

LECTURE 7: Lipids

Lipids Importance

- Heterogenous group of compounds that are insoluble in water but soluble in non-polar solvents such as chloroform
- Occur in plants and animals as storage and structural components
- Supply the essential fatty acids that are not synthesized in human beings
- Essential for the absorption of fat soluble vitamins A, D, E, and K
- Fats are deposited in the adipose tissue that serves as a reserve source of energy during starvation
- Improve the palatability of the diet

Lipid Classification

Simple Lipids

- Esters of fatty acids with glycerol and monohydric alcohols
- Fats are triglycerides that are esters of fatty acids with glycerol (vegetable oils, ghee, and butter)
- Waxes are esters of fatty acids and alcohol (bees wax)
- Simple Lipids contain fatty acids and glycerol or long chain alcohols (fats, oils, waxes)
- Also referred to as oils, fats, or neutral fats

Compound Lipids

Compound Lipids

- Contain chemical groups in addition to alcohol and fatty acids
- Esters containing chemical groups in addition to alcohol and fatty acids
- Phospholipids – contain phosphate group
- Glycolipids contain hexose units preferably galactose
- Plant Sulpholipids – contain sulfated hexose

Triacylglycerols are composed of three fatty acids esterified to the hydroxyl groups of glycerol

- Triacylglycerol that are solids at room temperature are called fats
- Liquid triacylglycerols are called as oils
- Waxes are esters of long-chain saturated and unsaturated fatty acids with long chain alcohol

Structure of Simple Lipids

Glycerophospholipids – glycerol, fatty acid, phosphoric acid, and a nitrogenous base and this is an important structural lipid in membranes – Phosphatidyl choline (lecithin) – contains nitrogenous base choline.

Present in the membranes of cells having both metabolic and structural functions –

Sphingophospholipids - phosphate and fatty acids are attached to the alcohol sphingosine instead of glycerol (linkage is by amide and not ester)

Derived Lipids

- Derivatives of hydrolysis of simple and complex lipids
- Sterols – Possess a cyclic ring structure with one secondary alcoholic group. Occur in the free state as esters with fatty acids. Classified as: – Animal sterols – cholesterol – brain

consists of 5.5% and blood of human being consists of 150-250 mg/100 ml – Plant sterols – phytosterol – Mycoesterol – ergosterol

Plant Fatty Acids

- Fatty acids are carboxylic acids with hydrocarbon chains of 2-36 carbons
- More than 200 fatty acids have been isolated from plants but only a few are present in large quantities (major fatty acids)

Essential Fatty Acids: fatty acids that are not synthesized in the body but required for normal body growth are called essential fatty acids

- Linoleic and linolenic acids are essential fatty acids, arachidonic is synthesized from linolenic acid Fatty Acid
- Linolenic acid belongs to n-3 family whereas linoleic acid is grouped under n-6 family

Note:

- Major fatty acids are saturated and unsaturated with an unbranched carbon chain
 - Saturated fatty acids are: Lauric, Myristic, Palmitic, and Stearic
 - Unsaturated fatty acids are oleic, linoleic, and linolenic acid
 - The double bonds of all naturally occurring unsaturated fatty acids are in cis configuration
 - Non-polar hydrocarbon chain accounts for the poor solubility of fatty acids in water
 - Minor fatty acids are characterized by a high content of short and medium chain saturated fatty acids (cow and goat milk)
- Lipid Classification
- Unusual fatty acids are found only in few individual species or genus
 - Castor bean seed oil is rich in ricinoleic acid
 - Hydnocarpic and chaulmoogric acids are found in chaulmoogra oil used in the treatment of leprosy

Properties of Fats

- Sources of fats – butter, cooking oil, egg, meat, nuts, milk, cereals, pulses, fruits and vegetables
 - Solubility – Soluble in acetone, benzene, hot alcohol
 - Fats have sharp melting range for confectionary
 - Specific heat increases with increasing unsaturation
 - Viscosity decreases with increases unsaturation
 - Hydrogenation – preparation of refined oil under optimal temperature and pressure in presence of nickel catalyst – Hydrogen is added to the unsaturated linkages
 - Rancidity – Development of off-flavors in fats is known as rancidity – hydrolytic and oxidative – Hydrolytic – fat is hydrolyzed by lipases, free fatty acids are formed that contribute to off odours – Oxidative – oxidation takes place at the unsaturated linkage resulting in the formation of peroxides which breakdown into aldehydes and ketones – Antioxidant is a substance that is added to fats to retard the oxidative breakdown of fat and prevent spoilage. They act by combining with free radicals and disrupting free radical chain mechanism (Tocopherol)
- Nutritional Aspect of Lipids
- Normal human plasma contains 500 mg/100 ml of which 120 mg are triglycerides, 180 mg cholesterol and 10-15 mg free fatty acids

- Adult human synthesizes about 2000 mg of cholesterol
- Blood cholesterol level of over 250 mg/100 ml increases the risk of coronary heart disease
- Consumption of essential fatty acids is reported to reduce cholesterol levels.