Tishk International University
Faculty of Applied Sciences
Nutrition and Dietetics Department
Principles of Food Science

Lipid Structure and Functions in Food

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Outlines

- Previous Lecture
- Food Lipid
- Lipid Structure
- Lipid Function in Food

Learning Outcome

Understand the Chemical Structure of Lipids

Analyze the Role of Lipids in Food

Evaluate the Impact of Lipids on Health and Food Processing

Food Lipid

Lipids

- Lipids are a heterogeneous group of compounds related to fatty acids, fats, oils, waxes, and other related substances.
- The term **"lipid"** was first used by German biochemist Bloor in 1943.
- The word lipid is derived from the Greek word **"lipos," meaning fat.**
- Lipids are **insoluble in water but soluble in organic solvents** such as benzene, ether, chloroform, and acetone.
- They yield fatty acids upon hydrolysis, which are used by living organisms.
- Lipids are not polymers like carbohydrates or proteins.
- **Providing 9 kcal per gram**

Food Lipid

Macromolecules and Dietary Importance:

- Lipids are macromolecules and a major component of the diet because of their high energy value.

Basic Component:

- The basic component of all lipids is **fatty acids**.

Definition of Fats or Lipids:

- Fats or lipids are defined as the esters of glycerol (alcohols) and fatty acids, also known as triglycerides.

Presence in Nature:

- Lipids are found in most plants and animals.

Occurrence in Plants:

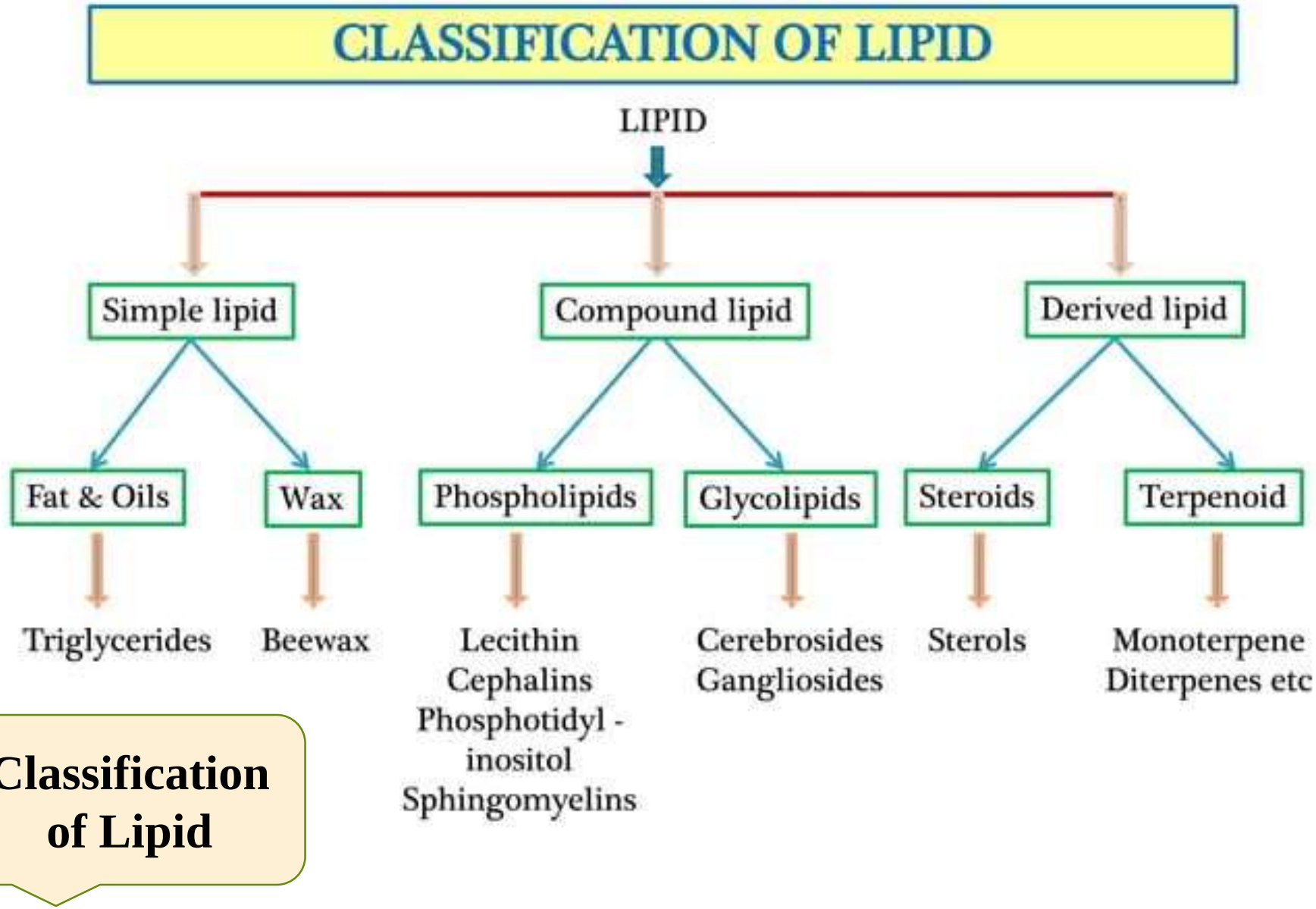
- In plants, lipids are mainly found in **seeds** and **fruits**.

Occurrence in Animals:

- In animals, lipids are found in **adipose tissue**, **bone marrow**, and **nerve tissue**.

Types of lipids, including:

- **Fatty Acids**
- **Neutral Fats and Oils**
- **Waxes**
- **Phospholipids**
- **Sterols**
- **Fat-Soluble Vitamins (lipids)**



Classification of Lipid

1. Simple Lipids

- Esters of fatty acids with alcohols. They are primarily used for energy storage and insulation.

1.Fats and Oils (Triglycerides):

- **Structure**: Consist of one glycerol molecule esterified to three fatty acids.
- **Function**: Energy storage
- **Examples**:
  - **Fats**: Solid at room temperature (e.g., butter).
  - **Oils**: Liquid at room temperature (e.g., olive oil).

Saturated fatty acids

Laurie (C12:0)

Myristic (C14:0)

Palmitic (C16:0)

Stearic (C18:0)

Monounsaturated fatty acid

Oleic (C18:1ω-9)

Polyunsaturated fatty acids

Linoleic (C18:2ω-6)

Linolenic (C18:3ω-3)

Arachidonic (C20:4ω-6)

Eicosapentaenoic (C20:5ω-3)

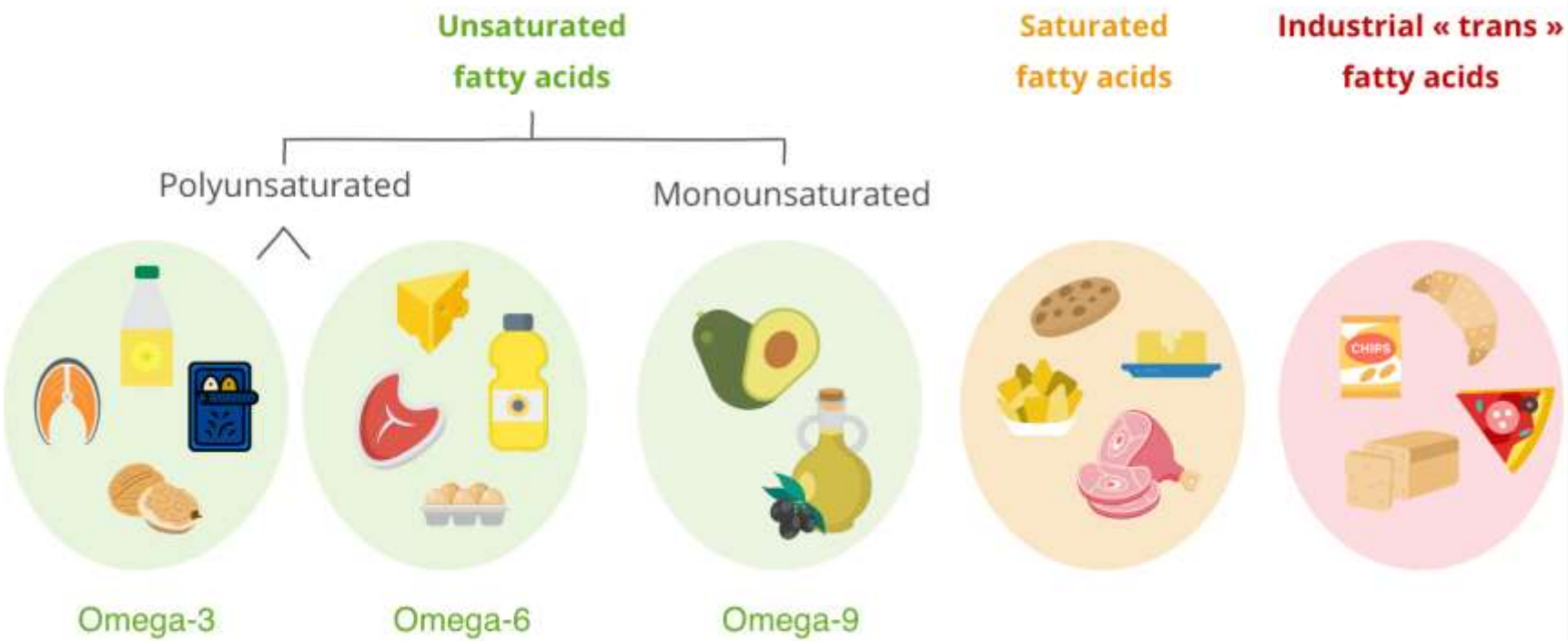
Docosahexaenoic (C22:6ω-3)

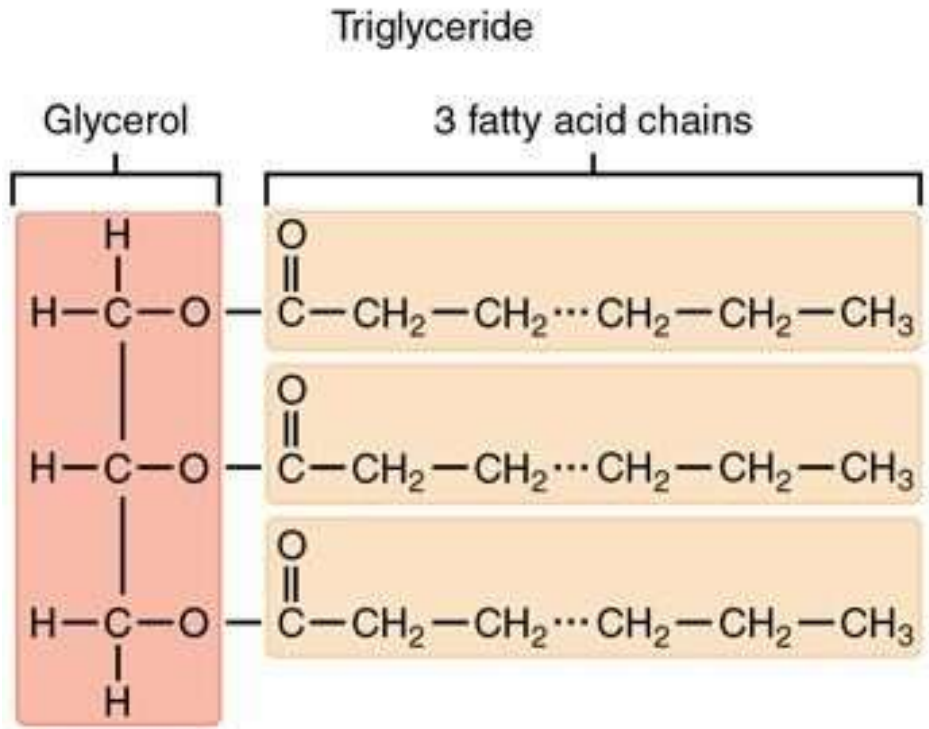
Differences between oils and fats

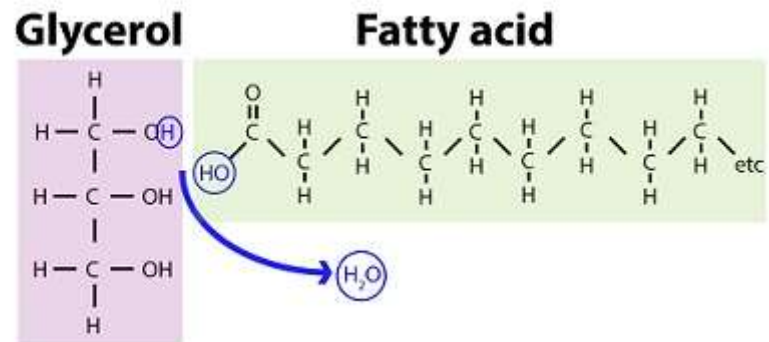
Differences	Fats	Oils
Sources	Mainly animals	Mainly plants
Fatty acid	Saturated	Unsaturated
Bonding	No double bond	Have double bond
State at room conditions	Solid	Liquid
Melting point	High	Low

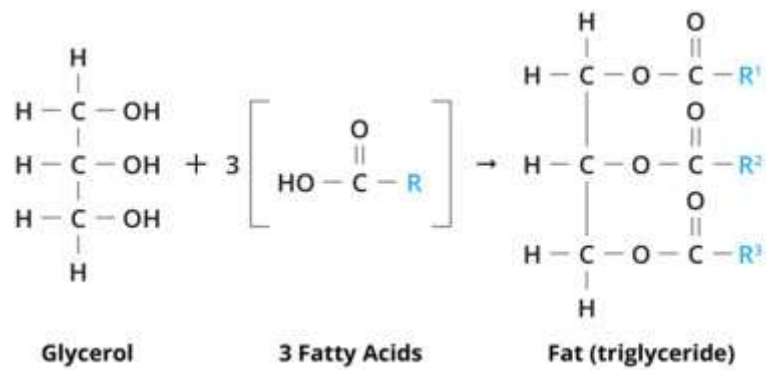
Types of Fatty Acids	Examples of Sources	Health Impacts and Intake Recommendations
Saturated  • No double bond • Straight structure • Solid at room temperature	 Beef  Butter  Coconut oil	• Increase risk of heart disease • Less than 20g of saturated fats per day (for a 2000 kcal diet)
Trans  • One or more double bonds in trans configuration • Straight structure • Semi-solid/Solid at room temperature	 Margarine  Cream soup with puff pastry  Chicken pie	• Increase risk of heart disease • Less than 2.2g of trans fats per day (for a 2000 kcal diet)
Monounsaturated  • One double bond in cis configuration • Bent structure • Liquid at room temperature	 Olive oil  Canola oil  Peanut oil	• May reduce risk of heart disease • Moderate intake of monounsaturated fats
Polyunsaturated  • Multiple double bonds in cis configuration • Even more "bent" in structure • Liquid at room temperature	 Soybean oil  Corn oil  Fatty fish	• May reduce risk of heart disease • Moderate intake of polyunsaturated fats

Summary of the different kinds of fat




Triglyceride
Glycerol
3 fatty acid chains


Glycerol
Fatty acid
etc


Glycerol
3 Fatty Acids
Fat (triglyceride)

Waxes

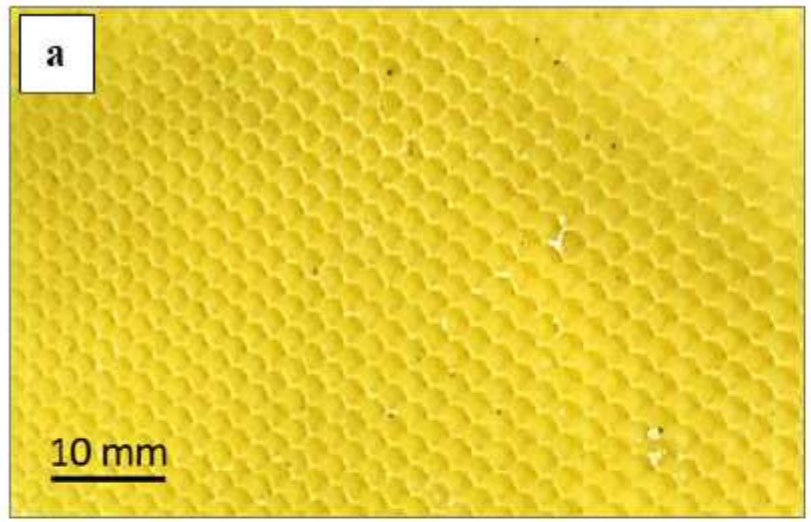
- Esters of long-chain fatty acids with long-chain alcohols.

•Function

- Protective coatings for plants and animals (e.g., on leaves or fur).

•Examples

- Beeswax in honeycombs.
- Lanolin in sheep wool.



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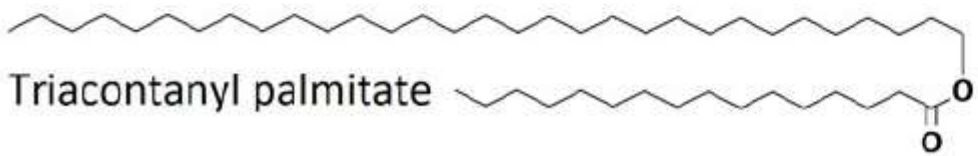

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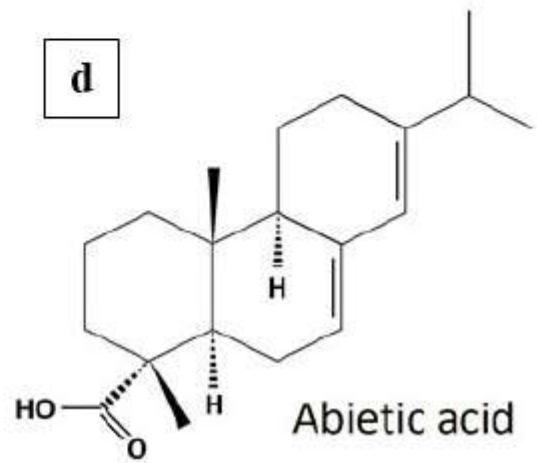


Abietic acid

2. Compound Lipids

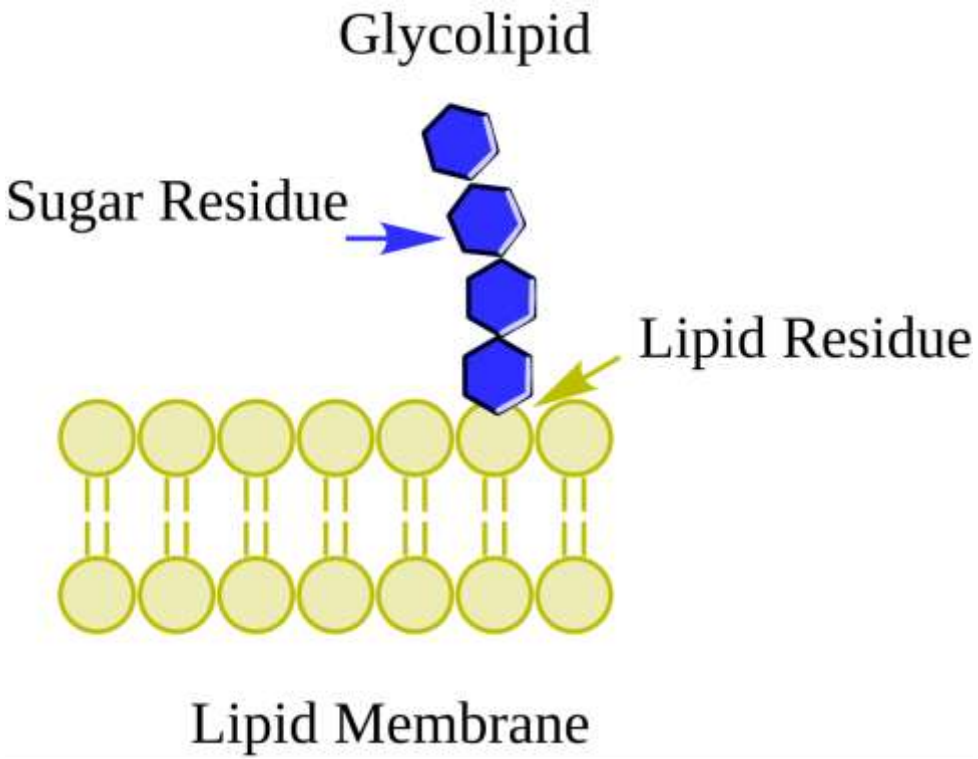
- Lipids containing additional groups like phosphate or carbohydrates, in addition to fatty acids and alcohols.

Phospholipids:

- **Structure**: Contain two fatty acids, glycerol, and a phosphate group.
- **Function**: Structural component of cell membranes, forming lipid bilayers.
- **Examples**:
  - **Phosphatidylcholine**: Found in cell membranes.
  - **Phosphatidylethanolamine**: Found in neural tissues.

2. Glycolipids:

- Lipids with a carbohydrate group attached.
- Involved in cell recognition and signaling.

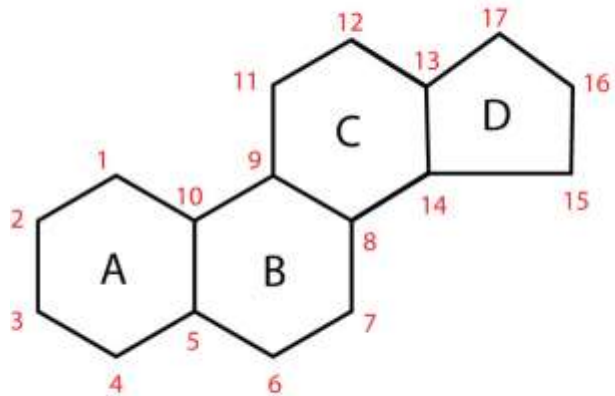


3. Derived Lipids

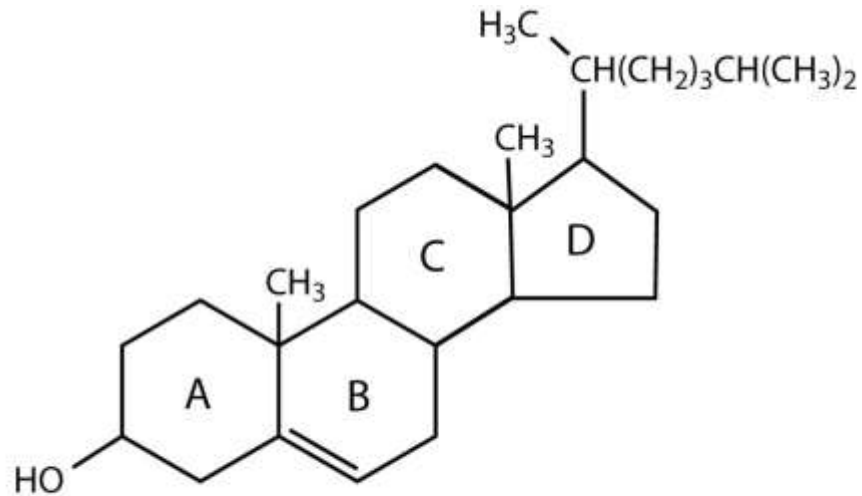
- Lipids derived from hydrolysis of simple and compound lipids or directly from their precursors.

Steroids:

- Characterized by a four-ring carbon backbone.
- **Function**: Hormones, membrane stability, and bile acids.
- **Examples**:
  - Cholesterol: Precursor to steroid hormones.
  - Testosterone: Male sex hormone.



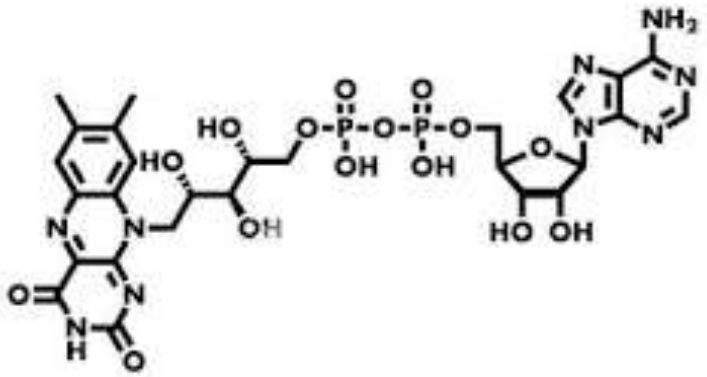
(a) Steroid skeleton



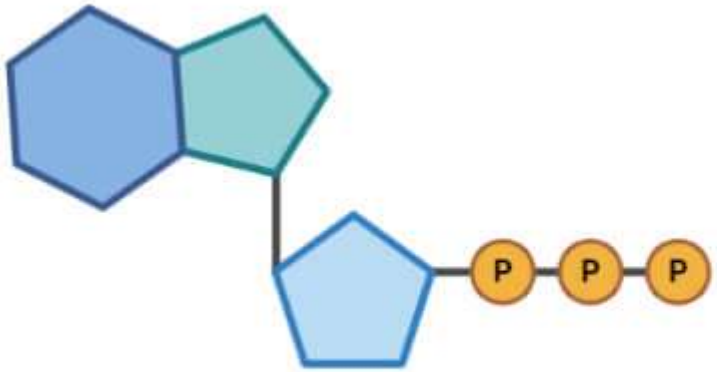
(b) Cholesterol

Lipid Functions:

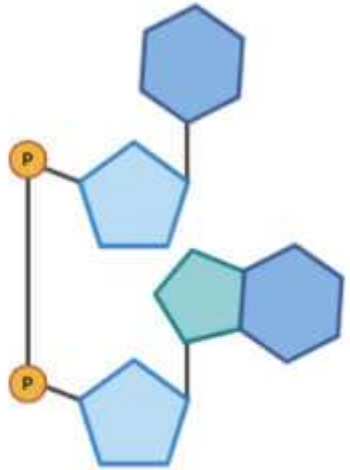
- Serve as energy sources and reserves.
- Store energy as starch or glycogen.
- Act as components in coenzymes (e.g., ATP, FAD, NAD).
- Serve as nucleotide components in RNA (ribose) and DNA (deoxyribose).
- Play roles in the immune system, fertilization, growth, and development.



FAD



ATP



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Roles of Food Lipids

Energy Source:

- Lipids provide a high-energy yield of 9 kcal per gram.

Carrier of Fat-Soluble Vitamins:

- Essential for the absorption and transport of vitamins A, D, E, and K.

Main Flavor Source of Foods:

- Contributes to the flavor and aroma of various foods.

Hormone and Cell Structure:

- Plays a key role in building cell membranes and synthesizing hormones.

Nervous System:

- Lipids, especially myelin, are crucial for nerve insulation and signaling.

Thermal Insulation of the Body:

- Helps maintain body temperature by acting as an insulator.

Mouthfeel:

- Provides a smooth and creamy texture in foods.

Texture of Foods:

- Enhances the overall texture and consistency of food products.

Emulsifying Agents:

- Phospholipids act as emulsifiers to stabilize mixtures of oil and water.

Mold Releasing and Anti-Spattering Agent:

- Used in food processing to release molds and reduce spattering during cooking.


thank
you