Lipids

Tuesday, 17 April 2018 11:22 am

- Structurally highly diverse
- Lipids are defined as being highly hydrophobic
- Small variations in structure make a big difference to function

Function

- Energy storage
  - Reduced compounds, high energy - can be highly oxidised
  - Hydrophobic, really good packing
- Insulation
  - Low thermal conductivity
  - High heat capacity (ability to absorb heat)
  - Mechanical protection - protection against shocks
- Water repellent
  - Keeps surfaces dry
  - Prevents excess wetting (birds)
  - Prevents evaporation - water loss
  - Buoyancy in marine animals
- Membrane structure
- Cofactors of enzymes
  - Vitamin K for blood clotting
  - Coenzyme Q - ATP synthesis
- Signalling molecules
  - Paracrine hormones - locally active
  - Steroid hormones - globally active
  - Growth factors
  - Vitamins A and D
- Pigments - double bonds
- Antioxidants

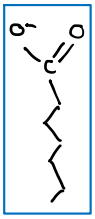
Two main categories

- Contains fatty acids
- Does not contain fatty acids

Fatty Acids

- Long chain carboxylic acids - 4 to 36 carbons - unbranched
- Saturated - no double bonds
- Monounsaturated - one double bond
- Polyunsaturated - many double bonds

Alkyl Chain →



- Almost all fatty acids have an even number of carbons

Unsaturation

- Double bonds, in the alkyl chain
- Can result in cis or trans configurations
  - Cis configurations are more naturally occurring
  - Trans configurations are harder to metabolise

Cis Trans

Properties

- As alkyl length increases, melting point increases
- As alkyl length increases, solubility decreases
- More cis, double bonds - melting point decreases
  - Less efficient packing because of the kink in the tail
  - Saturated and trans-unsaturated fats stack particularly well

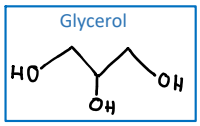
Trans fatty Acids

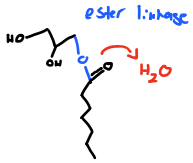
- Form by partial dehydrogenation of unsaturated of unsaturated fatty acids
  - Increases temperature stability
  - Increases shelf life
- Also formed by deep frying
- Less freely broken down by enzymes, greater build up in the system

Triacylglycerols (3-long chain-glycerol backbone)

- Primary storage lipid
  - Solid at RT - called fats
  - Liquid at RT - called oils
- Less dense than water
- Less soluble than fatty acids because of lack of polar COO^-
- The OH groups of the glycerol react with the COO^- groups of the fatty acid to form ester linkages in a dehydration/condensation reaction

Glycerol





Fats Vs Polysaccharides

- Fats carry more energy (more reduced)
- Fats carry less water per gram
- Glucose/glycogen - short term energy stores
- Fats are long term energy storage
  - Highly efficient
  - Slow delivery of energy

Waxes

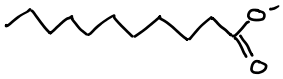
- Long chain saturated and unsaturated fatty acids bonded (ester) to a long chain alcohol
- Have a high melting point/are insoluble

Systematic Naming

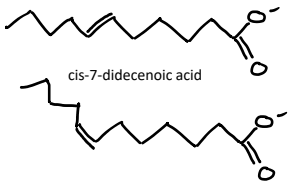
- Base hydrocarbon - alkane/alkene - length
  - anoic for alkane
  - enoic for alkene
- "-oic acid" suffix
- Configuration - bond position

E.g.

decanoic acid



trans-6-decenoic acid



cis-7-didecenoic acid

Delta/Omega Numbering

- Ratio of the number of carbons to the number of double bonds
  E.g. octadecenoic acid
  18: 2

Delta

- Counting from the carboxyl end, where are the location of the double bonds
  E.g. cis-2,5-nonenoic acid
  9: $2^{\Delta 2,5}$

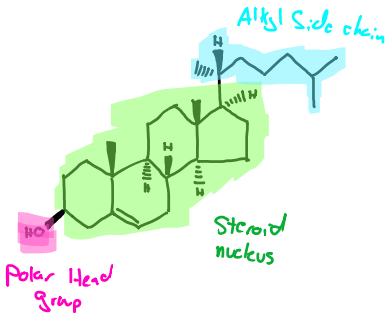
Omega

- Counting from the terminal end, where are the location of the double bonds
  E.g. cis-2,5-nonenoic acid
  9: $2^{\omega 4,6}$

Sterols

- Smaller fats, ring based structure
- Cholesterol modulates fluidity and permeability
  - Thickens plasma membrane by slotting in between phospholipid tails
- Transported through the blood stream, bound to proteins
- All possess a four ringed structure

Basic structure of sterol:



Cholesterol

- Enters hydrophilic region of bilayer, increasing melting point, and decreasing fluidity
- Has high interaction with hydrophobic tails

Steroids

- Derivative of sterols - oxidised
- No alkyl side chain
- Synthesised from cholesterol
- Carried through the bloodstream
- More polar than cholesterol
- Used as intracellular messaging

Vitamins

- Present in smaller quantities
- Lipid soluble (A, D, E, K)
- Signalling nearby cells

Vitamin D

- UV light breaks the $C9 \rightarrow 10$ bond in cholesterol to form vitamin D
- Regulates Cu^+ deposition in bones

Vitamin A

- Converted from βcarotene by breaking it in half with UV light
- Used as a pigment and precursor to hormones

Vitamin E/K - (lipid quinones)

- Polymers of isoprene
- Antioxidant
- Regulates blood clotting

Isoprene

- Slow delivery of energy

Waxes

- Long chain saturated and unsaturated fatty acids bonded (ester) to a long chain alcohol
- Have a high melting point/are insoluble
- Mostly for protection/waterproofing

Vitamin E/K - (lipid quinones)

- Polymers of isoprene
- Antioxidant
- Regulates blood clotting
- Acts as electron carriers
- Sugar carriers

Isoprene