

## LIPIDS

In this concept, we will discuss one class of biological polymers called lipids or fats. You might be familiar with this class of biopolymers, which are found in butters and oils.

We will discuss saturated and unsaturated fats, and what those terms mean for the molecule's structure as well as its properties at room temperature.



1. Which of the following is a source of lipids?

- Sugar, fruits, and bread
- Water
- Steaks
- **Butter and oils**

## STRUCTURES AND PROPERTIES OF LIPIDS

The category of biomolecules known as **lipids** contain fats and oils as well as fatty acids. The monomer of a lipid is a **fatty acid**. The fatty acids are the simplest lipids and are found as components in more complex lipids. A fatty acid contains a long carbon chain attached to a carboxylic acid group at one end. Fatty acids that contain only single bonds between carbon atoms are **saturated fatty acids**.

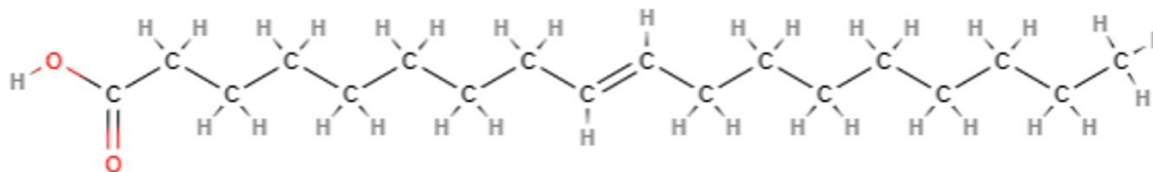
Recall from the organic chemistry lesson that saturated carbon chains contain all single bonds and are called alkanes. One example of a saturated fat is **butanoic acid**, a component of butter. This contains a four-carbon chain with a carboxylic acid functional group on the end carbon:  $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$ .

If there is one double bond between carbon atoms in a fatty acid, then it is a monounsaturated fatty acid; if there are more than one double bonds between carbon atoms, then the fatty acid is polyunsaturated.

You will notice in the structures of oleic acid,  $\text{CH}_3(\text{CH}_2)_7\text{CHCH}(\text{CH}_2)_7\text{COOH}$ , and linoleic acid,  $\text{CH}_3(\text{CH}_2)_4\text{CHCHCH}_2\text{CHCH}(\text{CH}_2)_7\text{COOH}$ , **the double bonds cause the molecules to curve and take up more area than a saturated fat**. This decrease in the molecule's density causes unsaturated fats to be liquid at room temperature (oils), compared to the densely packed and solid saturated fats that contain single bonds.

- Mnemonic: "Solid, single bonds, and saturated." This refers to the structure (all single bonds) and relative density (solid) of the saturated fats.
- Mnemonic: "Unsaturated oils" The oils include unsaturated alkenes, either monounsaturated or polyunsaturated.

**One type of unsaturated fat is called trans fats**, referring to the position of the carbons around the double bond that creates a linear structure rather than a curved structure. Trans fats are often created through the process of hydrogenation and include the hydrogenated oils found in margarine, such as trans-oleic acid. Because of their arrangement, they are similar in structure to saturated fats and thus are solids at room temperature.



## SATURATED OR UNSATURATED

Lipids	
UNSATURATED	SATURATED
$\text{CH}_3\text{CHCHCH}_2\text{CHCHCH}_2\text{COOH}$	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{COOH}$
$\text{CH}_2\text{CH}_2\text{CH}_2\text{COOH}$	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CHCHCHCHCH}_2\text{CH}_2\text{COOH}$

Answer the following questions about lipids

2. Triglycerides are:

- Always unsaturated
- **Made of fatty acid monomers**
- Used for catalysis in the body
- Soluble in

water Select all that apply.

3. Saturated fatty acids contain \_\_\_\_\_ functional groups

- **Alkanes**
- Amine
- **Carboxylic acid**
- Halogen
- Alkenes

From the condensed structural formula, determine if the structure represents a saturated fatty acid, monounsaturated fatty acid, or a polyunsaturated fatty acid.

	SATURATED FATTY ACID	MONOUNSATURATED FATTY ACID	POLYUNSATURATED FATTY ACID
$\text{CH}_3\text{CH}_2\text{CHCHCH}_2\text{COOH}$			X
$\text{CH}_3\text{CHCHCH}_2\text{CH}_2\text{COOH}$			X
$\text{CH}_3\text{CHCHCH}_2\text{CHCHCH}_2\text{COOH}$			
$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{COOH}$		X	

4. Contains carboxylic acid = **Both Saturated and Unsaturated**

Contains a single double carbon-to-carbon bond = **Unsaturated**

Contains multiple double carbon-to-carbon bonds =

**Unsaturated** Solid at room temperature = **Saturated**

Contains no carbon-to-carbon double bonds = **Saturated**

Liquid at room temp = **Unsaturated**

Does not mix with water = **Both Saturated and Unsaturated**