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**18/SCI05/010**

**MEDICAL LABORATORY SCIENCE.**

**BCH 202.**

**QUESTION.**

**Is Vitamin C a Coenzyme? Justify your answer. Describe the chemistry of phospholipids. Differentiate between phospholipids and glycolipids… To aid for reading.**

Many enzymes are simple proteins consisting entirely of one or more amino acid chains. Other enzymes contain a non-protein component called a cofactor that is necessary for the enzyme’s proper functioning. There are two types of cofactors: inorganic ions [e.g., zinc or Cu(I) ions] and organic molecules known as coenzymes. Most coenzymes are vitamins or are derived from vitamins.

Vitamins are organic compounds that are essential in very small (trace) amounts for the maintenance of normal metabolism. They generally cannot be synthesized at adequate levels by the body and must be obtained from the diet. The absence or shortage of a vitamin may result in a vitamin-deficiency disease. In the first half of the 20th century, a major focus of biochemistry was the identification, isolation, and characterization of vitamins. Despite accumulating evidence that people needed more than just carbohydrates, fats, and proteins in their diets for normal growth and health, it was not until the early 1900s that research established the need for trace nutrients in the diet.

**Fat-Soluble Vitamins and Physiological Functions**

* vitamin A (retinol)
* formation of vision pigments; differentiation of epithelial cells
* night blindness; continued deficiency leads to total blindness
* vitamin D (cholecalciferol)
* increases the body’s ability to absorb calcium and phosphorus
* osteomalacia (softening of the bones); known as rickets in children
* vitamin E (tocopherol)
* fat-soluble antioxidant
* damage to cell membranes
* vitamin K (phylloquinone)
* formation of prothrombin, a key enzyme in the blood-clotting process increases the time required for blood to clot.

Because organisms differ in their synthetic abilities, a substance that is a vitamin for one species may not be so for another. Over the past 100 years, scientists have identified and isolated 13 vitamins required in the human diet and have divided them into two broad categories: the fat-soluble vitamins, which include vitamins A, D, E, and K, and the water-soluble vitamins, which are the B complex vitamins and vitamin C. All fat-soluble vitamins contain a high proportion of hydrocarbon structural components. There are one or two oxygen atoms present, but the compounds as a whole are nonpolar. In contrast, water-soluble vitamins contain large numbers of electronegative oxygen and nitrogen atoms, which can engage in hydrogen bonding with water. Most water-soluble vitamins act as coenzymes or are required for the synthesis of coenzymes. The fat-soluble vitamins are important for a variety of physiological functions.

**Water-Soluble Vitamins and Physiological Functions**

**vitamin B1 (thiamine)**

*thiamine pyrophosphate*

**decarboxylation reactions**

*beri-beri*

**vitamin B2 (riboflavin)**

*flavin mononucleotide or flavin adenine dinucleotide*

*oxidation-reduction reactions involving two hydrogen atoms*

*—*

**vitamin B3 (niacin)**

*nicotinamide adenine dinucleotide or nicotinamide adenine dinucleotide phosphate*

*oxidation-reduction reactions involving the hydride ion (H−)*

*pellagra*

**vitamin B6 (pyridoxine)**

*pyridoxal phosphate*

***variety of reactions including the transfer of amino groups***

**vitamin B12 (cyanocobalamin)**

*methylcobalamin or deoxyadenoxylcobalamin*

**intramolecular rearrangement reactions**

*pernicious anemia*

**biotin**

**carboxylation reactions**

**—**

**folic acid**

*tetrahydrofolate*

**carrier of one-carbon units such as the formyl group**

*anemia*

**pantothenic Acid**

**coenzyme A**

***carrier of acyl groups***

**—**

**vitamin C (ascorbic acid)**

**none**

**antioxidant; *formation of collagen, a protein found in tendons, ligaments, and bone***

*scurvy*

Vitamins C and E, as well as the pro-vitamin β-carotene can act as antioxidants in the body. Antioxidants prevent damage from free radicals, which are molecules that are highly reactive because they have unpaired electrons. Free radicals are formed not only through metabolic reactions involving oxygen but also by such environmental factors as radiation and pollution.

**β-**carotene is known as a provitamin because it can be converted to vitamin A in the body. Free radicals react most commonly react with lipoproteins and unsaturated fatty acids in cell membranes, removing an electron from those molecules and thus generating a new free radical. The process becomes a chain reaction that finally leads to the oxidative degradation of the affected compounds. Antioxidants react with free radicals to stop these chain reactions by forming a more stable molecule or, in the case of vitamin E, a free radical that is much less reactive (vitamin E is converted back to its original form through interaction with vitamin C).

Vitamins are organic compounds that are essential in very small amounts for the maintenance of normal metabolism. Vitamins are divided into two broad categories: fat-soluble vitamins and water-soluble vitamins. Most water-soluble vitamins are needed for the formation of coenzymes, which are organic molecules needed by some enzymes for catalytic activity.

***A coenzyme is one type of cofactor. Coenzymes are organic molecules required by some enzymes for activity. A cofactor can be either a coenzyme or an inorganic ion.***

***Coenzymes are synthesized from vitamins.***

**CHEMISTRY OF PHOSPHOLIPIDS.**

* Phospholipids consist of a glycerol molecule, two fatty acids, and a phosphate group that is modified by an alcohol.
* The phosphate group is the negatively-charged polar head, which is hydrophilic.
* The fatty acid chains are the uncharged, nonpolar tails, which are hydrophobic.
* Since the tails are hydrophobic, they face the inside, away from the water and meet in the inner region of the membrane.
* Since the heads are hydrophilic, they face outward and are attracted to the intracellular and extracellular fluid.
* If phospholipids are placed in water, they form into micelles, which are lipid molecules that arrange themselves in a spherical form in aqueous solutions.

Phospholipids are major components of the plasma membrane, the outermost layer of animal cells. Like fats, they are composed of fatty acid chains attached to a glycerol backbone. Unlike triglycerides, which have three fatty acids, phospholipids have two fatty acids that help form a diacylglycerol. The third carbon of the glycerol backbone is also occupied by a modified phosphate group However, just a phosphate group attached to a diacylglycerol does not qualify as a phospholipid. This would be considered a phosphatidate (diacylglycerol 3-phosphate), the precursor to phospholipids. To qualify as a phospholipid, the phosphate group should be modified by an alcohol. Phosphatidylcholine and phosphatidylserine are examples of two important phospholipids that are found in plasma membranes.

Phospholipid Molecule A phospholipid is a molecule with two fatty acids and a modified phosphate group attached to a glycerol backbone. The phosphate may be modified by the addition of charged or polar chemical groups. Two chemical groups that may modify the phosphate, choline and serine, are shown here. Both choline and serine attach to the phosphate group at the position labeled R via the hydroxyl group indicated in green.

**Structure of a Phospholipid Molecule**

A phospholipid is an amphipathic molecule which means it has both a hydrophobic and a hydrophilic component. A single phospholipid molecule has a phosphate group on one end, called the “head,” and two side-by-side chains of fatty acids that make up the lipid “tails. ” The phosphate group is negatively charged, making the head polar and hydrophilic, or “water loving.” The phosphate heads are thus attracted to the water molecules in their environment.

The lipid tails, on the other hand, are uncharged, nonpolar, and hydrophobic, or “water fearing.” A hydrophobic molecule repels and is repelled by water. Some lipid tails consist of saturated fatty acids and some contain unsaturated fatty acids. This combination adds to the fluidity of the tails that are constantly in motion.

**DIFFERENCES BETWEEN PHOSPHOLIPIDS AND GLYCOLIPIDS.**

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| --- | --- | --- |
|  | **Glycolipids** | **Phospholipids** |
| **Definition** | Glycolipids are lipids containing carbohydrate. | Phospholipids are lipids containing phosphate groups. |
| **Composition** | Residue and carbohydrate moiety. | Residue and phosphate group. |
| **Structure** | Hydrophilic head and hydrophobic tail. | Hydrophilic head and two hydrophilic tails. |
| **Occurrence** | Cell Membrane | * Bio- membrane such as cell membrane. * Lysosomal membrane. * mitochondrial membrane, endoplasmic reticulum membrane. * Golgi apparatus membrane. |