

Significance of Lipids

Lipids are a broad group of naturally occurring molecules such as fats, oils, phospholipids, glycolipids and cholesterol. They are generally insoluble in water but soluble in organic solvents, and this simple chemical property makes them very important in the body. One of the main significances of lipids is their role as an energy source. Gram for gram, fats provide about 9 kcal of energy, which is more than double that of carbohydrates and proteins (4 kcal/g). Triacylglycerols stored in adipose tissue act as the chief energy reserve of the body and are mobilised during fasting, prolonged exercise or starvation. Organs like the heart, liver and resting skeletal muscles use fatty acids as a major fuel, and during long-term fasting the liver converts fatty acids to ketone bodies that can also be used by the brain.

Lipids are also essential structural components of cells. Phospholipids, glycolipids and cholesterol form the basic framework of biological membranes as a lipid bilayer. This bilayer acts as a selective barrier, controlling the entry and exit of substances, and its fluidity is crucial for the functioning of membrane proteins, receptors, transporters and enzymes. The degree of unsaturation of fatty acids and the presence of cholesterol help regulate membrane fluidity. Certain lipids such as sphingomyelin form the myelin sheath around nerve fibres, providing electrical insulation and allowing rapid conduction of nerve impulses. In addition, fat stored under the skin acts as thermal insulation, helping to maintain body temperature, and fat deposits around organs like the kidneys and heart act as cushioning to protect them from mechanical injury.

Lipids are very important in digestion, absorption and transport of nutrients. Bile salts, which are synthesised from cholesterol in the liver, emulsify dietary fats in the intestine, breaking them into small droplets and increasing the surface area for the action of pancreatic lipase. Together with phospholipids, they form micelles that carry fatty acids, monoglycerides, cholesterol and fat-soluble vitamins (A, D, E and K) to the intestinal mucosa for absorption. Many biologically active molecules are lipid-derived. Cholesterol is the precursor of steroid hormones such as cortisol, aldosterone, estrogen, progesterone and testosterone, which regulate metabolism, salt–water balance and reproductive functions. Polyunsaturated fatty acids like arachidonic acid give rise to eicosanoids (prostaglandins, thromboxanes and leukotrienes), which act as local hormones involved in inflammation, pain, blood clotting, smooth muscle contraction and regulation of blood flow.

Lipids also play a central role in cell signalling and communication. Glycolipids on the outer surface of the cell membrane contribute to the glycocalyx and are involved in cell–cell recognition, adhesion and immune responses; for example, blood group antigens are glycolipid or glycoprotein in nature. Nutritionally, certain fatty acids such as linoleic acid (ω -6) and α -linolenic acid (ω -3) are essential because the human body cannot synthesise them. They are required for normal growth, membrane structure, brain and retinal development, and for the synthesis of various eicosanoids. Lipids are transported in blood as lipoproteins (chylomicrons, VLDL, LDL, HDL), and their balance is important for health; high LDL is associated with atherosclerosis, whereas HDL is considered protective.

From a health and disease perspective, lipids have a double-edged role. Adequate lipid intake is necessary for energy supply, absorption of fat-soluble vitamins and normal physiological functions, but excess intake or disturbed lipid metabolism can lead to obesity, fatty liver, hyperlipidaemia and cardiovascular diseases. Industrially and commercially, lipids are widely used in the food industry (cooking oils, ghee, butter, margarine), in cosmetics (creams, ointments, lotions using waxes and fatty substances), in pharmaceuticals (lipid-based drug delivery systems such as liposomes), and in the manufacture of soaps and detergents through saponification. Plant and algal oils are also being used for biodiesel production as an alternative fuel source. Overall, lipids are not just “fats” for energy storage; they are key players in structure, function, regulation and even technology related to living systems.
