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:

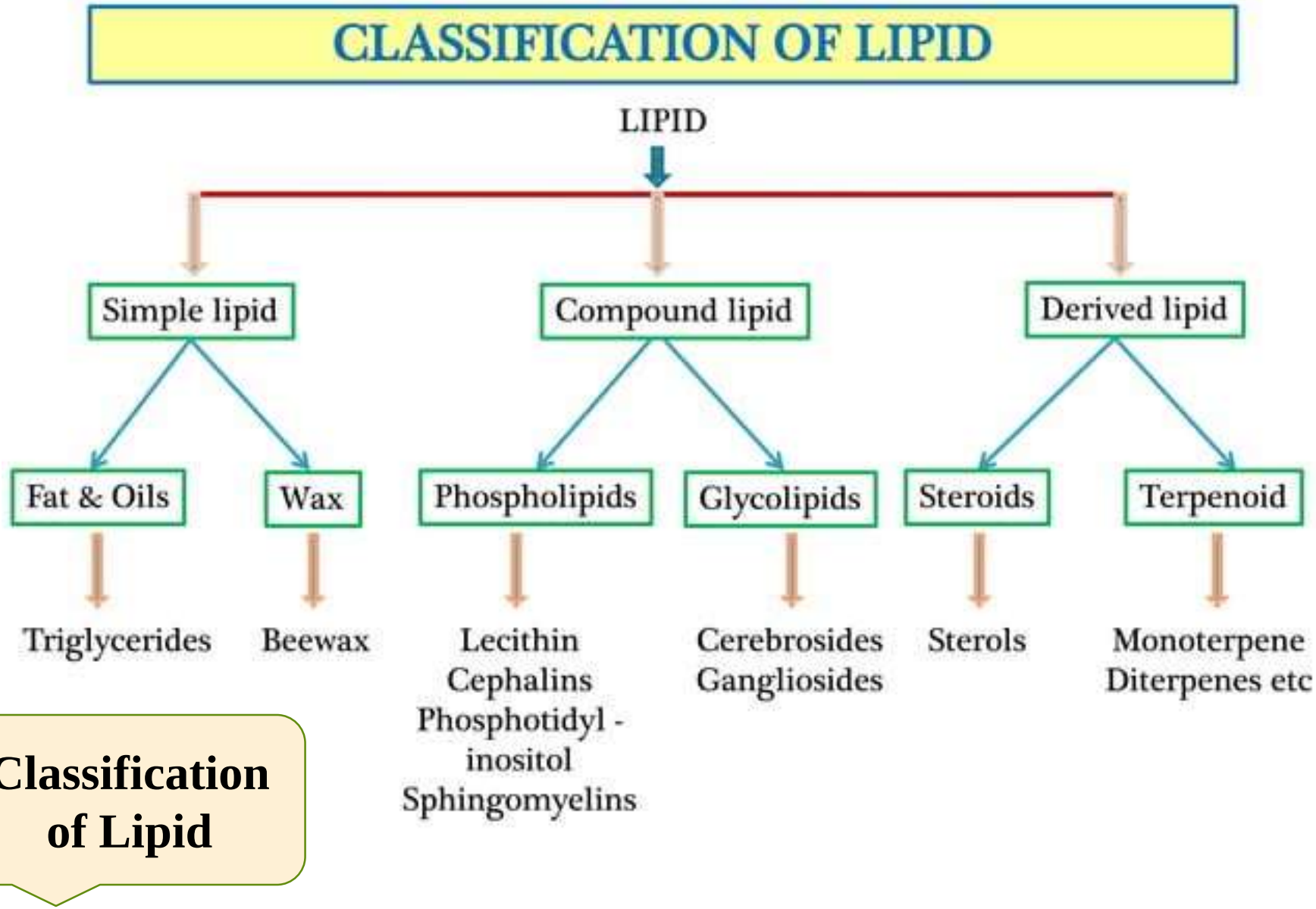
- In plants, lipids are mainly found in **seeds** and **fruits**.

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)

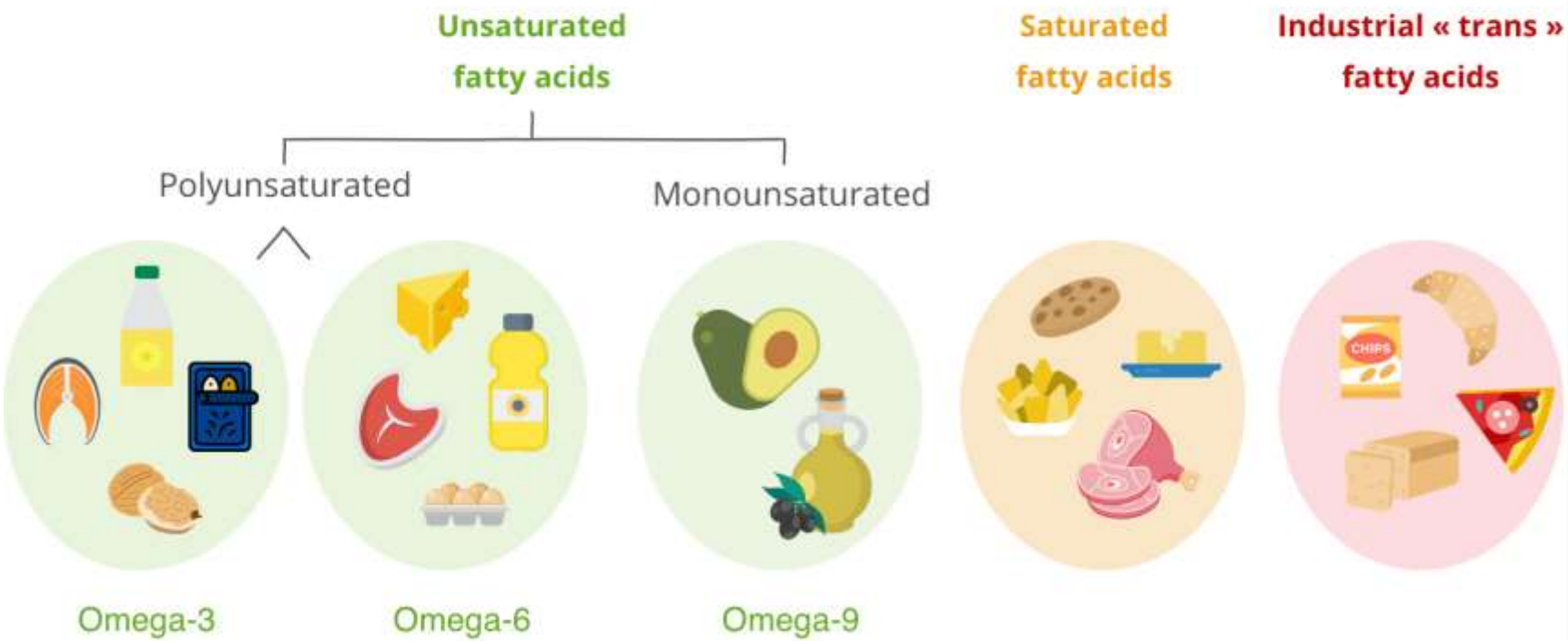
Docosahexaenoic (C22:6ω-3)

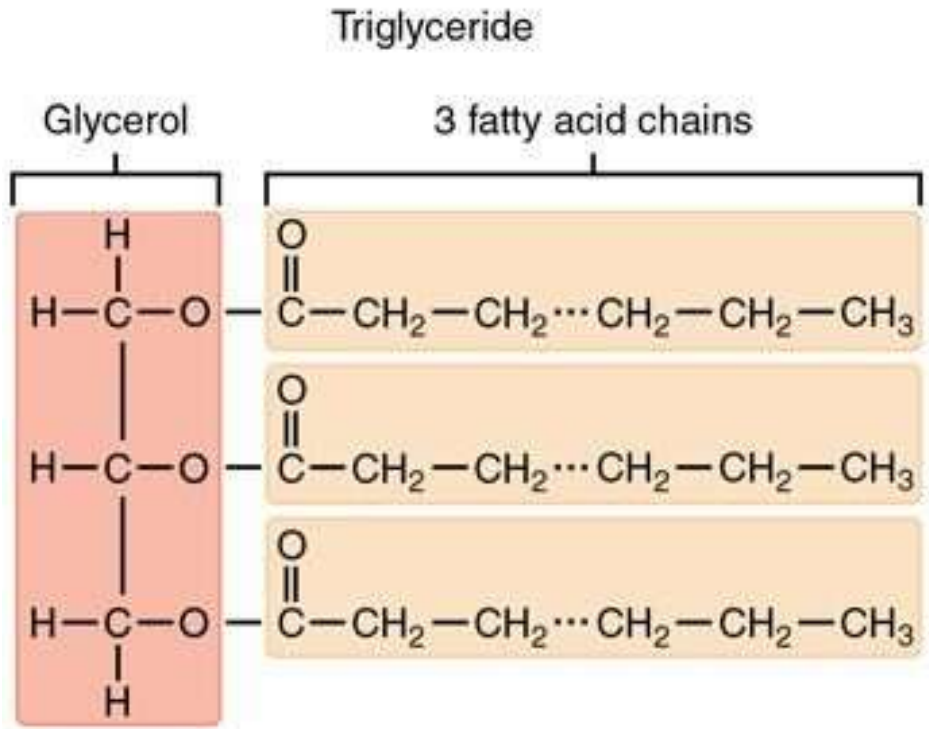
Differences between oils and fats

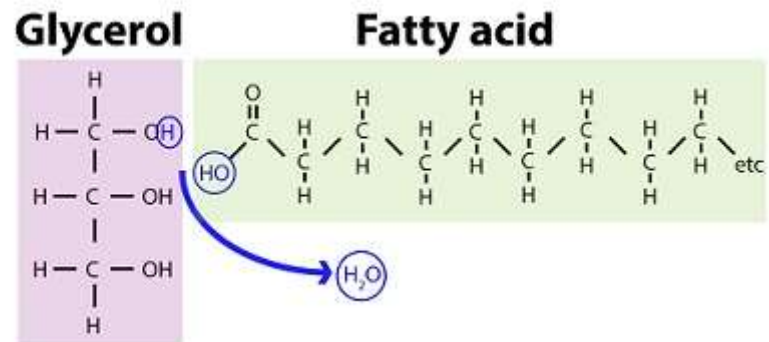
Differences	Fats	Oils
Sources	Mainly animals	Mainly plants
Fatty acid	Saturated	Unsaturated
Bonding	No double bond	Have double bond
State at room conditions	Solid	Liquid
Melting point	High	Low

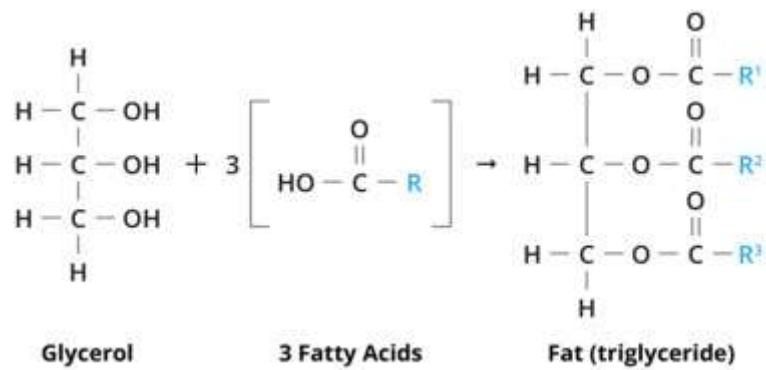
Types of Fatty Acids	Examples of Sources	Health Impacts and Intake Recommendations
Saturated  • No double bond • Straight structure • Solid at room temperature	 Beef  Butter  Coconut oil	• Increase risk of heart disease • Less than 20g of saturated fats per day (for a 2000 kcal diet)
Trans  • One or 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

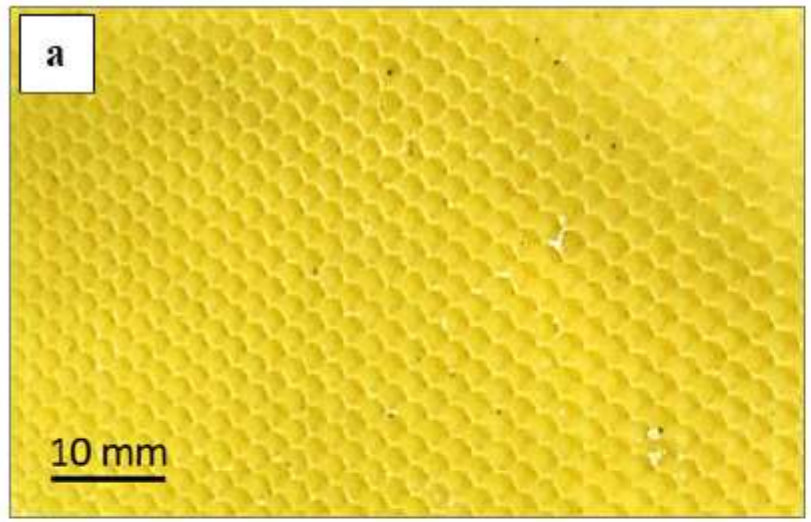
- Esters of long-chain fatty acids with long-chain alcohols.

•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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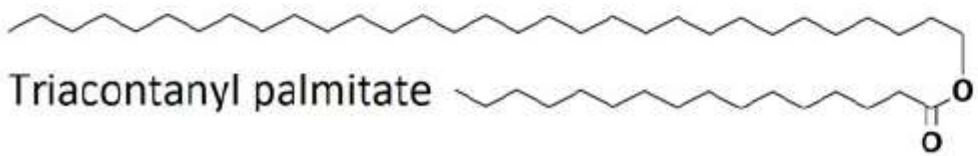

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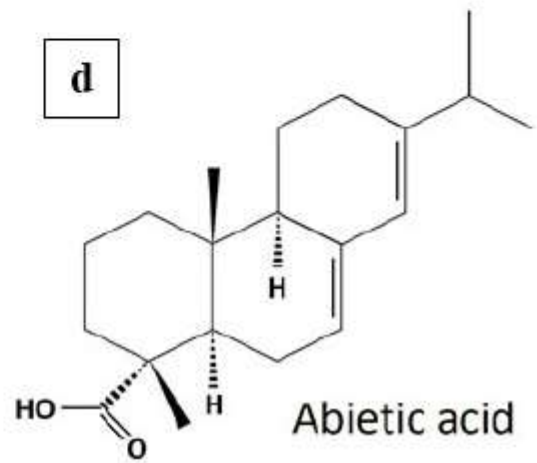


Abietic acid

2. Compound Lipids

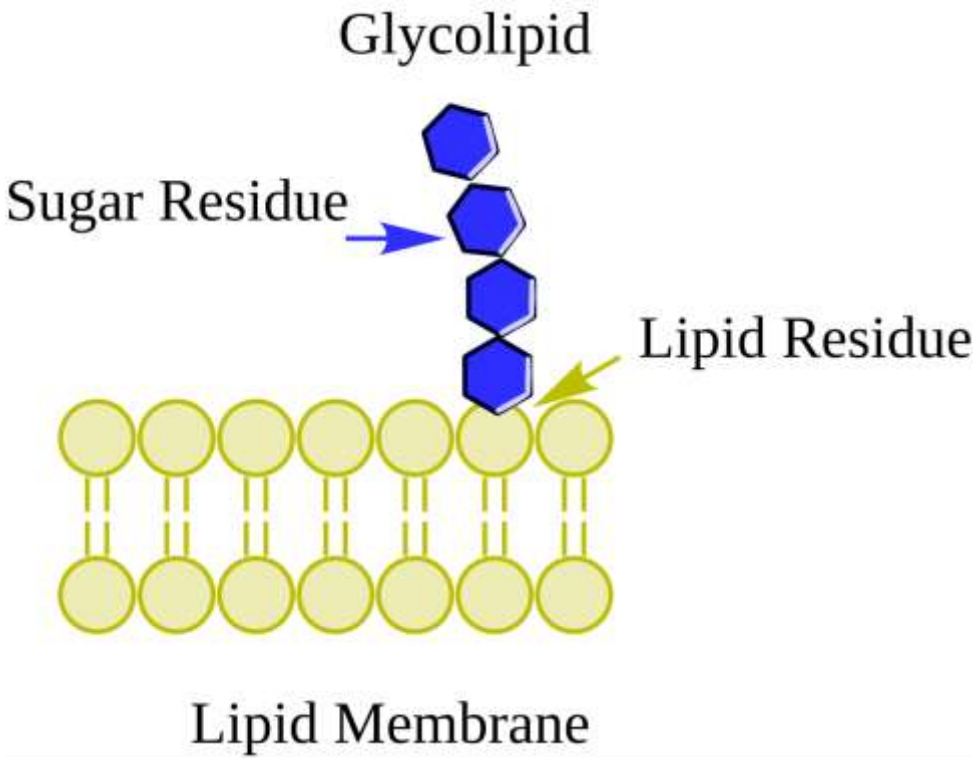
- Lipids containing additional groups like phosphate or carbohydrates, in addition to fatty acids and alcohols.

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.

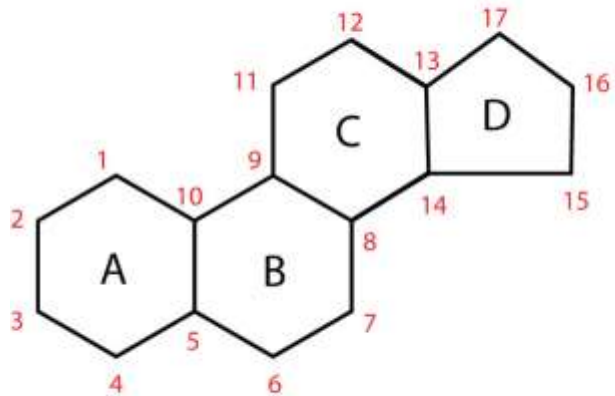


3. Derived Lipids

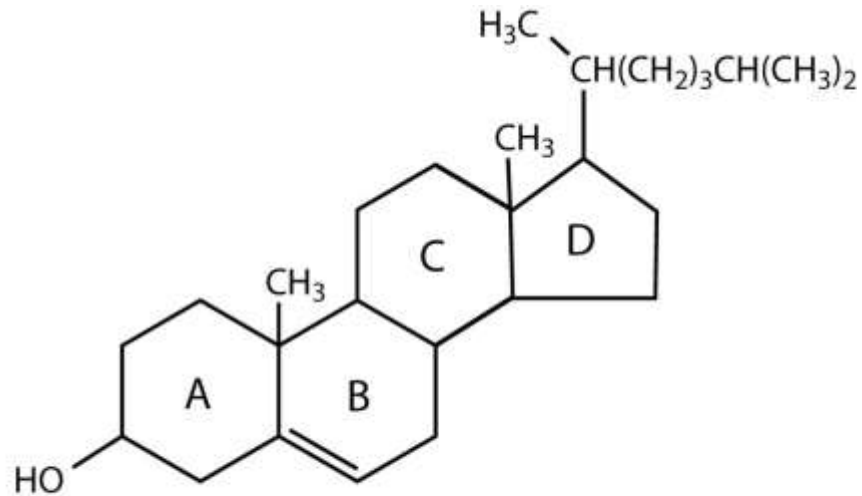
- Lipids derived from hydrolysis of simple and compound lipids or directly from their precursors.

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.



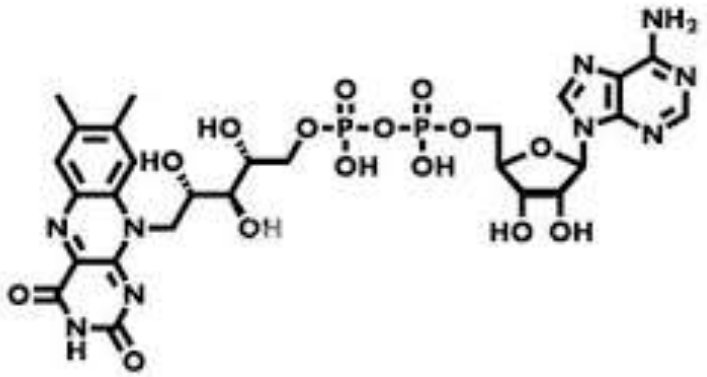
(a) Steroid skeleton



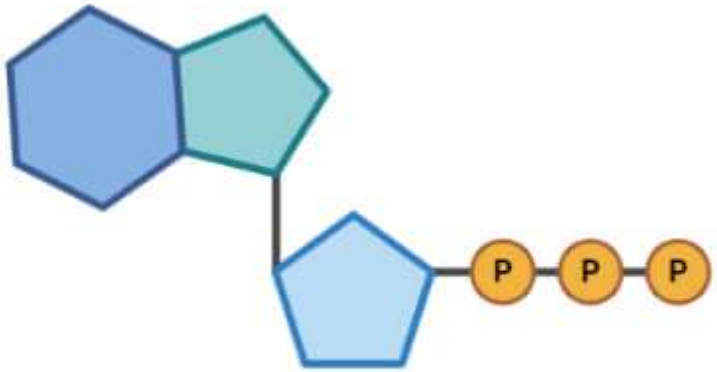
(b) Cholesterol

Lipid Functions:

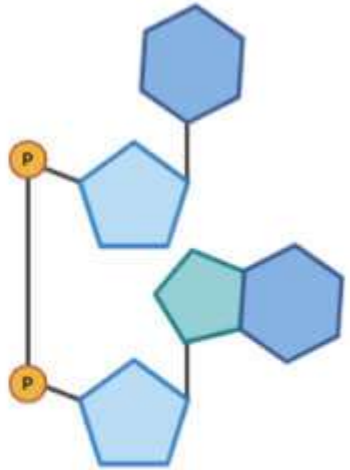
- Serve as energy sources and reserves.
- Store energy as starch or glycogen.
- Act as components in coenzymes (e.g., ATP, FAD, NAD).
- Serve as nucleotide components in RNA (ribose) and DNA (deoxyribose).
- Play roles in the immune system, fertilization, growth, and development.



FAD



ATP



NAD

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

Tishk International University
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Food Processing and Preservation (Cont.)

Outlines

Previous Lecture

Food Processing

Food Preservation

Learning Outcome

Understand Principles of Food Processing & Preservation

Evaluate the Impact on Food Quality & Safety

Apply Preservation Methods in Food Industry

Chemicals

Preservatives

Work either as:

- Direct microbial poisons or,
- Reducing the pH to a level that prevents the growth of microorganisms (MOs)

#Chemicals used today are:

Nitrates and Nitrites

1. To preserve meats

Sulphites

1. To prevent the browning of fruits and vegetables
2. To prevent fungal spoilage

Common food preservation methods:

- Bottling and canning
- Pickling
- Drying
- Salting
- Vacuum packing
- Cooling and freezing
- Waxing
- Pasteurization
- Boiling
- Smoking

Bottling and Canning

Bottling and canning are processes of preserving food by heating and then sealing it in an airtight container.

The food is boiled to kill microorganisms and then sealed to prevent other microorganisms from getting in.

PICKLING

Pickling food in vinegar or other acids makes it difficult for microorganisms to live.
Commonly pickled food includes onions, parkias, soya beans, and chillies.

Sugar can also be used in pickling fruits such as nutmegs, mangoes, and cherries.

The concentrated sugar solution used draws water from the fruit, thus preventing the growth of microorganisms.


MASON

Drying

A lot of food is preserved by drying under the sun.

Drying removes most water from food. Most bacteria die or become inactive when the food is dried.

Anchovies and dried chillies are examples of dried food.

Salting

Salting is an age-old way of preserving food. The salt draws out moisture and prevents microorganisms from growing. In this process, food such as fresh fish are gutted, washed, and coarse salt is rubbed into it.

A lot of our local foods are preserved by the salting process.

Vacuum Packing

Vacuum packing keeps food by sucking air out from its packaging.

Food is thus prevented from spoiling because there is no air.

Vacuum packing is commonly used for storing nuts, sliced fish, pickled, and dried fruit.

Cooling and Freezing

Cooling and freezing are the most common forms of food preservation.

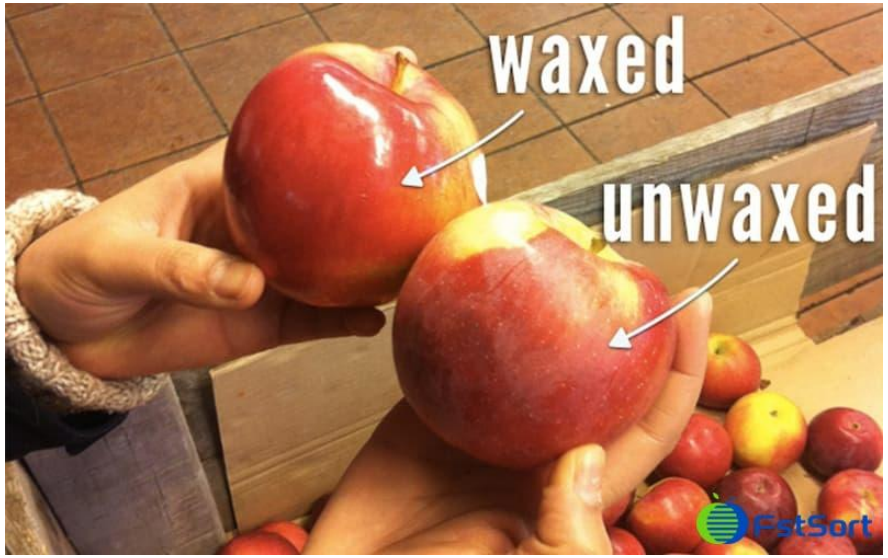
Cooling slows down the action of microorganisms, thus it takes longer to spoil. It allows fruit from different parts of the world to appear on our supermarket shelves (0 to -4°C).

At freezing temperature, microorganisms become inactive, thus food cannot spoil when it is frozen (-18°C).

Food like meat, fruit, and vegetables are kept in the refrigerator.

Waxing

Waxing of fruit and vegetables is also common. Apples, oranges, eggplants, and tomatoes are dipped into liquid wax to prevent the growth of fungi and loss of moisture.


waxed
unwaxed
FstSort

Pasteurization

Pasteurization means heating food to a certain temperature for some time, followed by rapid cooling. Heating at a high enough temperature kills most bacteria. However, it does not affect the taste and nutritional value of the food.

Fresh milk, yoghurt drink, and juices are pasteurized to make them last longer.


巴氏杀菌罐

Boiling

As food is heated and cooked, the heat kills microorganisms. Boiling kills most bacteria.However, those not affected by heat will grow when the conditions are suitable.

Smoking

Smoking is the process of drying food with smoke for a long period of time. This method is mainly used for fish, meat, and fruit such as bananas.

The drying effects of smoke and the chemicals produced from the smoke help to preserve the food.

Food Processing

Food processing is the set of methods and techniques used to transform raw ingredients into food or to transform food into other forms for consumption by humans or animals, either in the home or by the food processing industry.

Food processing typically takes clean, harvested crops or slaughtered and butchered animal products and uses these to produce attractive, marketable, and often long-life food products. Similar processes are used to produce animal feed. Aims of Food Processing To extend the shelf life to allow time for distribution, sales, and home storage.

To increase variety in the diet by providing a range of attractive flavors, colors, aromas, and textures in food (collectively known as eating quality, sensory characteristics, or organoleptic quality).To provide the nutrients required for health (termed the nutritional quality of a food).To generate income for the manufacturing company.

Food Processing
Examples of food processing methods include:

- Chopping
- Mixing
- Homogenizing
- Cooking
- Pasteurizing
- Blanching
- Spray-drying
- Frying
- Baking
- Packaging
- Addition of gas such as air entrainment for bread or gasification of soft drinks

Chopping

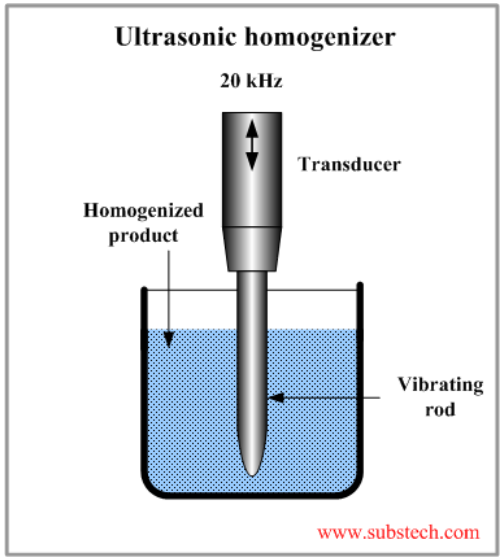
Chopping is a food processing technique that involves cutting food into smaller pieces using a knife, food processor, or other cutting tools. This method is commonly used for preparing ingredients for cooking or further processing, ensuring uniformity in size for even cooking and texture.

Mixing

Mixing is the process of combining multiple ingredients to achieve a uniform consistency, texture, or composition. It is widely used in baking, sauce production, and dairy processing, ensuring that all components blend well to create a homogenous mixture.

Homogenizing

Homogenizing is a mechanical process that breaks down and evenly distributes fat molecules in a liquid, preventing separation. It is commonly used in dairy processing, particularly in milk production, to ensure a smooth, consistent texture and improve shelf stability.



Cooking

Cooking is the application of heat to food to enhance its flavor, texture, and digestibility while also eliminating harmful bacteria. Various cooking methods, such as boiling, steaming, roasting, and grilling, are used to prepare meals and preserve nutrients.

Pasteurizing

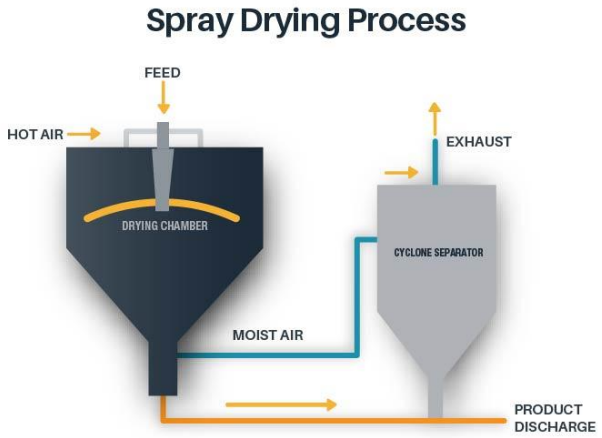
Pasteurization is a heat treatment process that destroys harmful bacteria in food and beverages, extending their shelf life. Commonly used for dairy products, fruit juices, and canned goods, this method involves heating food to a specific temperature for a set time before rapidly cooling it.

Blanching

Blanching is a short heat treatment process where food, usually vegetables, is briefly boiled or steamed before being rapidly cooled in ice water. This method helps in preserving color, texture, and flavor while also reducing microbial load and enzyme activity.

Spray-Drying

Spray-drying is a dehydration technique where liquid food is turned into powder by rapidly drying it with hot air. This method is used in the production of powdered milk, instant coffee, and other dry food ingredients, helping to improve storage and ease of use.



Frying

Frying is a cooking process where food is submerged in hot oil or fat to create a crispy texture and enhance flavor. It can be categorized into deep frying, pan frying, and stir-frying, depending on the amount of oil used and the cooking method

Baking

Baking is a dry heat cooking method where food is cooked in an enclosed space, such as an oven, using indirect heat. This process is commonly used for making bread, cakes, pastries, and other baked goods, resulting in a firm texture and enhanced flavors.

Packaging

Packaging involves enclosing food products in protective materials to preserve freshness, prevent contamination, and extend shelf life. Various packaging techniques, such as vacuum sealing, modified atmosphere packaging, and aseptic packaging, are used depending on the type of food.

Addition of Gas

Addition of Gas (Air Entrainment/Gasification)

Air entrainment or gasification is a food processing method where gas, such as carbon dioxide, is introduced into food or beverages to alter texture and enhance preservation. This process is commonly used in soft drink production to create carbonation and in bakery products to improve dough aeration.

CO_2 GH production in a reactor

Produced CO_2 GH

Addition of CO_2 GH as leavening agent, and gelling agents (EW, RF, AC) in the dough

Bake bread in oven

Test for physicochemical properties of bread

- Moisture
- Baking loss
- Volume
- Pore analysis
- Hardness


thank
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