

# 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.

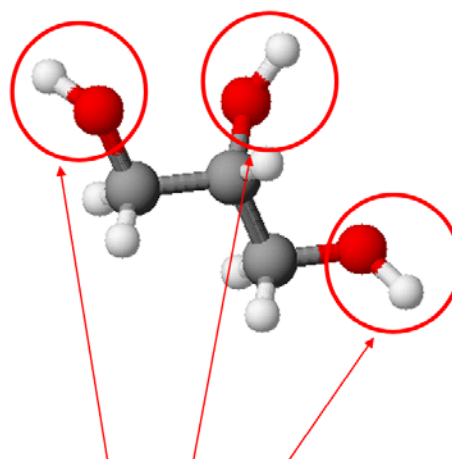
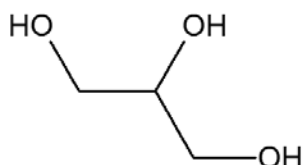
The basic unit of lipids is a triglyceride, synthesised from glycerol (propane-1,2,3-triol) and fatty acids.

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.

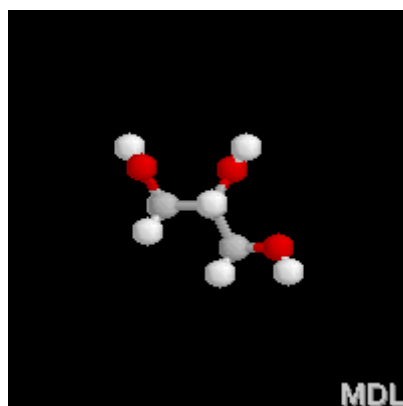
## Glycerol, $C_3H_8O_3$

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

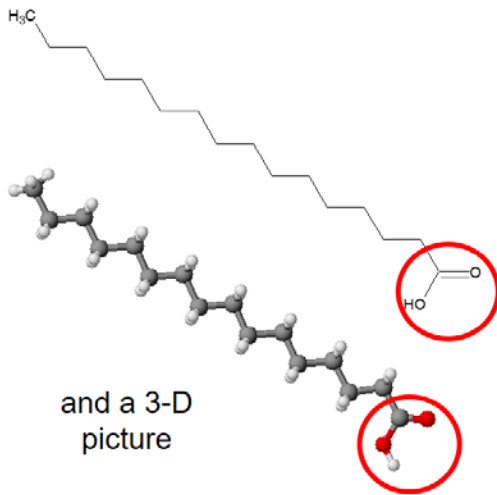
Fatty acids are also organic compounds. Each fatty acid has a **carboxylic acid** (-COOH) group. Some fatty acids are saturated. These means all carbon-carbon bonds are single covalent bonds. Other fatty acids are unsaturated. This means that while most carbon-carbon bonds are single covalent bonds,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

## Fatty acids

Fatty acids are carboxylic acids with a long hydrocarbon tail

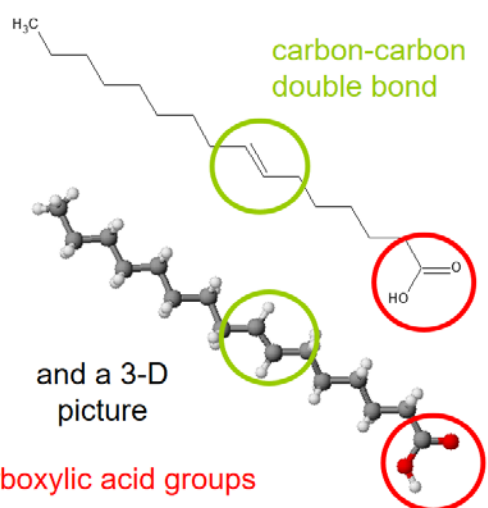
They may be **saturated** or **unsaturated**

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



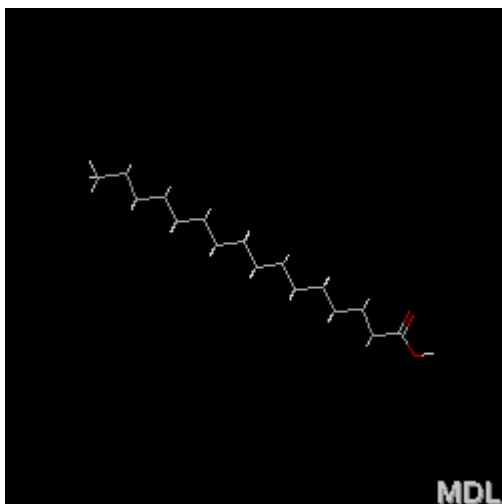
and a 3-D picture

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

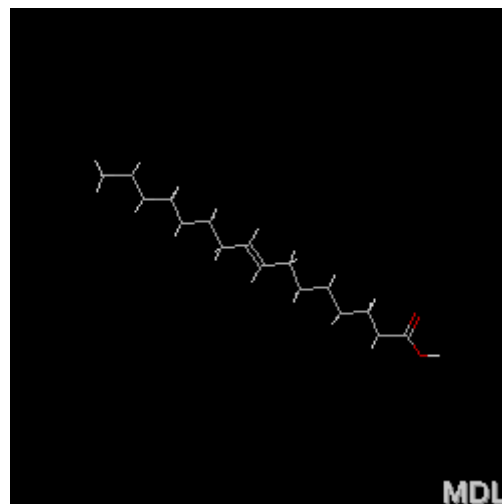


and a 3-D picture

carboxylic acid groups



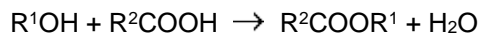
Saturated fatty acid



Unsaturated fatty acid

## Esters

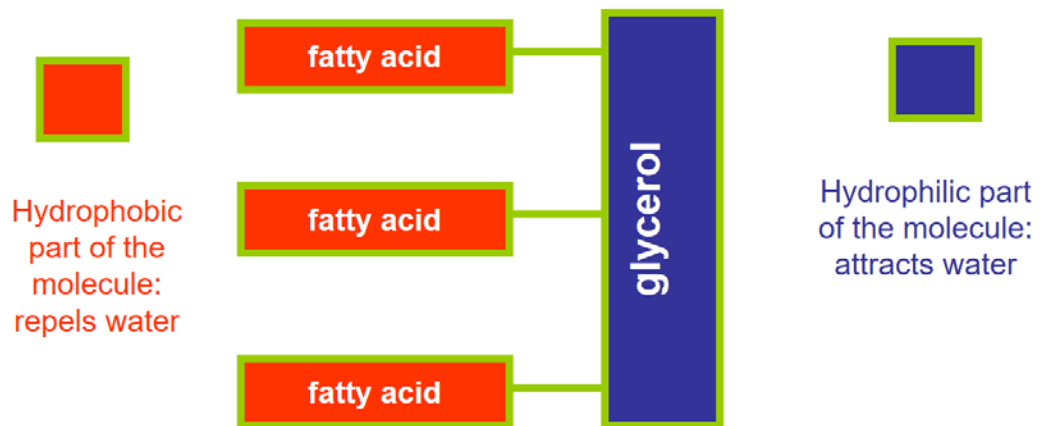
Alcohols react with carboxylic acids to form esters



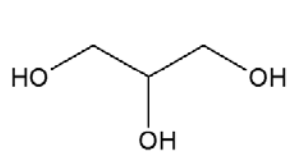
As with the formation of glycosidic and peptide bonds, this is a **condensation reaction**. A water molecule splits out. The glycerol molecule has three hydroxyl groups. When one reacts with a fatty acid a monoglyceride forms.

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

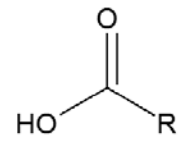
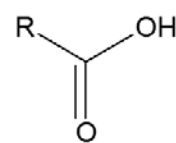
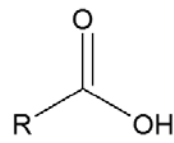
### Representation of a triglyceride



## Formation of a triglyceride

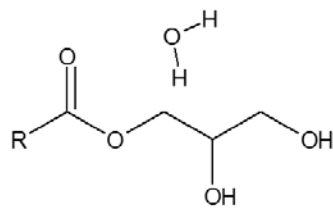


glycerol

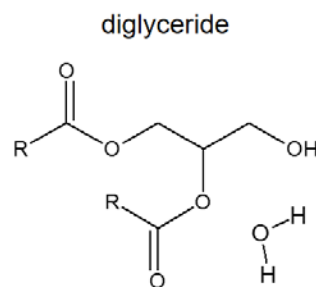


fatty acids (R is shorthand for the hydrocarbon tail)

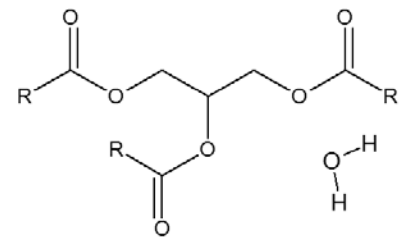
Each **fatty acid** reacts with a **hydroxyl** groups to form an **ester** group and a water molecule



monoglyceride



diglyceride



triglyceride

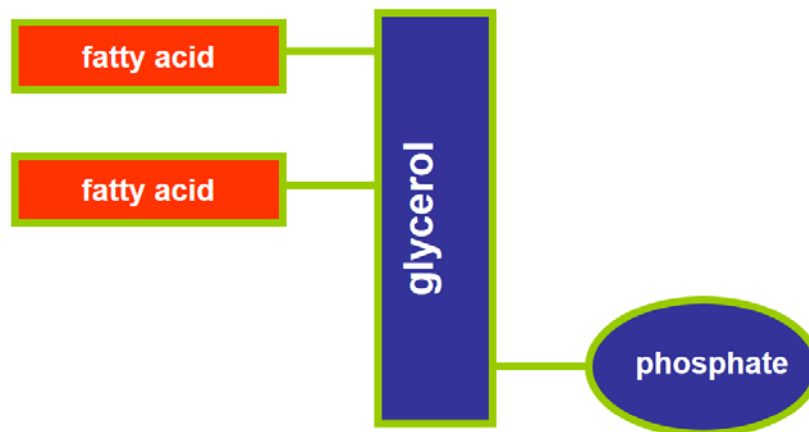


Triglycerides formed between glycerol and unsaturated fatty acids are usually oils. Those formed with saturated acids are usually fats.

## Phospholipids

Phosphoric acid is an inorganic compound. Its molecular formula is  $\text{H}_3\text{PO}_4$ . 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](#)