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1. vitamins are classified into 2 groups: fat soluble and water soluble vitamins

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

Biochemical significance of vitamins

-vitamins are essential for growth, development maintenance and reproduction. However they are not used for energy production.

-fat soluble vitamins are required for normal color vision, blood clotting, bone formation and maintenance of membrane structure.

-most water soluble vitamins function as precursors of coenzymes

-vitamin A and D act as steroid hormones.

-deficiency of fat soluble vitamins produce night blindness, skeletal deformation, hermorrages and hemolysis

-deficiency of water soluble vitamins produce beri beri, glositis, pelagra, microcytic anaemia, megaloblastic anemia and scurvy.

-some vitamins are used as drugs, for example folic acid analogs are used as anti cancer agents and antibiotic

-moderate consumption of some vitamins is found to decrease occurrence or severity of certain diseases for example consumption of vitamin E and D at moderate level reduces incidences of cancer and cardiovascular diseases.

- consumption of vitamin of vitamin C reduces severity of cold they also slow down aging process. However excess consumption of fat soluble vitamins will lead to toxicity.

- vitamin b2,b6 and folic acid are beneficiary to coronary artery disease patients.

2 coenzymes are non protein molecules required by enzymes to carry out catalytic functions. Water soluble vitamins are precursors of coenzymes and examples include

a. Thiamine which is a precursor of coenzyme thiamine pyrophosphate (TPP). TPP is a coenzyme involved in enzymatic rxns for oxidative decarboxylatiin and transketolase.e.g TPP is a coenzyme for pyruvate dehydrogenase which catalysis the conversion pyruvate into acetyl CoA. It is a coenzyme for Aplha ketoglutarate dehydrogenase which catalyse the conversion of alpha ketoglutarate to succinyl-CoA in TCA cycle.

b. 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.

3 The biochemical role of Vitamin A in vision is described in Wald's Visual Cycle.

i. Vitamin A helps the photoreceptors (rods and cons) in the retina to convert light into electrical signals carried by the optic nerve to the brain to interpret into images. Vit A called 11-cis- retinal combines with a protein called opsin to give rhodopsin, an essential light absorbing molecule needed for vision. It is a membrane protein found in the photoreceptor cells of 0the retina.

ii. When light falls on the retina, the 11-cis-retinal isomerizes to all-trans-retinal. A single photon can excite the rod cell. The photon produces immediate conformational change. The unstableintermediates produced are: Rhodopsin →Batho-rhodopsin → Lumirhodopsin →Metarhodopsin-I → Metarhodopsin-II → andfinally Opsin + all-trans-retinal. Each ofthese intermediaries has a lifespan ofonly few picosecond to microseconds.The all-trans-retinal is then released from the protein.

iii. Visual pigments are G-protein-coupledreceptors and 11-cis-retinal locks the receptor protein (opsin) in its inactive form The isomerization and photo-excitation leads to activation of G-protein and generation of cyclic-GMP. Cyclic GMP acts as the gate for cation specific channels. Transducin is the G-protein in retina. The nerve impulse thus generated in the retina is transmitted to visual centres in the brain. The signal is terminated by phosphorylation of a serine residue of activated rhodopsin, by an enzyme rhodopsin kinase, so that the inhibitory protein beta-arrestin can bind and inactivate rhodopsin.

Regeneration of 11-cis-retinal

i. After dissociation, opsin remains in retina; but trans-retinal enters the blood circulation. Later cis-retinal is generated,reaches retina. The re-attachment of 11-cis retinal to opsin is critical for shutting off the pigment's catalytic activity.

ii. The all-trans-retinal is isomerized to 11-cis-retinal in the retina itself in the dark by the enzyme retinal isomerase. This reaction is taking place in retinal pigment epithelium. The 11-cis retinal can recombine with opsin to regenerate rhodopsin.

iii. Alternatively, all-trans-retinal is transported to liver and then reduced to all-trans-retinol by alcohol dehydrogenase (ADH), an NADH dependent enzyme. ADH contains zinc, and therefore, zinc is important in retinol metabolism. The all-trans-retinol is isomerized to 11-cis-retinol and then oxidised to 11-cis-retinal in liver. This is then transported to retina. This completes the Wald's visual cycle.

4 Nucleotides are named according to the number of phosphates (mono-, di-, or tri-), the type of sugar (deoxy- or not), and the type of base.

5 In the retina, there are two types of photosensitive cells, the rods and the cones. Rods are responsible for perception in dim light and cones are responsible for vision in bright light as well as color vision. Rhodopsin present in rods is made up of 11-cis-retinal + opsin and the cons contain the photosensitive protein, conopsin. In humans, one eye contains about 120 million rods, each of which carries 120 million molecules of rhodopsin. The number of rods is more in cats, mice and owls. In cone proteins also, 11-cis-retinal is the chromophore. One eye contains about 6 million cones.

Bright light depletes stores of rhodopsin in rods. Therefore when a person shifts suddenly from bright light to a dimly lit area, there is difficulty in seeing, for example, entering a cinema theater. After a few minutes, rhodopsin is resynthesized and vision is improved. This period is called dark adaptation time. Deficiency of cis-retinal will lead to increase in dark adaptation time and night blindness. Reduction in number of cones or the cone proteins, will lead to color blindness.

6. Formation 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.

The production of vitamin D in the skin is directly proportional to the exposure to sunlight and inversely proportional to the pigmentation of skin. Excessive exposure to sunlight does not result in vitamin D toxicity since excess previtamin D3 and D3 are destroyed by sunlight itself.

7. The effect of an acid or an alkali to DNA depends on the concentration in which the nucleic acid is exposed to.

If DNA is exposed to low concentration of alkali it will not be too harmful to the nucleic acid though some damage is obviously incurred like for instance denaturation of some binding proteins or breakage of a few hydrogen bonds of the base pairing,etc. Exposure of DNA to moderate concentration of alkali causes deprotonation and the hydrogen bonding between the base pairs is disrupted causing the DNA to denature. If DNA is exposed to high concentration of alkali it will induce a hydrolysis of the phosphodiester bonds of the DNA and the DNA will be cleaved into smaller fragments.Alkali treatment is often used for isolation of plasmid DNA or any other extra chromosomal material so as to ensure the degradation of genomic DNA to avoid contamination of it into the desired product.

Considering the effect of Acid on DNA:

If DNA is exposed to low pH conditions, the DNA is deprived of the purines. This causes DNA melting. Also since A+G content is lost 50% of the sequence of the DNA is lost. Exposure of DNA to extremely low pH conditions (pH<3) i.e. high acidic conditions the phosphodiester bonding of the DNA is disrupted which cleaves the DNA into nucleosides and nucleotides.The effect of acid on DNA is the reason as to why the pH in the stomach is low. Since the pH is nearing 2.0 most of the bacterial load is reduced prior to digestion and decontaminated food is passed further.

8.Waston’s Crick contribution to the structure of DNA describes DNA as a double stranded, helical molecule, consisting of two sugar phosphate back bone on the outside held together by hydrogen bonding between nitrogenous bases in the inside.

9. Differences 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 |

10. Nucleotides are the subunits of nucleic acids, nucleotides have a variety of other functions in every cell: as energy carriers, components of enzyme cofactors, and chemical messengers.

A)Nucleotides Carry Chemical Energy in Cells: Nucleotides may have one, two, or three phosphate groups covalently linked at the 5' hydroxyl of ribose. These are referred to as nucleoside mono-, di-, and triphosphates. Nucleoside triphosphates are used as a source of chemical energy to drive a wide variety of biochemical reactions. ATP is by far the most widely used, but UTP, GTP, and CTP are used in specific reactions. Nucleoside triphosphates also serve as the activated precursors of DNA and RNA synthesis.

B)Nucleotides Are Components of Many Enzyme Cofactors: A variety of enzyme cofactors serving a wide range of chemical functions include adenosine as part of their structure. They are unrelated structurally except for the presence of adenosine. In none of these cofactors does the adenosine portion participate directly in the primary function, but removal of adenosine from these structures generally results in a drastic reduction of their activities. For example, removal of the adenosine nucleotide rom acetoacetyl-CoA reduces its reactivity as a substrate for β-ketoacylCoA transferase (an enzyme of lipid metabolism) by a factor of 106.

C) Some Nucleotides Are Intermediates in Cellular Communication

Cells respond to their environment by taking cues from hormones or other chemical signals in the surrounding medium. The interaction of these extracellular chemical signals (first messengers) with receptors on the cell surface often leads to the production of second messengers inside the cell, which in turn lead to adaptive changes in the cell interior. Often, the second messenger is a nucleotide.

One of the most common second messengers is the nucleotide adenosine 3',5'-cyclic monophosphate (cyclic AMP, or cAMP), formed from ATP in a reaction catalyzed by adenylate cyclase, associated with the inner face of the plasma membrane.Another regulatory nucleotide, ppGpp, is produced in bacteria in response to the slowdown in protein synthesis that occurs during amino acid starvation. This nucleotide inhibits the synthesis of the rRNA and tRNA molecules needed for protein synthesis, preventing the unnecessary production of nucleic acids.

