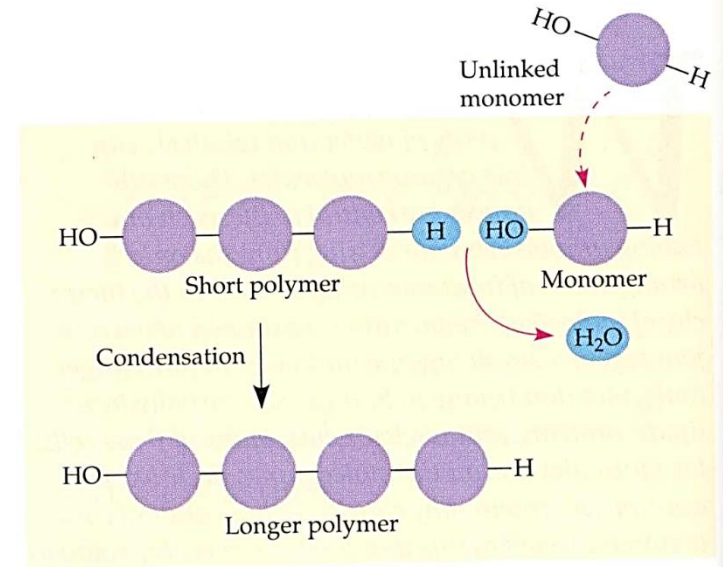


Lipids and Carbohydrates

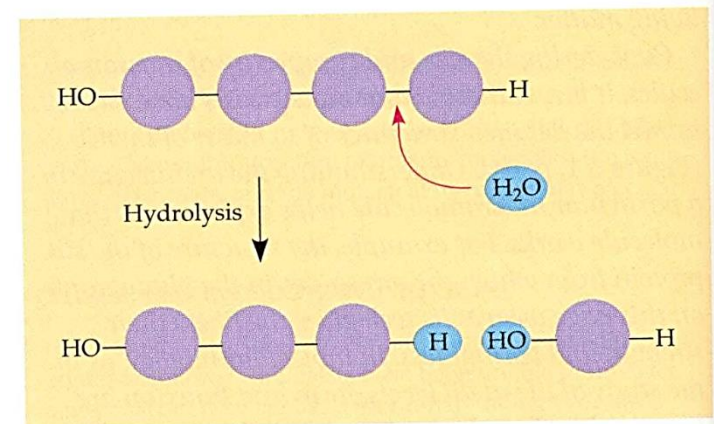
Figures, tables, graphs are copied from <http://www.estrellamountain.edu/faculty/farabee/biobk/biobooktoc.html>, when not the source site is indicated.

Biological Macromolecules

1. Lipids
2. Carbohydrates
3. Nucleic acids (DNA, RNA)
4. Proteins



(a) Condensation synthesis (dehydration) of a polymer

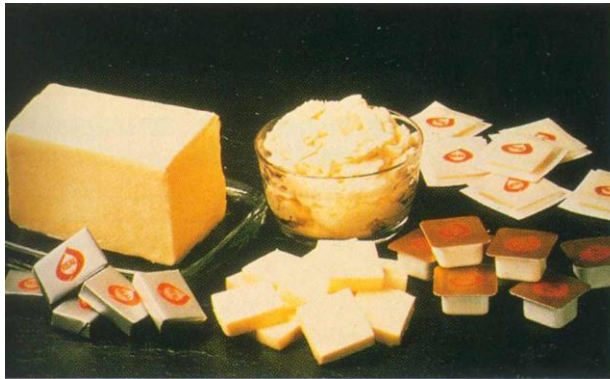


(b) Hydrolysis of a polymer

Lipids

- very good solubility in hydrophobic and organic solvents (e.g. carbon tetrachloride, benzene, acetone etc.)
- highly hydrophobic or amphipatic
- Groups of lipids:
 1. *Triglycerides*
 2. *Phospholipids*
 3. *Glycolipids*
 4. *Steroids*
 5. *Carotenoids*

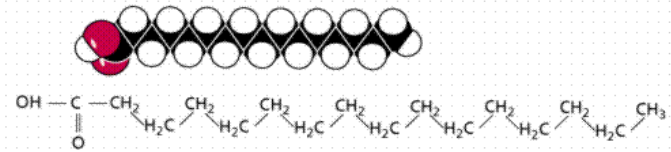
1., Triglycerides: Fats and oils



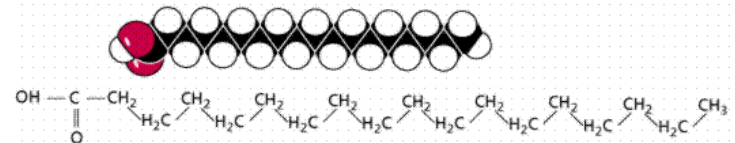
glycerol + 3 fatty acids

Fatty acids:

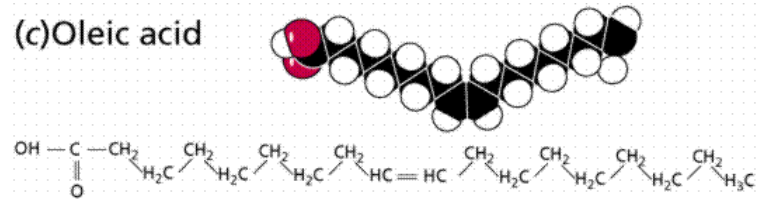
(a) Palmitic acid



(b) Stearic acid

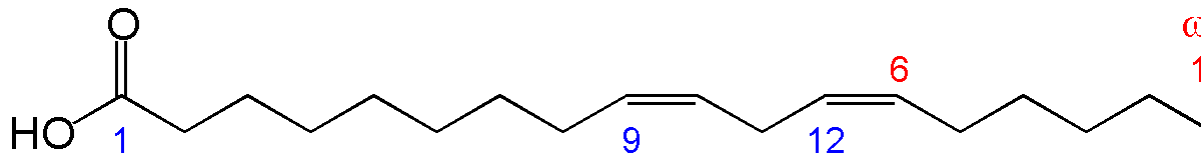


(c) Oleic acid

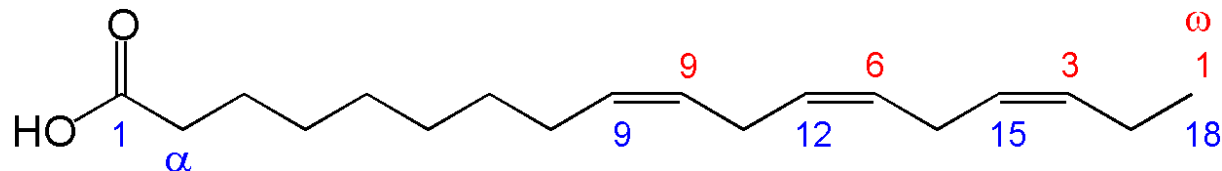


Essential fatty acids:

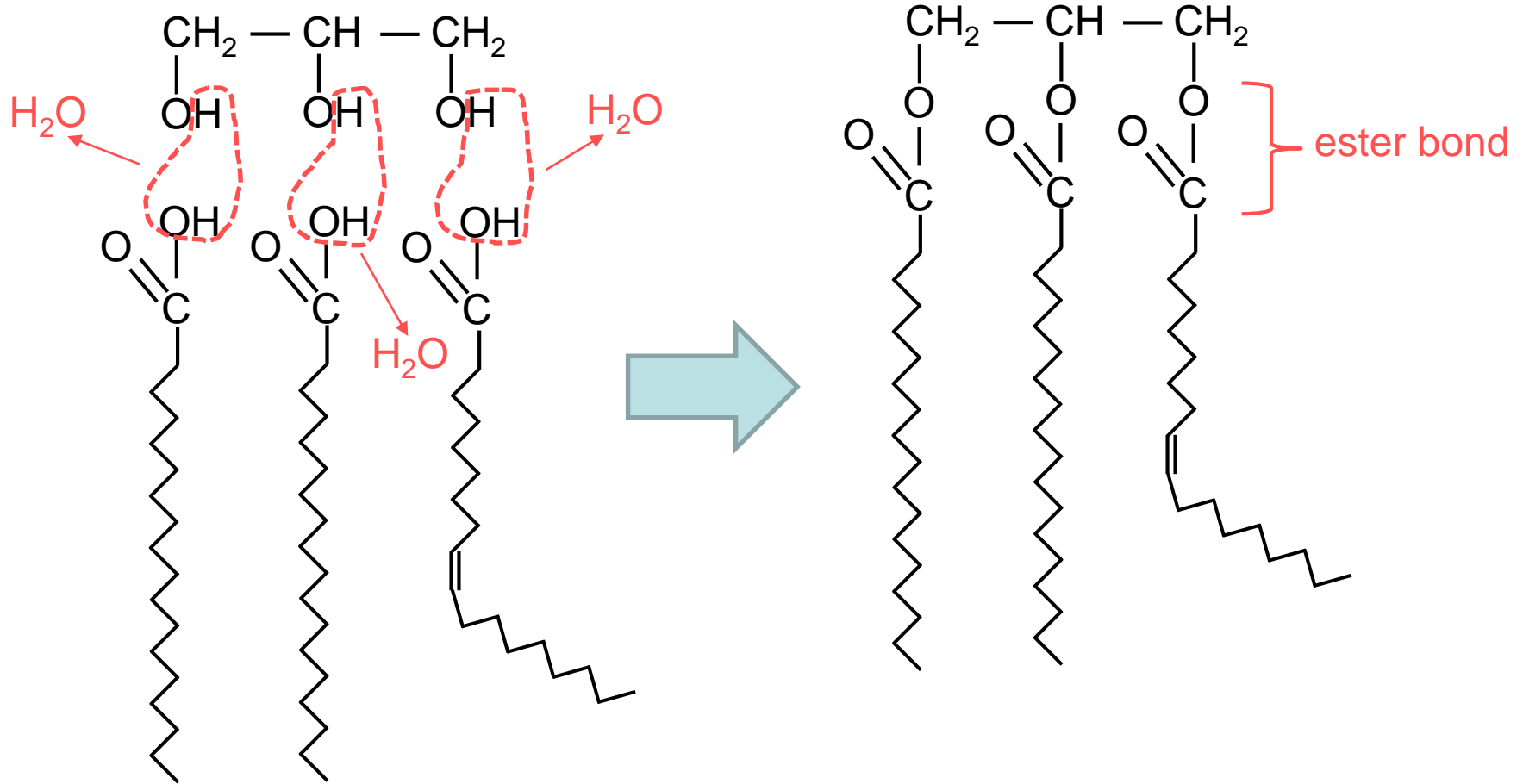
Linoleic acid (18:2, *n*-6), the shortest-chained *n*-6 fatty acid (Wikipedia)



ALA; Linolenic acid; cis, cis,cis-9,12,15-Octadecatrienoic acid; (Z,Z,Z)-9,12,15-Octadecatrienoic acid (Wikipedia)



The structure of triglycerides



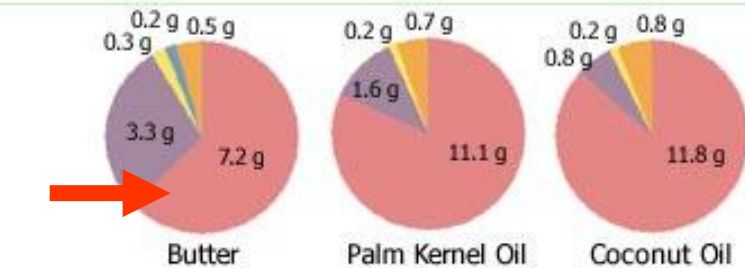
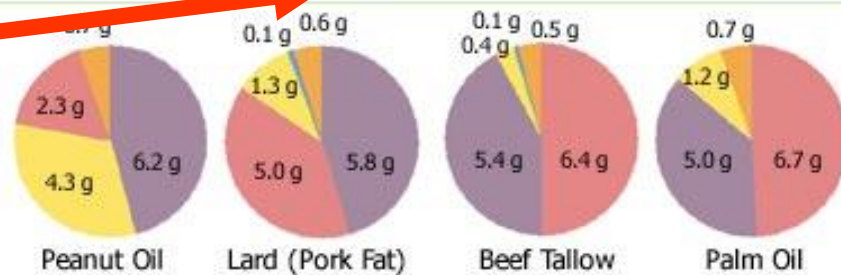
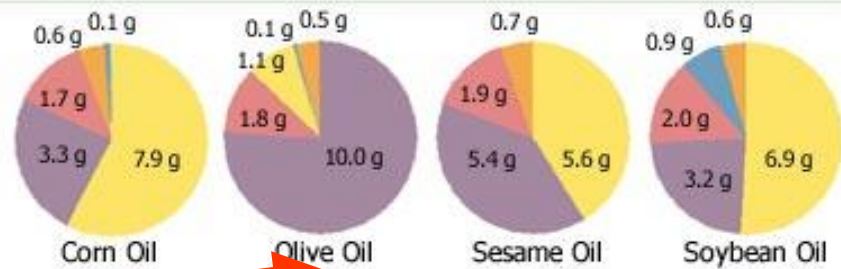
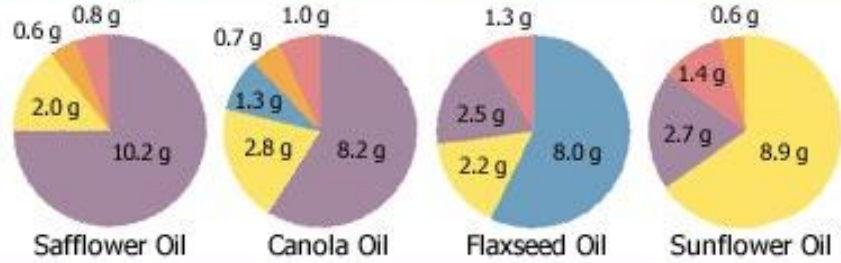
Stored as cytoplasmic lipid
fat as cushion, insulater (under skin, in abdomen)
obesity



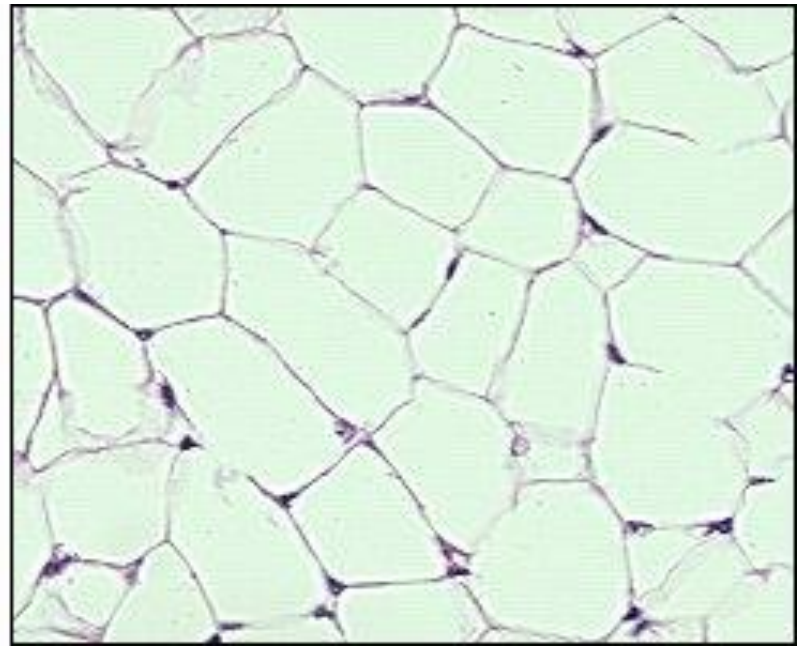
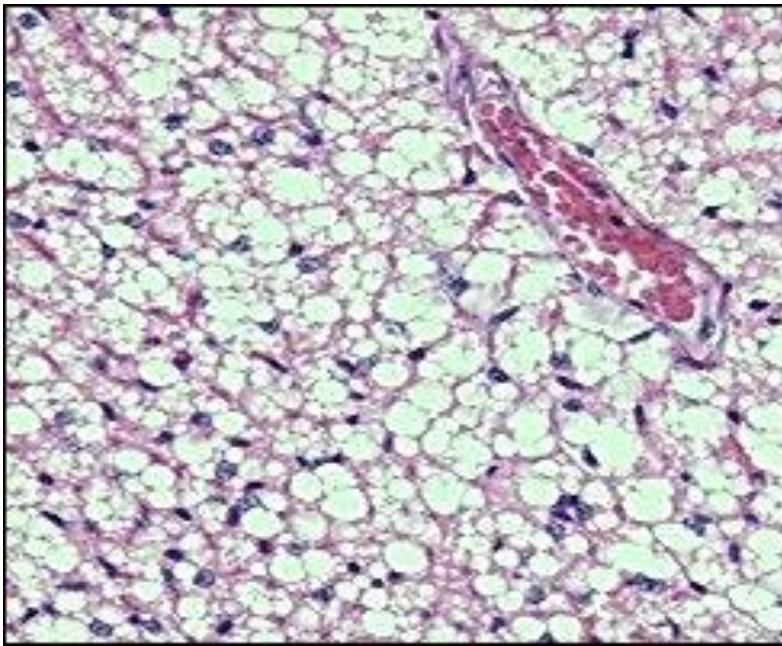
- Also:
- energy storage
 - organic solvent eg. Vitamins A, D, E, K

Fat Distribution in 1 Tbsp of Common Cooking Oils

■ Saturated Fat
■ Monounsaturated Fat
■ Other
■ Polyunsaturated Fats:
■ Linoleic Acid
■ Alpha-Linolenic Acid

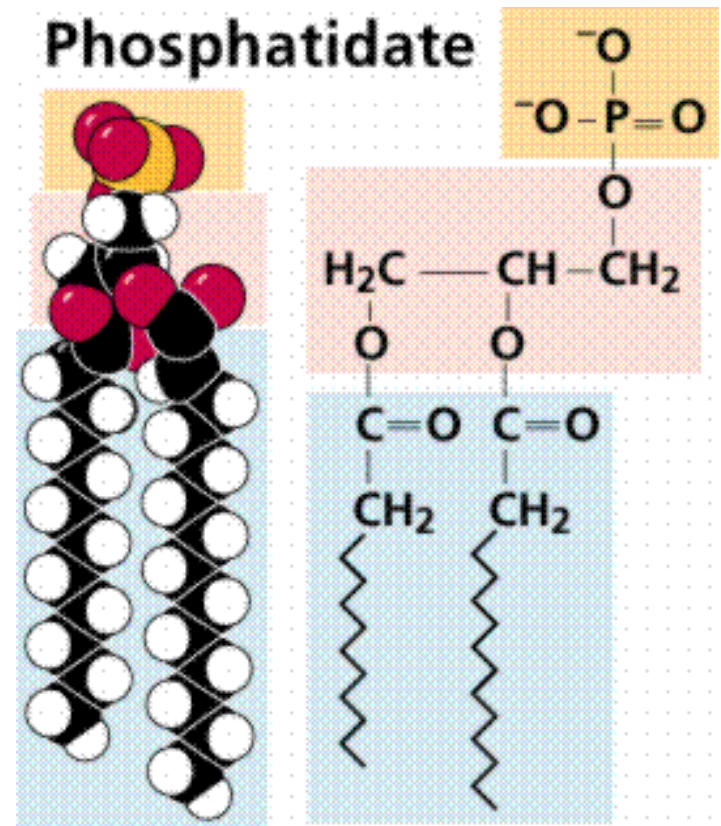


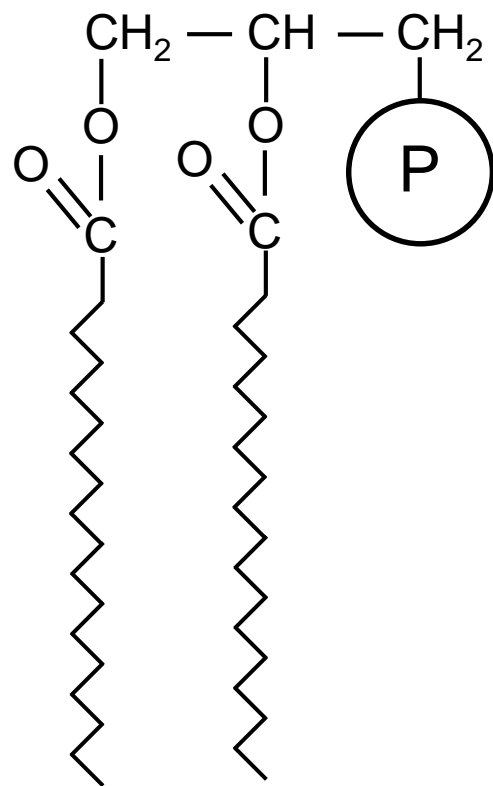
Lipid droplets in adipose cells



2., Phospholipids

- They contain phosphoric acid
- They are amphipathic lipids: contain hydrophobic and hydrophylic regions
- significance: membrane components

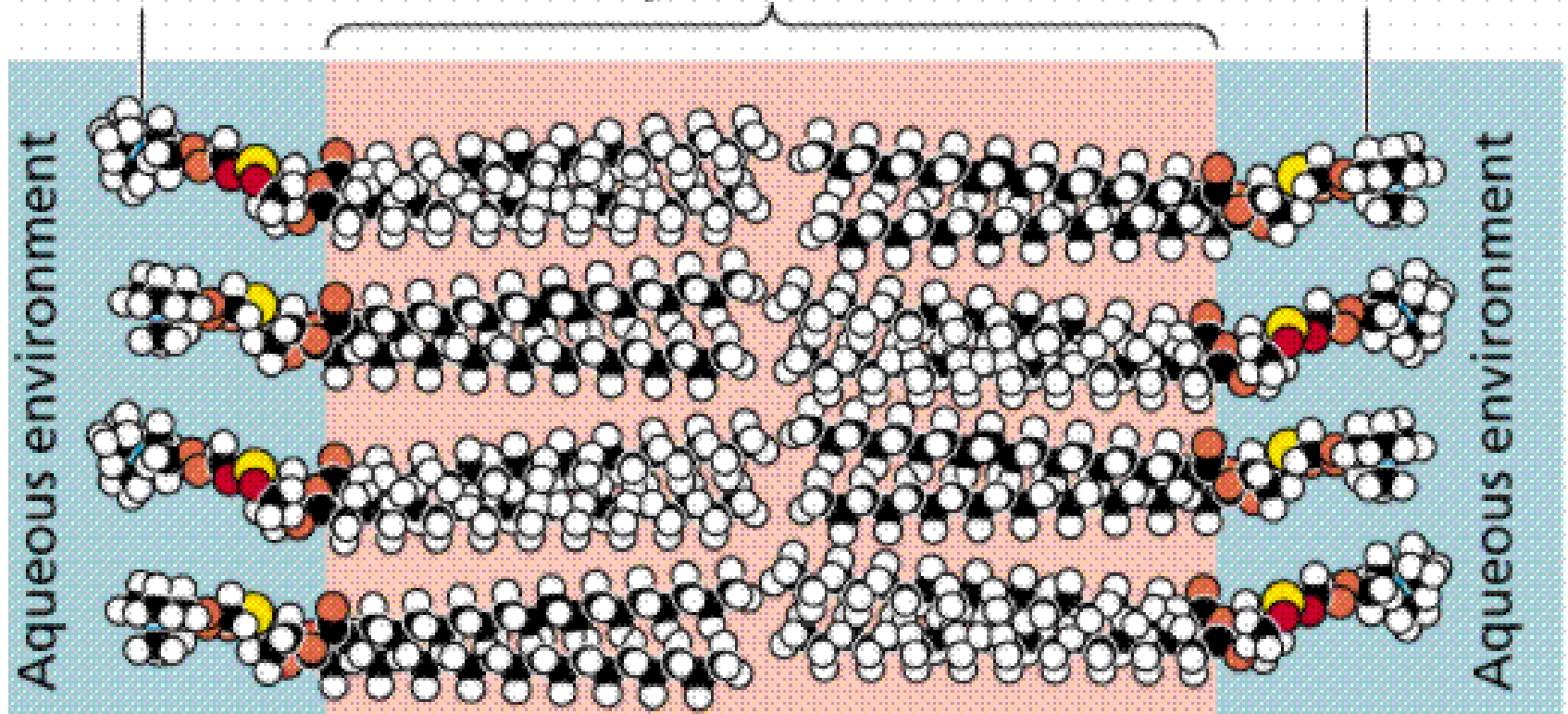


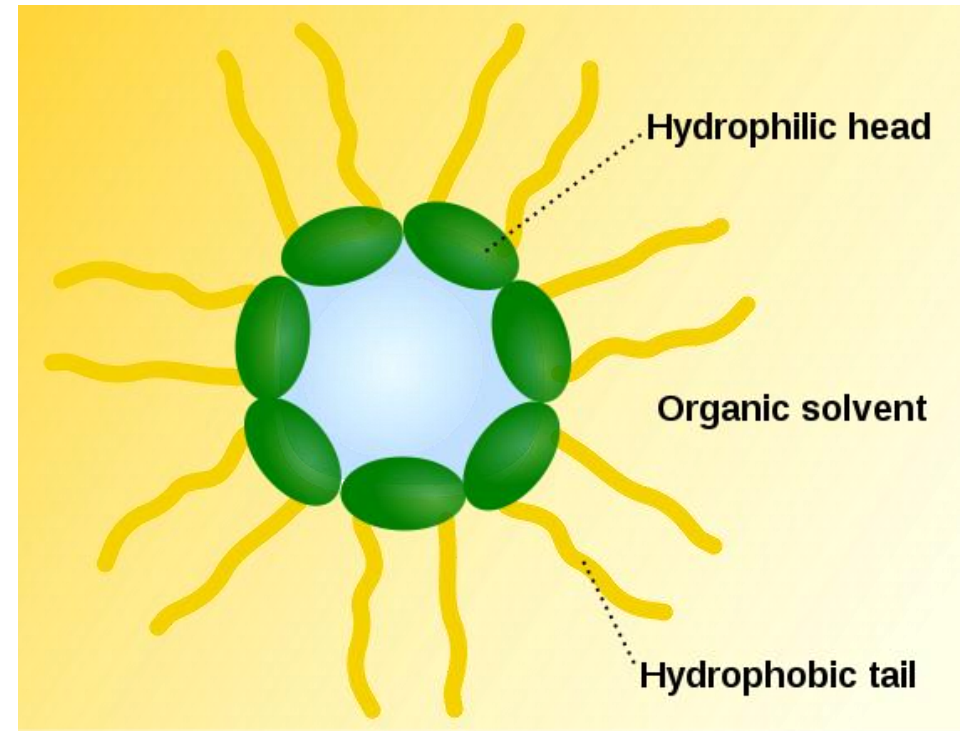
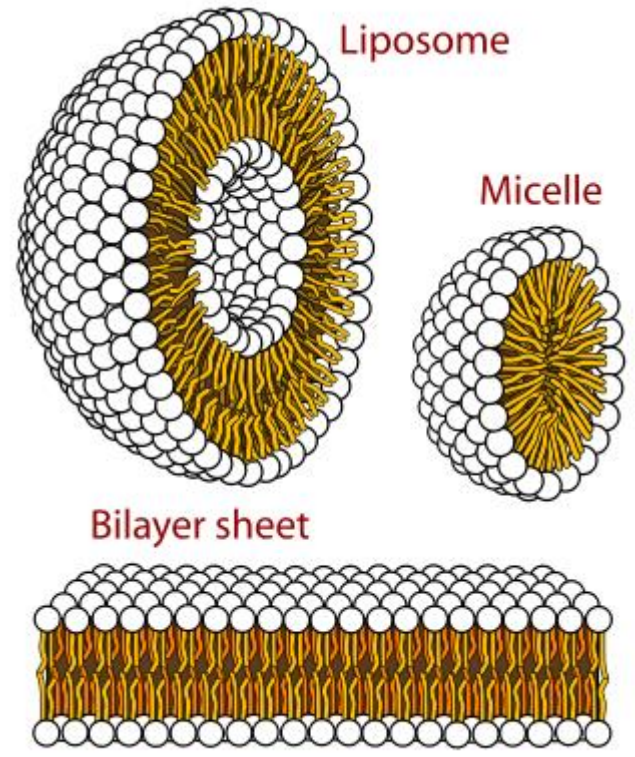
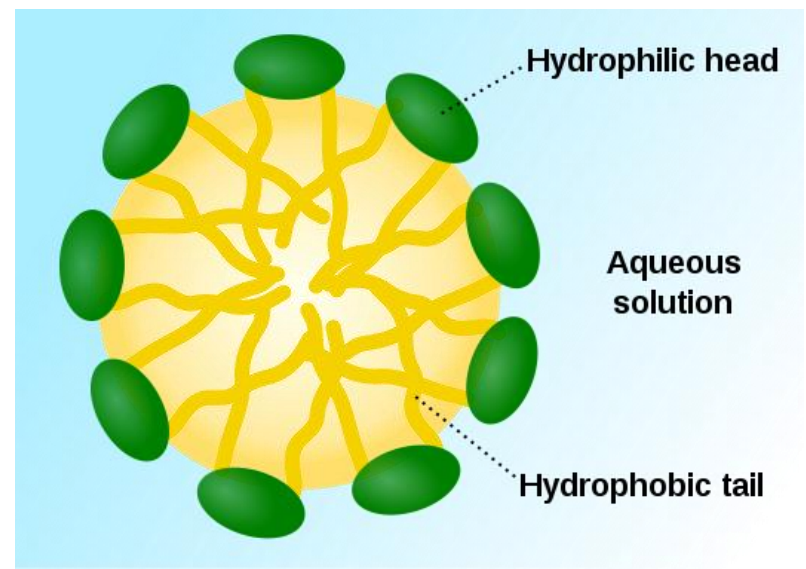


Polar,
hydrophilic
"head"

Nonpolar,
hydrophobic,
fatty acid "tails"

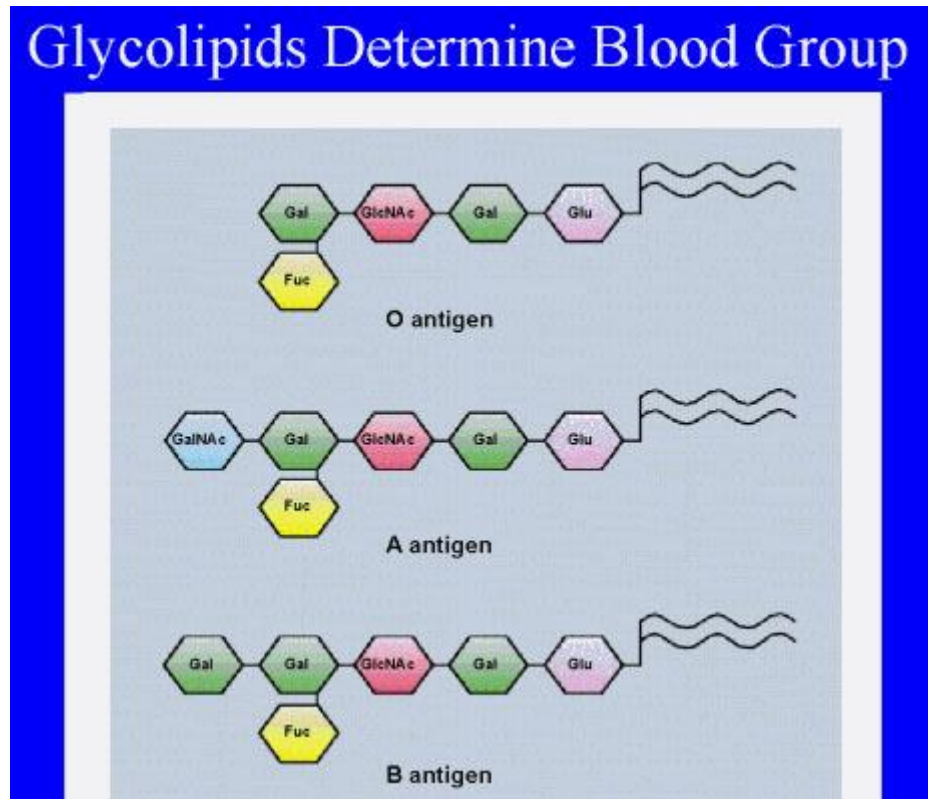
Polar,
hydrophilic
"head"





3., Glycolipids

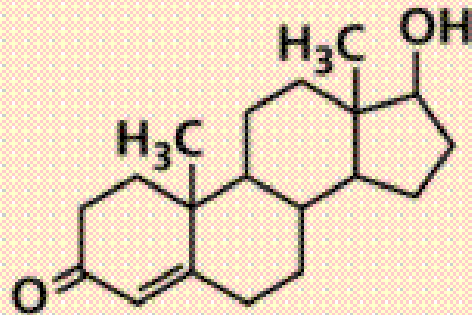
- they have sugar component
- They are markers, e.g.: ABO blood groups



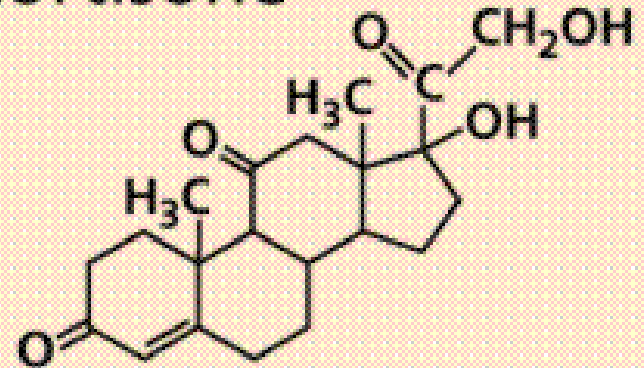
4., Steroids

sterane structure, e.g. cholesterol (membrane component), steroid hormones, bile acids, vitamin D3

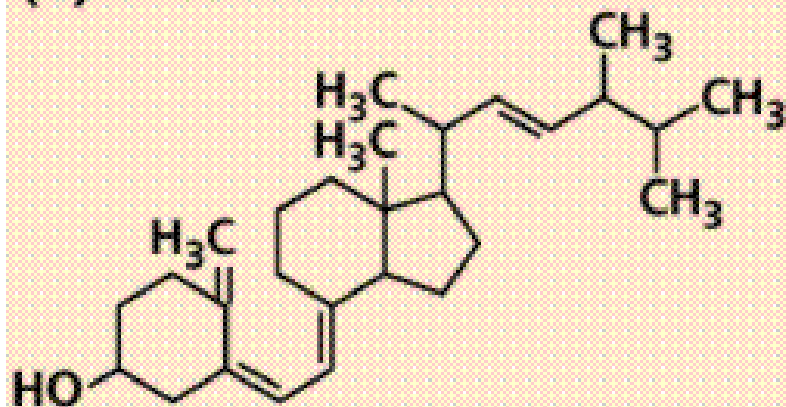
(a) Testosterone



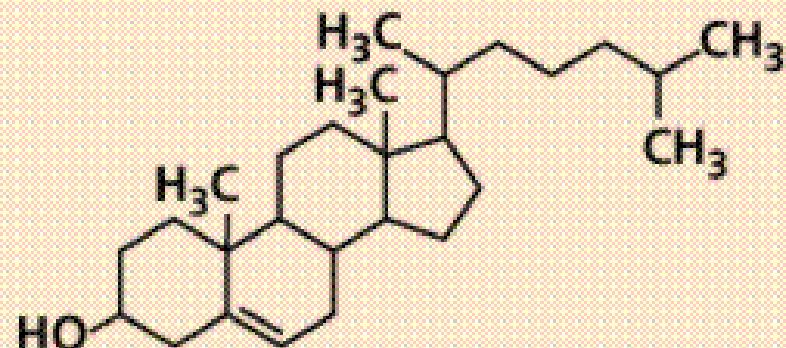
(b) Cortisone



(c) Vitamin D



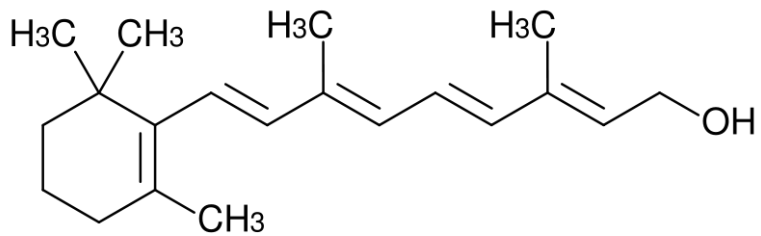
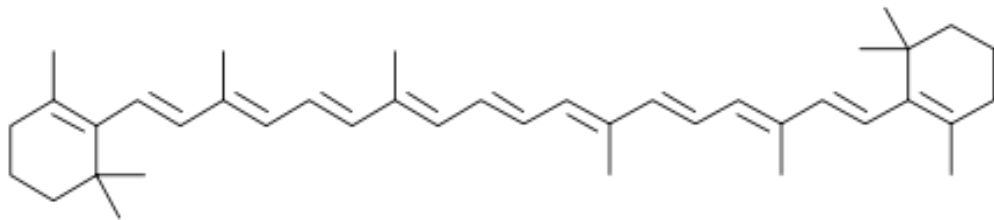
(d) Cholesterol



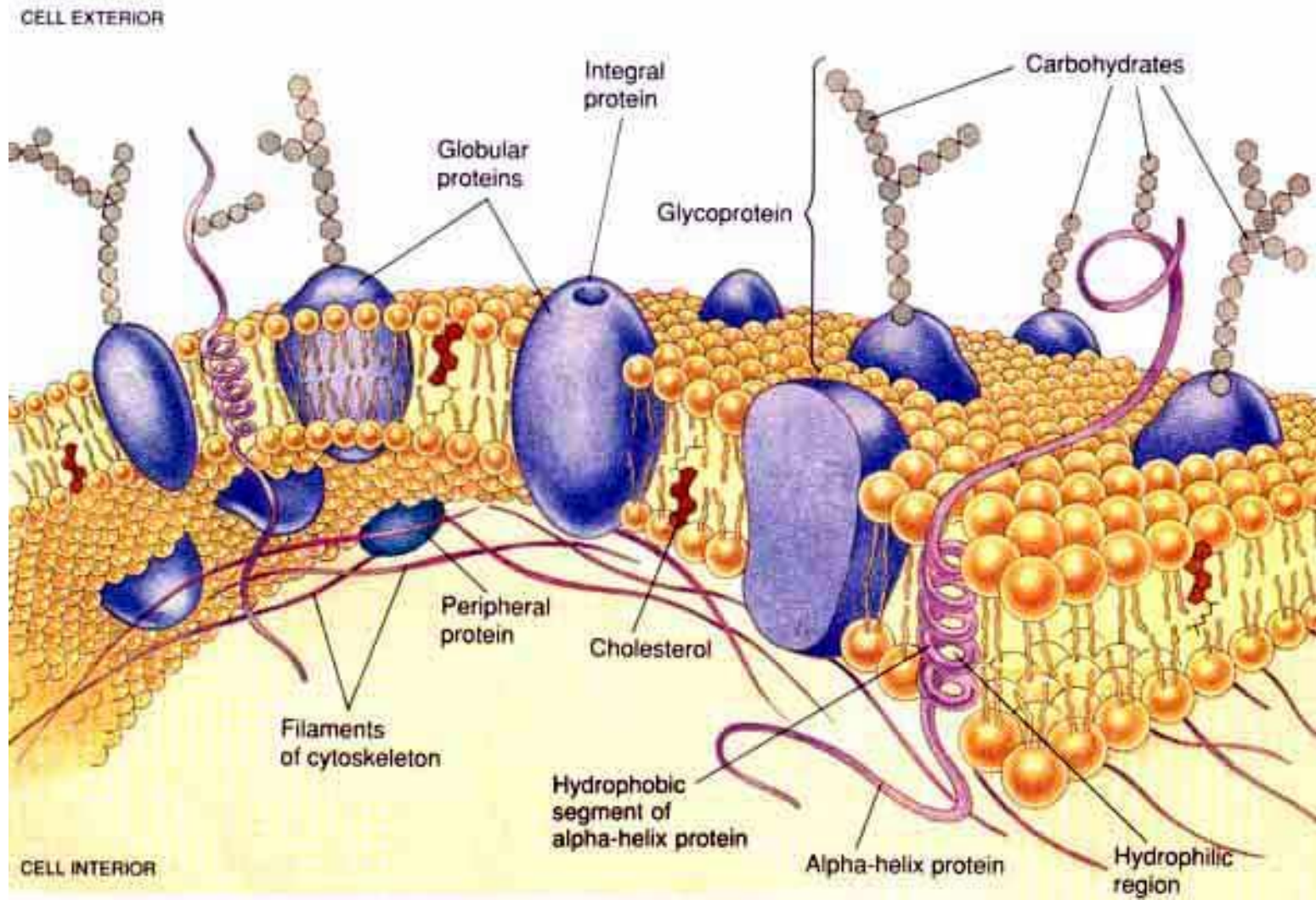
5., Carotenoids

pigments (conjugated double-bonds) e.g.:
carotene (carrot) , retinal (eye)





Cell membrane

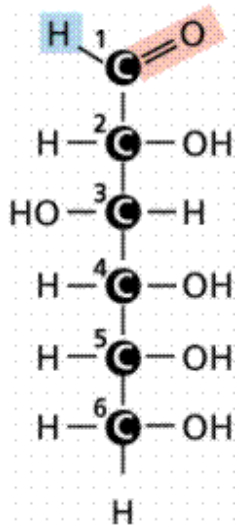


Biological Macromolecules

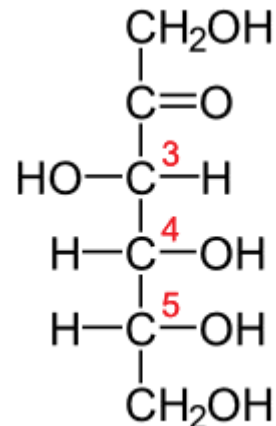
1. Lipids
2. **Carbohydrates**
3. Nucleic acids (DNA, RNA)
4. Proteins

Carbohydrates

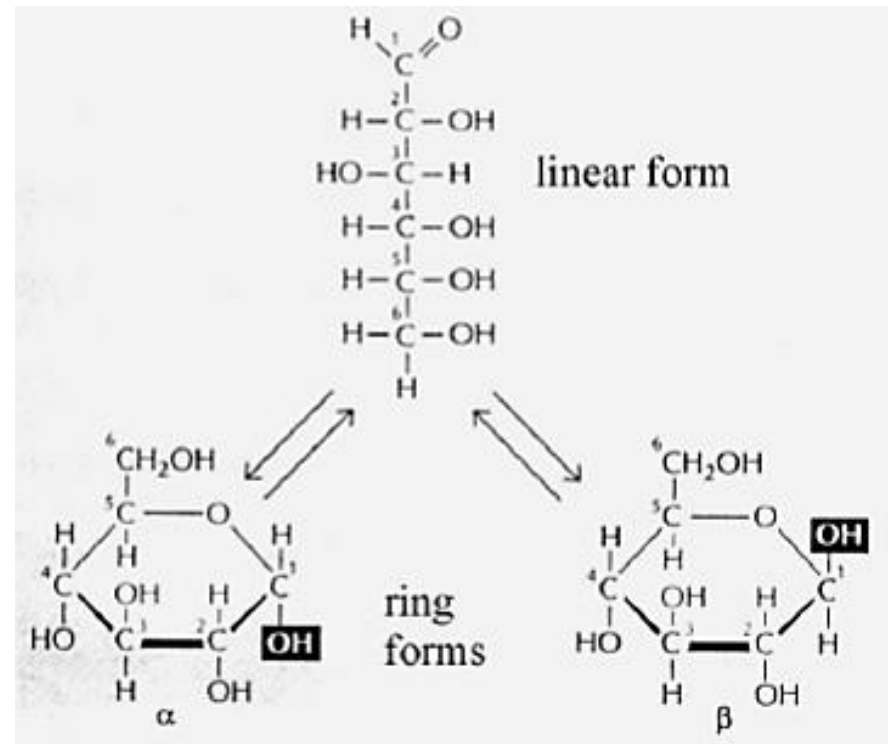
- general formula: $(\text{CH}_2\text{O})_n$
- they are polyhydroxi aldehydes or ketones



glucose

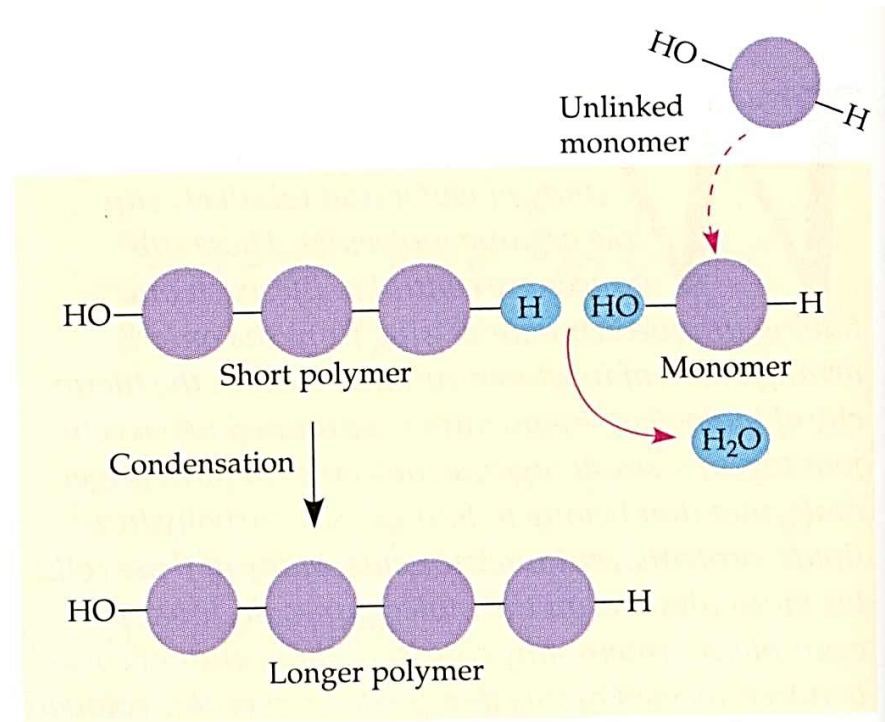


fructose



Carbohydrates

- *Monosaccharides*
- *Disaccharides*
- *Oligosaccharides*
- *polysaccharides*

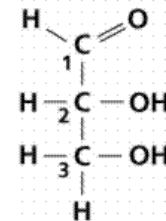


(a) Condensation synthesis (dehydration) of a polymer

Monosaccharides

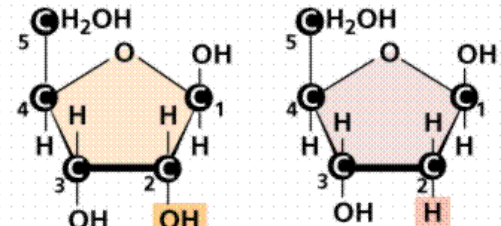
- *trioses*: e.g. glyceraldehyde-3-phosphate
- *pentoses*: e.g. ribose, deoxyribose
- *hexoses*: e.g. glucose, fructose, mannose, galactose

Three-carbon sugar



Glyceraldehyde

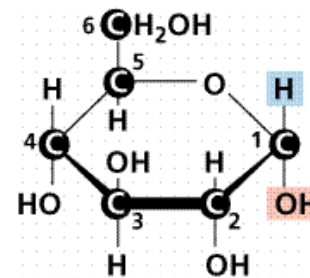
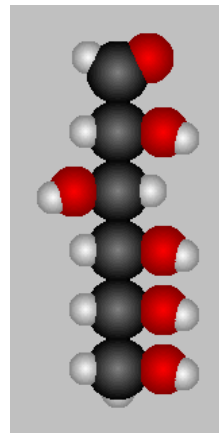
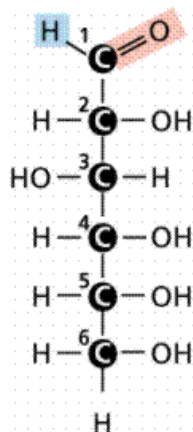
Five-carbon sugars



Ribose

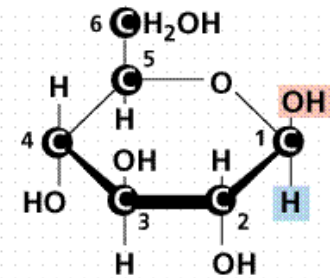
Deoxyribose

Six-carbon sugars

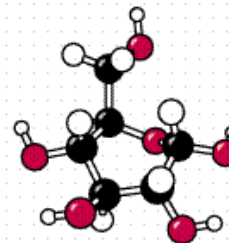


(c) α -Glucose

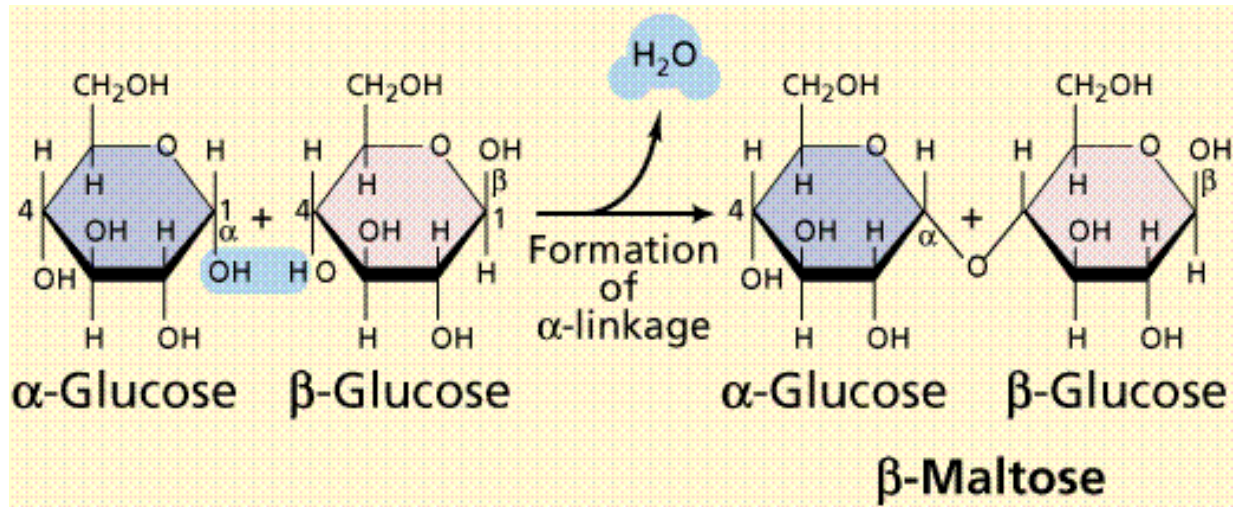
or



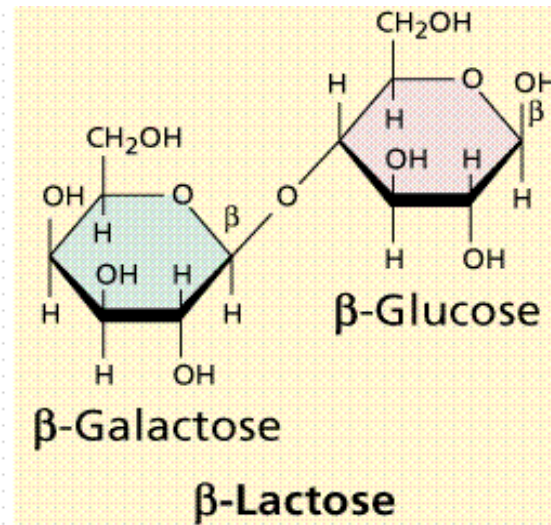
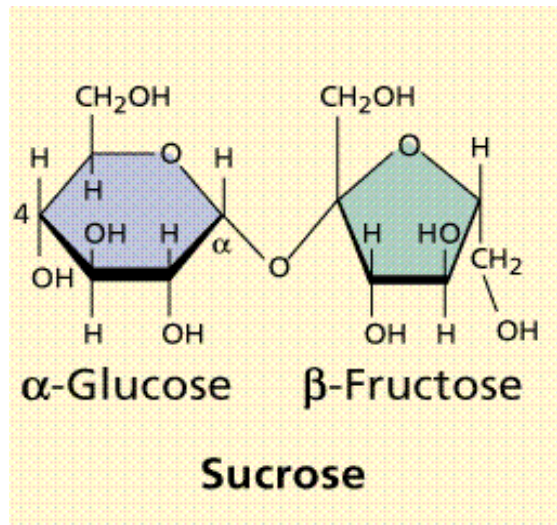
(d) β -Glucose



Disaccharides



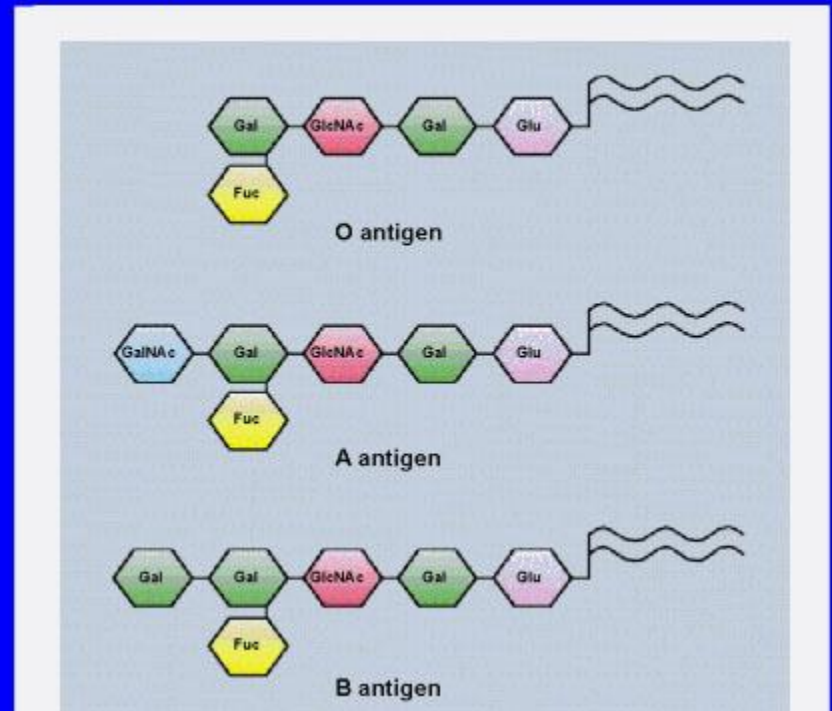
α (1 \rightarrow 4) glycosidic bond



Oligosaccharides

- consist of 3-10 monomers
- are bound to lipids, proteins by covalent bonds
- markers → ABO blood groups

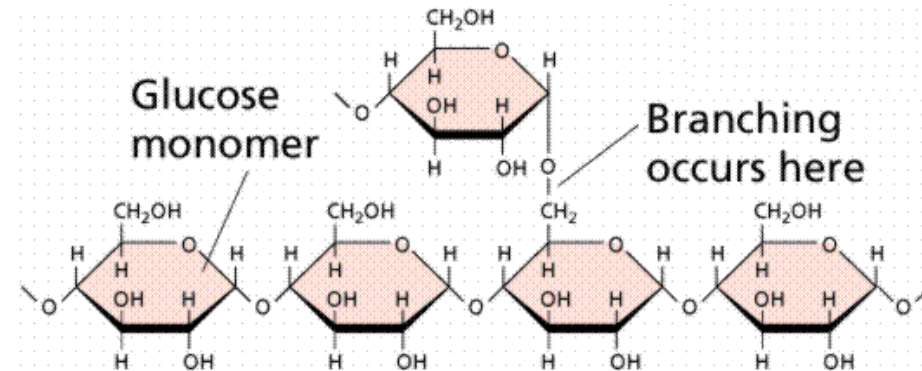
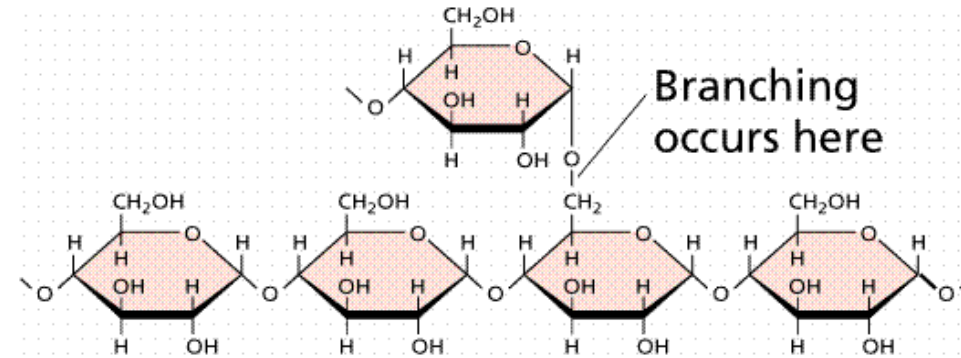
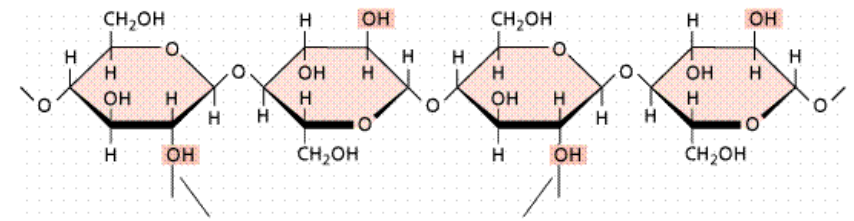
Glycolipids Determine Blood Group

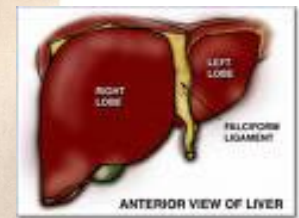
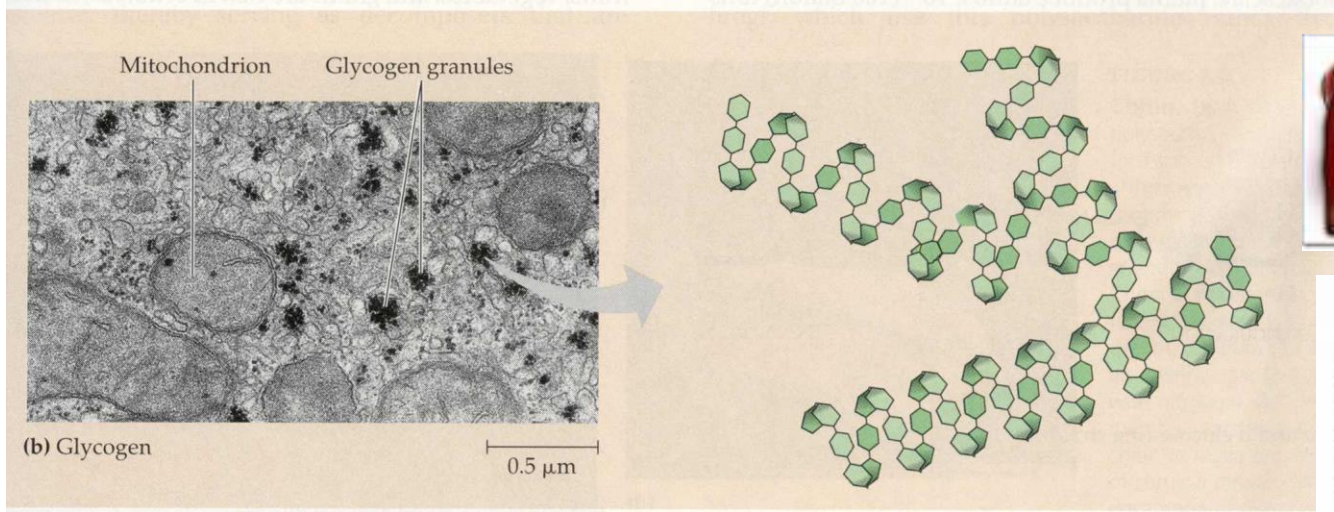
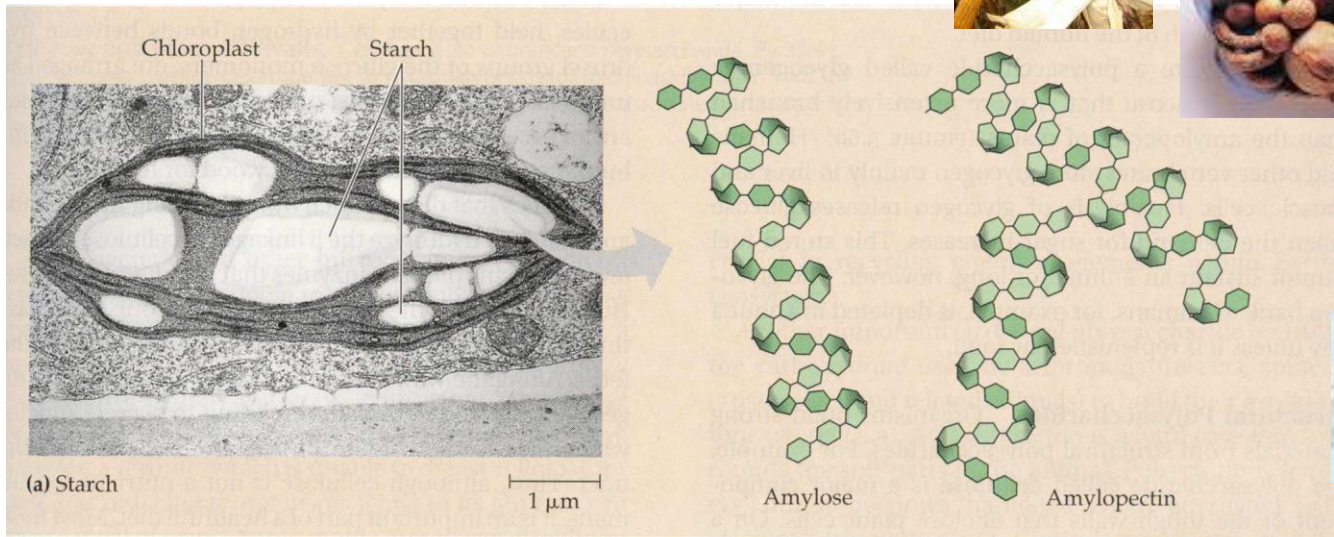


Polisaccharides

With glucose monomers:

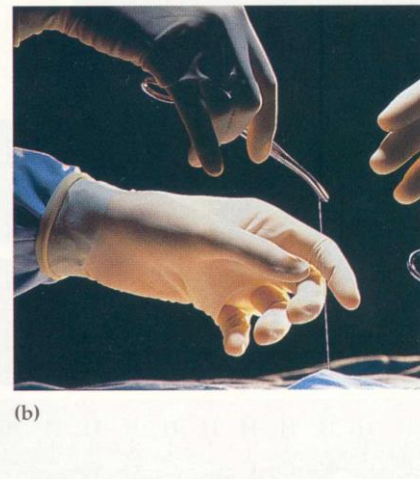
- cellulose (cell wall)
- starch:
 - amylose (helical structure, stabilized by H bonds)
- +
 - amylopectin (branched)
- glycogene: glucose storage (mainly in liver and muscle)





Glycogen is an important polysaccharide composed of glucose molecules, it is found in animals and humans (liver and skeletal muscles); function: energy storage.

Chitin



(b)

glycosaminoglycans

