 **IQRA NATIONAL UNIVERSITY**

**DEPARTMENT OF ALLIED HEALTH SCIENCES**

**FINAL-TERM EXAMINATIONS**

**SPRING – 2020**

Course title: Macronutrients in Human Nutrition

Course instructor: Prof. Dr. Jehangir Khan Khalil

Department: Human Nutrition and Dietetics, 2nd semester

Time allowed: 6 hrs

Marks: 50

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**NOTE:**

**Attempt all questions.**

**All questions carry equal marks.**

**Questions: 1**

Define the following: (10)

1. Bile acids
2. Hydrogenation of oil
3. Iodine Number
4. Lecithin
5. Triglycerides

# Answer:

## Bile acids:

**“*Steroid carboxylic derived from cholesterol made by liver that work with bile”***

Bile acids are steroid acids found predominantly in the bile of mammals and other vertebrates. Diverse bile acids are synthesized in the liver. Bile acids are conjugated with taurine or glycine to give anions called bile salts. Bile acids are pf two types’ primary bile acids and secondary bile acids. Primary bile acids are synthesized by the liver and secondary bile acids are a result of bacterial reactions in the colon.

## Hydrogenation of oil:

***“Hydrogenation is a process that uses hydrogen gas to change a liquid vegetable oil into a hard spread”***

*Or*

***-“An oil with trans-fatty acids that has been chemically changed from a room-temperature liquid state into a solid”***

This process stabilizes the oil and prevents spoilage from oxidation.

## Iodine number:

***“A measure of the unsaturation of a substance (as an oil or fat) expressed as the number of grams of iodine or equivalent halogen absorbed by 100 grams of the substance”***

The iodine number represents the content of double bonds and determines the overall unsaturation of fats. The higher the iodine number, the more iodine can attach, the more unsaturated acids are contained in the fat

## Lecithin:

***“Any of a group of phospholipids, occurring in animal and plant tissues and egg yolk, composed of units of choline, phosphoric acid, fatty acids****.”*

Lecithin is taken as a medicine and is also used in the manufacturing of medicines. Lecithin is used for treating memory disorders such as dementia and Alzheimer's disease.

## Triglycerides:

## *“****An ester formed from glycerol and three fatty acid groups”***

 Triglycerides are the main constituents of natural fats and oils. A triglyceride consists of three molecules of fatty acid combined with a molecule of the alcohol glycerol.

**Question: 2**

What are Lipids? What is the difference between fats and waxes? What is the importance of lipids in our body? (10)

# Answer:

## Lipids:

***“Any of a class of organic compounds that are fatty acids or their derivatives and are insoluble in water but soluble in organic solvents”***

They include many natural oils, waxes, and steroids. They are a source of stored energy and are a component of cell membranes.

## Types:

The types include fats and oils, waxes, phospholipids, and steroids. Fats are a stored form of energy and are also known as triacylglycerol’s or triglycerides. Fats are made up of fatty acids and either glycerol or sphingosine.

## Difference between fats and waxes:

## Fats:

***Fats are esters of fatty acids with glycerol, and are solid at, room temperature.***

## Functions:

* Fats are a source of energy in the human diet, together with carbohydrates and proteins, the other two main macronutrients.
* Structural component.
* Carrier of vitamins.

They act as messengers, helping proteins do their jobs. They also start chemical reactions involved in growth, immune function, reproduction and other aspects of basic metabolism.

## Types:

* Saturated fats.
* Tran’s fats.
* Monounsaturated fats.
* Polyunsaturated fats.

## Waxes:

***“A second group of neutral lipids that are of physiological importance, though they are a minor component of biological systems, are waxes.”***

## Functions:

Their strongly hydrophobic nature allows them to function as water repellents on the leaves of some plants, on feathers, and on the cuticles of certain insects. Waxes also serve as energy-storage substances in plankton (microscopic aquatic plants and animals) and in higher members of the aquatic food chain.

|  |  |
| --- | --- |
| Fats | Waxes |
| Fats and oils are made from glycerols and three fatty acids joined by dehydration synthesis. | Waxes are low melying point solids and have alcohol chains |
| Fats and oils may be saponified by means of either aqueous or alcoholic alkali. | They are only saponified by alcoholic alkali |

## Importance of lipids

Importance of lipids are the following:

* **They are chemical messengers** some lipids such as steroid hormones serve as chemical messengers between cells, tissues, and organs, and others communicate signals between biochemical systems within a single cell.
* **They are responsible for storage and provision of energy** one of the main functions lipids do is storing energy. If a person eats excessive amount of food, lipids help store the energy in the form of fat molecules in the body to use later
* **Maintenance of temperature when** **temperature** decreases, the composition of membrane lipids is expected to become more unsaturated to be able to maintain home viscosity. Although different in function, storage lipids (triacylglycerol fatty acids) are expected to respond totemperature changes in a similar way.
* They are responsible for Membrane lipid layer formation.
* Cholesterol formation.
* Prostaglandin formation and role in inflammation.
* They are “fat-soluble" vitamins.

**Question: 3**

What are prostaglandins (PGs)? And what are their functions?

# Answer:

## Prostaglandins:

***“A group of compounds with varying hormone-like effects, notably the promotion of uterine contractions. They are cyclic fatty acids.”***

The prostaglandins are a group of physiologically active lipid compounds called eicosanoids having diverse hormone-like effects in animals. Prostaglandins have been found in almost every tissue in humans and other animals. They are derived enzymatically from the fatty acid arachidonic acid.

## Structure:

Prostaglandins are derivatives of 20-carbon fatty acid- prostanoic hence known as prostanoids. Prostaglandins differ in their structure due to substituent group and double bond on cyclopetane ring.

## Synthesis:

* Arachidonic acid is the precursor for most of the prostaglandins in humans
* It occurs in the endoplasmic reticulum
* It occurs due to a specific stimuli by hormones

## Functions:

Following are the functions of prostaglandins:

* They act as local hormones
* They are produced in almost all tissues
* They are not stored and are degraded to inactive products at the side of their production
* They are produced in very small amounts

### **Regulation of blood pressure:**

The PG’s are vasodilators in function. This results in increased blood flow and decreased peripheral resistance to lower the blood pressure. They serve as agents in the treatment of hypertension.

* ***Inflammation:***

PGEI and PGE^2 induce the symptoms of inflammation due to arteriolar vasodilation. PG’s are neutral mediators of inflammatory reactions oh rheumatoid arthritis, psoriasis, conjunctivitis etc. corticosteroids are used to treat these inflammatory reactions since they inhibit prostaglandin synthesis.

* **Reproduction:**

They are used for medical termination of pregnancy and induction of labor.

* **Pain and fever:**

Pyrogens promote prostaglandin synthesis leading to the formation of PGE2 in hypothalamus regulation of body temperature. Migraines are also due to PGE2.

* **Regulation of gastric secretion:**

Prostaglandins inhibit gastric secretion. They are used for the treatment of gastric ulcers. They stimulate gastric secretion and increase the mobility of intestine which often causes diarrhea.

* **Effects on respiratory function:**

They are used for the treatment of asthma.

**Question: 4**

What are fatty acids? How fatty acids are classified?

# Answer:

## Fatty acids:

***“A carboxylic acid consisting of a hydrocarbon chain and a terminal carboxyl group, especially any of those occurring as esters in fats and oils.”***

## Classification of fatty acids: Fatty acids are classified according to the presence and number of double bonds in their carbon chain. Saturated fatty acids (SFA) contain no double bonds, monounsaturated fatty acids (MUFA) contain one, and polyunsaturated fatty acids (PUFA) contain more than one double bond.

## Both length and saturation of fatty acids affect the arrangement of the membrane in our body cells and thereby its fluidity. Shorter chain fatty acids and ones with greater unsaturation are less stiff and less viscous, making the membranes more flexible.

They are classified into three types:

1. Saturated fatty acids
2. Monounsaturated fatty acids
3. Polyunsaturated fatty acids

## Saturated fatty acids:

The saturated fatty acids are derived from both animal fats and plant oils. Rich sources of dietary saturated fatty acids include butter fat, meat fat, and tropical oils (palm oil, coconut oil, and palm kernel oil). Saturated fatty acids are straight-chain organic acids with an even number of carbon atoms.

### Functions:

They also play a significant role as barriers, such as for skin and in stabilizing biological membranes. Appropriate intake of lipids is essential for health maintenance. However, a high consumption of fat, especially saturated FAs, may be connected with several chronic diseases, such as heart disease and obesity.

## Monounsaturated fatty acids:

In biochemistry and nutrition, monounsaturated fatty acids (abbreviated MUFAs, or more plainly monounsaturated fats) are fatty acids that have one double bond in the fatty acid chain with all of the remainder carbon atoms being single-bonded.

### Functions:

Monounsaturated fats are good for your health in several ways: They can help lower your LDL (bad) cholesterol level. Cholesterol is a soft, waxy substance that can cause clogged, or blocked, arteries (blood vessels). Keeping your LDL level low reduces your risk for heart disease and stroke.

## Polyunsaturated fatty acids:

Polyunsaturated fatty acids (PUFAs) are fatty acids that contain more than one double bond in their backbone. This class includes many important compounds, such as essential fatty acids and those that give drying oils their characteristic property.

### Functions:

Having low LDL cholesterol reduces your risk for heart disease. Polyunsaturated fats include omega-3 and omega-6 fats. These are essential fatty acids that the body needs for brain function and cell growth.

## Further classification:

They are further classified based on chain length

1. Short chained upto 6 carbon atoms
2. Medium chain from 8 to 12 carbon atoms
3. Long chain from 14 to 18 carbon atoms
4. Very long chain from 20 carbon atoms onwards

**Question: 5 (10)**

Write short notes on the following:

1. Lipoproteins

## Definition:

***“A lipoprotein is a biochemical assembly whose primary purpose is to transport hydrophobic lipid molecules in water, as in blood plasma or other extracellular fluids.”***

Lipoproteins are lipid-protein complexes that allow all lipids derived from food or... Body cells extract cholesterol from the blood by means of tiny coated pits (receptors) on their surfaces; these receptors bind with the LDL particles (and their attached cholesterol) and draw them from the blood into the cell.

## Structure:

Lipoproteins are complex particles that have a central hydrophobic core of non-polar lipids, primarily cholesterol esters and triglycerides. This hydrophobic core is surrounded by a hydrophilic membrane consisting of phospholipids, free cholesterol, and apolipoproteins.

## Types:

Lipoproteins are classified into 4 major classes; chylomicron, very low density lipoprotein, low density lipoprotein and high density lipoprotein.

## Functions:

* In order for cholesterol and triglycerides to travel in the blood, they are often carried by proteins that make the cholesterol and triglycerides more soluble in blood.
* The role of lipoprotein particles is to transport fat molecules, such as triacylglycerol’s (also known as triglycerides), phospholipids, and cholesterol within the extracellular water of the body to all the cells and tissues of the body.

1. Cholesterol

## Definition:

***“Cholesterol is a waxy, fat-like substance that's found in all the cells in your body.”***

Your body needs some cholesterol to make hormones, vitamin D, and substances that help you digest foods. Your body makes all the cholesterol it needs.

## Functions:

* Cholesterol, given that it composes about 30% of all animal cell membranes, is required to build and maintain membranes and modulates membrane fluidity over the range of physiological temperatures. The hydroxyl group of each cholesterol molecule interacts with water molecules surrounding the membrane, as do the polar heads of the membrane phospholipids and sphingolipids, while the bulky steroid and the hydrocarbon chain are embedded in the membrane, alongside the nonpolar fatty-acid chain of the other lipids.
* Within the cell membrane, cholesterol also functions in intracellular transport, cell signaling and nerve conduction. Cholesterol is essential for the structure and function of invaginated caveolae and clathrin-coated pits, including caveola-dependent and clathrin-dependent endocytosis.
* Cholesterol regulates the biological process of substrate presentation and the enzymes that use substrate presentation as a mechanism of their activation
* Cholesterol is also implicated in cell signaling processes, assisting in the formation of lipid rafts in the plasma membrane, which brings receptor proteins in close proximity with high concentrations of second messenger molecules.
* Within cells, cholesterol is also a precursor molecule for several biochemical pathways. For example, it is the precursor molecule for the synthesis of vitamin D in the calcium metabolism and all steroid hormones,