LIPIDS

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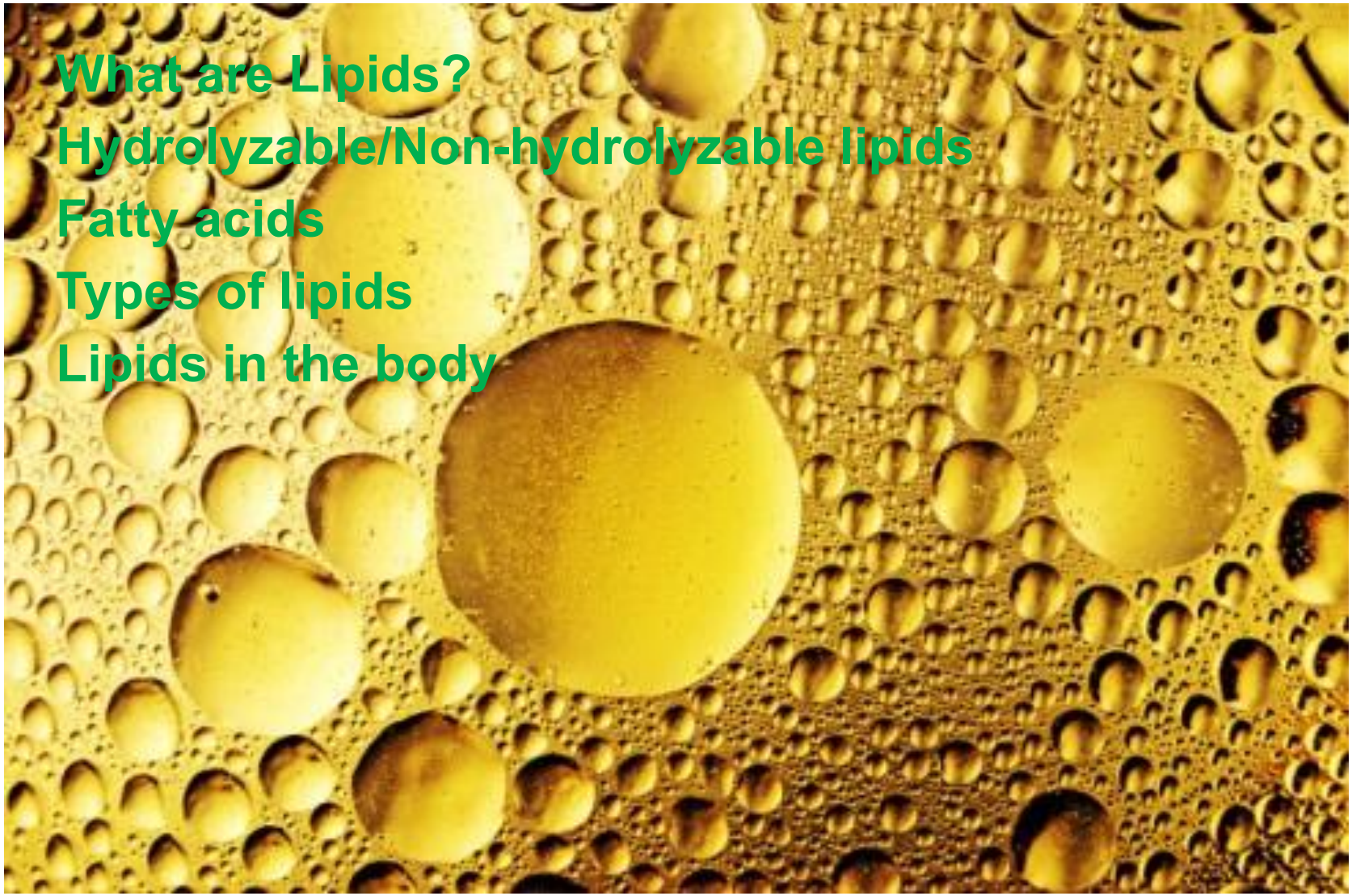
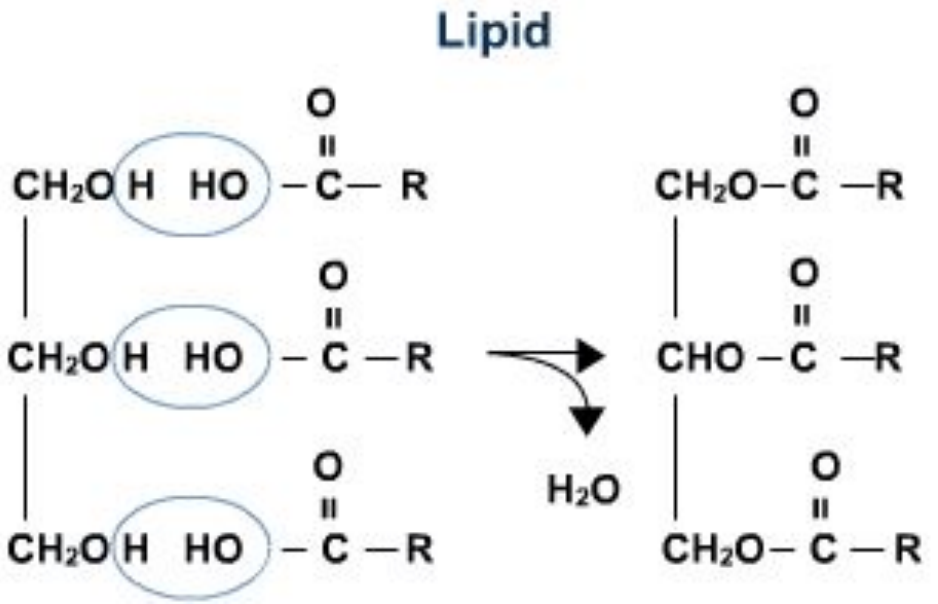
Plan



I. What are Lipids?
II. Hydrolyzable/Non-hydrolyzable lipids
III. Fatty acids
IV. Types of lipids
V. Lipids in the body

I. What are lipids

- Lipids are molecules that contain hydrocarbons and make up the building blocks of the structure and function of living cells. Examples of lipids include fats, oils, waxes, certain vitamins, hormones and most of the non-protein membrane of cells



I. What are lipids

What are lipids soluble in?

- Lipids are not soluble in water. They are non-polar and are thus soluble in nonpolar environments like in choloroform but not soluble in polar environments like water

What do lipids consist of?

- Lipids have mainly hydrocarbons in their composition and are highly reduced forms of carbon. When metabolized, lipids are oxidized to release large amounts of energy and thus are useful to living organisms

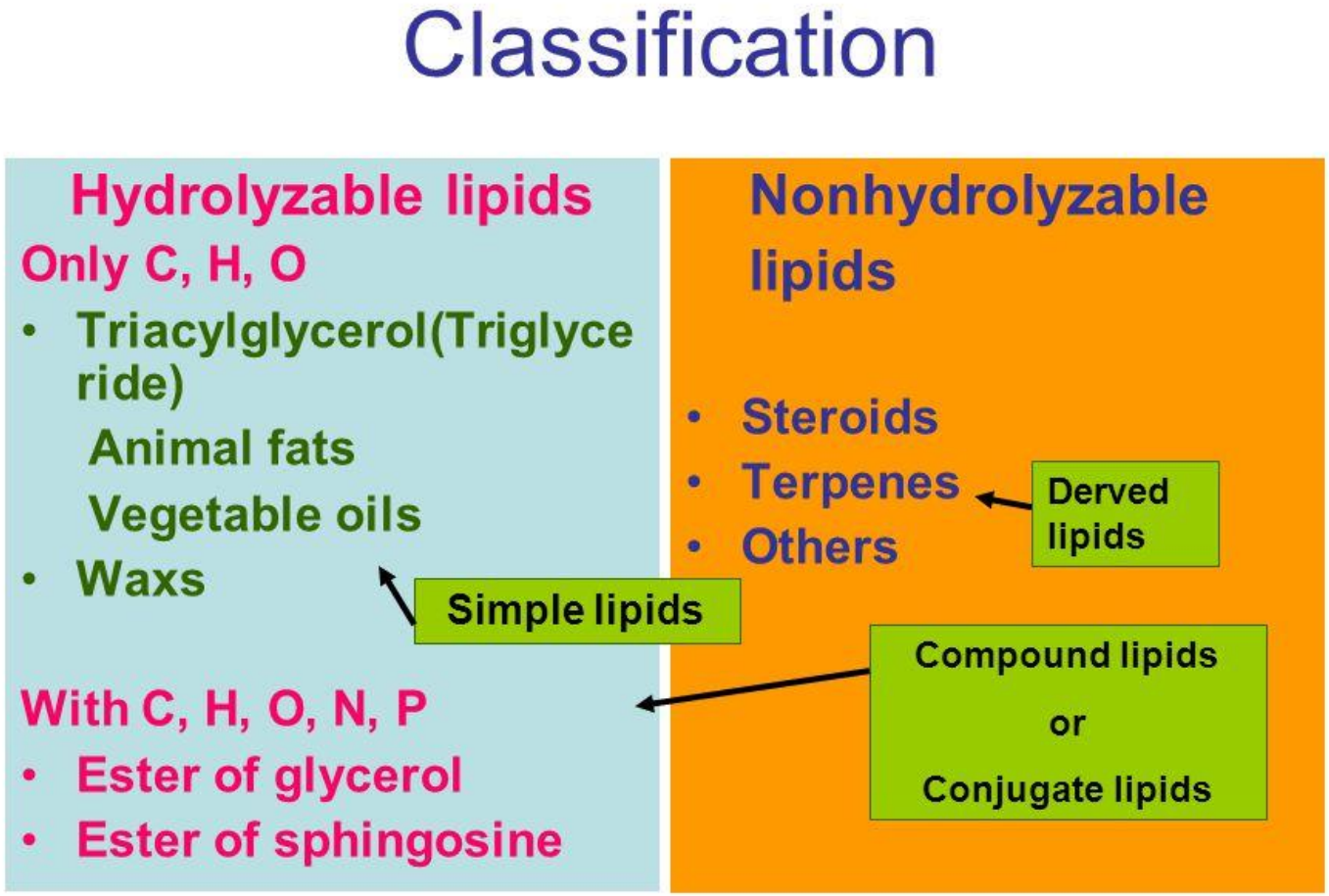
I. What are lipids

- Lipids are molecules that can be extracted from plants and animals using nonpolar solvents such as ether, chloroform and acetone. Fats (and the fatty acids from which they are made) belong to this group as do other steroids, phospholipids forming cell membrane components etc

II. Hydrolyzable/Non-hydrolyzable lipids

- Lipids that contain a functional group ester are hydrolysable in water. These include neutral fats, waxes, phospholipids, and glycolipids

II. Hydrolyzable/Non-hydrolyzable lipids



II. Hydrolyzable/Non-hydrolyzable lipids

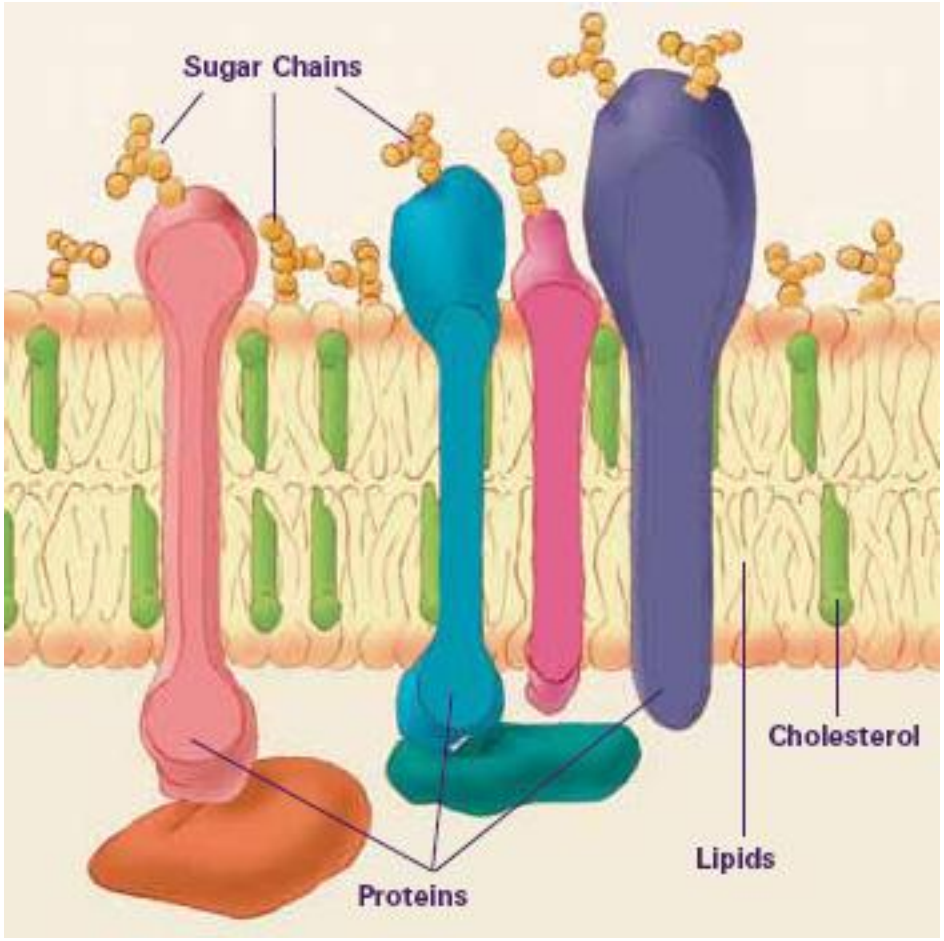
- Nonhydrolyzable lipids lack such functional groups and include steroids and fat-soluble vitamins (e.g. A, D, E, and K). Fats and oils are composed of triacylglycerols or triglycerides. These are composed of glycerol (1,2,3-trihydroxypropane) and 3 fatty acids to form a triester. Triglycerides are found in blood tests. Complete hydrolysis of triacylglycerols yields three fatty acids and a glycerol molecule

III. Fatty acids

- Fatty acids are long chain carboxylic acids (typically 16 or more carbon atoms) which may or may not contain carbon-carbon double bonds. The number of carbon atoms are almost always an even number and are usually unbranched. Oleic acid is the most abundant fatty acid in nature

III. Fatty acids

The membrane that surrounds a cell is made up of proteins and lipids. Depending on the membrane's location and role in the body, lipids can make up anywhere from 20 to 80 percent of the membrane, with the remainder being proteins. Cholesterol, which is not found in plant cells, is a type of lipid that helps stiffen the membrane. Image Credit: National Institute of General Medical Sciences



IV. Types of lipids

Waxes/fats and oils

- These are esters with long-chain carboxylic acids and long-alcohols. Fat is the name given to a class of triglycerides that appear as solid or semisolid at room temperature, fats are mainly present in animals. Oils are triglycerides that appear as a liquid at room temperature, oils are mainly present in plants and sometimes in fish

Mono/poly unsaturated and saturated

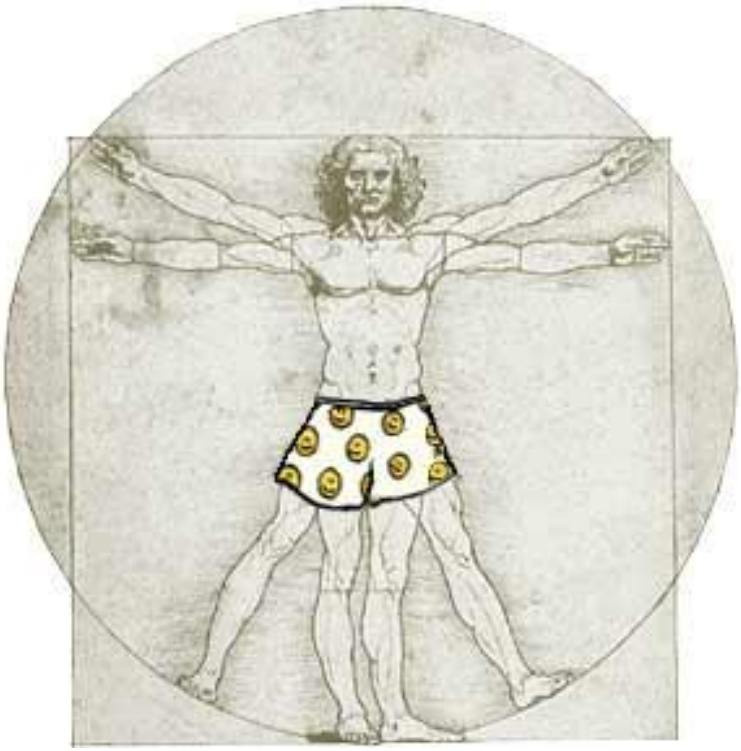
- Those fatty acids with no carbon-carbon double bonds are called saturated. Those that have two or more double bonds are called polyunsaturated. Oleic acid is monounsaturated

Mono/poly unsaturated and saturated

- Saturated fats are typically solids and are derived from animals, while unsaturated fats are liquids and usually extracted from plants.
- Unsaturated fats assume a particular geometry that prevents the molecules from packing as efficiently as they do in saturated molecules. Thus the boiling points of unsaturated fats is lower.

V. Lipids in the body

- Lipids are utilized or synthesized from the dietary fats. There are in addition numerous biosynthetic pathways to both break down and synthesize lipids in the body.



V. Lipids in the body

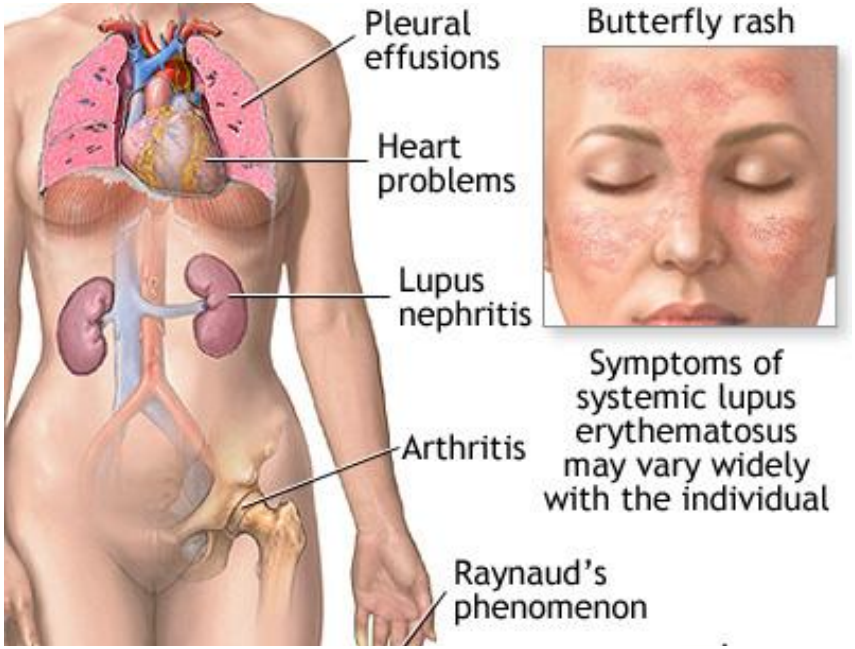
- There are, however, some essential lipids that need to be obtained from the diet. The main biological functions of lipids include storing energy as lipids may be broken down to yield large amounts of energy. Lipids also form the structural components of cell membranes and form various messengers and signalling molecules within the body

V. Lipids in the body

- Lipids play diverse roles in the normal functioning of the body:
  - they serve as the structural building material of all membranes of cells and organelles
  - they provide energy for living organisms - providing more than twice the energy content compared with carbohydrates and proteins on a weight basis
  - they function as molecular messengers and signalling molecules in the body
- Lipids are also biomarkers of disease and are involved in several pathological conditions. Lipids are also known to play a role in genetic modification and influence risk of chronic disease

Lipids and chronic diseases

- Fats in diet play a role in chronic diseases. Up to 70% of all cancers in the United States are attributable to diet for example. Around half of the population according to the USDA develops a diet-related chronic disease responsible for the leading causes of death like heart disease, cancer, stroke, diabetes, and arteriosclerosis. This raises the annual health costs to $250 billion in the USA. High fat, especially trans fats and unsaturated fats lead to heart disease, degenerative and inflammatory arthritis, osteoporosis, obesity, cancer etc



Dietary lipids

- Some of the fatty acids need to be taken in diet. This includes essential fatty acids (EFAs), linoleic acid (LA, an omega-6 fatty acid, 18:2n-6), and a-linolenic acid (LNA, an omega-3 fatty acid, 18:3n-3). These help in formation of polyunsaturated fatty acids (PUFAs) used in cellular structures and as precursors for the biosynthesis of many of the body's regulatory molecules like long-chain PUFAs, arachidonic acid, eicosapentaenoic acid (EPA, 20:5n-3), and docosahexaenoic acid (DHA, 22:6n-3) and eicosanoids. DHA again is necessary for normal neural and retinal development in the infant and young child

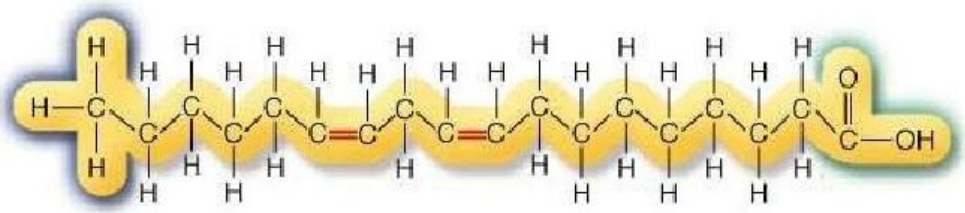
Effects of PUFA

- Dietary lipids help in biochemical and physiological functions as modulators of cell actions and genes. For example, the n-6 and n-3 PUFAs bind to the peroxisome proliferator-activated receptors (PPARs) on genes. This PPAR gene is important for lipid and carbohydrate metabolism. These also play a role in chronic diseases like diabetes and inflammatory conditions.
- PUFA in diet has been found to reduce risk of cardiovascular disease and cancers. In addition, n-3 fatty acids are known to lessen the severity and minimize symptoms of chronic inflammatory diseases, including rheumatoid arthritis and inflammatory bowel disease, and may even benefit in correcting psychological disorders.
- PUFAs modulate eicosanoid biosynthesis in various tissues and cell types and this can influence gene expression.

Foods with PUFA

- PUFA is present in three forms in food. These are LNA in vegetables, oilseeds, and nuts, and EPA and DHA in cold water fishes and algae.
- SDA is rich in plant oils (such as hempseed oil and black currant seed oil) but can be isolated and concentrated from marine fish. Since n-3 fatty acids cannot be synthesized in the body they must be either ingested directly or formed from LNA

Polyunsaturated Fatty Acid (PUFA)



Food supplements and fortification

- The diet needs to be low in saturated fats. Essential fatty acids and n-3 PUFA, however, are important in the diet.
- Sources of n-3 PUFAs are also added directly to infant formula to provide sufficient DHA for normal development of the nervous system during early infancy. These supplements are added to both dairy and non dairy products to reduce risk of heart disease, cancer risk and risk of obesity. The n-3 PUFA are contained and added in fish meal, fish oil, vegetable oils, linseed oil and canola oil etc

Lipids and vitamins

- A minimum amount of dietary fat is important because it helps in absorption of fat-soluble vitamins (A, D, E and K) and carotenoids

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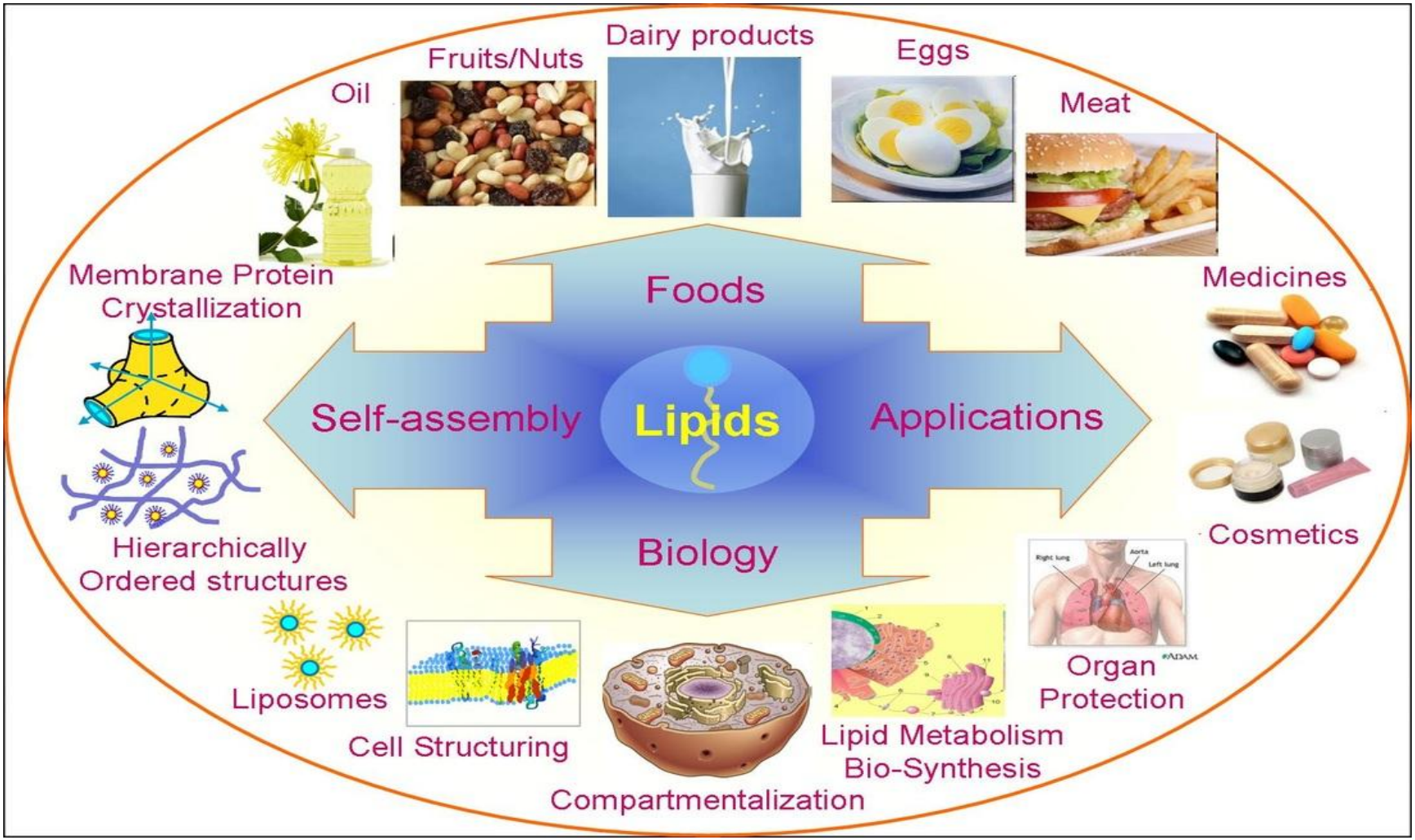
Oil
Fruits/Nuts
Dairy products
Eggs
Meat
Membrane Protein Crystallization
Foods
Medicines
Self-assembly
Lipids
Applications
Hierarchically Ordered structures
Biology
Cosmetics
Liposomes
Cell Structuring
Compartmentalization
Lipid Metabolism Bio-Synthesis
Organ Protection