I'm an organic chemistry noob, so please let me know of my mistakes on bert.hubert@netherlabs.nl. I wrote this document as part of learning enough organic chemistry to be able to read papers on the effects of various kinds of fat on our health.

1 Fatty acids

First, the fatty acids. Fatty acids consist of a chain of carbon and hydrogen atoms. The part with three hydrogen atoms, on the left in our picture, is known a methyl group. On the other end we find a carboxyl ($COOH$) group.

Saturated fatty acid, all carbon atoms have four neighbours (except carboxyl group at the end):

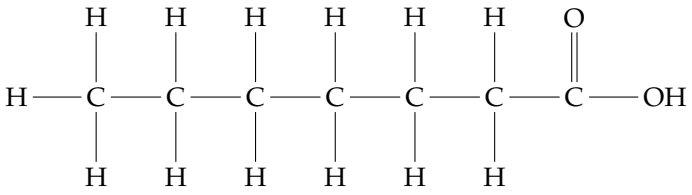


Figure 1: "Enanthic acid", or "Heptanoic acid", or $CH_3(CH_2)_5COOH$, or 7:0

(cis) Mono-unsaturated fatty acid, two carbon atoms lost a hydrogen atom each and now have a double bond together:

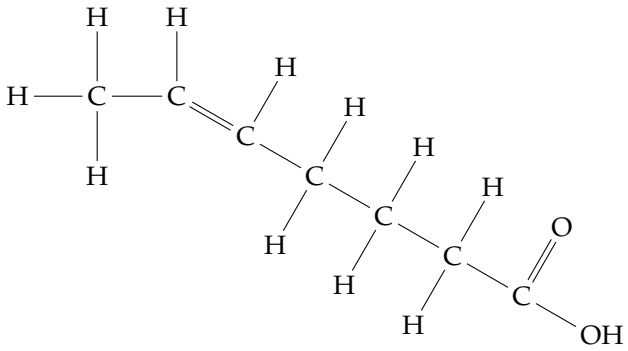


Figure 2: cis-Δ^5-heptanoic acid, 7:1, n-2

The bend is because the hydrogen atoms repel, which is normally counteracted by the hydrogen atoms on the other side, but they are gone. (cis) Poly-unsaturated fatty acid, same thing except it happened one more time:

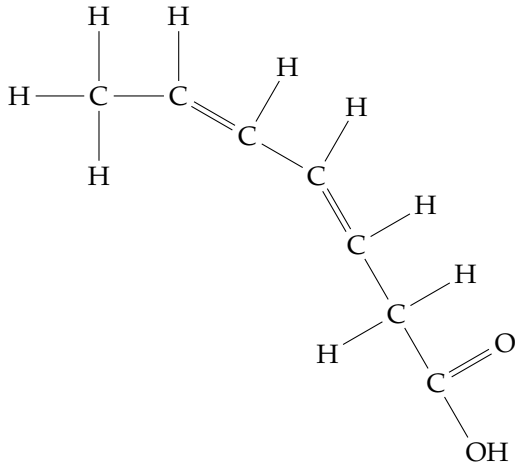


Figure 3: cis-cis-Δ^2, Δ^5-heptanoic acid, 7:2, n-2

Trans unsaturated fatty acid, here again two carbon atoms lost a hydrogen atom each, but they lost one on opposite ('trans') sides this time:

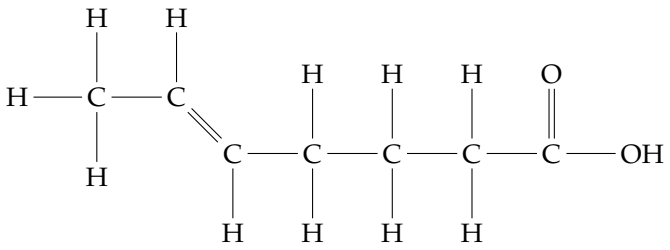
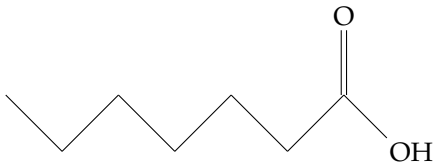


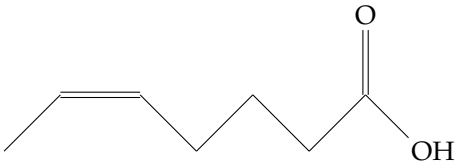
Figure 4: trans-Δ^5-heptanoic acid, 7:1, n-2

2 Skeletal representation

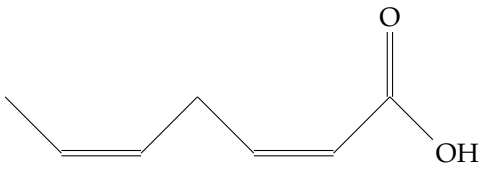
This again is saturated heptanoic acid, except we've left out all the "obligate" C and H atoms:



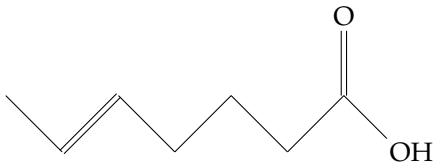
Monounsaturated version. There appears to be some meaning to the (lack of) kinks and the cis- or trans nature of a bond, where trans bonds are typically represented as "straight". I made up the kinks for the cis bonds:



Polyunsaturated, similar:



And here is a transfat:



3 Naming

The naming of fatty acids is highly complex, with no less than 5 methods in common use. Many specific fatty acids have been assigned names that are not directly related to their structure, like for example the enanthic acid above. There's no alternative to just looking up such names to find out what people mean. Secondly, there are names which

refer to the number of carbon atoms, like in this case heptanoic acid, in which you might recognize the greek word for 7.

In popular usage, we may hear of ω-3 oils or ω-6 oils. And although ω has a great ring to it, serious organic chemists now prefer to speak about n-3 or n-6 fatty acids. The number '3' or '6' denotes the first double bond as counted from the methyl group (on the left in our pictures). So 'n-3' fatty acid might refer to any kind of fatty acid that has a double bond there. It says nothing about any further double bonds.

A more exact way of writing the name of our n-2 fatty acid down is like this: cis-Δ^5-heptanoic acid. And to complicate things further, in this notation we count not starting at the methyl group, but from the other end, the carboxyl group! If there are further double bonds, they are written out explicitly: cis-cis-Δ^2, Δ^5-heptanoic acid.

Finally, as a sort of summary, this last fatty acid is known as '7:2', since it has 7 carbons and 2 double bonds.

4 Triglycerides

Fatty acids can be free ("FFA"), but can also be part of 'triglycerides', and this is how they are found in vegetable oil or in animal fats.

A triglyceride consists of a glycerol molecule, with a fatty acid hooked up to all three of its OH groups. These fatty acids are often of different kinds.

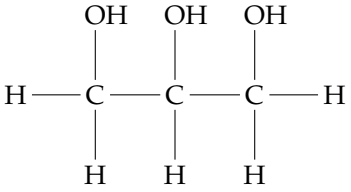


Figure 5: Glycerol

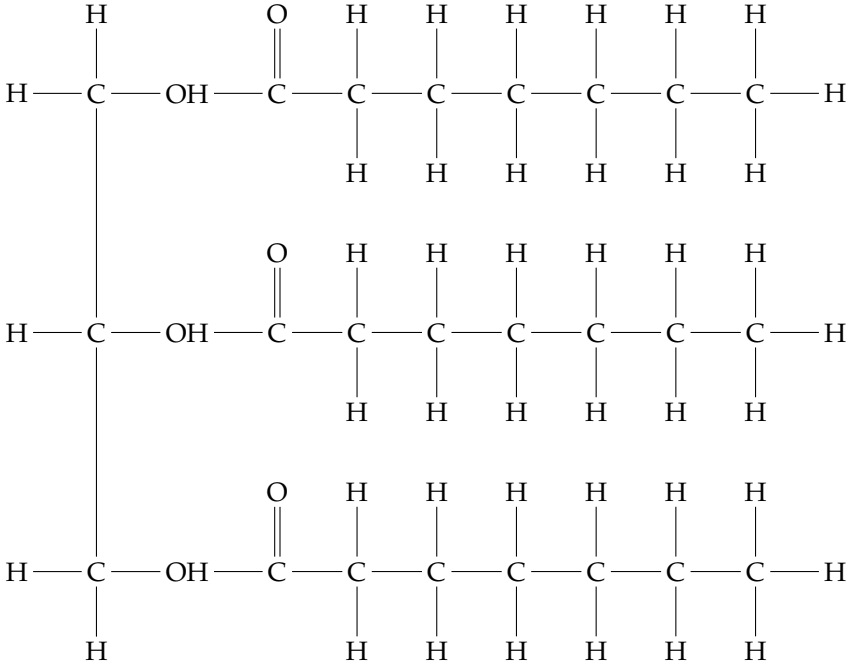


Figure 6: Triacylglycerol

This combination is then called a triglyceride, which is more broadly classified as an "ester". The combining of free fatty acids with glycerol is therefore also called "esterification". Triglyceride is also called triacylglycerol, TAG, or triacylglyceride.