




# OXIDATION OF LIPIDS AND PROTEINS

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## General Information on Lipids:


They contain C, H and O elements just like carbohydrates, however the ratio of "O" atoms to "C" atoms is less than the ratio in carbohydrates, therefore it is harder to burn them. Lipids are used as a source of energy and also used as building block in cell membranes.

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They are also found in vitamins A, D, E, K and in the structure of compounds such as prostaglandins that stimulates muscle contraction. They yield **twice** the energy that carbohydrates provided, however since the amount of oxygen in their structures is scarce, they are difficult to oxidize. People taking excessive amounts carbohydrates turn these foodstuff into lipids and store them in the form of fats.

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Excessive amount of fats are stored as a subcutaneous layer in the cells of fat tissue. Therefore, they aid in the thermoregulation.

they form the 15-25% of the cell membrane and are important in respect to the cell permeability.

They have polar and non-polar groups and since non-polar groups are found more, they do not dissolve in water but they dissolve in organic solvents like ether, chloroform, acetone etc.


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They are divided into 2 groups as **fats** and **oils**:

**1) Fats:** They have high melting points and are in solid form at room temperature (20°C). E.g. butter, tallow, lard, cacao butter.

**2) Oils:** They have low melting points and are in liquid form at room temperature. E.g.: olive oil, sunflower seed oil, corn seed oil.

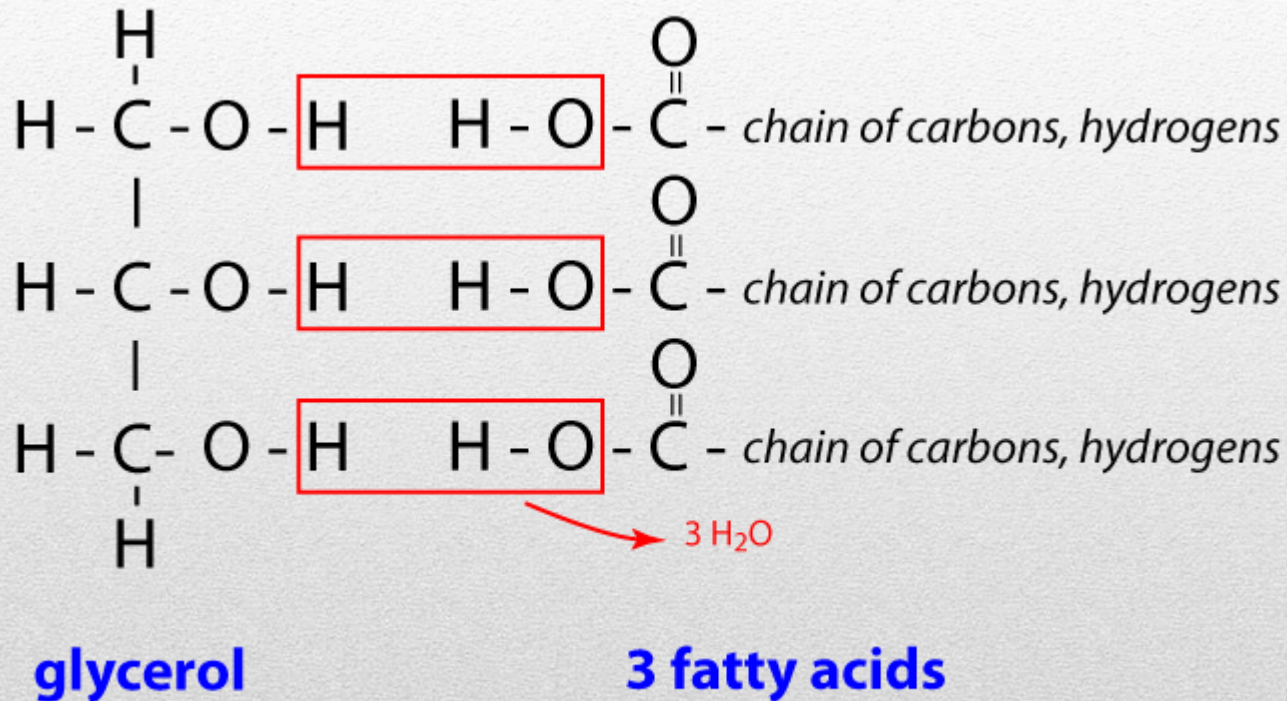
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Animal originated lipids are usually solids and vegetable oils are liquids. However, cacao butter found in cacao plant (*Theobroma cacao*) and fish oil and lipids obtained from whales are exceptions for both of these groups.

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# Chemical composition of lipids:





**Fatty acids:** They provide diversity and property to the lipids. A fatty acid molecule is formed of a long chain of carbons having a carboxyl group (-COOH) yielding acidic character. Fatty acids may contain 4 carbon atoms at the least and 24 carbon atoms at the most, however they mostly has 16 or 18 carbon atoms in the nature.

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Fatty acids are divided into two groups as saturated and unsaturated fatty acids:

**a) Saturated fatty acids:** H atoms are found in all "C" atoms in these fatty acids.

E.g. : Stearic acid, Palmitic acid

**b) Unsaturated fatty acids:** One or more double bonds are present in between carbon atoms. E.g. oleic acid, linoleic acid, linolenic acid.

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Fatty acids are also divided into the below mentioned groups according to the number of carboxyl groups they contain:

- Having one carboxyl group (**Monocarbon acids**)
  - Having two carboxyl groups (**Dicarbon acids**).
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# Some important fatty acids and their origins

## I- Monocarbon acids:

### A) Saturated fatty acids

1. Formic acid  $H-COOH$

2. Acetic acid  $H_3-COOH$

3. Butyric acid  $C_3H_7-COOH$

4. Palmitic acid  $C_{15}H_{31}-COOH$

5. Stearic acid  $C_{17}H_{35}-COOH$

## Origin:

Stinging nettle, ant secretions

Wine, vinegar.

Butter

Animal and vegetable oils

Animal and vegetable oils

## B) Unsaturated fatty acids

1. Oleic acid  $C_{17}H_{33}-COOH$

Olive oil, Cotton seed oil

2. Linoleic acid  $C_{17}H_{31}-COOH$

Soy and other vegetable oils

3. Linolenic acid  $C_{17}H_{29}-COOH$

Vegetable oils

## II) Dicarbon acids:

1. Oxalic acid       $\text{COOH-COOH}$

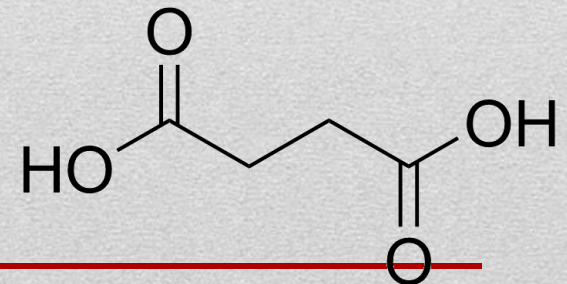
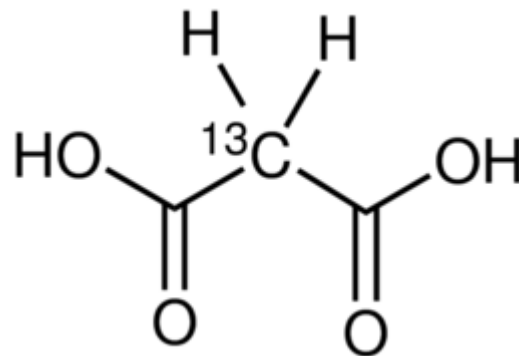
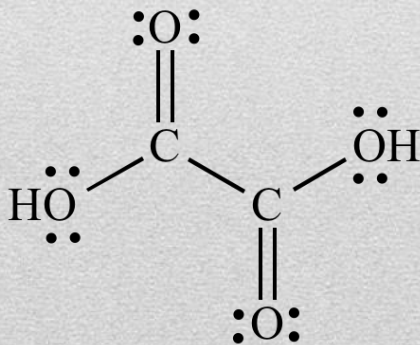
As "ca" salts in plants


2. Malonic acid       $\text{COOH-CH}_2\text{-COOH}$

Sugar beet

3. Succinic acid       $\text{COOH-CH}_2\text{-CH}_2\text{-COOH}$

*Aconitum* sp. and tea





If unsaturated fatty acids form the majority of a lipid, then it is liquid. Flax seed contains 60-75% unsaturated fatty acids. However, 75% of the cacao butter is formed of saturated fatty acids. They have high nutritional values yielding more calories compared to carbohydrates and proteins.

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## Importance of lipids:

- Source of energy and building blocks.
- Foodstuff (having high nutritional value).
- Have industrial usage.

Some important lipids obtained from plants are tabulated below:

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Plant species	Oil	Oil yield (%)
<i>Olive (Olea europaea)</i>	Olive oil	40-60
<i>Sesame (Sesamum indicum)</i>	Sesame seed oil	50-60
<i>Sunflower (Helianthus annuus)</i>	Sunflower seed oil	25-35
<i>Poppy (Papaver somniferum)</i>	Poppy seed oil	-
<i>Flax (Linum usitatissimum)</i>	Flax seed oil	40
<i>Castor plant Ricinus communis)</i>	Castor oil	33-60
<i>Soy (Soja hispida)</i>	Soy oil	13-26
<i>Hazelnut (Corylus avellana)</i>	Hazelnut oil	65
<i>Walnut (Juglans regia)</i>	Walnut oil	70
<i>Almond (Amygdalus orientalis)</i>	Almond seed oil	56
<i>Peanut (Arachys hypogea)</i>	Peanut oil	38-47
<i>Pamuk (Gossypium herbaceum)</i>	Cottonseed oil	18-30




# Trans fatty acids

Unsaturated fatty acids can be found in "cis" or "trans" forms. These forms depend on the positioning of hydrogen atoms around the carbon chain. In *cis* form, the free hydrogens of the C-C double bond are in the same plane, however in *trans* form, these hydrogens are found in opposite planes.

*Cis* form is more abundant in nature than *trans* form.

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Fatty acids may undergo a chemical reaction called hydrogenation during processing. This is common in margarines. These fats increase blood cholesterol.

*Trans*-fatty acids (TFA) are found in animal originated foodstuff like meat, oil and milk in low amounts.

TFA have to be limited to 1% of the total daily calories. For example, if your daily caloric intake is 2000 calories, then you should consume less than 2 g of TFA per day.

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## Why are trans fatty acids harmful?

Trans fats are easy to use, inexpensive to produce and last a long time. Trans fats give foods a desirable taste and texture. Many restaurants and fast-food outlets use trans fats to deep-fry foods because oils with trans fats can be used many times in commercial fryers.

Trans fats raise your bad (LDL) cholesterol levels and lower your good (HDL) cholesterol levels. Eating trans fats increases your risk of developing heart disease and stroke. It's also associated with a higher risk of developing type 2 diabetes.


e.g. Eating fries in lunch may result in obtaining 6.8 g TFA.

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## Omega 3 fatty acids


Omega 3 fatty acids are polyunsaturated fatty acids (PUFAs) with the first double bond (C=C) at the third carbon atom from the end of the carbon chain.

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These are known as essential fatty acids. They are essential for human health, however our bodies can not produce this fatty acid. It is found in fishes like salmon, tuna and turbot; in other marine organisms such as algae and in some plants (e.g. purslane) and walnut. It is vital for the functioning of brain and in the normal development and growth. They became popular recently since they reduce the risk for heart attack.

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Studies found that omega-3 fatty acid reduce inflammation and help in reducing chronic diseases like cardiac diseases, cancer and arthritis. Omega-3-fatty acids are found in high amounts in the brain and are important in cognitive (memory and brain performance) and behavioral functions. Babies who can not obtain sufficient amount of omega-3 fatty acid from their mothers during pregnancy are at risk of developing visual and nerve related problems. Symptoms for omega-3 fatty acid insufficiency are fatigue, bad memory, drying of the skin, cardiac problems, mood changes or depression and circulatory problems.

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## Omega 6 fatty acids

Omega 6 fatty acids are a family of pro-inflammatory and anti-inflammatory polyunsaturated fatty acids, the first carbon-carbon double bond is found in the n-6 position, that is, the sixth bond, counting from the methyl end.

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They are also considered to be essential fatty acids and are important for functioning of the brain and normal growth and development. They stimulate skin and hair development, protect bone health, regulate metabolism and maintain reproductive health. However, some omega-6 fatty acids (contrary to omega-3 fatty acids) increase the formation of inflammation. Therefore, they have to be taken within a certain balance.

Omega-6 fatty acids are found in evening primrose oil (*Oenothera biennis*) or blackcurrant (*Ribes nigrum*) oil. A blue-green algae called *Spirulina* also has omega-6 fatty acids.


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# Obesity

Obesity is an important health issue in the population. It leads to a life with poor quality and many health problems or result in the aggravation or present health related problems. Herbal preparations and food supplements used for weight loss are abused in our country since they can be purchased via websites without control.

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BMI is an indicator that is used to determine the prevalence and incidence of obesity. Obesity can also be determined with the evaluation of waist-hip circumference. BMI increases during the adult life in humans, reaches its peak value between the ages of 50-59 in both males and females and start to reduce after the age of 60 or stay as it is. Weight gain continues till the age of 65 in both normal and obese individuals and it stops around 65 years in men and women and with advancing age, weight loss starts.

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