UNIT 1 - BIOLOGY FOR ENGINEERS

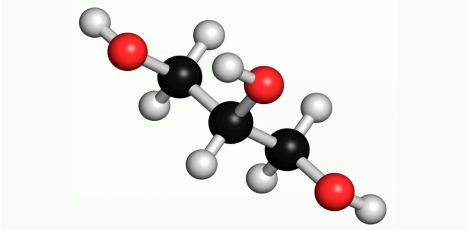
Carbohydrates:

Carbohydrates, often called carbs, are a vital macronutrient necessary for the human body to function correctly. They provide the body with energy, aid digestion, and play a crucial role in brain function.

Carbohydrates reign as the king of macronutrients and serve as the primary fuel for our bodies. They are the major macronutrients and primary energy sources for us.

When we eat carbs, our body breaks them down into simple sugars for their absorption into the bloodstream. As the sugar level rises, the pancreas releases insulin hormones. Insulin helps move sugar from the blood into the cells, where the sugar is utilized as an energy source, and every gram of carbohydrate provides four calories.

Structure of Carbohydrates



Carbohydrates are classified into two categories:

- Simple carbohydrates
- Complex carbohydrates

1. Simple carbohydrates: Simple sugars are carbohydrates composed of one or two sugar molecules, making them a rapid energy source. Common examples of simple carbohydrate-rich foods include table sugar, refined grains, and candies.

Simple carbohydrates are categorized into two types.

Monosaccharides: These refer to single sugar units such as glucose, galactose (found in milk), and fructose (found in fruits).

Disaccharides: These are composed of two sugar molecules, such as lactose (glucose + galactose) present in milk and sucrose or table sugar (glucose + fructose).

2. Complex carbohydrates: Complex carbohydrates are composed of long chains of sugar molecules commonly found in whole grains and fruits containing dietary fiber.

Polysaccharides: These carbohydrates contain hundreds or even thousands of sugar molecules linked together, and they function as food stores for plants and animals. Examples of polysaccharides include glycogen, as well as starches that are found in potatoes, rice, and wheat.

Simple carbohydrates provide a quick energy source but tend to leave a person feeling hungry again soon after consumption.

In contrast, complex carbohydrates tend to keep people fuller for longer periods and provide more significant health benefits than simple carbohydrates.

Carbohydrates are mainly present in three forms:

1. Starch

Starches in foods such as root vegetables, legumes, and grains consist of multiple glucose units linked together.

Although most starches are broken down into sugars by digestive enzymes, certain types of starch are resistant to these enzymes and are not digested in the small intestine. Instead, they undergo fermentation by bacteria in the large intestine, producing short-chain fatty acids and serving as dietary fiber.

2. Sugar

Sugary foods can provide a rapid energy source for the body because they are quickly broken down into simple sugars. However, this can cause a rapid rise in blood sugar levels, followed by a rapid drop.

Types of sugar:

- Naturally occurring sugars, for example, milk sugar.
- Added sugars are added to processed foods like sweets, candies, canned fruits, and desserts. Excess intake of such foods might result in obesity, type 2 diabetes, heart disease, and inflammation.

3. Dietary Fiber

Dietary fiber, also known as roughage, refers to the indigestible parts of plant-based foods, such as cellulose, hemicellulose, gums, and mucilages. Consuming a diet rich in fiber, including foods such as nuts, seeds, cereals, fruits, and vegetables, can positively impact overall health by reducing the incidence of various diseases.

Consuming between 25-40 grams of dietary fiber per day is recommended, incorporating both

Types of fiber in the diet.

Soluble dietary fiber- It is a type of fiber that dissolves in water to form a gel-like substance in the digestive tract. It can help lower blood cholesterol and glucose levels and promote healthy bowel movements.

Food sources rich in soluble fiber include oats, peas, beans, apples, citrus fruits, carrots, barley, and psyllium. Incorporating these foods into your diet can help support overall health and wellness.

Insoluble dietary fiber- Insoluble dietary fiber is resistant to water and cannot dissolve in it. This fiber promotes a healthy digestive system by increasing stool bulk and can be especially beneficial for individuals who struggle with constipation or irregular bowel movements.

Some good sources of insoluble fiber include whole wheat flour, wheat bran, nuts, beans, cauliflower, green beans, and potatoes. Incorporating these foods into your diet can help support healthy digestion and bowel movements.

According to the Indian Council of Medical Research (ICMR) dietary guidelines, a balanced diet for Indians should include healthy sources of carbohydrates that provide 50-60% of daily calories. However, individual requirements may vary depending on factors such as age, gender, activity level, and overall health status. It is essential to consult with a healthcare professional or registered dietitian to determine the optimal carbohydrate intake for your individual needs.

Functions of Carbohydrates

The functions of carbohydrates are:

1. Energy-giving

Carbohydrates are the nutrients that provide energy for the body, enabling us to carry out physical activities such as walking and even breathing. These nutrients are also vital for fueling the brain and energizing us.

2. Mood uplifter

According to certain studies, carbohydrates have been shown to facilitate the production of serotonin, a neurotransmitter associated with positive emotions. When serotonin levels are too low, it can lead to depression and other mental health issues.

3. Support muscle building

The role of carbohydrates in providing energy is essential for supporting intense workouts and replenishing depleted glycogen stores during bodybuilding. When combined with protein, carbohydrate intake can enhance muscle protein synthesis, aiding in the growth and repair of muscle tissue.

4. Support weight loss

A diet abundant in complex carbohydrates and rich in dietary fiber can help prevent overconsumption of calories, increase metabolism, and encourage body fat loss.

5. Promote digestive health

Consuming sufficient dietary fiber is crucial for maintaining a healthy gut, promoting efficient waste removal, and preventing constipation and other digestive problems.

6. Lowered Risk of Chronic Diseases

A diet rich in whole grains, fruits, and vegetables, which are sources of complex carbohydrates, can lower the risk of chronic diseases such as heart disease, type 2 diabetes, and some types of cancer.

7. Improved Athletic Performance

Consuming carbohydrates before and after exercise can improve athletic performance by providing energy for physical activity and promoting muscle recovery.

LIPIDS:

Lipids Definition – Lipids are organic molecules consisting of carbon, hydrogen, and oxygen atoms and serve as energy storage, structural support, and cell membrane composition in living organisms. Lipids include fats, oils, phospholipids, and steroids.

Classification of Lipids

Broadly, lipids classification is based on their chemical reactivity and the nature of their constituent molecules into two groups as follows:

1. Saponifiable Lipids
2. Nonsaponifable Lipids

Nonsaponifiable Lipids

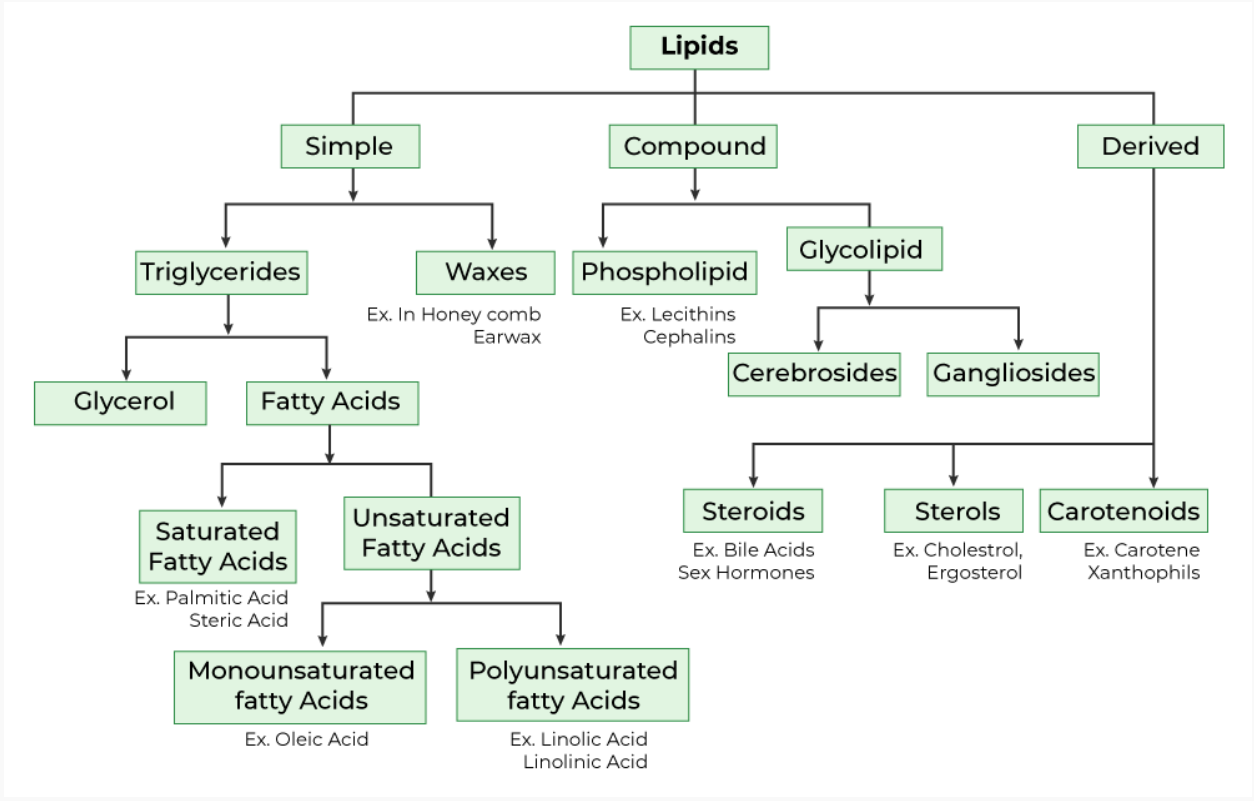
- These lipids cannot be hydrolyzed or saponified using alkaline hydrolysis.
- They are often complex and structurally diverse.
- Examples of nonsaponifiable lipids include cholesterol (a steroid) and carotenoids (found in pigments like beta-carotene).

Saponifable Lipids

- Saponifiable lipids can be hydrolyzed or saponified using alkaline hydrolysis.
- They consist of fatty acids and other components that can be broken down into simpler compounds.
- The most common saponifiable lipids are triglycerides (fats and oils), which consist of glycerol and fatty acids esterified together.
- When saponified, these lipids break down into glycerol and fatty acids.
- Saponifiable are further divided into Polar and non-Polar lipids.

Polar Lipids: Polar lipids are also known as amphipathic lipids because they have both hydrophilic (water-attracting) and hydrophobic (water-repellent) regions within their molecular structure. Examples of polar lipids include phospholipids and glycolipids.

Non- Polar Lipids: Non-polar lipids are hydrophobic and do not have a significant hydrophilic component in their structure. They are primarily involved in energy storage and insulation. For example, Triglycerides (fats and oils).



Lipids Function

Functions of lipids are mentioned below:

- Lipids, like adipose tissue, act as insulators and help to maintain body temperature by reducing heat loss.
- Lipids, especially triglycerides, act as energy storage in organisms, providing a reserve of metabolic fuel.
- Phospholipids form the lipid bilayers of cell membranes and regulate the passage of molecules in and out of cells.
- Protecting the plant leaves from direct heat and drying.
- Steroid hormones, derived from cholesterol, play vital roles in regulating various physiological processes, including metabolism, growth, and reproduction.
- It acts as the structural component of the body and also acts as the hydrophobic barrier.
- In plants, lipids can be stored as oils in seeds, providing a source of energy for germination and early growth.
- Lipids form waterproofing structures, such as the waxy cuticle on plant leaves or the oil on the feathers of water birds.

- It provides color to many fruits and vegetables with the presence of carotenoid pigment.

Examples of Lipids

Lipid example are Ghee, Butter, Oil, Cheese, Cholesterol, waxes, etc. All these compounds have one thing in common i.e., they are insoluble in water and are soluble in organic solvents.