Chapter 4
Fats

INTRODUCTION

Lipids include fats and oils, They have a greasy texture, are insoluble in water, and are soluble in some organic solvents. They are mostly made up of carbon, hydrogen, and oxygen, just as carbohydrates. They are a more concentrated source of energy than carbohydrates and proteins, giving two and a half times the amount of energy. Lipids, unlike carbohydrates, contain a little amount of oxygen and a higher amount of hydrogen and carbon. At 20°C, fats become solid. If they're lipid at that temperature, they're termed as oils.

In food preparation, simple fats and oils are quite important. The quality of a food product is primarily determined by the fats and oils used in its preparation. Glycerol and fatty acids are joined together to produce an ester in lipids. Monoglycerides, diglycerides, and triglycerides are formed when one, two, or three fatty acids are esterified with glycerol. Triglycerides are the most frequent type of fat used for cooking food.

FATTY ACID

Saturated Fatty Acids (SFAs) are made up of single carbon atom bonds. These fatty acids are mostly found in animal fats, however there are exceptions, such as coconut and palm oils. Vegetable oils have a very high percentage of saturated fatty acids and are solid. Some examples include stearic acid, palmitic acid, myristic acid, and butyric acid.

Unsaturated Fatty Acids: Unsaturated fatty acids do not obtain the full complement of hydrogen atoms. This causes a double bond to form between the atoms, resulting in one or more double bonds between the carbon atoms. There are two types of unsaturated fatty acids:

- **Monounsaturated Fatty Acids (MUFAs)** are a type of unsaturated fatty (MUFA) acids.
- **Polyunsaturated Fatty Acids (PUFAs)** are a type of polyunsaturated (PUFA) acids.

Mono Unsaturated Fatty Acids (MUFAs) : are those that have only one double bond between their carbon atoms. Ground nut oil, olive oil, and maize oil all include oleic acid, which is a monosaturated fatty acid. Vegetable oils are the most common source. There are certain exceptions, such as fish oils, which are liquid and contain mono and polyunsaturated fatty acids.

- A diet high in MUFA can reduce blood cholesterol level, lower the risk of heart diseases, stroke, breast cancer and reduces the pain in rheumatoid arthritis and help in weight loss.
- Foods which contain MUFA (oliec acid) are avocados, olives, olive oil, peanut butter, peanut oil. It is also known as Omega -9 - fatty acid.

Polyunsaturated Fatty Acids (PUFAs): are fatty acids with two or more double bonds. Vegetable oils are a good source of these.

Linoleic, linolenic, and arachidonic acids are examples. PUFA are of two types: Omega -3 and Omega- 6 fatty acids. The health benefits of Omega 3 are immense. They have been proven effective in the treatment and prevention of hundreds of medical conditions which includes high cholesterol, depression, anxiety, cancer, diabetes mellitus, arthritis and other cardiovascular disease.

Omega -6 fatty acids are a family of pro- inflammatory and anti -inflammatory fatty acids.

Fatty Acid Content in Different Fats in %

Fats	Saturated Fatty Acids	Mono Saturated Fatty Acids	Poly unsaturated Fatty Acids
Coconut Oil	92	6	2
Palm Oil	46	44	10
Cotton Seed Oil	25	25	50
Groundnut oil	19	50	31
Safflower oil	10	15	75
Sunflower oil	8	27	65
Corn oil	8	27	65
Soyabean oil	14	24	62
Butter	60	37	3

ESSENTIAL FATTY ACIDS (EFA)

Essential fatty acids are those that humans cannot produce. They can only be obtained through food. Linoleic acid is the most important fatty acid, as it is the building block for the creation of other vital fatty acids (e.g. linolenic and arachidonic acids). Vegetable oils contain a lot of linoleic acid. Linoleic acid is abundant in safflower oil, corn oil, sunflower oil, soyabean oil, sesame oil, and groundnut oil (between 40 and 75 percent). About 75% of the EFA is found in safflower oil.

Growth retardation, reproductive failure, and skin diseases can all be caused by a lack of EFA in the diet. As a result, EFA should account for at least 3% of total energy consumption. The following is a list of EFA:

1. Linoleic acid
2. Linolenic acid
3. Omega 3 fatty acids
4. Omega 6 fatty acids

- Omega- 3 and omega 6 are poly unsaturated fatty acids.
- Omega- 6 rich foods are safflower, sunflower, cottonseed, sesame and ground nut oil.
- Omega- 3 rich foods include olive oil, fish oil, mustard oil, soyabean and black gram, etc.

• To ensure that the body gets the required amounts of essential fatty acids, following blends of different oils should be used:

- Sesame + Mustard
- Ground nut + Mustard
- Soyabean + Olive
- Corn + Rice Bran

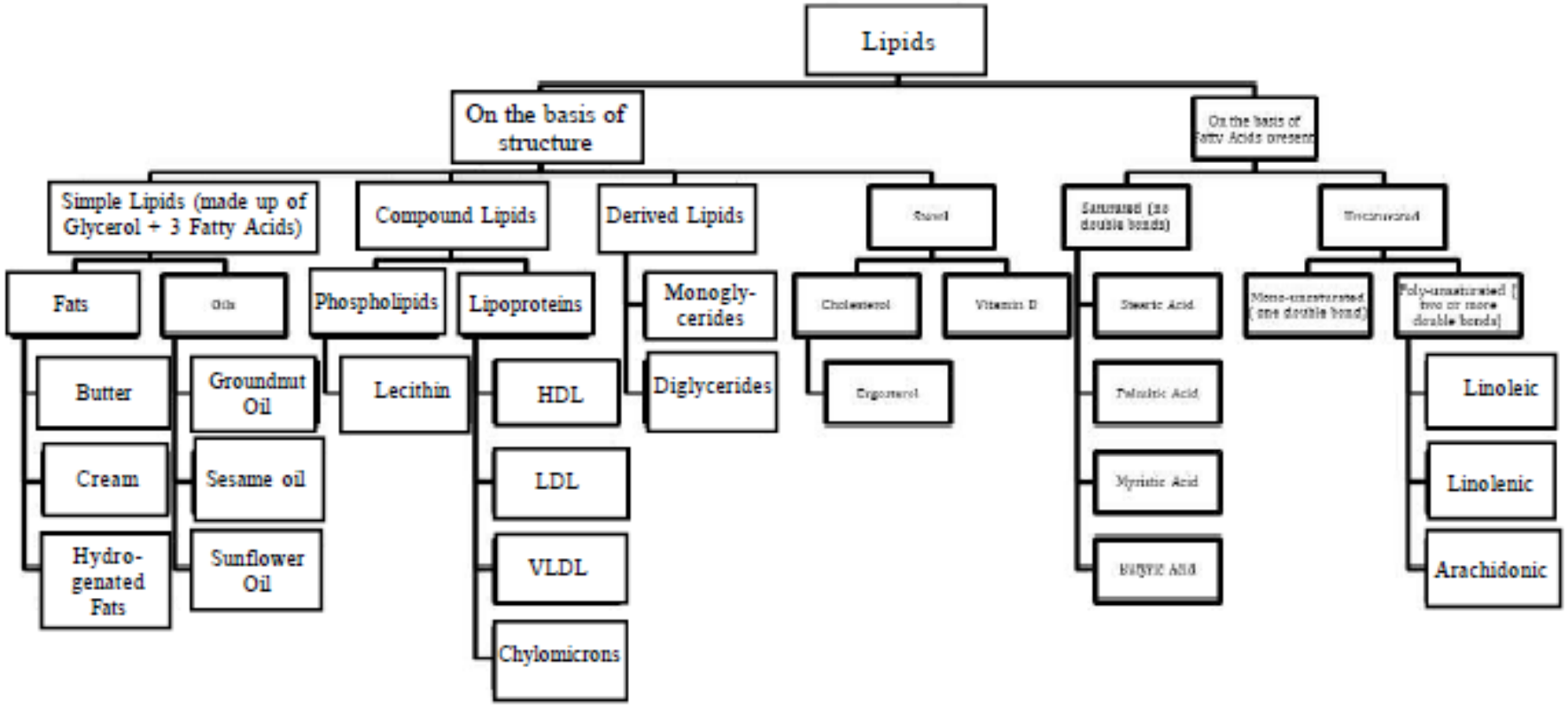
Functions of Essential Fatty Acids:

- Maintenance of the functioning and integrity of the cellular and sub cellular membranes.
- Regulation of cholesterol metabolism by transporting it between the blood and body tissues.
- Acts as precursor of an important group of hormones like compounds prostaglandins, which aids in regulating vascular function and help relief pain and inflammation.
- It delays blood clotting time.

NON-ESSENTIAL FATTYACIDS

These are those which can be synthesized by the body and which need not to be supplied through diet. These are found in palmitic acid, oleic acid and butyric acid.

CLASSIFICATION OF LIPIDS



- Simple lipids are composed of three fatty acids bound together by glycerol. They are mixed triglycerides, which indicates that the fat contains more than one type of fatty acid, such as cooking oils and butter. More than 98 percent of food and body fats are made up of simple lipids.
- Compound lipids**,** such as phospholipids, glycolipids, and lipoprotein are fats in which at least one fatty acid is substituted by carbohydrate, protein, or phosphorus, i.e. fats + non fat molecules.

- Derived lipids, which comprise monoglycerides, diglycerides, glycerol, and fatty acids, are the breakdown products of fats.
- Sterols have a benzene ring structure and are not formed up of fatty acids or glycerol. Cholesterol and fat-soluble vitamins A, D, E, and K are examples of fat-like compounds.
- Cholesterol is a fat-like substance found in food. Its structure differs from that of triglycerides. It is found in all body cells, with a high concentration in the brain and nerve tissue. The sebaceous glands secrete a lot of sebum, which contains a lot of cholesterol. A normal human being's blood contains 150- 250 mg per 100 mL. Cholesterol comes from two places in the human body- food and the liver, where it is synthesized. It has the following functions: -
  - Cholesterol is the building block for all steroid hormones.
  - It is also a Vitamin D precursor.
  - It is necessary for the production of bile.
  - It is a necessary component of cell membranes.
  - If it is consumed in excess, it leads to diseases of the cardiovascular system.

VISIBLE AND INVISIBLE FATS

Visible fats are those that have been separated from their sources, such as ghee made from milk and cooking oils made from seeds and nuts. As a result, estimating their daily calorie intake is simple. Fats that are not visible to the human eye are known as invisible fats. They can be found in practically every food, such as cereals, legumes, nuts, milk, eggs, and so on. It's tough to quantify how much they consume. In reality, unseen sources account for the majority of total consumption.

HYDROGENATION

When vegetable oils are hydrogenated in the presence of a Nickel catalyst at the right temperature and pressure, the liquid oils are turned to semi-solid fat. This is called “vanaspati,” or vegetable ghee, and it is a common cooking medium in India. Because the Vanaspati is deficient in fat soluble vitamins, unsaturated fatty acids are transformed to saturated fatty acids during the hydrogenation process, and important fatty acid content is dramatically reduced. Vitamins A and D are added to make it more nutritious.

REFINED OILS

Refining is usually done by treatment with steam and alkali to remove the free fatty acids and rancid materials. It does not bring any change in the unsaturated fatty acids of the oil. It only improves the quality and taste of oils.

RANCIDITY

Fats can be oxidized or spoilt by room temperature air, resulting in an unpleasant odor and flavor. This is referred to as rancidity. When fats and oils are stored for a long time, certain changes occur. High temperatures, moisture, metals, and air are some of the conditions that cause fats to get rancid. Antioxidants are commonly added to commercially produced fats and oils to protect them. Some lipids, such as vitamin E and vitamin C, are naturally preserved by the presence of antioxidants. As a result, hydrogenated fats and oils should be used for long-term storage. It can be avoided by storing items in airtight containers.

FUNCTIONS OF FATS

- **Energy :** Fats are a concrete sources of energy. One gram of fat gives 9 kcal when it is oxidized in the body. All tissues except those central nervous system and brain can utilize fat as a source of energy. Fats are deposited in the adipose tissue and this deposit serves as a reserve of energy during starvation.
- **Thermal Insulation :** Subcutaneous fat acts as an insulator against cold by retaining body heat.
- **Protein Sparing Action :** An adequate intake of fat in the diet allows proteins to perform their main functions of growth and maintenance. In this way, fats spare proteins from being oxidized for energy.
- **Protection of Vital Organs :** Fat provides a protective padding to vital organs, such as heart, kidney and intestine from mechanical shock and keeps them in place.
- **Absorption of Fat Soluble Vitamins :** Fats are essential for the absorptions of fats vitamins A,D,E and K, especially carotenoids present in foods of vegetable origin. So fat serve as vehicles for fat soluble vitamins.
- **Essential Fatty Acids :** Fats contain essentially fatty acids, viz. linoleic, linolenic and arachidonic acids, which are essential for maintaining tissues in normal health.
- **Satiety Value :** Fats improve the palatability of the diet and give satiety value, i.e., a feeling of fullness in the stomach.
- **Synthesis of Hormones :** The cholesterol is necessary for the synthesis of some steroid hormones and bile acids, e.g., sex hormone.
- **Precursors of Prostaglandins :** Poly unsaturated fatty acids are precursors of prostaglandins – a group of compounds now recognized as “local hormones.” They play a major role in controlling many of the physiological functions.

SOURCES

- **Animal Fats:** Ghee, butter, milk, cheese, egg, yolk, meat, and fish are all good sources of animal fats. Saturated fats make up the majority of animal fats
- **Vegetable Fats:** Groundnut, mustard, soyabean, sesame, coconut, almond, cashew nut, safflower, and sunflower, among others, store fat in their seeds.
- **Other Sources:** Most other foods, such as grains, legumes, and vegetables, contain little amounts of fat (invisible). In India, large amounts of invisible fats are consumed through cereal eating.

FAT REQUIREMENT

Fats should offer 20 to 30 percent of total dietary energy, according to the WHO expert committee on the prevention of coronary heart disease (CHD). Vegetable oils rich in essential fatty acids should account for at least 50% of total fat consumption. Fats should not account for more than 20% of total energy consumption, according to the ICMR (1989). Dietary fats contribute 30 to 40% of total calories in affluent countries.

DIGESTION AND ABSORPTION OF FATS

When a person eats, the meal enters the stomach, where gastric lipase creates a little amount of fat breakdown (process of splitting into smaller molecules by uniting with water). Bile secretion emulsifies fats in the duodenum. Lipases in the pancreas and the intestine break down fats into monoglycerides, diglycerides, and fatty acids. The digestive products move through the lacteals of the small intestines, into the thoracic duct, and finally into the bloodstream, where they reach every cell in the body.

FAT METABOLISM

- The liver aids in the oxidation of fats and prepares them for tissue deposition. Some fats are oxidized in the tissues to provide heat and energy. Fat is deposited in fat deposits to some extent. The liver must prepare fats for combustion in the tissues before they can be used as bodily fuel. The desaturation of fats is a chemical reaction that takes place in the liver cell. Carbon dioxide and water, which are expelled by the lungs, skin, and kidneys, are waste products that come from the burning of fat in the tissue. If the combustion is incomplete, acetone bodies form and exit the body along the same pathways. Acetone and diacetic acid can be discovered in the urine, and the volatile acetone can be smelled in the “sweet breath.”
- Fat is a superior fuel to glucose because it provides double the amount of heat and energy per gramme of fuel consumed. On the other hand, if burned with enough sugar, it is more difficult to digest, absorb, and burn.
- Combustion is incomplete if there is little or no sugar to burn with it, and ketone molecules develop. Acidosis occurs when a large number of ketone bodies are generated, resulting in sleepiness, coma, and eventually death. Fat that is not used as a source of energy can be stored in fatty tissues and bodily cavities.
- It has the potential to be stored in enormous quantities, resulting in obesity. The metabolism of the three food groups carbohydrate, fat, and protein is intricately interrelated, and consuming food in excess of the tissue’s requirements will result in weight gain.

DEFICIENCY OF FATS

- Phrenoderma, often called as load skin, is caused by a lack of necessary fatty acids in the diet. It is characterised by horny popular eruptions on the back and buttocks, as well as the posterior and lateral sides of the thighs.
- Phrenoderma in adults and children was quickly treated by the administration of safflower seed oil high in EFAand vitamins of the Bcomplex, according to recent investigations by Gopalan and associates in India.
- Lack of fat can lead to a shortage in fat- soluble vitamins, which can impact children's growth and weight.

EXCESSIVE FATS

The consequences associated with high fat consumption are of more concern today. It has the potential to endanger human health. Obesity is caused by excess fat that is accumulated in the adipose tissue. Adipose tissues make up 10 to 15 percent of body weight in healthy persons, but it can reach 30 percent in obese people. The majority of body fat is in the form of triglycerides, which the human body can produce.

HYPERCHOLESTEROLEMIAAND CORONARY HEART DISEASE

- Atherosclerosis and coronary heart disease are common when blood cholesterol levels exceed 250 mg per 100 ml. (Atherosclerosis is the narrowing of arteries as a result of cholesterol buildup; it causes a reduction in blood supply.)
- There has been some evidence in recent years that a high-fat diet increases the risk of colon cancer and breast cancer. Hansen and coworkers reported perianal discomfort and skin dryness in newborns on an EFA deficit diet in one investigation.