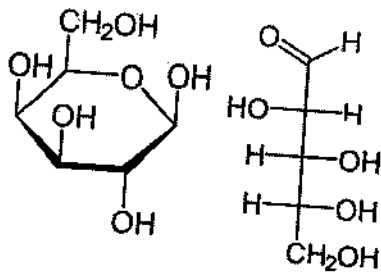


Answer key for
 Biochemistry I
 Sem I
 F. Y. B Pharm
 CBCS

①

QP code
 24792



D-Arabinose

Q1.

a.

b.

c. Calcitriol OR 1,25-dihydroxycholecalciferol

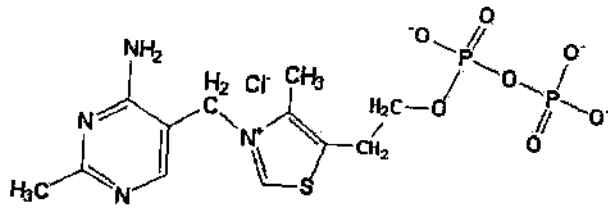
d.

Disaccharide made up of	Non reducing sugar α -D-glucose and β -D-fructose	Reducing sugar 2 α -D-glucose
Reducing/non-reducing	Non-reducing sugar	Reducing sugar
Mutarotation	No mutarotation	Shows mutarotation
Benedicts, fehling's, osazone test	negative	Positive Sunflower shaped osazone
Structure	<p>Sucrose α-D-glucopyranosyl β-D-fructofuranoside $\text{Glc}1 \leftrightarrow 2\text{Fru}$</p>	<p>Maltose α-D-glucopyranosyl (1-4)-D-glucopyranose</p>

e. A **tautomer** is a separate type isomer by an organic compound that has the property that it can quickly change their isomeric form by chemical reaction called **tautomerization**. Eg. keto-enol tautomerism

f. TPP

2

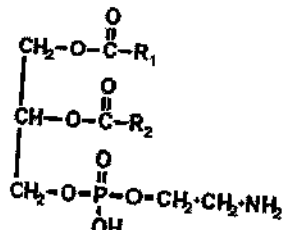


Thiamine pyrophosphate

g. The temperature at which the DNA strands are half denatured, meaning half double-stranded, half single-stranded, is called the melting temperature (T_m).

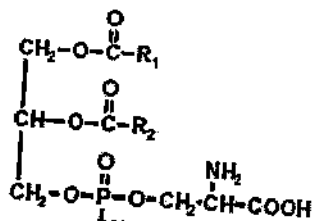
h. Inverted or invert sugar syrup is a mixture of glucose and fructose; it is obtained by splitting the disaccharide sucrose into these two components. Compared with its precursor, sucrose, inverted sugar is alluringly sweet and its products tend to retain moisture and are less prone to crystallization

i.



Cephalin

(Phosphatidyl ethanolamine)



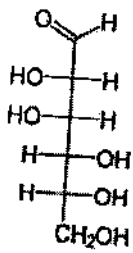
Cephalin

(Phosphatidyl serine)

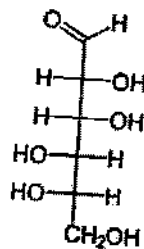
j. cellulase

k. night blindness or xerophthalmia

l.



D-Mannose



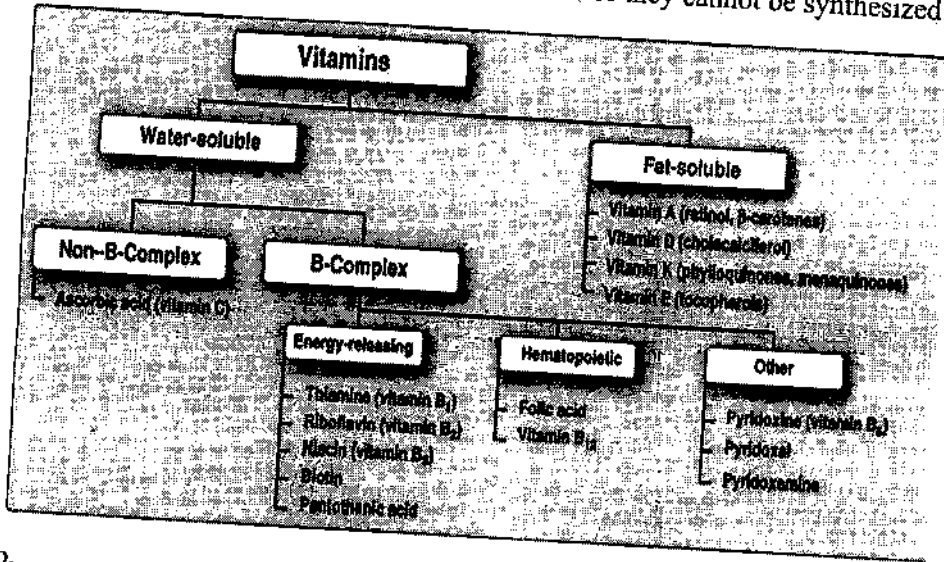
L-Mannose

m. metabolism = catabolism + anabolism

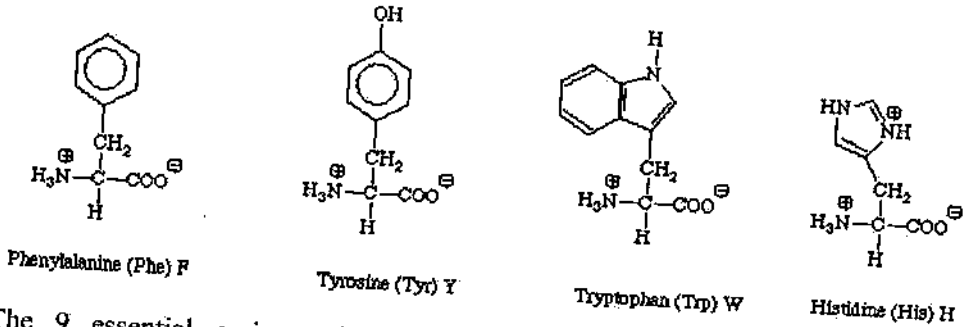
eg glycolysis + gluconeogenesis, glycogenesis + glycogenolysis

3

n. Vitamin: group of organic compounds which are essential for normal growth and nutrition and are required in small quantities in the diet because they cannot be synthesized by the body.



o.



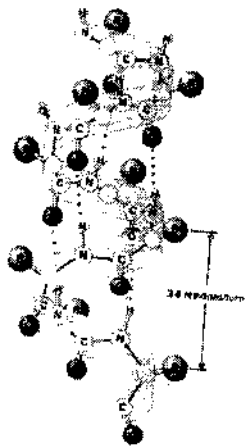
p. The 9 essential amino acids are: histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine.

Q2. a)

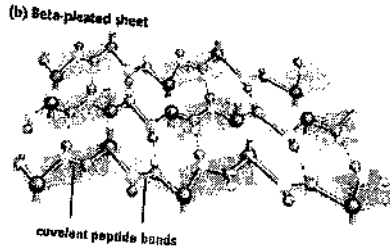
The **Alpha Helix** (α -helix) is a common motif in the secondary structure of proteins and is a righthand-spiral conformation (i.e. **helix**) in which every backbone N-H group donates a hydrogen bond to the backbone C=O group of the amino acid located three or four residues earlier along the protein sequence.

Beta sheets consist of **beta strands** (also β -strand) connected laterally by at least two or three backbone hydrogen bonds, forming a generally twisted, **pleated sheet**. A β -strand is a stretch of polypeptide chain typically 3 to 10 amino acids long with backbone in an extended conformation.

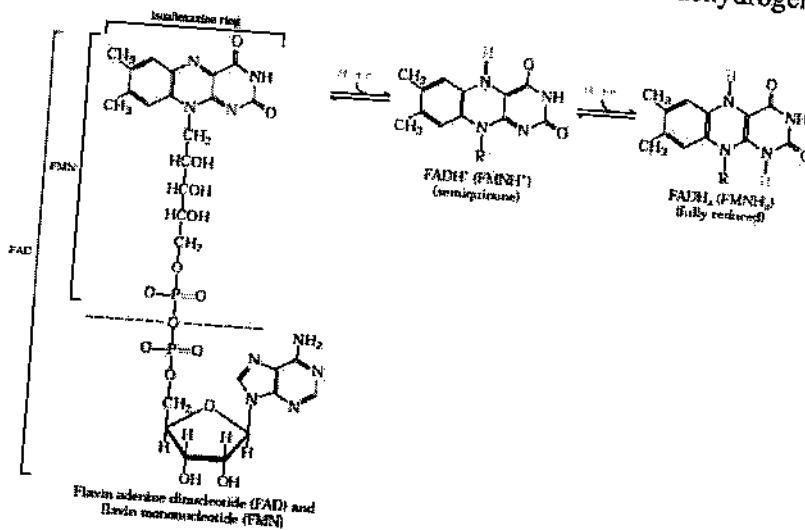
4



Alpha helix



Q2. b **Flavoproteins** are enzymes that catalyse oxidation-reduction reactions using either Flavin mononucleotide (FMN) or flavin adenine dinucleotide (FAD) as coenzyme. These coenzymes, the **flavin nucleotides**, are derived from the vitamin riboflavin. The fused ring structure of flavin nucleotides (the isoalloxazine ring) undergoes reversible reduction, accepting either one or two electrons in the form of one or two hydrogen atoms (each atom an electron plus a proton) from a reduced substrate. The fully reduced forms are abbreviated FADH₂ and FMNH₂. When a fully oxidized flavin nucleotide accepts only one electron (one hydrogen atom), the semiquinone form of the isoalloxazine ring is produced, abbreviated FADH• and FMNH•. Because flavoproteins can participate in either one- or two-electron transfers, this class of proteins is involved in a greater diversity of reactions than the NAD (P)-linked dehydrogenases.



Q2, c

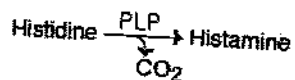
biochemical role Vitamin -B₆

Pyridoxal phosphate (PLP), the coenzyme of vitamin B₆ is found attached to the α-aminogroup of lysine in the enzyme. PLP is closely associated with the metabolism of aminoacids. The synthesis of certain specialized products such as serotonin, histamine, niacin coenzymes from the

5

amino acids independent on pyridoxine. Pyridoxal phosphate participates in reactions like transamination, decarboxylation, deamination, transsulfuration, condensation etc.

1. Transamination: Pyridoxal phosphate is involved in the transamination reaction (by transaminase) converting amino acids to keto acids. The keto acids enter the citric acid cycle and get oxidized to generate energy. Thus B6 is an energy releasing vitamin. It integrates carbohydrate and amino acid metabolisms
2. Decarboxylation: Some of the α -amino acids undergo decarboxylation to form the respective amines. This is carried out by a group of enzymes called decarboxylases which are dependent on PLP. Many biogenic amines with important functions are synthesized by PLP decarboxylation.



3. Pyridoxal phosphate is required for the synthesis of α -amino levulinic acid, the precursor for heme synthesis.
4. The synthesis of niacin coenzymes (NAD⁺ and NADP⁺) from tryptophan is dependent on PLP. The enzyme kynureninase requires PLP. In B₆ deficiency, 3-hydroxy anthranilic acid is diverted to xanthurenic acid. Increased excretion of xanthurenate in urine is an indication of B₆ deficiency.
5. PLP plays an important role in the metabolism of sulfur containing amino acids. Transsulfuration (transfer of sulfur) from homocysteine to serine occurs in the synthesis of cysteine. This is carried out by a PLP dependent cystathionine synthase. Taurine, a decarboxylated (PLP dependent) product of cysteine, is involved in the conjugation of bile acids.
6. Deamination of hydroxyl group containing amino acids requires PLP.

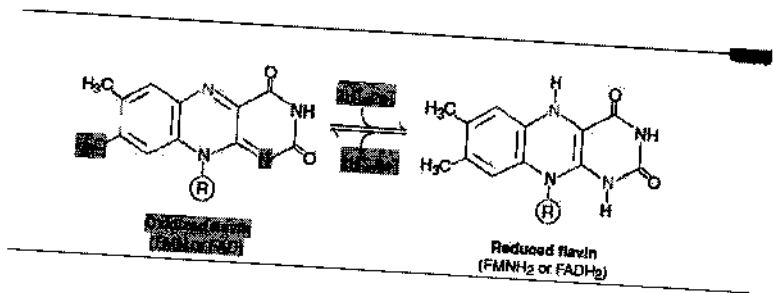
OR

Biochemical functions of Vitamin B₂ Riboflavin through its coenzymes takes part in a variety of cellular oxidation-reduction reactions.

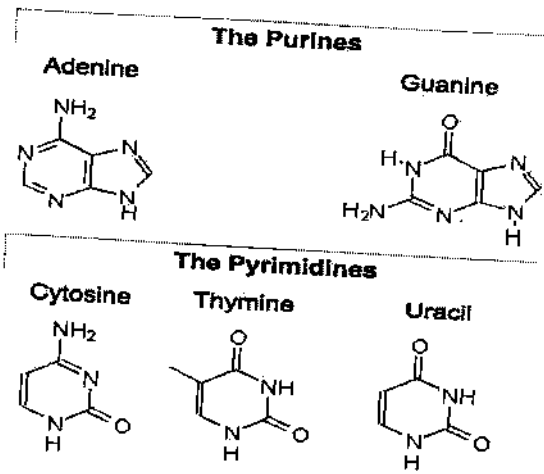
Flavin mononucleotide (FMN) and flavin adenine dinucleotide (FAD) are the two coenzyme forms of riboflavin. The ribitol (5 carbon) is linked to a phosphate in FMN. FAD is formed from FMN by the transfer of an AMP moiety from ATP

The flavin coenzymes (mostly FAD and to a lesser extent FMN) participate in many redox reactions responsible for energy production. The functional unit of both the coenzymes is isoalloxazine ring which serves as an acceptor of two hydrogen atoms (with electrons). FMN or FAD undergo identical reversible reactions accepting two hydrogen atoms forming FMNH₂ or FADH₂. Enzymes that use flavin coenzymes (FMN or FAD) are called flavoproteins. The coenzymes (prosthetic groups) often bind rather tightly, to the protein (apoenzyme) either by non-covalent bonds (mostly) or covalent bonds in the holoenzyme. Many flavoproteins contain metal atoms (iron, molybdenum etc.) which are known as metalloflavoproteins. The coenzymes, FAD and FMN are associated with certain enzymes involved in carbohydrate, lipid, protein and purine metabolisms, besides the electron transport chain. A few examples are listed in Table 7.2. Further details are given in the respective chapters

6



Q2 d.



Q2.e

- carbohydrates are broken down to provide glucose for energy
 - Digestion predominantly occurs via enzymes lining the wall of the small intestine
- The metabolism of carbohydrates is the process of getting the carbohydrates in the foods we eat into the right format to provide fuel to our body's cells. This process involves digestion, absorption and transportation. Most commonly, carbohydrate metabolism results in the production of glucose molecules which are the most efficient source of energy (ATP) for our muscles and our brains. Energy or fuel from our food is used for cell growth, repair and normal cell functioning.

Carbohydrates are most commonly consumed as polysaccharides (e.g. starch, fibre or cellulose) or disaccharides (e.g. lactose, sucrose, galactose) and therefore need to be broken down into their simpler monosaccharide forms which the body can utilise.

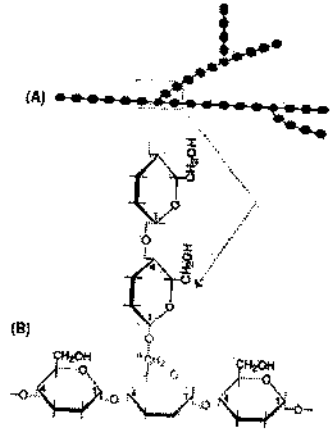
The digestion process of polysaccharides such as starch will begin in the mouth where it is hydrolysed by salivary amylase. The amount of starch hydrolysed in this environment is often quite small as most food does not stay in the mouth long. Once the food bolus reaches the stomach the salivary enzymes are denatured. As a result, digestion predominantly occurs in the small intestine with pancreatic amylase hydrolysing the starch to dextrin and maltose.

Enzymes classed as glucosidases on the brush border of the small intestine break down the dextrin and maltase, lactase and sucrase convert the other disaccharides into their two monosaccharide units.

Q3. a

Glycogen is the carbohydrate reserve in animals, hence often referred to as **animal starch**. It is present in high concentration in liver, followed by muscle, brain etc. Glycogen is also found in plants that do not possess chlorophyll (e.g. yeast, fungi). The structure of glycogen is similar to

that of amylopectin with more number of branches. **Glucose** is the repeating unit in glycogen joined together by (1 4) glycosidic bonds, and (1 6) glycosidic bonds at branching points . The molecular weight (up to 1 108) and the number of glucose units (up to 25,000) vary in glycogen depending on the source from which glycogen is obtained.

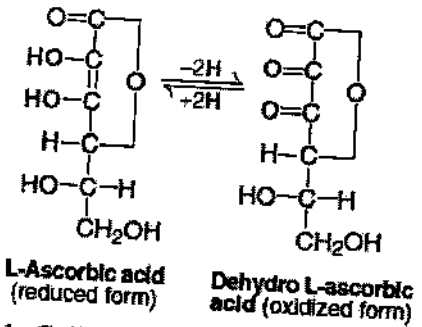


Q3b.

ascorbic acid

3

Ascorbic acid (anti-scurvy vitamin, vitamin C) is a hexose derivative and closely resembles monosaccharides in structure. The acidic property of vitamin C is due to the enolhydroxyl groups. It is a strong reducing agent. L-Ascorbic acid undergoes oxidation to form dehydroascorbic acid and this reaction is reversible. Both ascorbic acid and dehydroascorbic acid are biologically active. However, D-ascorbic acid is inactive. The plasma and tissues predominantly contain ascorbic acid in the reduced form. Most of the functions of vitamin C are related to its property to undergo reversible oxidation-reduction i.e., interconversion of ascorbic acid and dehydroascorbic acid.



1. Collagen formation: Vitamin C plays the role of a coenzyme in hydroxylation of proline and lysine while procollagen is converted to collagen. Hydroxyproline and hydroxylysine are essential for the collagen cross-linking and the strength of the fiber. In this way, vitamin C is necessary for maintenance of normal connective tissue and wound healing process.
2. Bone formation: Bone tissues possess an inorganic matrix, collagen and the inorganic calcium, phosphate etc. Vitamin C is required for bone formation.
3. Iron and hemoglobin metabolism: Ascorbic acid enhances iron absorption by keeping it in the ferrous form.

4. Tryptophan metabolism: Vitamin C is essential for the hydroxylation of tryptophan (enzyme-hydroxylase) to hydroxytryptophan in the synthesis of serotonin.
5. Tyrosine metabolism: Ascorbic acid is required for the oxidation of p-hydroxyphenylpyruvate (enzyme hydroxylase) to homogentisic acid in tyrosine metabolism.
6. Folic acid metabolism: The active form of the vitamin folic acid is tetrahydrofolate (FH₄). Vitamin C is needed for the formation of FH₄ (enzyme-folic acid reductase). Further, in association with FH₄, ascorbic acid is involved in the maturation of erythrocytes.
7. Peptide hormone synthesis: Many peptide hormones contain carboxyl terminal amide which is derived from terminal glycine. Hydroxylation of glycine is carried out by peptidylglycine hydroxylase which requires vitamin C.
8. Synthesis of corticosteroid hormones: Adrenal gland possesses high levels of ascorbic acid, particularly in periods of stress. It is believed that vitamin C is necessary for the hydroxylation reactions in the synthesis of corticosteroid hormones.
9. Sparing action of other vitamins: Ascorbic acid is a strong antioxidant. It spares vitamin A, vitamin E, and some B-complex vitamins from oxidation.
10. Immunological function: Vitamin C enhances the synthesis of immunoglobulins (antibodies) and increases the phagocytic action of leucocytes.
11. Preventive action on cataract: Vitamin C reduces the risk of cataract formation.
12. Preventive action on chronic diseases: As an antioxidant, vitamin C reduces the risk of cancer, cataract, and coronary heart diseases.

Q3 c. Watson- Crick Model

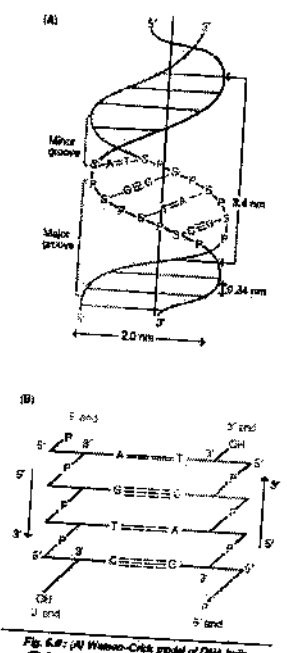


Fig. 5.8: (A) Watson-Crick model of DNA helix
(B) Complementary base pairing in DNA helix.

Watson and Crick shared the Nobel Prize in 1962 for their discovery, along with Maurice Wilkins (1916 - 2004), who had produced a large body of crystallographic data supporting the model. DNA structure is considered as a milestone in the era of modern biology. The structure of DNA double helix is comparable to a twisted ladder.

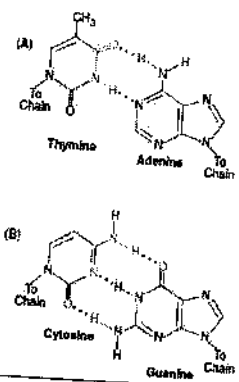


Fig. 5.10: Complementary base pairing in DNA
(A) Thymine pairs with adenine by 2 hydrogen bonds
(B) Cytosine pairs with guanine by 3 hydrogen bonds.

The double helical structure of DNA was proposed by James Watson and Francis Crick in 1953. The elucidation of DNA structure is considered as a milestone in the era of modern biology. The structure of DNA double helix is comparable to a twisted ladder. The salient features of Watson-Crick model of DNA are

1. The DNA is a right handed double helix. It consists of two polydeoxyribonucleotide chains (strands) twisted around each other on

a common axis.

2. The two strands are antiparallel, i.e., one strand runs in the 5'to 3'direction while the other in 3'to 5'direction. This is comparable to two parallel adjacent roads carrying traffic in opposite direction.
3. The width (or diameter) of a double helix is 20 A° (2 nm).
4. Each turn (pitch) of the helix is 34 A° (3.4 nm) with 10 pairs of nucleotides, each pair placed at a distance of about 3.4 A°.
5. Each strand of DNA has a hydrophilic deoxyribose phosphate backbone (3'-5'phosphodiester bonds) on the outside (periphery) of the molecule while the hydrophobic bases are stacked inside (core).
6. The two polynucleotide chains are not identical but complementary to each other due to base pairing.
7. The two strands are held together by hydrogen bonds formed by complementary base pairs (Fig.5.10). The A-T pair has 2 hydrogen bonds while G-C pair has 3 hydrogen bonds. The G-C is stronger by about 50% than A = T.
8. The hydrogen bonds are formed between a purine and a pyrimidine only. If two purines face each other, they would not fit into the allowable space. And two pyrimidines would be too far to form hydrogen bonds. The onlybase arrangement possible in DNA structure, from spatial considerations is A-T, T-A, G-C and C-G.
9. The complementary base pairing in DNA helix proves Chargaff's rule. The content of adenine equals to that of thymine (A = T) and guanine equals to that of cytosine (G = C).
10. The genetic information resides on one of the two strands known as template strand or sense strand. The opposite strand is antisense strand. The double helix has (wide) major grooves and (narrow) minor grooves along the phosphodiester backbone. Proteins interact with DNA at these grooves, without disrupting thebase pairs and double helix.

Q3. d

laws of thermodynamics

Two fundamental laws of thermodynamics: The first law is the principle of the conservation of energy:for any physical or chemical change, the totalamount of energy in the universe remains constant;energy may change form or it may be transportedfrom one region to another, but it cannot be createdor destroyed. The second law of thermodynamics, whichcan be stated in several forms, says that the universealways tends toward increasing disorder: in all naturalprocesses, the entropy of the universe increases.

Q3 e. fatty acids, in the form of triglycerides or free fatty acids bound to albumin, are ingested in the diet or synthesized by the liver (described above). Very little synthesis of free fatty acids occurs in the adipocytes. Triglycerides are the most significant source of fatty acids, because this is the form in which dietary lipids are assembled by the gut and liver. Triglycerides made up of long chain fatty acids, in the form of chylomicrons (from intestinal absorption) or lipoproteins (from hepatic synthesis), are hydrolyzed to glycerol and free fatty acids by an enzyme called lipoprotein lipase (LPL). Lipoprotein lipase is synthesized in adipocytes and secreted into adjacent endothelial cells.. The triglycerides within the adipocyte are acted upon by a multi-enzyme complex called hormone sensitive lipase (HSL), which hydrolyzes the triglyceride into free fatty acids and glycerol. These lipases act consecutively on triglycerides, diglycerides, and monoglycerides. Triglyceride lipase regulates the rate of lipolysis, because its activity is low.

(11)

Q4. A.

Based on the nutritional requirements, amino acids are grouped into two classes—essential and nonessential.

1. **Essential or indispensable amino acids** : The amino acids which cannot be synthesized by the body and, therefore, need to be supplied through the diet are called essential amino acids. They are required for proper growth and maintenance of the individual. The ten amino acids listed below are essential for humans (and also rats) : Arginine, Valine, Histidine, Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, Threonine, Tryptophan. [The code A.V. HILL, MP., T. T. (first letter of each amino acid) may be memorized to recall essential amino acids. The two amino acids namely arginine and histidine can be synthesized by adults and not by growing children, hence these are considered as semi-essential amino acids (remember Ah, to recall). Thus, 8 amino acids are absolutely essential while 2 are semi-essential.

2. **Non-essential or dispensable amino acids** : The body can synthesize about 10 amino acids to meet the biological needs, hence

For structures refer Biochemistry by Styanarayan pgno. 49

Q4 b. Glycolipids (glycosphingolipids) are important constituents of cell membrane and nervous tissues (particularly the brain). Cerebrosides are the simplest form of glycolipids. They contain a ceramide (sphingosine attached to a fatty acid) and one or more sugars. Galactocerebroside (galactosylceramide) and glucocerebroside are the most important glycolipids. It contains the fatty acid cerebronic acid. Sulfagalactosylceramide is the sulfate derived from galactosylceramide.

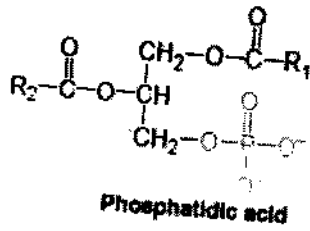
Gangliosides: These are predominantly found in ganglions and are the most complex form of glycosphingolipids. They are the derivatives of cerebrosides and contain one or more molecules of N-acetylneuraminic acid (NANA), the most important sialic acid. The structure of NANA is given in carbohydrate chemistry. The most important gangliosides present in the brain are GM1, GM2, GD, and GT, (G represents ganglioside while M, D and T indicate mono-, di- or tri- sialic acid residues, and the number denotes the carbohydrate sequence attached to the ceramide).

Phospholipids: These are complex or compound lipids containing phosphoric acid, in addition to fatty acids, nitrogenous base and alcohol.

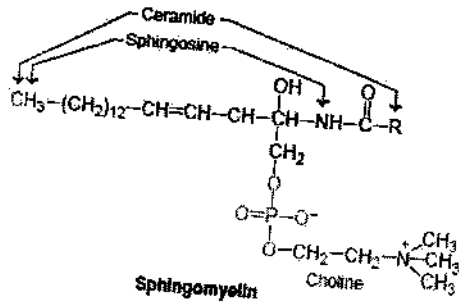
There are two classes of phospholipids 1. Glycerophospholipids (or phosphoglycerides) that contain glycerol as the alcohol. 2. Sphingophospholipids (or sphingomyelins) that contain sphingosine as the alcohol.

Glycerophospholipids Glycerophospholipids are the major lipids that occur in biological membranes. They consist of glycerol 3-phosphate esterified at its C1 and C2 with fatty acids. Usually, C1 contains a saturated fatty acid while C2 contains an unsaturated fatty acid.

Phosphatidic acid: This is the simplest phospholipid. It does not occur in good concentration in the tissues. Basically, phosphatidic acid is an intermediate in the synthesis of triacylglycerols and phospholipids. The other glycerophospholipids containing different nitrogenous bases or other groups may be regarded as the derivatives of phosphatidic acid like phosphatidylethanolamine, phosphatidylcholine, phosphatidylserine, plasmalogen, cardiolipin.



Sphingomyelins Sphingosine is an amino alcohol present in sphingomyelins (sphingophospholipids). They do not contain glycerol at all. Sphingosine is attached by an amide linkage to a fatty acid to produce ceramide. The alcohol group of sphingosine is bound to phosphorylcholine in sphingomyelin structure. Sphingomyelins are important constituents of myelin and are found in good quantity in brain and nervous tissues. Ceramide, acts as a second messenger (signaling molecule) by regulating programmed cell death (apoptosis), cell cycle and cell differentiation. A ceramide containing a 30-carbon fatty acid is a major component of skin, and it regulates skin's water permeability.



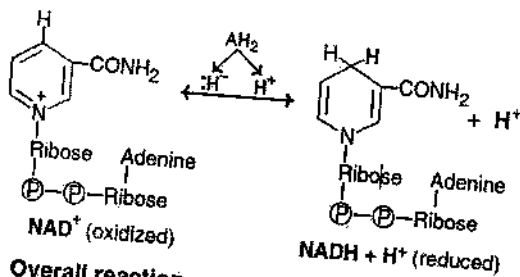
Functions of phospholipids: Phospholipids constitute an important group of compound lipids that perform a wide variety of functions

1. In association with proteins, phospholipids form the structural components of membranes and regulate membrane permeability.
2. Phospholipids (lecithin, cephalin and cardiolipin) in the mitochondria maintain the conformation of electron transport chain components, and thus cellular respiration.
3. Phospholipids participate in the absorption of fat from the intestine.
4. Phospholipids are essential for the synthesis of different lipoproteins, and thus participate in the transport of lipids.
5. Accumulation of fat in liver (fatty liver) can be prevented by phospholipids, hence they are regarded as lipotropic factors.
6. Arachidonic acid, an unsaturated fatty acid liberated from phospholipids, serves as a precursor for the synthesis of eicosanoids (prostaglandins, prostacyclins, thromboxanes etc.).
7. Phospholipids participate in the reverse cholesterol transport and thus help in the removal of cholesterol from the body.

8. Phospholipids act as surfactants (agents lowering surface tension). For instance, dipalmitoyl phosphatidylcholine is an important

Q4 c. Nicotinamide

The coenzymes NAD⁺ and NADP⁺ are involved in a variety of oxidation-reduction reactions. They accept hydride ion (hydrogen atom and one electron :H⁻) and undergo reduction in the pyridine ring. This results in the neutralization of positive charges. The nitrogen atom and the fourth carbon atom of nicotinamide ring participate in the reaction. While one atom of hydrogen (as hydride ion) from the substrate (AH₂) is accepted by the coenzyme, the other hydrogen ion (H⁺) is released into the surrounding medium. This reaction is reversed when NADH is oxidized to NAD⁺. NADP⁺ also functions like NAD⁺ in the oxidation-reduction reactions. A large number of enzymes (about 40) belonging to the class oxidoreductases are dependent on NAD⁺ or NADP⁺. The coenzymes are loosely bound to the enzymes and can be separated easily by dialysis. NAD⁺ and NADP⁺ participate in almost all the metabolisms (carbohydrate, lipid, protein etc.). Some enzymes are exclusively dependent on NAD⁺ whereas some require only NADP⁺. A few enzymes cause either NAD⁺ or NADP⁺. NADH produced is oxidized in the electron transport chain to generate ATP. NADPH is also important for many biosynthetic reactions as it donates reducing equivalents.

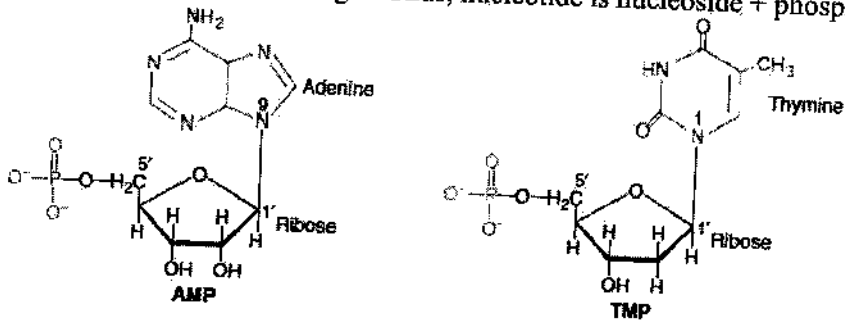


OR

Vitamin B5 is absorbed in the small intestine by simple diffusion, and then is phosphorylated by ATP. Vitamin B5 is converted into the active coenzyme A. The biological role of vitamin B5 was identified in 1950. Vitamin B5 is an ingredient of coenzyme A. Coenzyme A is essential for the action of several enzymes that participate in many reactions which are included acetyl and acyl groups. Converting carbohydrates, lipids, amino acids is related to coenzyme A. Vitamin B5 plays an important metabolic role in the human body. One of the important roles of vitamin B5 is related to the production of adrenal hormones and energy. It has long been known that this vitamin increases the reserves of energy in the body and strengthens the sporting opportunities. Vitamin B5 lowers blood cholesterol levels and protect the body against cardiovascular disease. This is primarily related to the derivative of pantothenic acid - panthetine. Vitamin B5 helps in faster wound healing. It also seems that this vitamin stimulate cell growth and healing process. This claim has not been fully confirmed, but all indications point to it.

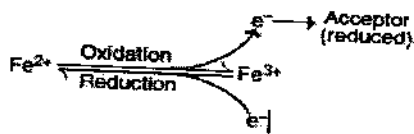
Q4 d Nucleotides are composed of a nitrogenous base, a pentose sugar and a phosphate. Nucleotides perform a wide variety of functions in the living cells, besides being the building

blocks or monomeric units in the nucleic acid (DNA and RNA) structure. These include their role as structural components of some coenzymes of B-complex vitamins (e.g. FAD, NAD⁺), in the energy reactions of cells (ATP is the energy currency), and in the control of metabolic reactions. The nucleotide essentially consists of nucleobase, sugar and phosphate. The term nucleoside refers to base + sugar. Thus, nucleotide is nucleoside + phosphate. For eg



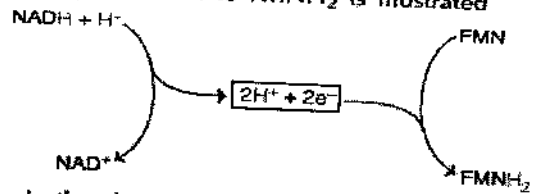
Q4. e

Oxidation is defined as the loss of electrons and reduction as the gain of electrons. This may be illustrated by the interconversion of ferrous ion (Fe²⁺) to ferric ion (Fe³⁺).



The electron lost in the oxidation is accepted by an acceptor which is said to be reduced. Thus the oxidation-reduction is a tightly coupled process.

The general principle of oxidation-reduction is applicable to biological systems also. The oxidation of NADH to NAD⁺ coupled with the reduction of FMN to FMNH₂ is illustrated



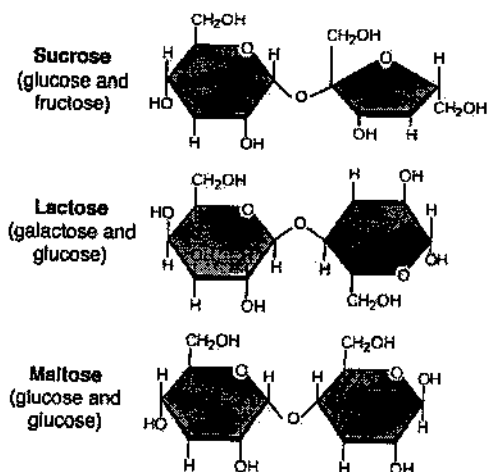
In the above illustration, there are two redox pairs NADH/NAD⁺ and FMN/FMNH₂. The redox pairs differ in their tendency to lose or gain electrons.

Q5. a

Diasaccharides: A **disaccharide** (also called a double sugar or biose) is the sugar formed when two monosaccharides (simple sugars) are joined by glycosidic linkage. Like monosaccharides, **disaccharides** are soluble in water. Three common examples are sucrose, lactose, and maltose.

There are two functionally different classes of disaccharides:

- Reducing disaccharides, in which one monosaccharide, the reducing sugar of the pair, still has a free hemiacetal unit that can perform as a reducing aldehyde group; cellobiose and maltose are examples of reducing disaccharides, each with one hemiacetal unit, the other occupied by the glycosidic bond, which prevents it from acting as a reducing agent.
- Non-reducing disaccharides, in which the component monosaccharides bond through an acetal linkage between their anomeric centers. This results in neither monosaccharide being left with a hemiacetal unit that is free to act as a reducing agent. Sucrose and trehalose are examples of non-reducing disaccharides because their glycosidic bond is between their respective hemiacetal carbon atoms. The reduced chemical reactivity of the non-reducing sugars in comparison to reducing sugars, may be an advantage where stability in storage is important.



Q.5 b

Folic Acid

Folic acid or is abundantly found in green leafy vegetables. It is important for one carbon metabolism and is required for the synthesis of certain amino acids, purines and the pyrimidine-thymine.

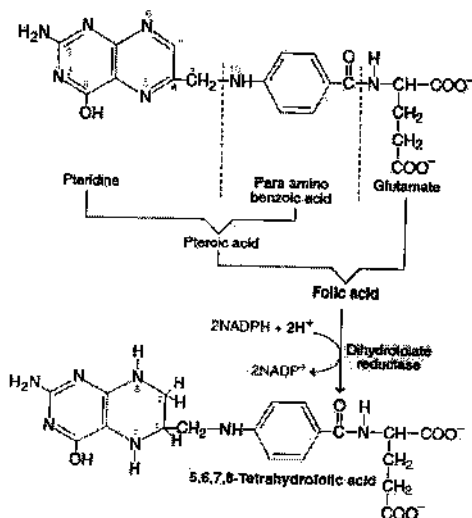
Folic acid consists of three components— pteridine ring, p-amino benzoic acid (PABA) and glutamic acid (1 to 7 residues). Folic acid mostly has one glutamic acid residue and is known as pteroyl-glutamic acid (PGA).

The active form of folic acid is tetrahydrofolate (THF or FH4). It is synthesized from folic acid by the enzyme dihydrofolate reductase. The reducing equivalents are provided by 2 moles of

6

NADPH. The hydrogen atoms are present at positions 5, 6, 7 and 8 of THF.

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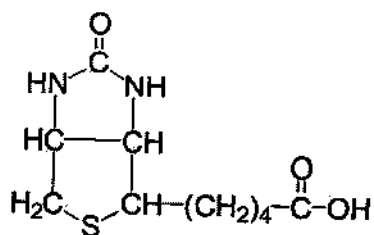
Tetrahydrofolate (THF or FH₄), the coenzyme of folic acid, is actively involved in the one carbon metabolism. THF serves as an acceptor or donor of one carbon units (formyl, methyl etc.) in a variety of reactions involving amino acid and nucleotide metabolism.

Many important compounds are synthesized in one carbon metabolism.

1. Purines (carbon 2, 8) which are incorporated into DNA and RNA.
2. Pyrimidine nucleotide deoxythymidylic acid (dTMP), involved in the synthesis of DNA.
3. Glycine, serine, ethanolamine and choline are produced.
4. N-Formylmethionine, the initiator of protein biosynthesis is formed.

OR

Biotin is a water-soluble B-vitamin, also called vitamin B₇ and formerly known as vitamin H or coenzyme R.



It is composed of a ureido ring fused with a tetrahydrothiophene ring. A valeric acid substituent is attached to one of the carbon atoms of the tetrahydrothiophene ring. Biotin is a coenzyme for carboxylase enzymes, involved in the synthesis of fatty acids, isoleucine, and valine, and in gluconeogenesis. D-(+)-Biotin is a cofactor responsible for carbon dioxide transfer in several carboxylase enzymes: for following enzyme reaction Refer styanarayan pg.no 147

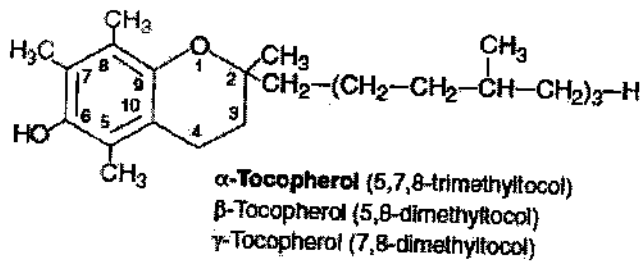
- Acetyl-CoA carboxylase alpha, Acetyl-CoA carboxylase beta, Methylcrotonyl-CoA carboxylase, Propionyl-CoA carboxylase, Pyruvate carboxylase

Biotin deficiency is uncommon, since it is well distributed in foods and also supplied by the intestinal bacteria. The deficiency may however, be associated with the following two causes.

1. Destruction of intestinal flora due to prolonged use of drugs such as sulfonamides.
2. High consumption of raw eggs.

Q5c

Vitamin E (tocopherol) is a naturally occurring antioxidant. It is essential for normal reproduction in many animals, hence known as anti-sterility vitamin. Vitamin E is described as a 'vitamin in search of a disease.' This is due to the lack of any specific vitamin E deficiency disease in humans. About 8 tocopherols (vitamin E vitamers) have been identified— α , β , γ , δ , etc. Among these, α -tocopherol is the most active. The tocopherols are derivatives of 6-hydroxy chromane (tocol) ring with isoprenoid (3 units) side chain. The antioxidant property is due to the hydroxyl group of chromane ring.



Biochemical functions: Most of the functions of vitamin E are related to its antioxidant property. It prevents the nonenzymatic oxidations of various cell components (e.g. unsaturated fatty acids) by molecular oxygen and free radicals such as superoxide (O_2^-) and hydrogen peroxide (H_2O_2). The element selenium helps in these functions. Vitamin E is lipophilic in character and is found in association with lipoproteins, fat deposits and cellular membranes. It protects the polyunsaturated fatty acids (PUFA) from peroxidation reactions. Vitamin E acts as a scavenger and gets itself oxidized (to quinone form) by free radicals (R) and spares PUFA.

The biochemical functions of vitamin E, related either directly or indirectly to its antioxidant property, are given hereunder 1. Vitamin E is essential for the membrane structure and integrity of the cell, hence it is regarded as a membrane antioxidant. 2. It prevents the peroxidation of polyunsaturated fatty acids in various tissues and membranes. It protects RBC from hemolysis by oxidizing agents (e.g. H_2O_2). 3. It is closely associated with reproductive functions and prevents sterility. Vitamin E preserves and maintains germinal epithelium of gonads for proper reproductive function. 4. It increases the synthesis of heme by enhancing the activity of enzymes δ -aminolevulinic acid (ALA) synthase and ALA dehydratase. 5. It is required for cellular respiration— through electron transport chain (believed to stabilize coenzyme Q). 6. Vitamin E prevents the oxidation of vitamin A and carotenes. 7. It is required for proper storage of creatine in skeletal muscle. 8. Vitamin E is needed for optimal absorption of amino acids from the intestine. 9. It is involved in proper synthesis of nucleic acids. 10. Vitamin E protects liver from being damaged by toxic compounds such as carbon tetrachloride. 11. It works in association with vitamins A, C and E-carotene, to delay the onset of cataract. 12. Vitamin E has been recommended for the prevention of chronic diseases such as cancer and heart diseases. Clinical trials in this regard are rather disappointing, hence it is no more recommended. However, some clinicians continue to use it particularly in subjects susceptible to heart attacks. It is believed that

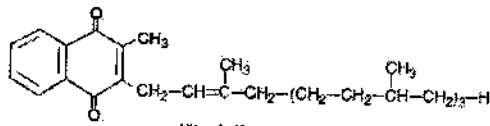
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vitamin E prevents the oxidation of LDL. (The oxidized LDL have been implicated to promote heart diseases.)

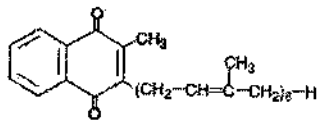
OR

Vitamin K is the only fat soluble vitamin with a specific coenzyme function. It is required for the production of blood clotting factors, essential for coagulation.

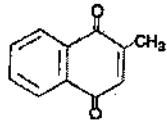
Chemistry: Vitamin K exists in different forms. Vitamin K₁ (phylloquinone) is present in plants. Vitamin K₂ (menaquinone) is produced by the intestinal bacteria and also found in animals. Vitamin K₃ (menadione) is a synthetic form. All the three vitamins (K₁, K₂, K₃) are naphthoquinone derivatives. Isoprenoid side chain is present in vitamins K₁ and K₂. The three vitamins are stable to heat. Their activity is, however, lost by oxidizing agents, irradiation, strong acids and alkalies.



Vitamin K₁ (phylloquinone)



Vitamin K₂ (menaquinone)

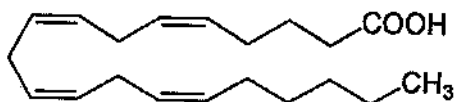


Vitamin K₃ (menadione)

Biochemical functions: The functions of vitamin K are concerned with blood clotting process. It brings about the post translational (after protein biosynthesis in the cell) modification of certain blood clotting factors. The clotting factors II (prothrombin), VII, IX and X are synthesized as inactive precursors (zymogens) in the liver. Vitamin K acts as a coenzyme for the carboxylation of glutamic acid residues present in the proteins and this reaction is catalysed by a carboxylase (microsomal). It involves the conversion of glutamate (Glu) to γ -carboxyglutamate (Gla) and requires vitamin K, O₂ and CO₂. The formation of γ -carboxyglutamate is inhibited by dicumarol, an anticoagulant found in spoiled sweet clover. Warfarin is a synthetic analogue that can inhibit vitamin K action. Vitamin K is also required for the carboxylation of glutamic acid residues of osteocalcin, a calcium binding protein present in the bone.

Q5 d. structure of Arachidonic acid

2

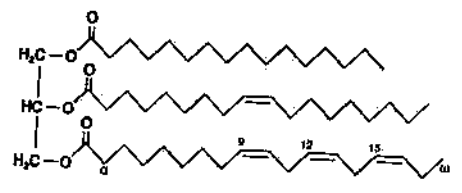


Q5.e I. Digestion of proteins by gastric secretion Protein digestion begins in the stomach. Gastric juice produced by stomach contains hydrochloric acid and a protease proenzyme namely pepsinogen.

II. Digestion of proteins by pancreatic proteases: The proteases of pancreatic juice are secreted as zymogens (proenzymes) and then converted to active forms. These processes are initiated by the release of two polypeptide hormones, namely cholecystokinin and secretin from the intestine.

III. Digestion of proteins by small intestinal enzymes: The luminal surface of intestinal epithelial cells contains aminopeptidases and dipeptidases. Amino peptidase is a non-specific exopeptidase which repeatedly cleaves N-terminal amino acids one by one to produce free amino acids and smaller peptides. The dipeptidases act on different dipeptides to liberate amino acids.

Q6. a



an ester derived from glycerol and three fatty acids (from tri-and glyceride). Triglycerides are the main constituents of body fat in humans and other animals, as well as vegetable fat. They are also present in the blood to enable the bidirectional transference of adipose fat and blood glucose from the liver, and are a major component of human skin oils

There are many different types of triglyceride, with the main division between saturated and unsaturated types. fats are "saturated" with hydrogen — all available places where hydrogen atoms could be bonded to carbon atoms are occupied. These have a higher melting point and are more likely to be solid at room temperature. Unsaturated fats have double bonds between some of the carbon atoms, reducing the number of places where hydrogen atoms can bond to carbon atoms. These have a lower melting point and are more likely to be liquid at room temperature.

Q6 b

. Known as the sunshine vitamin, vitamin D is produced by the body in response to skin being exposed to sunlight. It is also occurs naturally in a few foods -- including some fish, fish liver oils, and egg yolks -- and in fortified dairy and grain products.

Vitamin D is essential for strong bones, because it helps the body use calcium from the diet. Traditionally, vitamin D deficiency has been associated with rickets, a disease in which the bone tissue doesn't properly mineralize, leading to soft bones and skeletal deformities. But increasingly, research is revealing the importance of vitamin D in protecting against a host of health problems

22

nucleotides are arranged into codons consisting of 3 bases each. Each such codon specifies an amino acid.

Q6 d.

Enthalpy: a thermodynamic quantity equivalent to the total heat content of a system. It is equal to the internal energy of the system plus the product of pressure and volume. The change in enthalpy associated with a particular chemical process.

Entropy: thermodynamic quantity representing the unavailability of a system's thermal energy for conversion into mechanical work, often interpreted as the degree of disorder or randomness in the system.

Q6 e

Rancidification, the product of which can be described as **rancidity,** is the chemical decomposition of fats, oils and other lipids (this degradation also occurs in mechanical cutting fluids).

When these processes occur in food, undesirable odors and flavors can result. In some cases, however, the flavors can be desirable (as in aged cheeses).

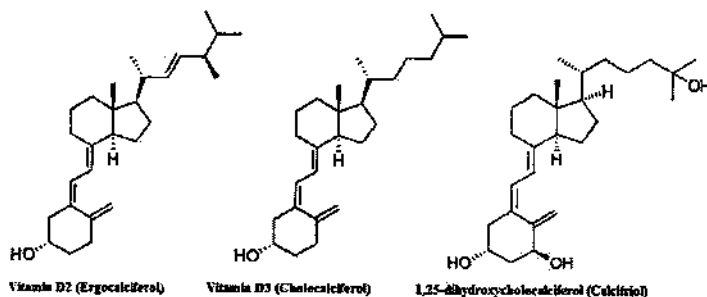
In processed meats, these flavors are collectively known as warmed-over flavor. Rancidification can also detract from the nutritional value of the food. Some vitamins are highly sensitive to degradation.

Hydrolytic rancidity:Hydrolytic rancidity occurs when water splits fatty acid chains away from the glycerol backbone in triglycerides (fats). The chemical term is ester hydrolysis. Usually this hydrolysis process goes unnoticed, since most fatty acids are odorless and tasteless. A particular problem arises with butter, which contains triglycerides with a high content of butyric acid derivatives and acetic acids.

Oxidative rancidity:Oxidative rancidity is associated with the degradation by oxygen in the air. Via a free radical process, the double bonds of an unsaturated fatty acid can undergo cleavage, releasing volatile aldehydes and ketones. This process can be suppressed by the exclusion of oxygen or by the addition of antioxidants. Oxidation primarily occurs with unsaturated fats.

Microbial rancidity:Microbial rancidity refers to a process in which microorganisms, such as bacteria, use their enzymes such as lipases to break down fat. This pathway can be prevented by sterilization.

21



Calcitriol (1,25-DHCC) is the biologically active form of vitamin D. It regulates the plasma levels of calcium and phosphate. Calcitriol acts at 3 different levels (intestine, kidney and bone) to maintain plasma calcium (normal 9–11 mg/dl).

1. **Action of calcitriol on the intestine:** Calcitriol increases the intestinal absorption of calcium and phosphate. In the intestinal cells, calcitriol binds with a cytosolic receptor to form a calcitriol-receptor complex. This complex then approaches the nucleus and interacts with a specific DNA leading to the synthesis of a specific calcium binding protein. This protein increases the calcium uptake by the intestine. The mechanism of action of calcitriol on the target tissue (intestine) is similar to the action of a steroid hormone.

2. **Action of calcitriol on the bone:** In the osteoblasts of bone, calcitriol stimulates calcium uptake for deposition as calcium phosphate. Thus calcitriol is essential for bone formation. The bone is an important reservoir of calcium and phosphate. Calcitriol along with parathyroid hormone increases the mobilization of calcium and phosphate from the bone. This causes elevation in the plasma calcium and phosphate levels.

3. **Action of calcitriol on the kidney:** Calcitriol is also involved in minimizing the excretion of calcium and phosphate through the kidney, by decreasing their excretion and enhancing reabsorption.

Or vitamin A refer satyanarayan pg. no. 118-119

Q6c. Messenger RNA (mRNA) – transfers DNA code to ribosomes for translation. This carries information from the nucleus to the ribosomes which are sites for protein synthesis. The coding sequence on the mRNA determines the amino acid sequence in the protein. The mRNA is a straight molecule extends from the 5' to 3' end. It is transcribed from a DNA template. On the mRNA nucleotides are arranged into codons consisting of 3 bases each. Each such codon specifies an amino acid.

Transfer RNA (tRNA) – brings amino acids to ribosomes for protein synthesis. This carries information from the nucleus to the ribosomes which are sites for protein synthesis. The coding sequence on the mRNA determines the amino acid sequence in the protein. The mRNA is a straight molecule extends from the 5' to 3' end. It is transcribed from a DNA template. On the mRNA nucleotides are arranged into codons consisting of 3 bases each. Each such codon specifies an amino acid.

Ribosomal RNA (rRNA) – Ribosomes are made of rRNA and protein. This carries information from the nucleus to the ribosomes which are sites for protein synthesis. The coding sequence on the mRNA determines the amino acid sequence in the protein. The mRNA is a straight molecule extends from the 5' to 3' end. It is transcribed from a DNA template. On the mRNA