

Lipids

Lipid is the collective name for fats, oils, waxes and fat-like molecules (such as steroids) found in the body. Their roles include:

- components of cell membranes (phospholipids and cholesterol)
- energy stores
- chemical messengers (steroid 'hormones')
- protection, waterproofing, insulation and buoyancy agents.

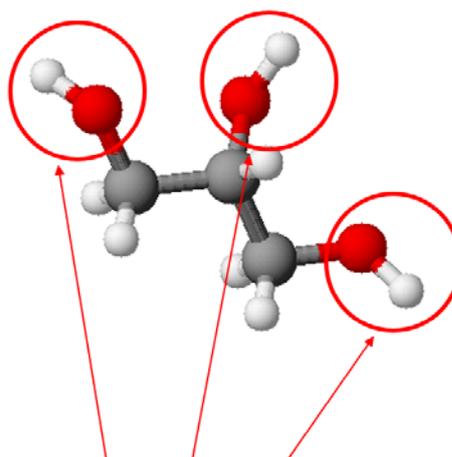
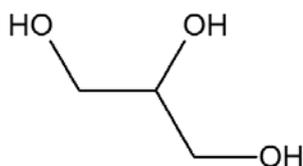
The basic unit of lipids is a triglyceride, synthesised from glycerol (propane-1,2,3-triol) and fatty acids.

Glycerol is a type of alcohol. **Alcohols** are organic compounds. Their molecules are characterised by **hydroxyl groups**, -OH. Glycerol is a **trihydric** alcohol, which means each molecule has three hydroxyl groups.

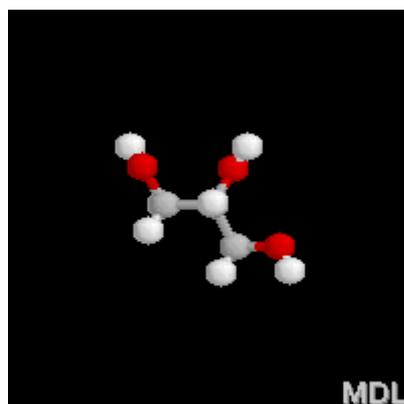
Glycerol, C₃H₈O₃

Glycerol is a trihydric alcohol, in other words each molecule has three hydroxyl groups

Its skeletal formula is



There is one hydroxyl (alcohol) group attached to each carbon atom in the chain



Glycerol

Fatty acids

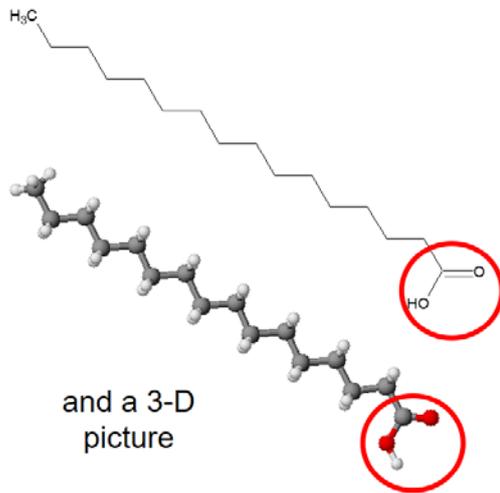
Fatty acids are also organic compounds. Each fatty acid has a **carboxylic acid** (-COOH) group. Some fatty acids are saturated. These means all carbon-carbon bonds are single covalent bonds. Other fatty acids are unsaturated. This means that while most carbon-carbon bonds are single covalent bonds, some are double bonds.

Fatty acids

Fatty acids are carboxylic acids with a long hydrocarbon tail

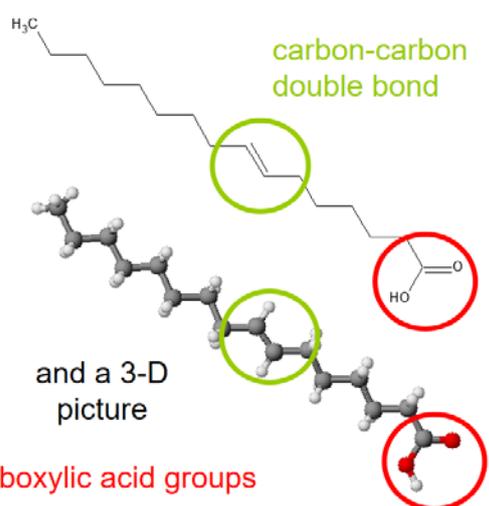
They may be **saturated** or **unsaturated**

Here is the skeletal formula for a typical **saturated** fatty acid



and a 3-D picture

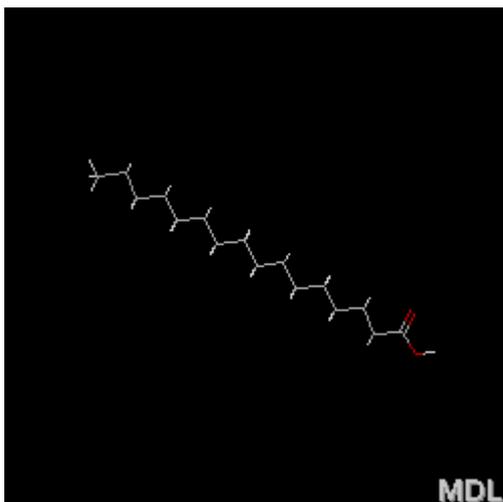
Here is the skeletal formula for a typical **unsaturated** fatty acid



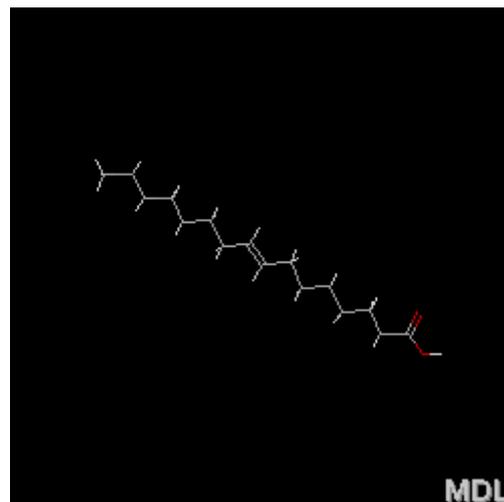
and a 3-D picture

carboxylic acid groups

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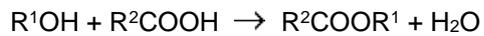
Saturated fatty acid



Unsaturated fatty acid

Esters

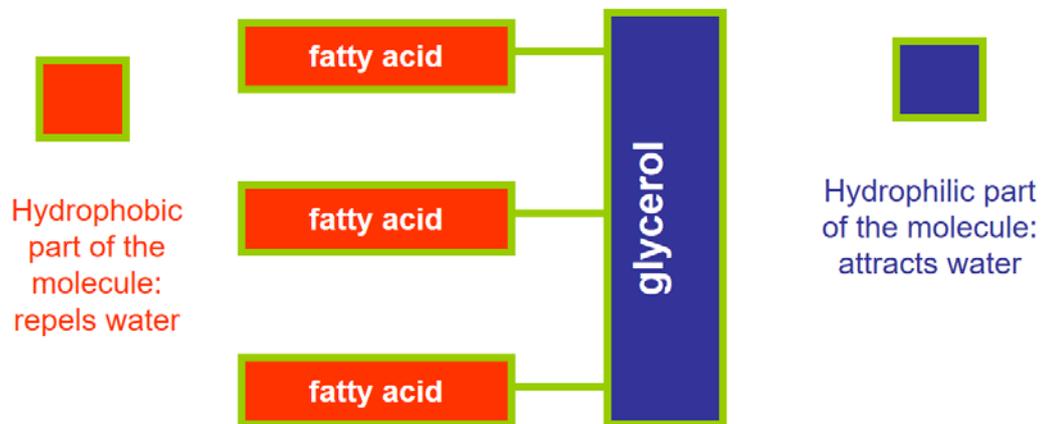
Alcohols react with carboxylic acids to form esters



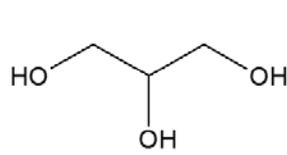
As with the formation of glycosidic and peptide bonds, this is a **condensation reaction**. A water molecule splits out. The glycerol molecule has three hydroxyl groups. When one reacts with a fatty acid a monoglyceride forms.

When two react with two fatty acid molecules a diglyceride forms. And when three react with three fatty acid molecules a triglyceride forms.

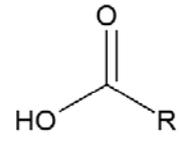
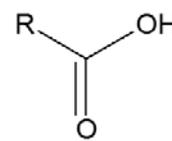
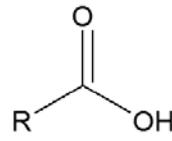
Representation of a triglyceride



Formation of a triglyceride

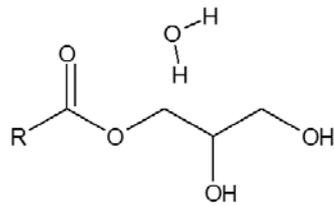


glycerol

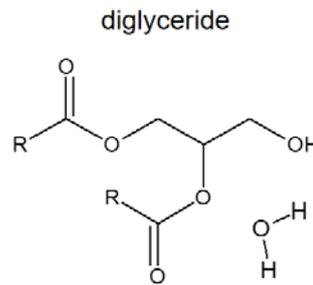


fatty acids (R is shorthand for the hydrocarbon tail)

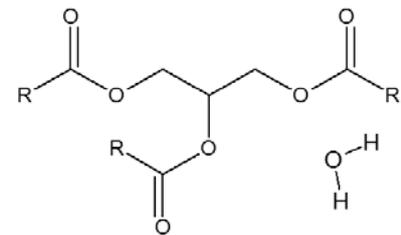
Each fatty acid reacts with a hydroxyl groups to form an ester group and a water molecule



monoglyceride



diglyceride



triglyceride

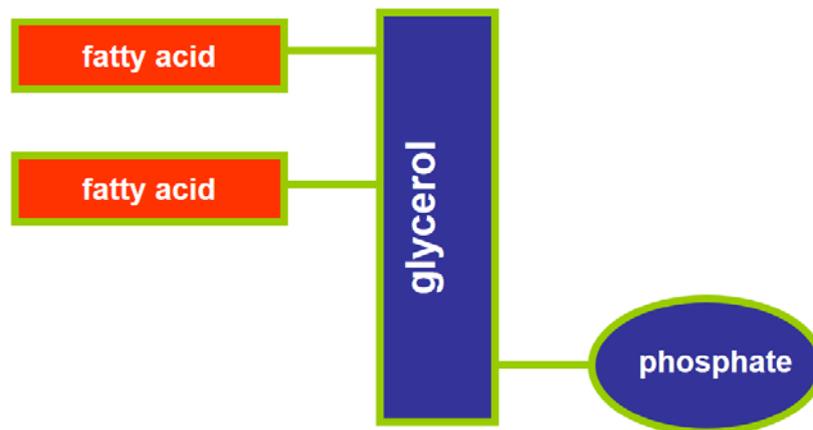


Triglycerides formed between glycerol and unsaturated fatty acids are usually oils. Those formed with saturated acids are usually fats.

Phospholipids

Phosphoric acid is an inorganic compound. Its molecular formula is H_3PO_4 . Like fatty acids, it can react with alcohols to form esters (in this case, usually called phosphate esters). In phospholipids, one of the fatty acids of a triglyceride is substituted by a phosphate group.

Representation of a phospholipid



Hydrophobic part of the molecule: repels water



Hydrophilic part of the molecule: attracts water

Phospholipids have a key role in the structure and properties of **cell membranes**.

Test your knowledge

[Take quiz on Lipids](#)