
Lipids
Video III
Bio by Tash
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# INTRODUCTION TO LIPIDS

- Lipids are a diverse group of hydrophobic molecules.
- They are large biological molecules, but not considered polymers or macromolecules.
- Lipids are made up of carbon (C), hydrogen (H), and oxygen (O).
- The ratio of hydrogen to oxygen is not 2:1 (unlike in carbohydrates); instead, hydrogen is present in larger amounts.
- **lipids contain much less oxygen than carbohydrates.**
- They are insoluble in water (hydrophobic) but soluble in organic solvents like alcohol and ether.
- Due to their structure, lipids are efficient energy stores and play structural and functional roles in cells.

# Fats and Oils – Important Groups of Lipids

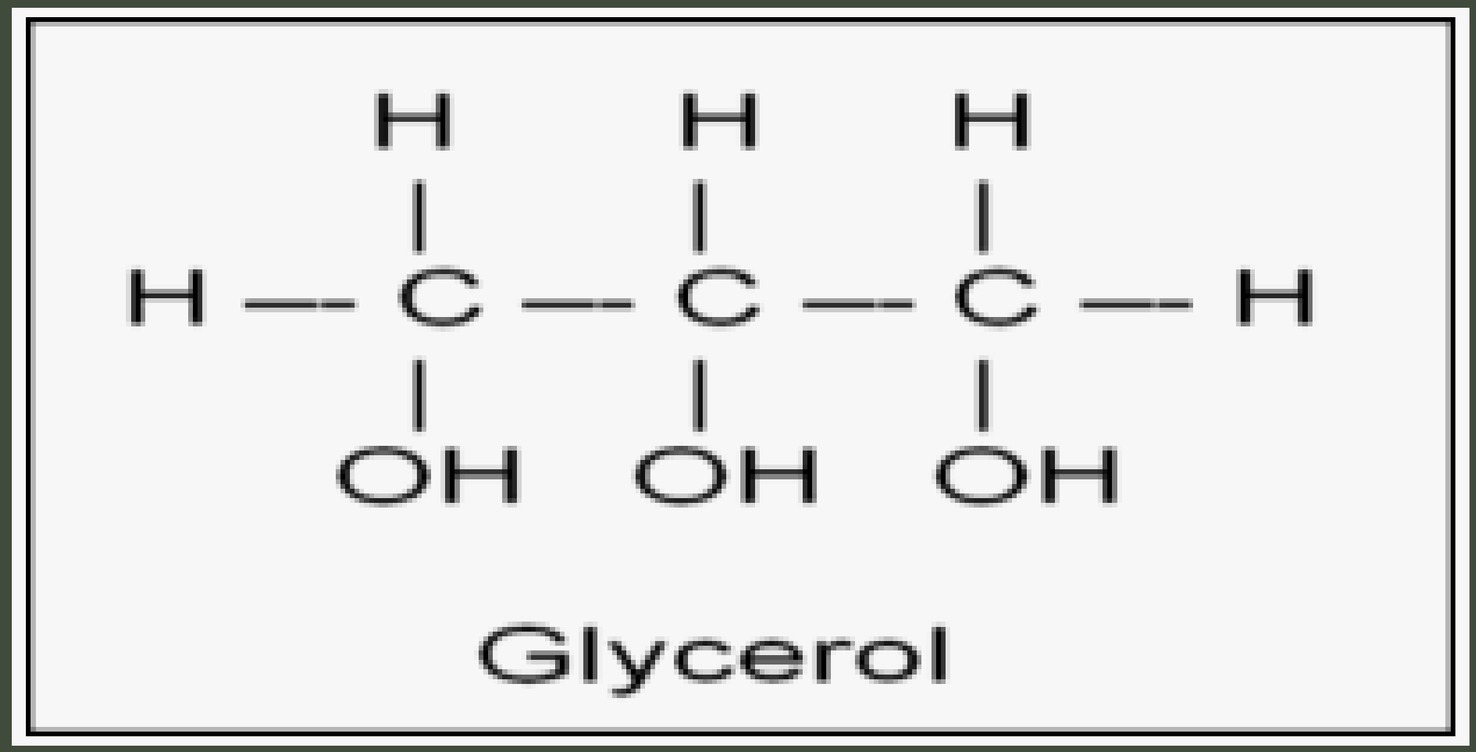
- Fats and oils are two important types of lipids.
- Chemically, they are very similar, but differ in their physical state at room temperature:
- Fats (e.g., butter) are solids.
- Oils (e.g., olive oil) are liquids.
- Sources:
- Fats mainly come from animal sources.
- Oils are primarily obtained from plant sources

# Basic Structure of Fats and Oils

Fats and oils are made of two main types of organic substances:
Fatty acids and glycerol

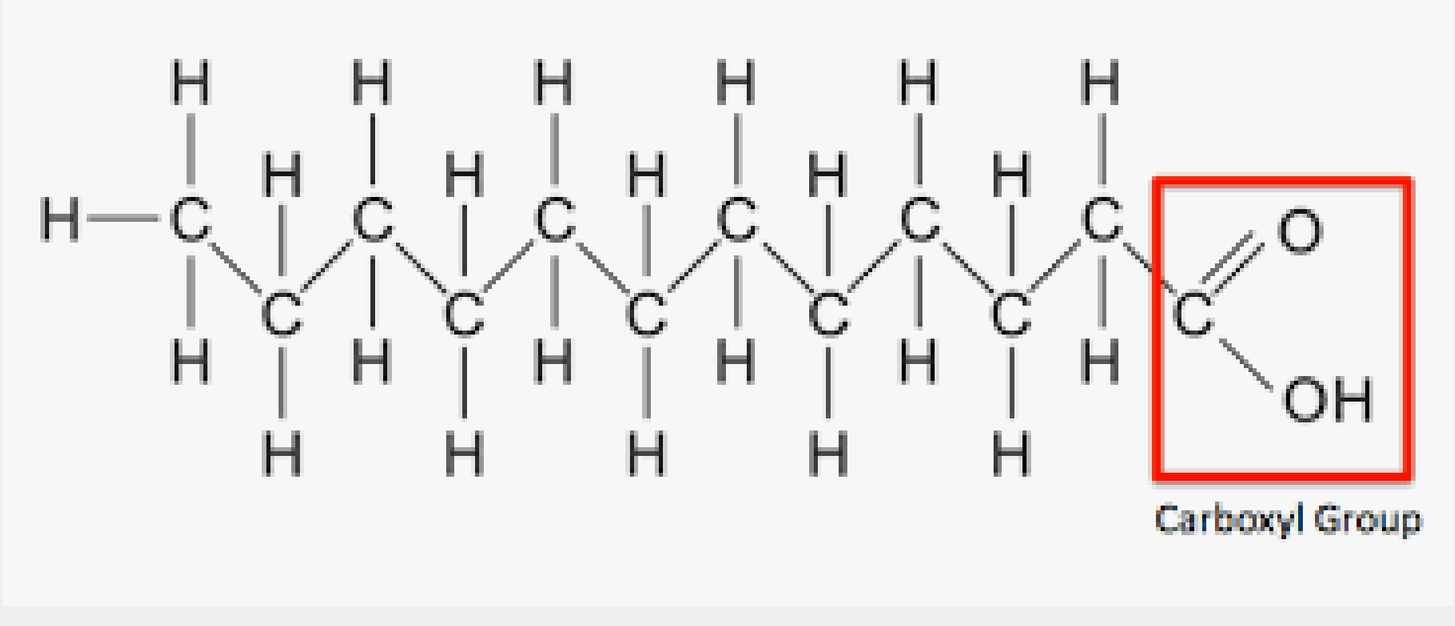
two are combined using ester bonds, formed in a condensation reaction (removal of water).

# Glycerol




- Glycerol is an alcohol that contains three carbon atoms, and each carbon is attached to a single hydroxyl (-OH) group.

# Fatty Acids




- Fatty acids are hydrocarbon chains typically consisting of 16 to 18 carbon atoms, with a carboxyl (-COOH) group at one end of the chain
- **Living tissues** contain **more than 70 different types** of fatty acids.

# Variation in Fatty Acids

**1. Length of the Carbon Chain**

Most fatty acids have chains that are typically 15 to 17 carbon atoms long.

**2. Degree of Saturation (number of double bonds between carbon atoms)**

There are two groups of fatty acids depending on the degree of saturation,

1. Saturated Fatty Acids: Each carbon atom is joined to the next by a single covalent bond.

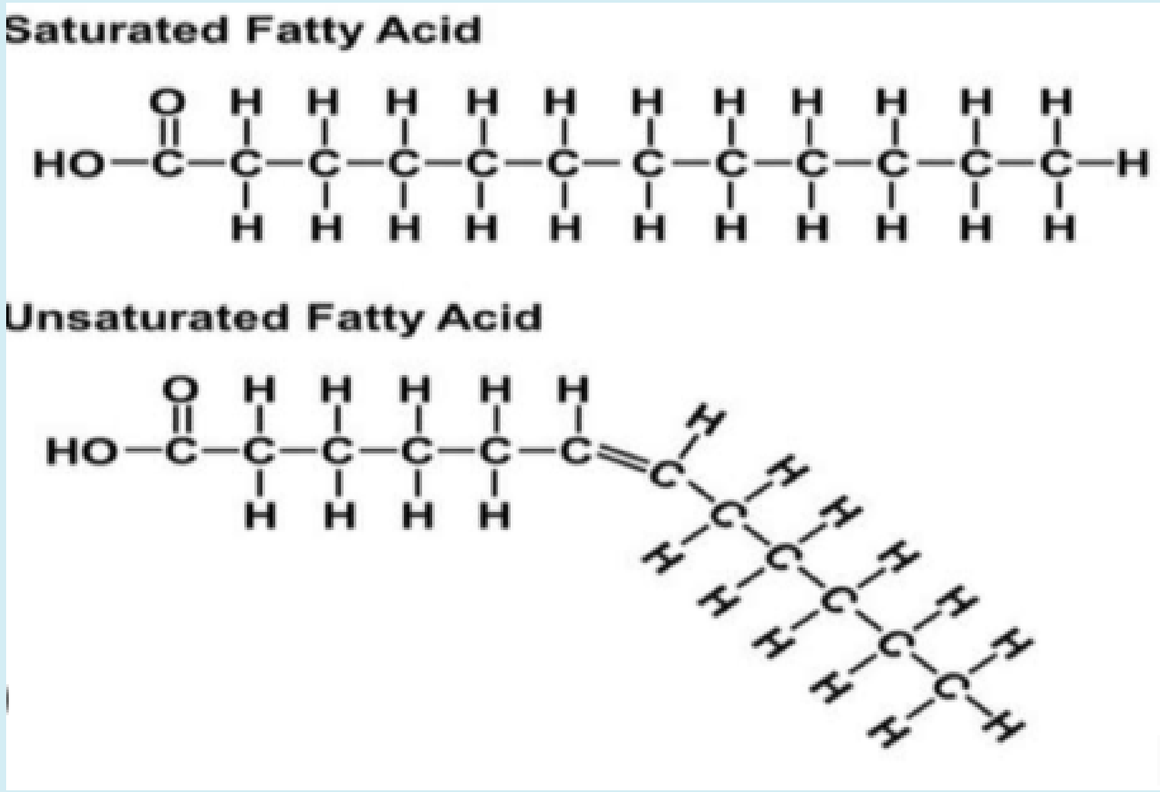
These fatty acids have no double bonds.
Example: Stearic acid

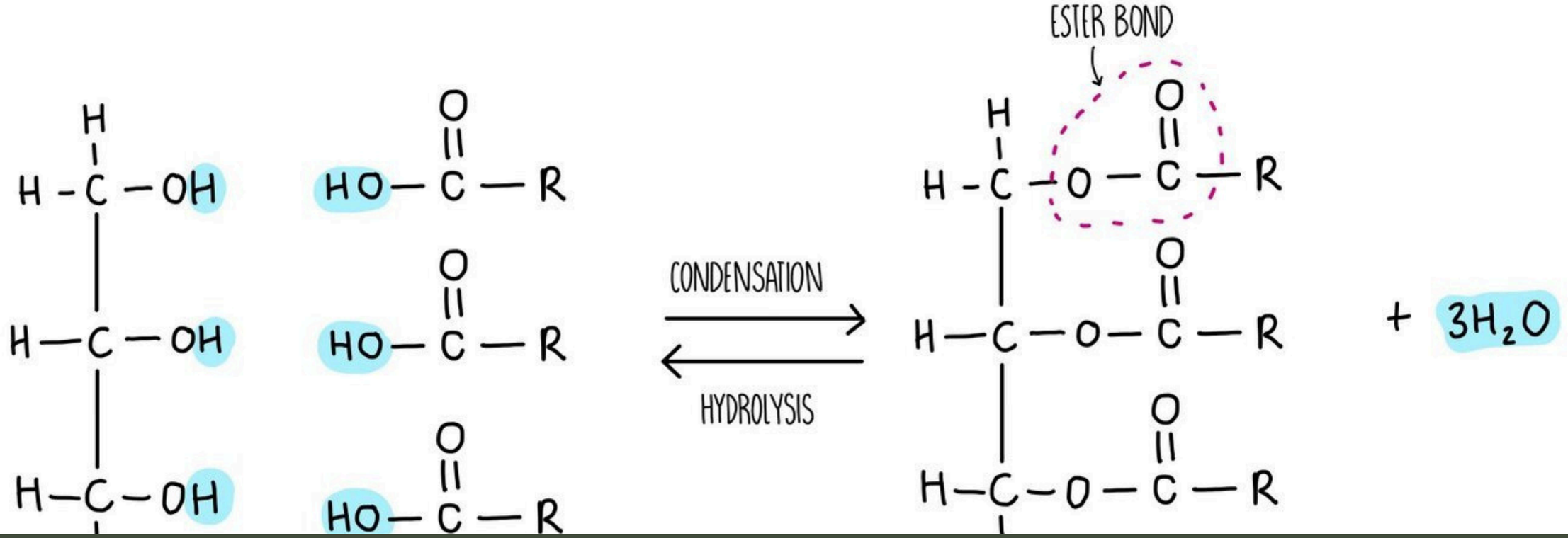
# 2. Unsaturated Fatty Acids:

- Contain **one or more double covalent bonds** between carbon atoms.

- These are Two types:
  - **Monounsaturated Fatty Acid**: Has **one** carbon-carbon double bond.

  - **Polyunsaturated Fatty Acid**: Has **more than one** carbon-carbon double bond.
- Example: **Linoleic acid**
    - A **polyunsaturated fatty acid** is an **essential fatty acid**,
      - It **cannot be synthesized** by the human body.
      - It **must be obtained** through the diet.



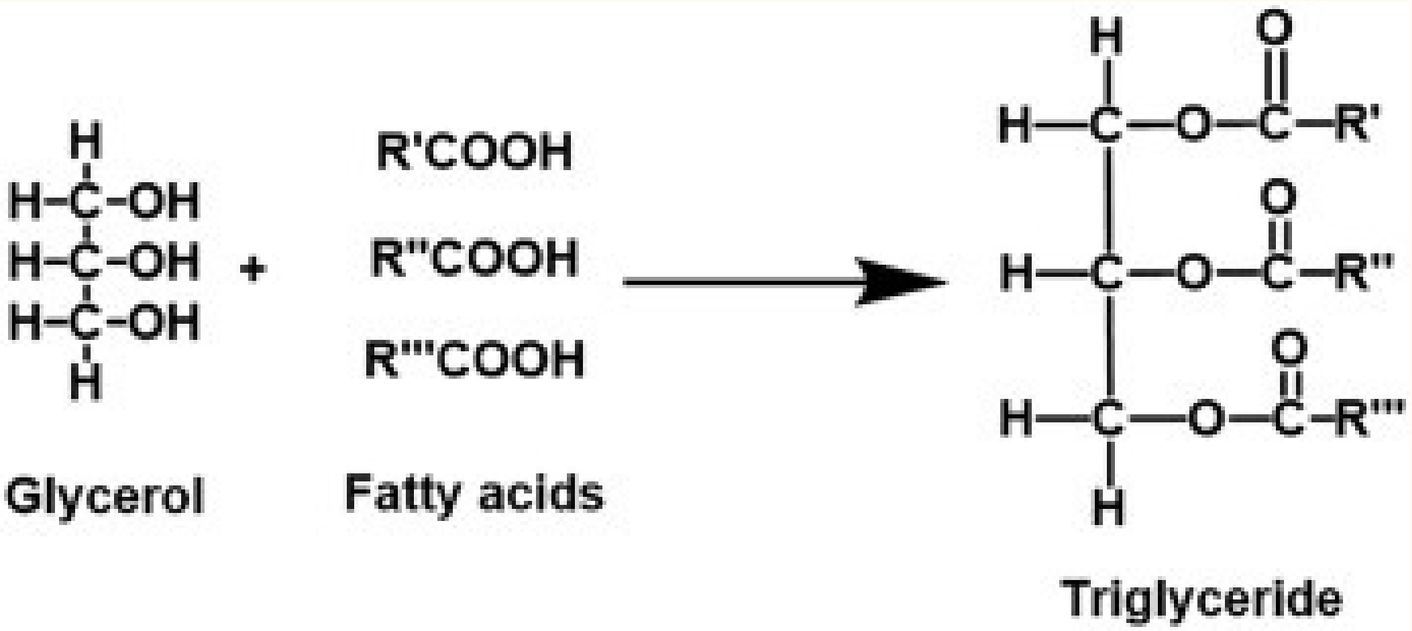



# Ester Bond

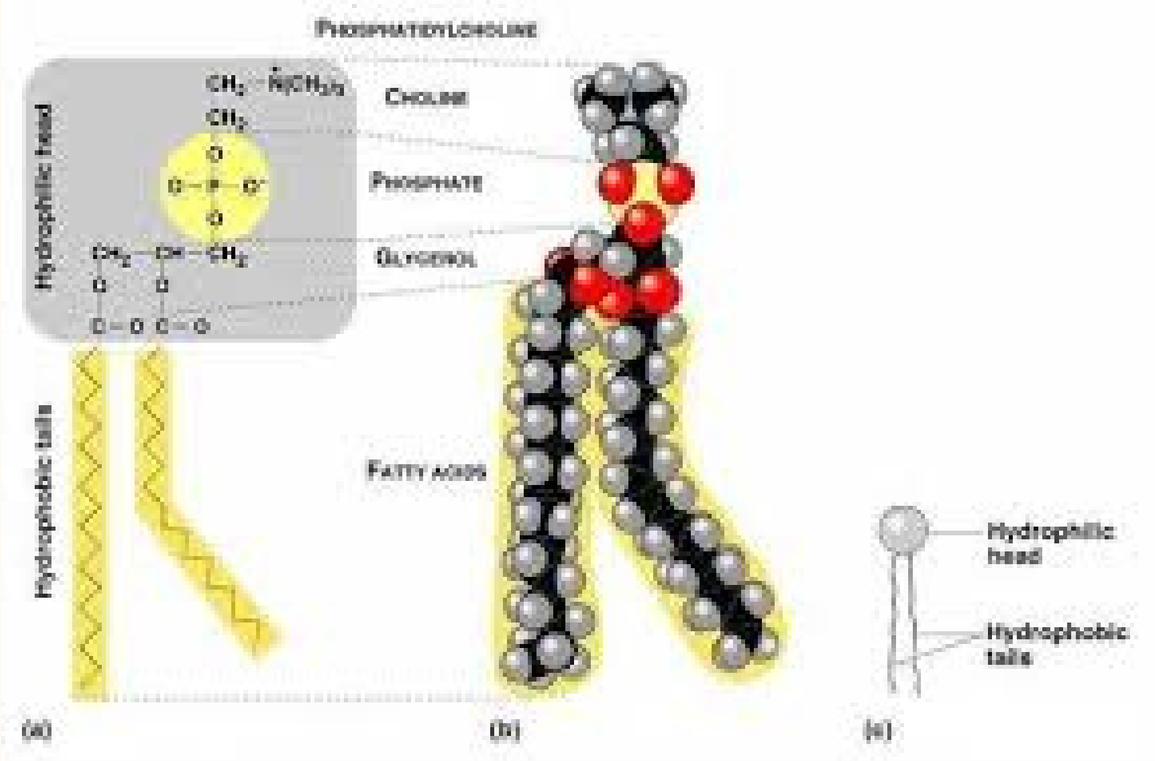
- An **ester bond** is a type of **covalent bond** formed between a **carboxylic acid group (-COOH)** and an **alcohol group (-OH)** during a **condensation reaction** (A reaction in which a molecule of water is removed).
- This is known as esterification
- In biological systems, ester bonds are most commonly found in **lipids**, especially in **triglycerides**.

# Triglycerides

- Triglycerides are a type of lipid used mainly for long-term energy storage in both animals and plants.
- They are the most common form of fat found in the body and in foods.
- A triglyceride is made up of:
  - One glycerol molecule
  - Three fatty acid molecules
- These components are joined together by ester bonds, formed through a condensation reaction (a reaction where water is removed).



# Phospholipids



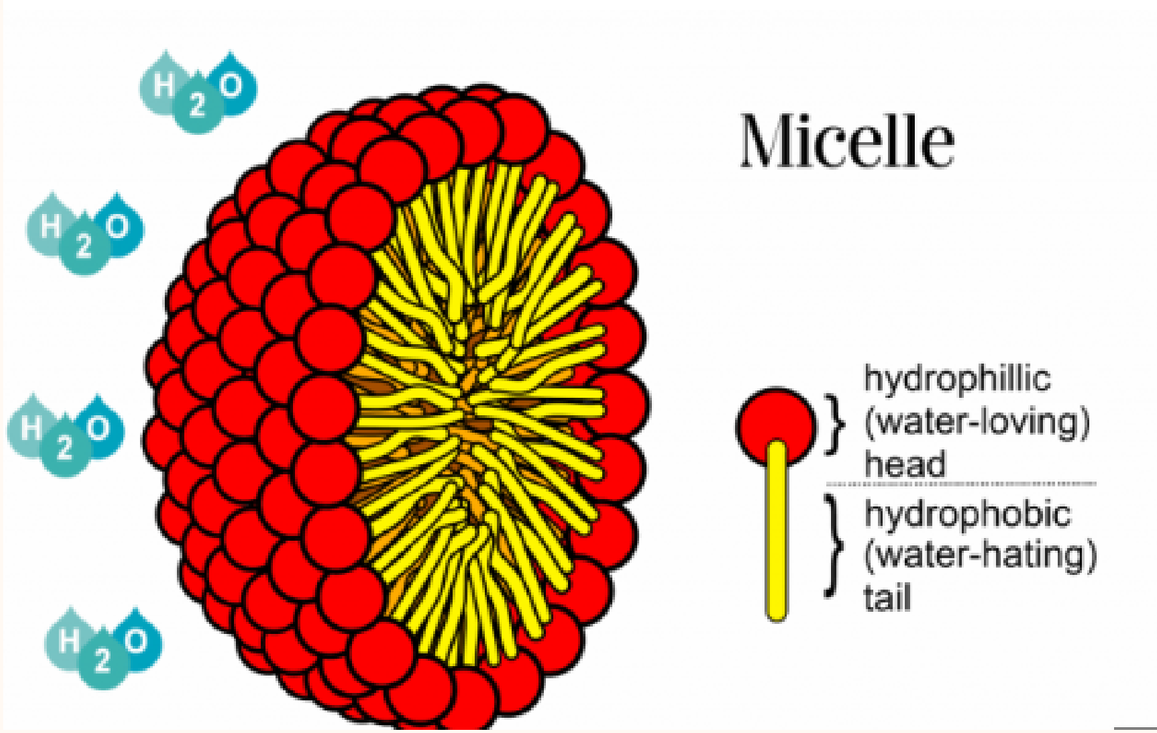

- **Phospholipids** are a special type of **lipid** that are essential components of **cell membranes**.
- They are **structurally similar to triglycerides**, but with a key difference:
- **One of the three fatty acids is replaced by a phosphate group**
- A phospholipid molecule consists of:
  - **One Glycerol Molecule**
  - **Two Fatty Acid Chains**
  - **One Phosphate Group ($PO_4^{3-}$)**, which is often bonded to another small polar molecule (like choline)

- Glycerol with phosphate group makes the hydrophilic head part of the phospholipid molecule while two hydrocarbon chains make the hydrophilic tail part.

- The **phosphate head**:
  - **Carries a negative charge**
  - Is **soluble in water**
  - Is **hydrophilic** ("water-loving")
- The **fatty acid tails**:
  - Are **neutral**
  - Are **insoluble in water**
  - Are **hydrophobic** ("water-hating")

- The amphoteric nature of phospholipid causes them to arrange themselves in specific ways when placed in an aqueous (water-based) environment. Two common structures are:
  **1. Monolayer**
- A **monolayer** forms when **phospholipids are spread on the surface of water**, such as in experimental setups or simple lipid-water interfaces.
- In this arrangement:
  - The **hydrophilic (polar) phosphate heads** face **downward into the water**, attracted to it.
  - The **hydrophobic (non-polar) fatty acid tails** point **upward into the air**, away from the water.
- This forms a **single layer** of phospholipid molecules.
- It demonstrates the amphipathic nature of phospholipids and how they orient themselves to minimize energy in watery environments.

- **2. Micelles** *(sometimes called "mesels")*
- **Micelles** are **spherical clusters** of phospholipid molecules that form when phospholipids are **completely surrounded by water**.
- In a micelle:
    - The **hydrophilic phosphate heads** are oriented **outwards**, facing the surrounding water and interacting with it.
    - The **hydrophobic fatty acid tails** are **folded inward**, away from the water, hidden in the center of the sphere.
- This structure is **energetically stable** in water because:
    - Water interacts only with the **polar heads**.
    - The **non-polar tails are shielded** from water.



# Biological Roles of Lipids

**Energy Storage**

- Triglycerides store about 3 times more energy per gram than the same mass of carbohydrates.
- This is due to the high number of C–H bonds, which release large amounts of energy when oxidized.

- **Energy Source**
- During aerobic respiration, lipids are oxidized, breaking C–H bonds to release energy.
- Products of lipid oxidation:
  → Carbon dioxide ($CO_2$)
  → Water ($H_2O$)
  → ATP (adenosine triphosphate) – a high-energy molecule used for cellular activities.

## Component of Cell Membranes

- Phospholipids form the bilayer structure of all cell membranes.
- They contribute to membrane fluidity and permeability.

## Insulation and Protection

- Thermal insulation in mammals (e.g., under the skin)
- Shock absorption for internal organs

## Waterproofing

- Waxy lipids help in water retention in plants and insects.
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## Hormone Production

- Steroid hormones (e.g., testosterone, estrogen) are lipid-based molecules.

THANKS FOR

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