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dietary fats

1. structure and digestion

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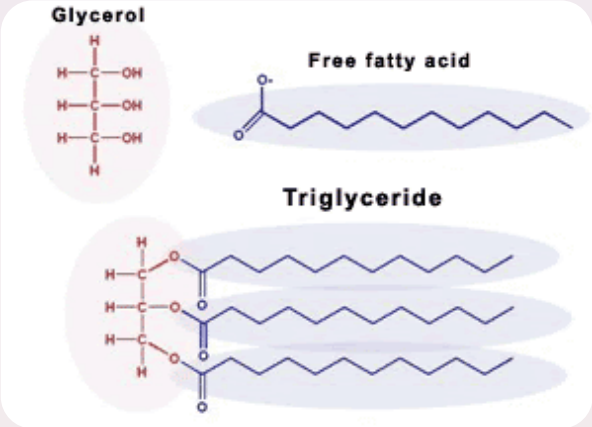
Fats, or lipids, are one of three key macronutrients found in food alongside protein and carbohydrates. Owing to them being insoluble, they have a unique set of uses by the body. Fats keep us warm, protect our organs, enable us to absorb certain vitamins and provide an efficient energy store, with every gram supplying nine calories per gram (kcal/g). This compares to four calories per gram from carbohydrate and protein.

The main type of fats in food are triglycerides, or triaglycerols. From a chemical perspective, these are natural esters of glycerol with various fatty acids. Other compounds under the umbrella 'fats' are phosophoglycerols (phospholipids) and cholesteryl esters (cholesterol). Cholesterol is a sterol, or ringed lipid, with an alcohol unit at one end. It is important to cell membranes and is a precursor to other important molecules such as vitamin D and bile acids.

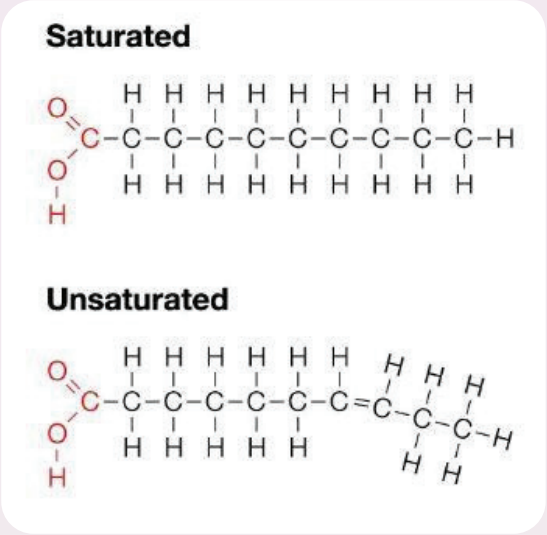
Triglycerides are named as such since they are made up of three fatty acids with a glycerol (sugar alcohol) backbone. The fatty acids within a triglyceride will determine the properties of that fat, such as solubility, melting point and health effects.



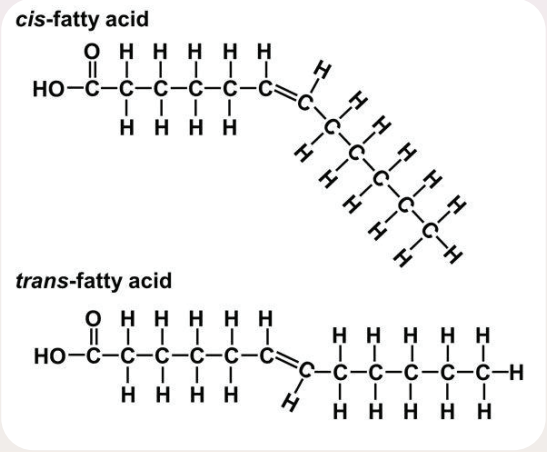
saturated & unsaturated fats

Fatty acids are a chain of carbon atoms with a varying number of hydrogen atoms attached, the difference between 'saturated' and 'unsaturated' fatty acids is the number of hydrogen atoms attached to his carbon backbone.

Saturated fatty acids are those where the carbons each have two hydrogens attached, aside from the carbon at the end which has three, and therefore have no double bonds. 'Unsaturated' fatty acids are those that have one or more double bonds between two carbon atoms. If one double bond is present it's a 'mono'-unsaturated fat, and if there are two or more double bonds it's 'poly'-unsaturated fat.



Of the unsaturated fats, there's also the distinction of 'cis' and 'trans' fats. This describes the configuration of the double bond and impacts the properties of the fatty acid.



Cis are the predominant portion of naturally occurring unsaturated fats, with the small portion of trans fats found in nature produced by ruminants. Meaning they are present in animal products such as milk and meat. Other trans fats found in foods typically result from an industrial process called 'partial hydrogenation', which is used to change the semi-solid form of plant oils to solids for food manufacturing. Although this process has largely been eradicated from the food industry since the health implications of eating such fats came to light.

The length of the carbon chain, level of unsaturation (number of double bonds) and position of the double bonds determine properties of the fat. For example, saturated fats will be solid at room temperature whilst mono- or polyunsaturated fats will be semi-liquid or liquid. The longer the chain of carbons in the fatty acid the higher the melting point, the more double bonds the lower the melting point.

digestion of fats

Triglycerides, and a small amount of cholesterol, are absorbed by intestinal cells called 'enterocytes' where they are packaged into transport complexes called 'chylomicrons'. Chylomicrons are a type of lipoprotein, as lipids are insoluble in water they need to be transported as part of a lipid-protein complex.

Lipoproteins have an inner core of triglycerides and cholesterol esters and an outer shell of phospholipids, cholesterol and apoproteins. The latter play a structural role and are

recognised by cell receptors along the fat digestion pathway.

As well as chylomicrons, other lipoproteins involved in fat digestion are classed according to their density. Density is dependent on the lipid to protein ratio, and as lipid reduces the lipoprotein will be smaller and more dense. Key when discussing fundamentals of fat transport are Very Low, Low and High Density Lipoproteins (VLDL, LDL and HDL, respectively).

Once exogenous fat, fat from our diet, is packaged into chylomicrons it is broken down by the enzyme lipoprotein lipase and then reassembled or stored by adipose or muscle tissues. Any remaining fats are then transported to the liver, in a chylomicron remnant.

Endogenous fats, those formed and packaged by the liver, are transported in VLDL for uptake by adipose or muscle tissues. Once free fatty acids are transferred to these tissues, to be reassembled to triglycerides, the VLDL forms an intermediary state (IDL) before forming LDL and HDL. LDL transports lipids to peripheral tissue and the liver, whist HDL can return cholesterol to VLDL, chylomicrons or the liver. Cholesterol delivered to the liver is removed via bile.

In relation to health, the density and size of the lipoproteins circulating in our blood matters since this determines their ability to enter and exit arteries. For example, LDL can enter arteries but not exit whilst HDL can both enter and exit arteries. For this reason, LDL is considered 'pro-atherogenic' and a risk factor for atherosclerosis. Intake of saturated fats can impact the amount of LDL circulating in the blood, owing to mechanisms such as their ability inhibit the liver's uptake of LDL.

summary

The main dietary fats are triglycerides, which consist of three fatty acids and a glycerol backbone. These fatty acids are either saturated or unsaturated, dependent on the number of double bonds, and this, along with the configuration of the double bonds, determines the behaviour of the fat. Digestion of fats requires a series of lipoproteins that enable insoluble fat to be transported and transferred to tissues for storage or further breakdown. Certain lipoproteins are considered pro-atherogenic, such as Low Density Lipoprotein (LDL), so the amount of these in the blood is important when it comes to health and this is impacted by factors such as saturated fat intake.

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