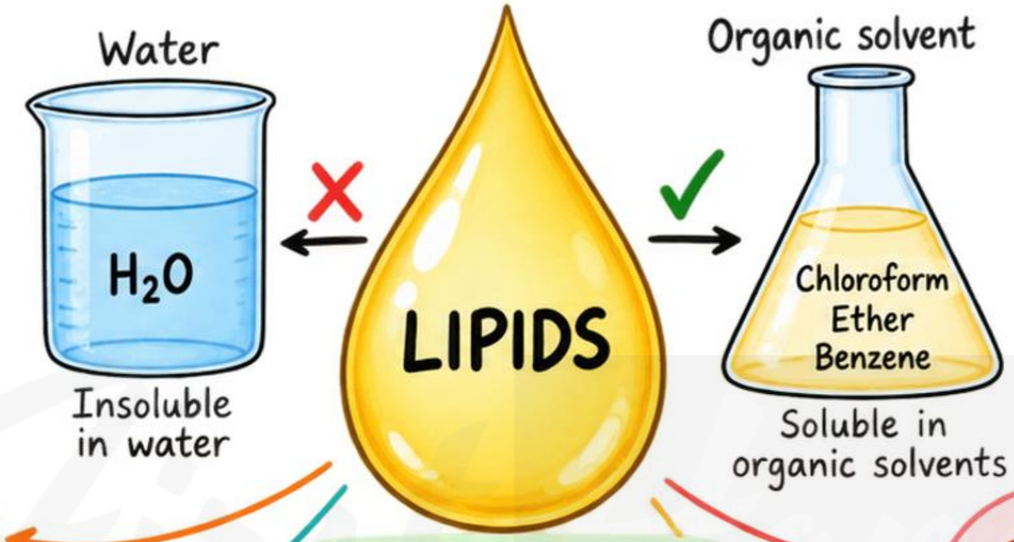
ENGLISH CHAPTER NOTES

DIPLOMA IN PHARMACY

LIPIDS: DEFINITION & FUNCTIONS

DEFINITION

Lipids are a diverse group of naturally occurring organic compounds that are insoluble in water but soluble in organic solvents such as chloroform, ether and benzene.



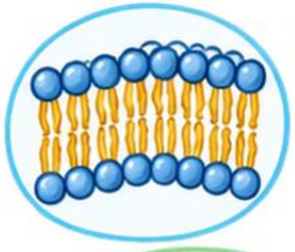
COMPOSITION

Mainly carbon, hydrogen and oxygen; some lipids also contain phosphorus, nitrogen or sulfur.

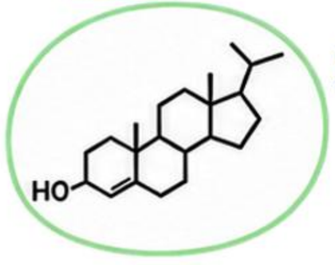
MAIN FUNCTIONS



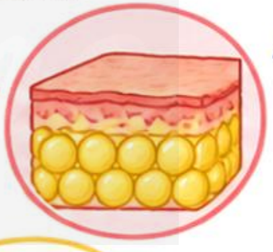
1. **Energy reserve**
   9 kcal/g.



2. **Cell membranes**
   phospholipids and cholesterol.



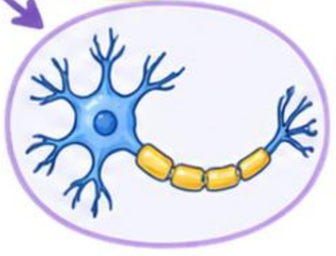
3. **Hormone formation**
   cholesterol is a steroid-hormone precursor.



4. **Insulation and protection**
   adipose tissue reduces heat loss and cushions organs.



5. **Vitamin absorption**
   carries vitamins A, D, E and K.



6. **Nerve function**
   lipids form the myelin sheath.

KEY IDEA

Lipids are hydrophobic or amphipathic molecules with structural, storage and signalling roles.

CLASSIFICATION OF LIPIDS

SIMPLE LIPIDS

Esters of fatty acids with alcohols.

- Fats and oils: fatty acids + glycerol — tripalmitin, triolein.
- Waxes: long-chain fatty acid + long-chain alcohol — beeswax contains myricyl palmitate.


Oil


Fat


Beeswax

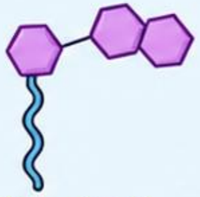
LIPIDS

COMPOUND / COMPLEX LIPIDS

Contain fatty acids and alcohol plus another group.

- Phospholipids — phosphate; lecithin, cephalin.
- Glycolipids — carbohydrate; cerebrosides, gangliosides.
- Lipoproteins — protein; HDL, LDL.


Phospholipid


Glycolipid

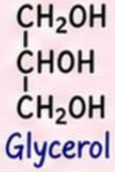

Lipoprotein (HDL)

DERIVED LIPIDS

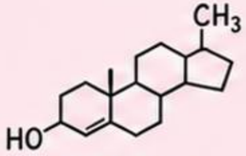
Products or components derived from simple and complex lipids.
Fatty acids, glycerol, cholesterol and fat-soluble vitamins.



Fatty acids



Glycerol



Cholesterol



Fat-soluble vitamins

MISCELLANEOUS LIPIDS

Lipid-like compounds: squalene, carotenoids and hydrocarbons.


Squalene


Carotenoids


Hydrocarbons

REMEMBER | Simple = fatty acid + alcohol; complex = an additional functional group is present.

TRIGLYCERIDES: STRUCTURE & PROPERTIES

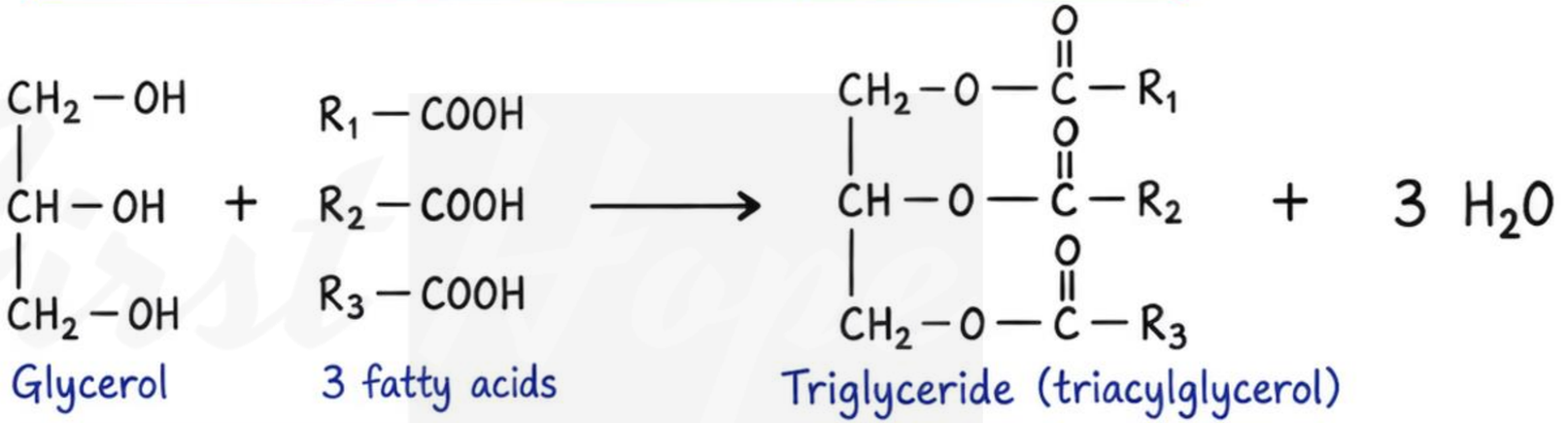
DEFINITION

Triglycerides, or triacylglycerols, are esters formed from one glycerol and three fatty acids. They are the common storage lipids in food and the body.

ESTERIFICATION

Glycerol + 3 fatty acids → triglyceride + 3 H_2O

Each glycerol –OH reacts with a fatty-acid –COOH to form an ester bond, –COO–.



TYPES

- Simple triglyceride — all three fatty acids are the same.
- Mixed triglyceride — two or three different fatty acids.
- Fat — usually solid at room temperature; richer in saturated fatty acids.
- Oil — usually liquid at room temperature; richer in unsaturated fatty acids.

FAT vs OIL (at room temperature)



Fat

Solid at room temperature

Richer in saturated fatty acids



Oil

Liquid at room temperature

Richer in unsaturated fatty acids

PROPERTIES

- Hydrolysis by lipase gives glycerol and fatty acids.
- Saponification with NaOH or KOH gives glycerol and soap.
- Oxidation can cause rancidity: unpleasant smell and taste.
- Energy value = 9 kcal/g.

SATURATED & UNSATURATED FATTY ACIDS

FATTY ACID

A long hydrocarbon chain with a terminal carboxyl group, −COOH. Natural fatty acids commonly have an even number of carbon atoms.

SATURATED FATTY ACIDS — SFA

- No carbon–carbon double bond.
- Straight chains pack closely.
- Usually higher melting point; many are solid at room temperature.
- Common in animal fats and some tropical oils.

Examples: palmitic acid, C16:0; stearic acid, C18:0.



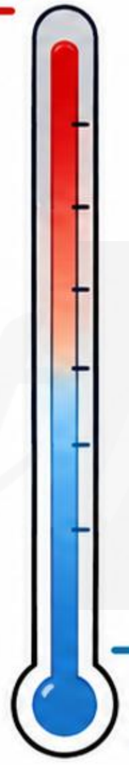
Straight chains pack closely (higher melting point)



Animal fats

Some tropical oils

Higher melting point



Lower melting point

UNSATURATED FATTY ACIDS — UFA

- One or more C=C double bonds.
- Cis double bonds create bends, so chains pack less closely.
- Usually lower melting point; many are liquid oils.

MUFA

one double bond — oleic acid, C18:1.

PUFA

two or more double bonds — linoleic acid, α-linolenic acid, arachidonic acid.



Cis double bond (kink)



Cis double bonds (more kinks)

KEY POINT

Degree of unsaturation strongly affects melting point and membrane fluidity.



Olive oil (rich in MUFA)



Nuts (rich in PUFA)



Fish (rich in PUFA)

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