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2Differences between DNA and RNA

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| DNA | RNA |
| It is mostly found in nucleus and nucleotide | It is mostly found in the cytoplasm |
| It contains deoxyribose sugar | It contains ribose sugar |
| Its nitrogenous bases are adenine, thymine, cytosine,guanine | Its bases are adenine, uracil, cytosine, guanine |
| It is a long polymer | It is shorter than DNA |
| Adenine pairs with thymine | Arginine pairs with uracil |
| It is double stranded | It is single stranded |
| It exhibits a double helix structure | It forms a secondary and tertiary structure |
| DNA is more prone to UV damage | Less prone to uv damage |
| It carries the genetic information neccesary for development and function | It is mainly involved in protein synthesis and sometimes regulates gene expression |

3 Biosynthesis of calcitriol

Vitamin D is a prohormone. The cholecalciferol is first transported to liver, where hydroxylation at 25th position occurs, to form 25-hydroxy cholecalciferol (25-HCC). The hepatic 25-hydroxylase is a microsomal monooxygenase. It requires cytochrome P-450 and NADPH. 25-HCC is the major storage form. In plasma, 25-HCC is bound to "vitamin D binding protein" (VDBP), an alpha-2 globulin. In the kidney, it is further hydroxylated at the 1st position. The 1-alpha hydroxylase is located in mitochondria of proximal convoluted tubules. It requires cytochrome P-450, NADPH and ferrodoxin (an iron-sulfur protein). Thus 1,25dihydroxy cholecalciferol (DHCC) is generated. Since it contains three hydroxyl groups at 1, 3 and 25 positions, it is also called Calcitriol. The calcitriol thus formed is the active form of vitamin and it increases the blood calcium level; it is a hormone . 24,25-dihydroxy cholecalciferol may be formed by hydroxylation of 25-HCC at the 24th position.

4 coenzymes are non protein molecules required by enzymes to carry out catalytic functions. They are loosely bound to enzymes and are organic in nature. Water soluble vitamins are precursors of coenzymes.

Riboflavin is a precursor of coenzyme FMN or FAD, which are required by several oxidation-reduction rxns in metabolism. FAD and FMN are coenzymes of succinate dehydrogenase in TCA cycle, acyl CoA dehydrogenase in fatty acid oxidation, amino acid oxidase in destination of amino acids.

5i Nucleosides: Nucleosides are formed when bases are attached to the pentose sugar, D-ribose . All the bases are attached to the corresponding pentose sugar by a beta-N-glycosidic bond between the 1st carbon of the pentose sugar and N9 of a purine or N1 of a pyrimidine.

ii Nucleotides are precursors of the nucleic acids, deoxy-ribonucleic acid (DNA) and ribonucleic acid (RNA). A nucleotide is made up of 3 components:Nitrogenous base, (a purine or a pyrimidine): Pentose sugar ( a ribose)and a Phosphate groups esterified to the sugar.

In summary, when a base combines with a pentose sugar (ribose) , a nucleoside is formed. When the nucleoside is esterified to a phosphate group, it is called a nucleotide or nucleoside mono-phosphate. RNA are polymers of nucleoside monophosphates.

Bases Of RNA

-Purines bases include: Adenine and Guanine

-Pyrimidines include: Cytosine and Uracil

7 Vitamins are organic nutrients that are required in small quantities for a variety of biochemical functions and which generally cannot be synthesised by the body and must therefore be supplied by the diet.

CLASSIFICATION

Vitamins are grouped into two categories based on their solubility

a. water soluble vitamins include: thiamine, riboflavin, pantothenic acid, pyridoxine, biotin, Felicia acid, cobalamin, vitamin C (ascorbic acid).

b. Fat soluble vitamins include : vitamin A, vitamin D, vitamin E, vitamin K

Thiamine (vitamin B1)

Sources:aleurone layer of cereals, yeast, meat, green vegetables

Active form: Thiamine pyrophosphate (Tpp)

Function: a Thiamine is a precursor for the coenyme Tpp. Tpp is a coenzme involved in series of enzymatic rxns mainly for oxidative decarboxylation and transketolase reaction e.g in the conversionof pyruvate into acetyl CoA by the enzyme pyruvate dehydrogenase

b Thiamine is mainly required of carbohydrate metabolism.

Deficiencies :dry-beri beri, wet beri beri, wernicke, polyneuritis.

Riboflabin (vitamin B2)

Sources: liver, dried yeast, egg and whole milk

Active form or coenzyme form: flavin mononucleotide (FMN) and flavin adenine dinucleotide (FAD). Enzymes containing riboflavin are called flavoproteins

Functions: a Riboflavin are precursors of coenzyme FMN and FAD which are required by several oxidation -reduction rxns in metabolism (carbohydrates, protein, nucleic acid, lipid metabolism) and electron transport chain.

b They are involved in protection against peroxidation in metabolism of xenobiotics

Deficiencies: cheilosis, glossitis, angular somatitis.

Niacin (vitamin B3)

Sources: yeast, liver, legumes and meat

Active form: Nicotinamide adenine dinucleotide(NAD+) and nicotinamide adenine dinuleotide phosphate (NADP+)

Functions: NAD+ and NADP+are involved in various oxidation and reduction reactions catalyzed by dehydrogenase in metabolism, they are therefore involved in many metabolic pathways.

Deficiencies: pellagra, dermatitis, diarrhoea, dementia.

Pantothenic acid( vitamin B5)

Active form: Coenzyme A (CoA-SH) and acyl carrier protein (Acp)

Function: a It is a component of Coenzyne A and acrylic carrier protein.

Deficiency: burning food syndrome

Pyridoxine ( vitamin B6)

Active form: pyridoxal phosphate (PLP)

Function: PLP acts as coenzyme for many reasons in amino acid metabolism such as: decarboxylation, transamination, non oxidative destination.

b heme synthesis: ALA synthase is dependent on PLP

Deficiency: neurological disorders like depression, nervousness and irritability. Vitamin B6 deficiency causes hypochromic microcytic anaemia.

Biotin

Sources: liver, kidney, vegetables, and egg yolk

Active form: biocytin

Function: biotin is a coenzyme of carboxylase reactions, it is a carrier of Co2.

Biotin antagonist , Avidin, a protein present in egg white has a great affinity for biotin, hence intake of raw egg may cause biotin deficiency.

Folic acid

Sources: vegetables

Active form: Tetrahydrofolate ( THF)

Function: THF acts as a carrier of one carbon unit.

Deficiency: megaloblastic anaemia. Deficiency occurs mostly in pregnant women and alcoholics.

Cobalamin (vitamin B12)

Sources:meat, eggs, milk dairy products, fish etc. It’s sources are of animal origin

Active form: methylcobalamin and deoxyadenosylcobalamin.

Function: a they act as coenzymes in two enzyme systems : isomerization of methylmalonyl-CoA to succinyl CoA and conversion of homocysteine to methionine.

Deficiency: pernicious anaemia, megaloblastic anaemia, methylmalonic aciduria.

Vitamin C (ascorbic acid)

Sources: leafy vegetables, fruits esp citrus fruits, strawberries, tomatoes, spinach and potatoes. Animals synthesize ascorbic acid as they have the enzyme gluconolactone which humans lack.

Active form: Ascorbic acid

Function : collagen synthesis, conversionof folic acid to its active form, absorption of iron in intestine, strong reducing agent, antioxidant.

Deficiency: scurvy, abnormal bone development, poor wound healing, anaemia.

Vitamin A

Sources: carrot,green leafy vegetables, fish liver oil

Active form: 11-cis-retinal, all trans-retinal.

Function: it is present in rods and cones of the retina and thus aids in vison

Deficiency: night blindness, herophthalmia, keratomalacia.

Vitamin D (cholecalciferol)

Sources: it is derived from either 7-dehydrocholesterol or ergosterol by the action of ultraviolet radiations, cod liver oil

Active form: cholecalciferol

Function: absorption of calcium

Deficiency: rickets and osteomalacia

Vitamin E

Sources : vegetables

Active form: tocopherol

Function : most powerful natural antioxidant and also reduces the risk of atherosclerosis.

Deficiency: human deficiency has been reported

Vitamin k

Sources: plants, intestinal bacteria,tomatoes,cheese,milk

Active forms: phylloquinone, menaquinone, menadione.

Function: necessary for coagulation

Deficiency: bleeding tendencies, internal bleeding, bruising tendency, echymosis, prolonged prothrombine time and delayed clotting time.

Metabolism of vitamin D

Vitamin D is derived either from 7-dehydrocholesterol or ergosterol by the action of ultraviolet radiations. 7-dehydrocholesterol, an intermediate of a minor pathway of cholesterol synthesis, is available in the Malpighian layer of epidermis. In the skin, ultraviolet light (290-315 nm) breaks the bond between position 9 and 10 of the steroid ring. So, the ring B is opened, to form the provitamin, secosterol. The cis double bond between 5th and 6th carbon atoms, is then isomerized to a trans double bond (rotation on the 6th carbon atom) to give rise to vitamin D3 or cholecalciferol. So, vitamin D is called the “sun-shine vitamin”.

8 Glycolipids, as their name implies, are sugar containing lipids. Glycolipids like sphingomyelin are derived from sphingosine. Sphingosine reacts with acyl-CoA to form ceramide. Cerebroside and gangliosides are the different types of glycolipids.

Forms of Glycolipids

Four classes of glycolipids have been distinguished:

1. Cerebrosides

2. Gangliosides

3. Globosides

4. Sulfatides

1)Cerebroside is the simplest glycosphingolipid. In a cerebroside, glucose or galactose is linked to the terminal hydroxyl group of ceramide to form glucocerebroside or galactocerebroside.

Galactocerebroside is a major lipid of myelin, whereas glucocerebroside is the major glycolipid of extraneural tissues and a precursor of most of the more complex glycolipids.

Ceramide reacts with UDP-glucose or UDP-galactose to form glucocerebroside or galactocerebroside respectively.

2)Gangliosides are the more complex glycolipids, contain a branched chain oligosaccharide of as many as seven sugar residues. Gangliosides are produced from ceramide by the stepwise addition of activated sugar, e.g. UDP-glucose, UDP-galactose and sialic acid usually N-acetylneuraminic acid (NANA)

3) Globosides (Ceramide + Oligosaccharide)

Globosides contain two or more sugar molecules attached to ceramide.These glycolipids are important constituents of the RBC-membrane and are the determinants of the A,B,O blood group system

4) Sulfatides (Ceramide + Monosaccharide + Sulfate)

Sulfatides are cerebrosides in which the monosaccharide contains a sulfate ester.

9 Cells are the structural and functional units of all living organisms. The major parts of a cell are the nucleus and the cytoplasm. The electron microscope allowed classification of cells into two major groups,prokaryotes and eukaryotes,based on the presence and absence of the true nucleus.

Eukaryotes :-Eukaryotes have nucleus which is covered by nuclear membrane. Animals, plants and fungi belong to the eukaryotes. Eukaryotic cells are much larger than prokaryotes. Unlike prokaryotes, eukaryotes have a variety of other membrane-bound organelles (subcellular elements) in their cytoplasm, including: Mitochondria,Lysosome,Endoplasmic reticulum and Golgi complexes.

Prokaryotes :- Prokaryotes have no typical nucleus and subcellular components. Bacteria and blue green algae belong to the prokaryotes.

A cell has three major components:

1. Cell membrane (Plasma membrane)

2. Cytoplasm with its organelles

3. Nucleus.

CELL MEMBRANE (PlaPLASMAsma MEMBRANE)

The cell is enveloped by a thin membrane called cell membrane or plasma membrane. • Cell membranes mainly consist of lipids, proteins and smaller proportion of carbohydrates that are linked to lipids and proteins. The cell membrane is an organized structure consisting of a lipid bilayer primarily of phospholipids and penetrated protein molecules forming a mosaic-like pattern.

Membrane Lipids

The major classes of membrane lipids are:Phospholipids, Glycolipids, Cholesterol. They all are amphipathic molecules, i.e. they have both hydrophobic and hydrophilic ends. Membrane lipids spontaneously form bilayer in aqueous medium, burrying their hydrophobic tails and leaving their hydrophilic ends exposed to the water.

Membrane Proteins

Proteins of the membrane are classified into two major categories:

– Integral proteins or intrinsic proteins or transmembrane proteins and

– Peripheral or extrinsic proteins.

Integral proteins are either partially or totally immersed in the lipid bilayer. Many integral membrane proteins span the lipid bilayer from one side to the other and are called transmembrane protein whereas others are partly embedded in either the outer or inner leaflet of the lipid bilayer. Transmembrane proteins act as enzymes and transport carriers for ions as well as water soluble substances, such as glucose.

Peripheral proteins are attached to the surface of the lipid bilayer by electrostatic and hydrogen bonds. They bound loosely to the polar head groups of the membrane phospholipid bilayer. Peripheral proteins function almost entirely as enzymes and receptors.

Membrane Carbohydrates

Membrane carbohydrate is not free. It occurs in combination with proteins or lipids in the form of glycoproteins or glycolipids. Most of the integral proteins are glycoproteins and about one-tenth of the membrane lipid molecules are glycolipids. The carbohydrate portion of these molecules protrude to the outside of the cell, dangling outward from the cell surface.Many of the carbohydrates act as receptor for hormones. Some carbohydrate moieties function in antibody processing.

Functions of Cell Membrane

• Protective function: The cell membrane protects the cytoplasm and the organelles of the cytoplasm.

• Maintenance of shape and size of the cell.

• As a semipermeable membrane: The cell membrane permits only some substances to pass in either direction, and it forms a barrier for other substances.

CYTOPLASM AND ITS ORGANELLES

Cytoplasm is the internal volume bounded by the plasma membrane. The clear fluid portion of the cytoplasm in which the particles are suspended is called cytosol.

Six important organelles that are suspended in the cytoplasm are:

1. Endoplasmic reticulum

2. Golgi apparatus

3. Lysosomes

4. Peroxisomes

5. Mitochondria

6. Nucleus.

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| Organelles | Functions |
| Lysosome | Intracellular digestion of macromolecules and hydrolysis of nucleic acid, protein,  glycosaminoglycans, glycolipids, sphingolipids |
| Golgi apparatus | Post-transcriptional modification and sorting of proteins and export of proteins |
| Rough endoplasmic reticulum | Biosynthesis of protein and secretion |
| Smooth endoplasmic reticulum | Biosynthesis of steroid hormones and phospholipids, metabolism of foreign compounds |
| Peroxisomes | Metabolism of hydrogen peroxide and oxidation of long-chain fatty acids |
| Mitochondrion | ATP synthesis, site for tricarboxylic acid cycle, fatty acid oxidation, oxidative  phosphorylation, part of urea cycle and part of heme synthesis |
| Cytosol | Site for glycolysis, pentose phosphate pathway, part of gluconeogenesis, urea cycle  and heme synthesis, purine and pyrimidine nucleotide synthesis |
| Nucleolus | Synthesis of rRNA and formation of ribosomes |

NUCLEUS

The cells with nucleus are called eukaryotes and those without nucleus are known as prokaryotes. Most of the cells have only one nucleus but cells of skeletal muscles have many nuclei. The matured red blood cell contains no nucleus.

The nucleus is spherical in shape and situated near the center of the cell. The nucleus is surrounded by the nuclear envelope. The space enclosed by the nuclear envelope is called nucleoplasm, within this the nucleolus is present. Nucleolus is an organized structure of DNA, RNA and protein that is involved in the synthesis of ribosomal RNA. The remaining nuclear DNA is dispersed throughout the nucleoplasm in the form of chromatin fibers. At mitosis, chromatin is condensed into discrete structures called chromosomes.

Functions of Nucleus

• Replication: Synthesis of new DNA.

• Transcription: The synthesis of the three major types of RNA: ribosomal RNA (rRNA), messenger RNA (mRNA) and transfer RNA (tRNA).

CYTOSKELETON

The cytoplasm of most eukaryotic cells contains network of protein filaments, that interact extensively with each other and with the component of the plasma membrane. Such an extensive intracellular network of protein has been called cytoskeleton. The plasma membrane is anchored to the cytoskeleton. The cytoskeleton is not a rigid permanent framework of the cell but is a dynamic, changing structure.

• The cytoskeleton consists of three primary proteinfilaments:

1. Microfilaments

2. Microtubules

3. Intermediate filaments.





