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Study Questions

Answers

1. Vitamins are classified based on their solubility into two groups namely; **Water soluble vitamins** and **Fat soluble vitamins**.

 The Water soluble vitamins include:

1. B complex vitamins;
2. Thiamine B1
3. Riboflavin B2
4. Niacin B3
5. Pantothenic acid B5
6. Pyridoxine B6
7. Biocin
8. Folic acid
9. Cobalamin B12
10. Vitamin C or Ascorbic acid.

The Fat soluble vitamins include:

1. Vitamin A
2. Vitamin D
3. Vitamin E
4. Vitamin K

 Biochemical significance of vitamins

 Vitamins are organic nutrients that are required in small

quantities for a variety of biochemical functions. These Vitamins are healthy for human growth, metabolism, development and body function. They also act as coenzymes for certain reactions in the body.

Other functions include;

1. Thiamine (Vitamin B1) acts as a Coenzyme for oxidative decarboxylation and transketolase reaction.
2. Niacin are involved in catalyzing ox red reactions in oxidative pathways
3. Biotin is involved in carboxylation reactions
4. Folic acid is involved in cell growth and reproduction
5. Cobalamin is involved in blood formation, neural function and growth
6. Vitamin A aids in vision cycle
7. Vitamin D aids in bone and tooth structure
8. Role of coenzymes in metabolism.

 They are needed in a reaction to aid enzymes for optimum activity.

1. Thiamine (Vitamin B1): aid in carbohydrate metabolism as a coenzyme to pyruvate dehydrogenase (PD) in their active form- Thiamine Pyrophosphate (TPP)

 Pyruvate AcetylcoA

 PD (TPP)

1. Riboflavin is a precursor of coenzymes FMN and FAD, which are required by several oxidation reduction reactions in metabolism. They serve as coenzymes for oxidoreductase enzymes involved in carbohydrate, protein, lipid, nucleic acid metabolism and electron transport chain.
2. Nomenclature of Nucleosides, Nucleotides and nucleic acid

 Nucleic acids are macromolecules present in all living cells in combination with proteins. They are polymers of nuclessotides.

 **Nucleosides** are structural units of composed of only a pentose sugar and Nitrogenous base while **Nucleotides** are structural units of nucleic acids composed of three components: pentose sugar, Nitrogenous bases (purine and pyrimidine bases) and phosphate group.

The naming of nucleosides and nucleotides is stated below;

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Bases |  | Purines |  | Pyrimidines |  |
|  |  | Adenine (A) | Guanine (G) | Cytosine (C) | Uracil (U)Thymine(T) |
| Nucleosides | RNA | Adenosine | Guanosine | Cytidine | Uridine |
|  | DNA | Deoxyadenosine | Deoxyguanosine | Deoxycytidine | Deoxythymidine |
| Nucleotides | RNA | Adenosine 5’ monophosphate | Guanosine 5’ monophosphate | Cytidine 5’ monophoshate | Uridine 5’ monophosphate |
|  | DNA | Deoxyadenosine 5’ monophosphate | Deoxyguanosine 5’ monophosphate | Deoxycytidine 5’ monophoshate | Deoxythymidine 5’ monophosphate |

1. Pathway showing the Involvement of Vitamin A in vision

**Visual purple or rhodopsin**

 **11- cis retinal opsin**

 Opsin light

 **11- cis retinal**

 **Complex of all trans retinal and**

Retinal Isomerase **Conformationally changed opsin**

 Nerve

 Impulse to

 **All trans retinal** Opsinbrain

 Alcohol dehydrogenase NADP + H+ = NADP

 **All trans retinol**

 Blood

 **Liver stores**

 (all trans retinol)

 Vitamin A in diet **Wald’s visual cycle**

1. Visual response of an individual to bright and dim light

 The retina of the eye possess Rods and Cone cells which contain photoreceptor pigment in their membrane and vitamin A is a

component of these pigments. **Rhodopsin** or visual purple, the visual pigment of rod cells in the retina consists of **11-cis-retinal** bound to protein **opsin**.

 When a person enters from bright light to dark there is difficulty in seeing due to depletion of rhodopsin, but after few minutes the vision

improves. During these few minutes, rhodopsin is resynthesized and vision is improved. The time taken for regeneration of rhodopsin is known as **dark**

**adaptation time.** While vision in dim light is mediated by rhodopsin

of the rod cells, color vision or vision in bright light is mediated by three different retinal containing pigments in the cone cells, the three pigments are called porphyropsin, iodopsin and cyanopsin and are sensitive to the three essential colors: red, green and blue respectively. All these pigments consist of 11-cis-retinal bound to protein opsin. Thus, when light strikes the retina, it bleaches one or more of these pigments, depending on the color

quality of the light. The pigments are converted to all-trans retinal, and the protein moiety opsin is released as in the case of rhodopsin. This reaction

gives rise to the nerve impulse that is read out in the brain as color:

– Red if porphyropsin is split

– Green if iodopsin is split

– Blue if cyanopsin is split.

1. Biosynthetic pathway involving the exposure of sunlight to skin and its relation to a named Vitamin.

 This involves the production of Vitamin D in the body. The naturally produced D3 or cholecalciferol, is the form of **Vitamin D** is obtained from animal sources in the diet, or made in the **skin by the action**

**of ultraviolet light from sunlight on 7-dehydrocholesterol**

 **Cholesterol**

 Dehydrogenation

 **7 – Dehydrocholesterol**

UV light

 On skin

 **Cholecalciferol (Vitamin D3)**

**Biosynthetic pathway involving the exposure of sunlight to skin**

1. Effects of acids and alkalis on nucleic acids

 Nucleic acids include Deoxyribonucleic acid or DNA and Ribonucleic acid or RNA. For DNA, **high concentration of base** will induce a hydrolysis of the phosphodiester bonds of the DNA and the DNA will be cleaved into smaller fragments but **low concentration of alkali** will not be too harmful to the nucleic acid though some damage is incurred like denaturation of some binding proteins or breakage of a few hydrogen bonds while at extremely low pH i.e **high acidic conditions**, the phosphodiester bonding of the DNA is disrupted which cleaves the DNA into nucleosides and nucleotides, this is why the pH in the stomach is low.

 While For RNA, **acid effect** is variable as RNA is more resistant to acid hydrolysis compared to DNA while in **Alkali**, RNA is readily hydrolyzed because the 2’-OH group in RNA acts as an intramolecular neutrophil. In the alkaline hydrolysis of RNA, it forms a 2’-3’ cyclic intermediate.

1. Contributions of Watson-Crick in the structure of DNA

 In 1953, James Watson and Francis Crick deduced the three-dimensional structure of DNA. The important features of their model of DNA are as follows:

1. Two helical polynucleotide chains are coiled around a common axis. The chains run in opposite direction (anti parallel) like the diagram below.
2. The purine and pyrimidine bases are on the inside of the helix, whereas the phosphate and deoxyribose units are on the outside.
3. The diameter of the helix is 20 Å. Adjacent bases are separated by 3.4 Å along the helix axis and the helical structure repeats after ten residues on each chain, i.e. at intervals of 34 Å.
4. The two chains are held together by hydrogen bonds between complementary pairs of bases:

 Adenine is always paired with thymine by formation of two hydrogen bonds. Guanine is always paired with cytosine by formation of three hydrogen bonds**.**

1. The two strands are always complementary to each other. In a double stranded DNA molecule, the content of adenine equals to that of thymine and the contents of guanine equals to that of cytosine. The complementary base pairing proves the **Chargaff’s rule.**

 The model proposed by Watson and Crickis a **B form of DNA *(B-DNA)*** which is a righthanded helix of 10 base pairs per turn, containinggrooves of alternate size, known as major and minor grooves.

1. Differences between DNA and RNA

|  |  |
| --- | --- |
| DNA | RNA |
| 1. Contains Deoxyribose sugar
 | Contains Ribose sugar |
| 1. Contains Cytosine and Thymine but not Uracil
 | Contains Cytosine and Uracil but not Thymine |
| 1. DNA is found in nucleus and small in mitochondrion
 | RNA is found in cytoplasm and small in nucleolus |
| 1. DNA is a double stranded molecule
 | RNA is a single stranded molecule  |

1. Functions of Nucleotides
2. They are the energy currencies of the cell.
3. They provide monomers for genetic information in DNA and RNA.
4. They are signaling molecules, acting like hormones directly or as transducers of information.
5. They serve as universal carriers of metabolic energy and high-energy electrons.
6. They aid in metabolism and enzyme reactions.