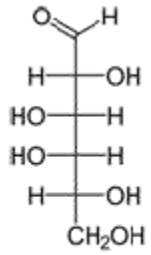
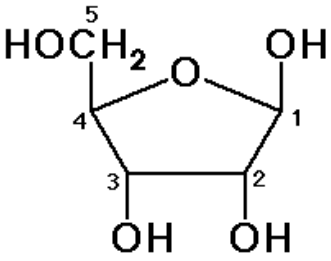
Q.P.Code: 40336

Q.1 A. Draw the structure of β- D-galactose by Fischer Projection Formula

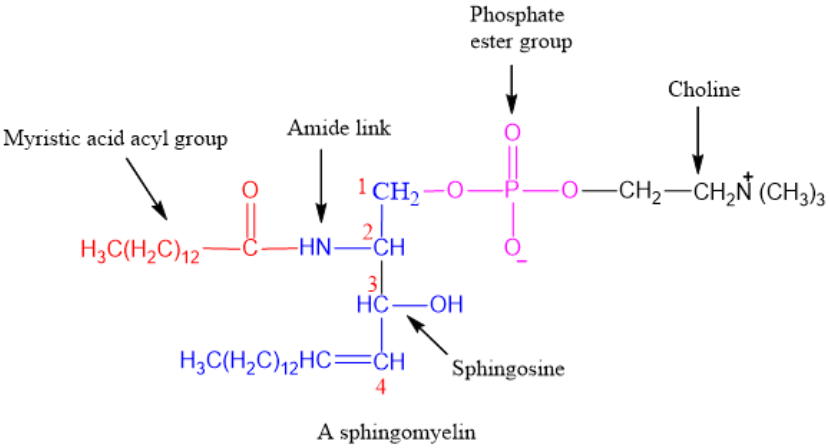


D-Galactose

b. Draw the structure of β- D-ribose by Haworth Projection Formula



c. Draw structure of Sphingomyelin 1



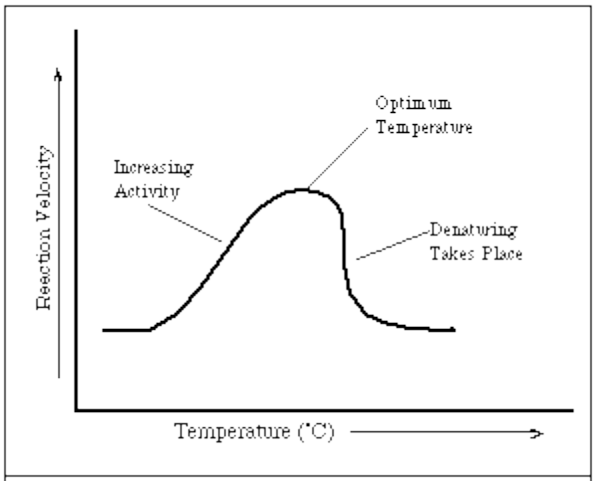
A sphingomyelin

d. Explain effect of Temperature on enzyme activity

temperature affects the reaction rate of enzymes, as do pH, substrate concentration and enzyme concentration. At low temperatures, enzymes have low activity. As the temperature rises the rate of reaction increases, usually 2-fold for every 10 degree Celsius rise.

The activity peaks at a specific temperature unique to the enzyme. This is known as the optimum temperature - the temperature at which an enzyme is maximally active. Beyond the optimum

temperature the activity of the enzyme decreases. At extreme temperatures, the enzymes are denatured and activity ceases.



e. Give the Mechanism of Renin-Angiotensin converting enzyme inhibitors.

ACE is a zinc metalloenzyme. The zinc ion is essential to its activity, since it directly participates in the catalysis of the peptide hydrolysis. Therefore, ACE can be inhibited by metal-chelating agents.

The E384 residue was found to have a dual function. First it acts as a general base to activate water as a nucleophile. Then it acts as a general acid to cleave the C-N bond.

f. Name the active form of Vit-B3. NAD and NADH

g. Explain Rancidity

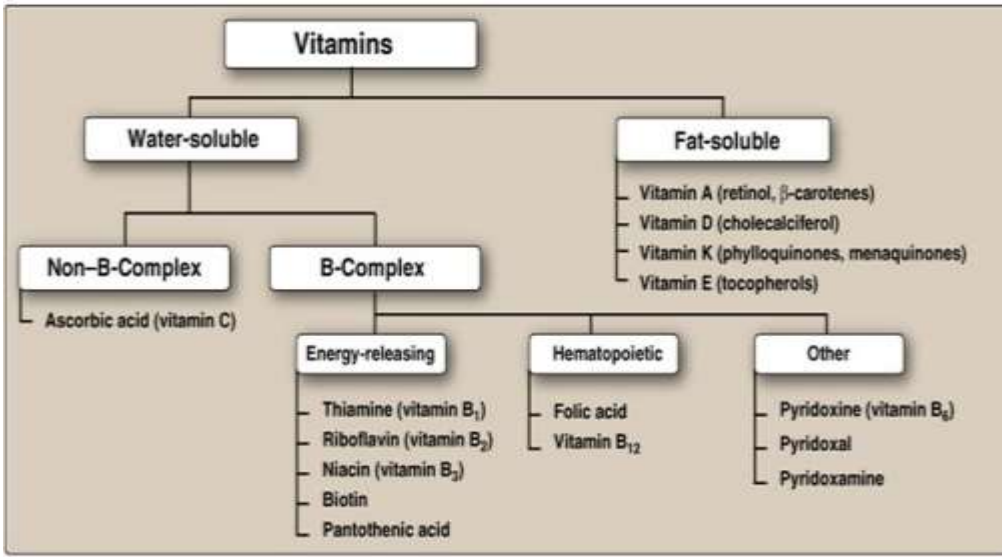
Rancidity is the complete or incomplete oxidation or hydrolysis of fats and oils when exposed to air, light, moisture or by bacterial action, resulting in unpleasant taste and odor.

h. What is Reversible enzyme inhibition

he reversible inhibitors, in most cases, bind to the enzyme active site with relatively greater affinity as compared to that of their native substrate analogs. The enzyme inactivation is not irreversible in these cases, as the bound inhibitor is not covalently bound at the active site, and is reversibly released from the active site. Most of the reversible inhibitors are developed based on the concept of transition state analog inhibition, that is, the enzymes have greater affinity toward the substrates that resemble the transition states, as compared to the native substrate molecules in the ground state. The reversible inhibition of serine proteases is an example of this type of inhibitors.

i. Define vitamin and enlist fat soluble vitamins

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.



j. Classification of amino acid based on Nutritional requirement.

Essential AA	Nonessential AA	Conditionally essential AA
Arginine	Alanine	Cysteine
Histidine	Asparagine	Glutamine
Isoleucine	Aspartate	Hydroxyproline
Leucine	Glutamate	Proline
Lysine	Glycine	Taurine
Methionine	Serine	
Phenylalanine	Tyrosine	
Threonine		
Tryptophan		
Valine		

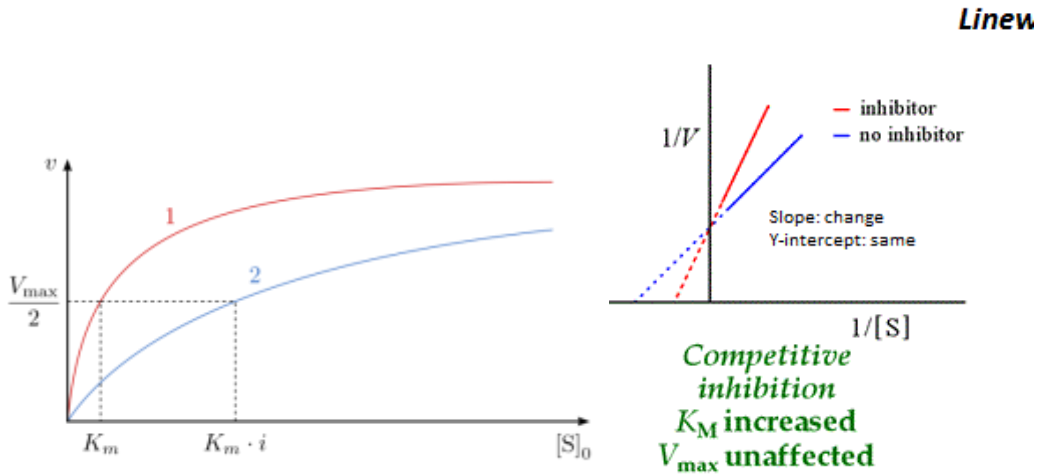
k. Define anabolism with example

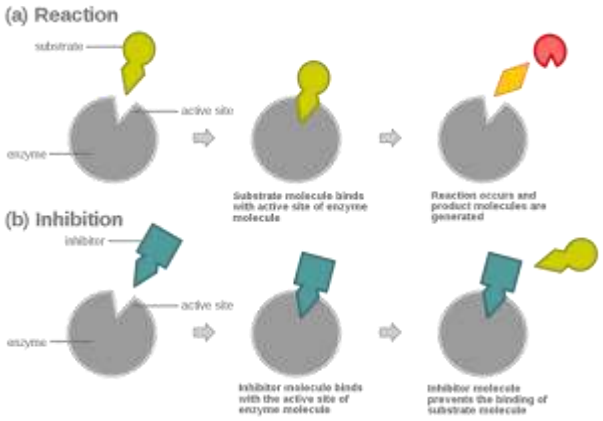
nabolism is the set of metabolic pathways that construct molecules from smaller units. These reactions require energy, known also as an endergonic process. Anabolism is the building-up aspect of metabolism, whereas catabolism is the breaking-down aspect. Anabolism is usually synonymous with biosynthesis. Eg Glycogenesis, fatty acid synthesis

Q.2 a. Write a note on primary and tertiary structure of Protein.

b. Explain NADH2 as Energy Carrier 3

c. Discuss Competitive enzyme inhibition using Michelis Menten and Lineweaver Burk plot



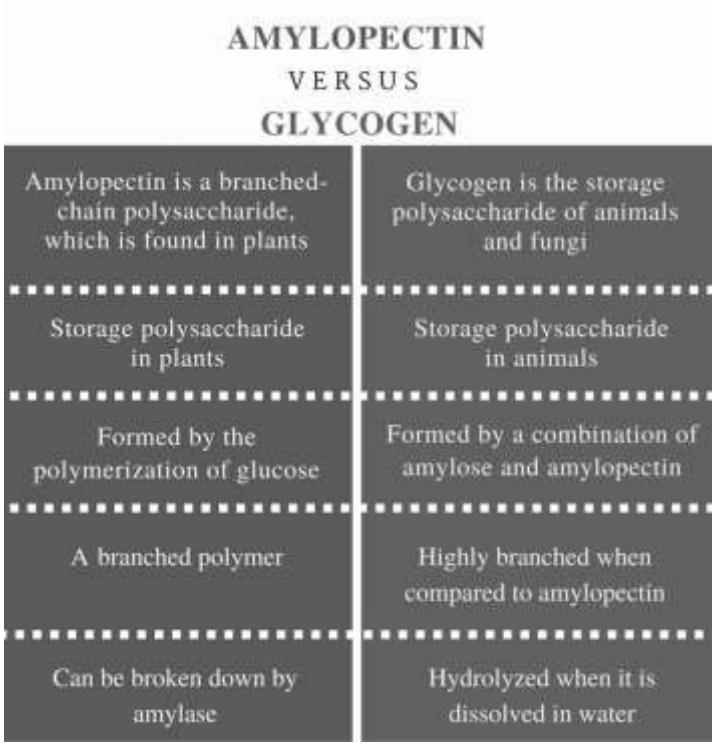


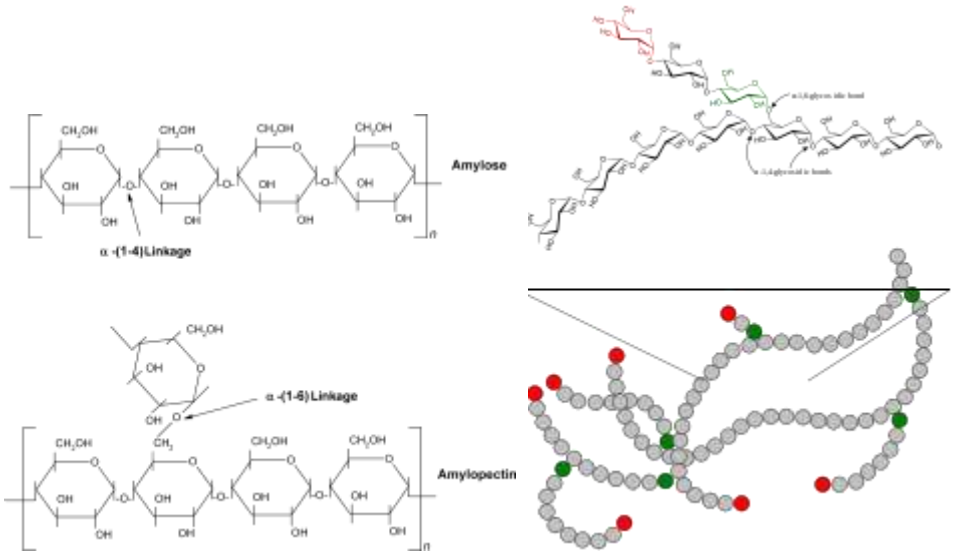
Competitive inhibition is interruption of a chemical pathway owing to one chemical substance inhibiting the effect of another by competing with it for binding or bonding. Any metabolic or chemical messenger system can potentially be affected by this principle, but several classes of competitive inhibition are especially important in biochemistry and medicine, including the competitive form of enzyme inhibition, the competitive form of receptor antagonism, the competitive form of antimetabolite activity, and the competitive form of poisoning (which can include any of the aforementioned types).

d. Give the role of Liver in digestion and absorption of Food

The liver has multiple functions, but its main function within the digestive system is to process the nutrients absorbed from the small intestine. Bile from the liver secreted into the small intestine also plays an important role in digesting fat. In addition, the liver is the body's chemical "factory." It takes the raw materials absorbed by the intestine and makes all the various chemicals the body needs to function. The liver also detoxifies potentially harmful chemicals. It breaks down and secretes many drugs.

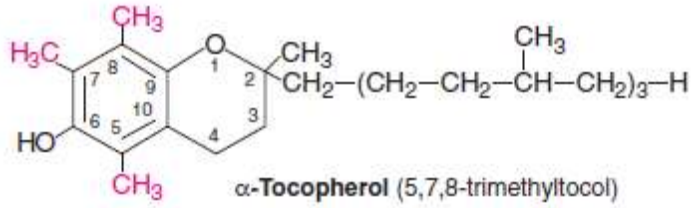
Q.3 a. Compare glycogen and starch in terms of structure and function





b. Write a note on Vitamin-E or Vitamin-K.

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.



α-Tocopherol (5,7,8-trimethyltocol)
β-Tocopherol (5,8-dimethyltocol)
γ-Tocopherol (7,8-dimethyltocol)

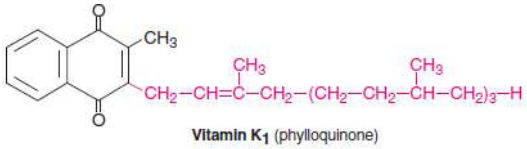
Biochemical functions: Most of the functions of vitamin E are related to its antioxidant property. It prevents the nonenzymatic oxidations of various cell components (e.g. unsaturated fatty acids) by molecular oxygen and free radicals such as superoxide (O_2 –) and hydrogen peroxide (H_2O_2). The element 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 vitamin E prevents the oxidation of LDL. (The oxidized LDL have been implicated to promote heart diseases.)

OR

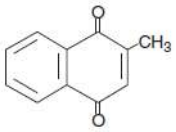
Vitamin K is the only fat soluble vitamin with a specific coenzyme function. It is required forthe production of blood clotting factors, essential for coagulation.

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 K_1 (phylloquinone)

Vitamin K_2 (menaquinone)

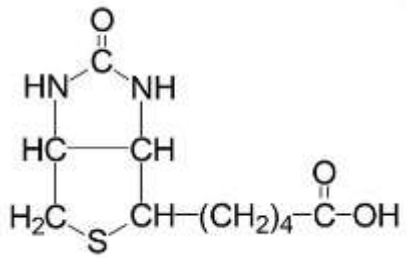


Vitamin K_3 (menadione)

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, O_2 and CO_2. The formation of γ-carboxyglutamate is inhibited by dicumarol, an anticoagulant found in spoilt 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.

c. Write a note on Biotin

Biotin is a water-soluble B-vitamin, also called **vitamin B_7** and formerly known as **vitamin H** or **coenzyme R**.

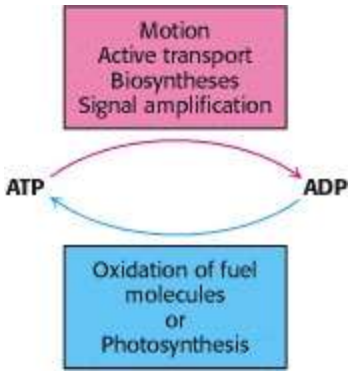


It is composed of a ureido ring fused with a tetrahydrothiophene ring. A valeric acid substituent is attached to one of the carbon atoms of the tetrahydrothiophene ring. Biotin is a coenzyme for carboxylase enzymes, involved in the synthesis of fatty acids, isoleucine, and valine, and in gluconeogenesis.D-(+)-Biotin is a cofactor responsible for carbon dioxide transfer in several carboxylase enzymes:for following enzyme reaction Refer styanarayan pg.no147

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

Biotin **deficiency is uncommon**, sinceit 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.

3 d. Justify" Oxidation as Source of Energy in Biological system" ATP serves as the principal *immediate donor of free energy* in biological systems rather than as a long-term storage form of free energy. In a typical cell, an ATP molecule is consumed within a minute of its formation. Although the total quantity of ATP in the body is limited to approximately 100 g, *the turnover of this small quantity of ATP is very high*. For example, a resting human being consumes about 40 kg of ATP in 24 hours. During strenuous exertion, the rate of utilization of ATP may be as high as 0.5 kg/minute. For a 2-hour run, 60 kg (132 pounds) of ATP is utilized. Clearly, it is vital to have mechanisms for regenerating ATP. Motion, active transport, signal amplification, and biosynthesis can occur only if ATP is continually regenerated from ADP . The generation of ATP is one of the primary roles of catabolism. The carbon in fuel molecules—such as glucose and fats—is oxidized to CO_2, and the energy released is used to regenerate ATP from ADP and P_i.



Q.4a. Classify amino acids based on their chemical structure with example of each class (Structures not required)

a) Amino acid with aliphatic side chain - Glycin, alanine
b) Amino acid containing Hydroxyl group- Serine, tyrosine
c) Sulfur containing-Cystein, Methionine
d) Acidic amino acid- Glutamic acid, Aspartic acid
e) Bascic amin acid-Lyseine,argentine
f) Aromatic -phenylalanine,tyrosine

b. Write a note on Lipoproteins

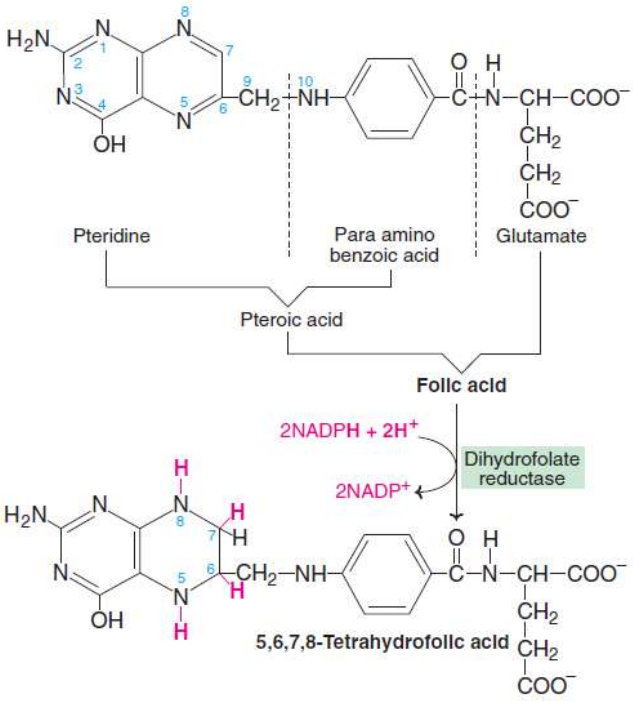
c. Write a note on Vitamin-B2 or Vitamin-B9

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



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.

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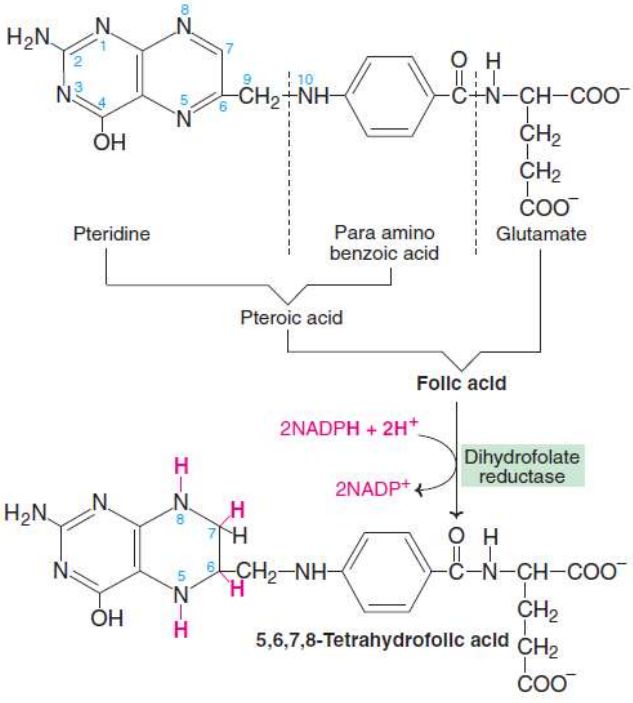

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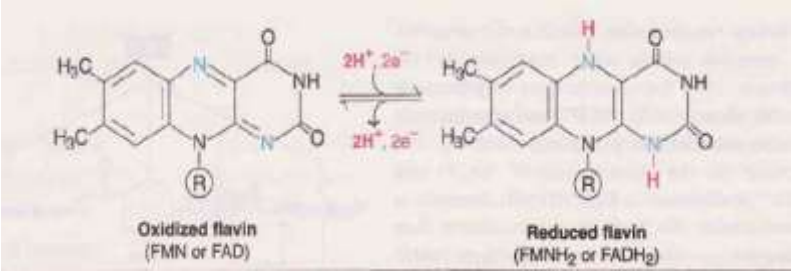
Vit B_2

Riboflavin is stable to heat but sensitive to light. When exposed to ultra-violet rays of sunlight, it is converted to lumiflavin which exhibits yellow fluorescence. The substances namely lactoflavin (from milk), hepatoflavin (from liver) and ovoflavin (from eggs) which were originally thought to be different are structurally identical to riboflavin. Flavin mononucleotide (FMN) and flavin adenine dinucleotide (FAD) are the two coenzyme forms of riboflavin.



3 d. Explain thermodynamically Favorable Reactions

Basically, the higher the temperature, the stronger the mobility of atoms/molecules, and thus the more chance (probability) for them to overcome the energy barrier, as a result, the faster the rate of a reaction or process. --- one way to speed up the reaction is heating it up. • The other way to speed up the reaction is to use catalyst, to lower down the energy barrier, i.e., decreasing the activation energy, ΔGa . For example, 1. In the Haber process, finely divided iron serves as a catalyst for the synthesis of ammonia from nitrogen and hydrogen, whereas such reaction can hardly occur without catalysts due to the high activation energy. 2. Petroleum refining makes intensive use of catalysis for alkylation, catalytic cracking (breaking long-chain hydrocarbons into smaller pieces), naphtha reforming and steam reforming (conversion of hydrocarbons into synthesis gas). 3. Another example is “catalytic converter”, typically composed of platinum and rhodium, working as a catalyst to convert the toxic by-products of combustion less-toxic substances, such as $2CO + 2NO \rightarrow 2CO2 + N2$

Q.5a. Write a note on Disaccharides

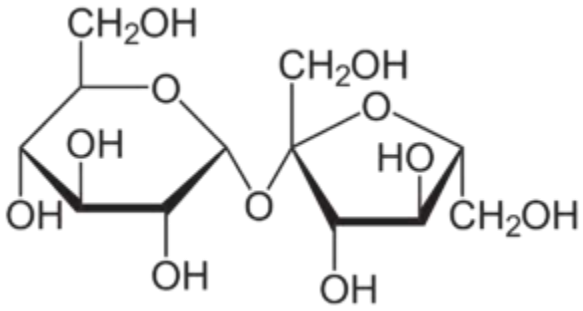
Disaccharides

Disaccharides are sugars (carbohydrate molecules) that form when two simple sugars i.e. monosaccharides combine to form a disaccharide.

Cyclic monosaccharides react with alcohols to form acetals and ketals. Sometimes this alcohol is actually a carbohydrate since they function very similarly to alcohols. So when this happens individual monosaccharides link together to make an acetal. This linkage is known as *glycosidic linkage.*

This linkage is an oxide linkage formed by the loss of a water molecule. When two monosaccharides are linked together by glycosidic linkage the resulting product is a disaccharide. Now let us take a look at some common and important disaccharides.

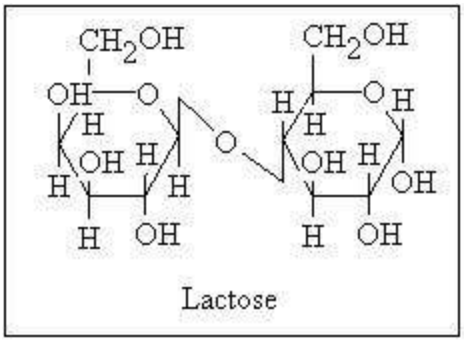
Sucrose



This is the most important disaccharide. It is popularly known as *table sugar*. Sucrose is found in all photosynthetic plants. It is commercially obtained from sugarcane and sugar beets via an industrial process. Let us take a look at some chemical properties of sucrose

- The molecular formula of sucrose is **$C_{12}H_{22}O_{11}$.**
- If sucrose goes through acid catalysed hydrolysis it will give one mole of D-Glucose and one mole of D-Fructose.
- The chemical structure of sucrose comprises of α form of glucose and β form of fructose
- The glycosidic linkage is α linkage because the molecule formation is in α orientation
- Sucrose is a non-reducing sugar. As you can see from the structure it is combined (linked) at the hemiacetal oxygen and does not have a free hemiacetal hydroxide
- Since has no free hemiacetal hydroxide it does not show mutarotation (α to β conversion). Sucrose also does not form osazones for the same reason.
- We can prove the structural formula of sucrose by hydrolysing it with α-glycosidase enzymes which only hydrolyses α glucose. This test is positive for sucrose.

Lactose



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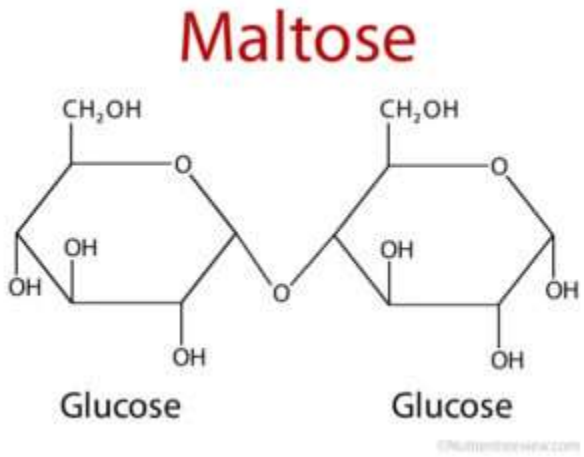
This is a disaccharide you may already be familiar with. Lactose is the primary ingredient found in the milk of all mammals. Unlike the majority of saccharides, lactose is not sweet to taste. Lactose consists of one galactose carbohydrate and one glucose carbohydrate. These are bound together by a 1-4 glycosidic bond in a beta orientation.

If you look at the structure of lactose you will see that there is one significant difference between galactose and glucose. Galactose's fourth carbon has a different orientation in galactose than in sucrose. If it was not so the resulting molecule would have just been sucrose (glucose+glucose) instead of lactose.

Also from the structure, we can notice that lactose is a reacting sugar since it has one free hemiacetal hydroxide. So when we react Lactose with bromine water it will give monocarboxylic acid.

Maltose



Maltose is another disaccharide commonly found. It has two monosaccharide glucose molecules bound together, The link is between the first carbon atom of glucose and the fourth carbon of

another glucose molecule. This, as you know, is the one-four glycosidic linkage. Let us look at a few of its properties

- On acid catalysed hydrolysis one mole of maltose gives two moles of D-glucose.
- Maltose has a free hemiacetal hydroxide, hence it undergoes mutarotation. It exists as both α-Maltose and also β-Maltose
- For the same reasons it also gives a positive test with Benedicts and Tollens reagent.

b. Explain effect of substrate concentration on enzyme activity

Enzyme Concentration

In order to study the effect of increasing the enzyme concentration upon the reaction rate, the substrate must be present in an excess amount; i.e., the reaction must be independent of the substrate concentration. Any change in the amount of product formed over a specified period of time will be dependent upon the level of enzyme present. Graphically this can be represented as:

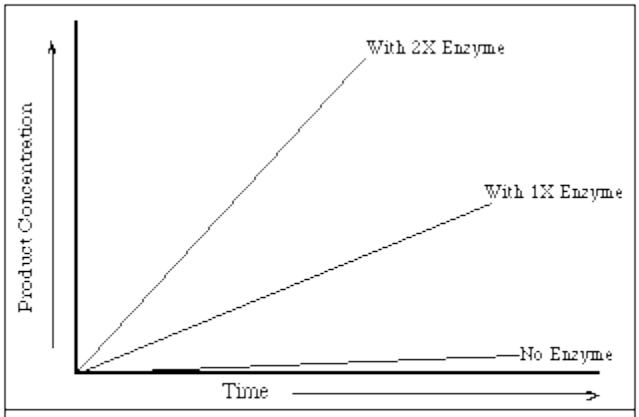


FIGURE 4
"Zero order" reaction rate is independent of substrate concentration.

These reactions are said to be "zero order" because the rates are independent of substrate concentration, and are equal to some constant k. The formation of product proceeds at a rate which is linear with time. The addition of more substrate does not serve to increase the rate. In zero order kinetics, allowing the assay to run for double time results in double the amount of product.

Table I: Reaction Orders with Respect to Substrate Concentration

Order	Rate Equation	Comments
zero	rate = k	rate is independent of substrate concentration

Table I: Reaction Orders with Respect to Substrate Concentration

Order	Rate Equation	Comments
first	rate = k[S]	rate is proportional to the first power of substrate concentration
second	rate = k[S][S]=k[S]^2	rate is proportional to the square of the substrate concentration
second	rate = k[S_1][S_2]	rate is proportional to the first power of each of two reactants

The amount of enzyme present in a reaction is measured by the activity it catalyzes. The relationship between activity and concentration is affected by many factors such as temperature, pH, etc. An enzyme assay must be designed so that the observed activity is proportional to the amount of enzyme present in order that the enzyme concentration is the only limiting factor. It is satisfied only when the reaction is zero order.

In Figure 5, activity is directly proportional to concentration in the area AB, but not in BC. Enzyme activity is generally greatest when substrate concentration is unlimiting.

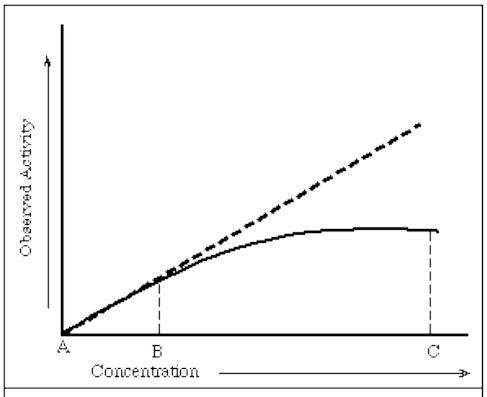


FIGURE 5
Activity vs. Concentration

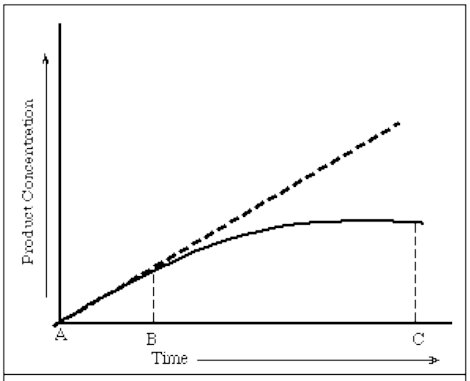


FIGURE 6
Reaction rate limited by substrate concentration

When the concentration of the product of an enzymatic reaction is plotted against time, a similar curve results, Figure 6.

Between A and B, the curve represents a zero order reaction; that is, one in which the rate is constant with time. As substrate is used up, the enzyme's active sites are no longer saturated, substrate concentration becomes rate limiting, and the reaction becomes first order between B and C.

To measure enzyme activity ideally, the measurements must be made in that portion of the curve where the reaction is zero order. A reaction is most likely to be zero order initially since substrate concentration is then highest. To be certain that a reaction is zero order, multiple measurements of product (or substrate) concentration must be made.

Figure 7 illustrates three types of reactions which might be encountered in enzyme assays and shows the problems which might be enountered if only single measurements are made.

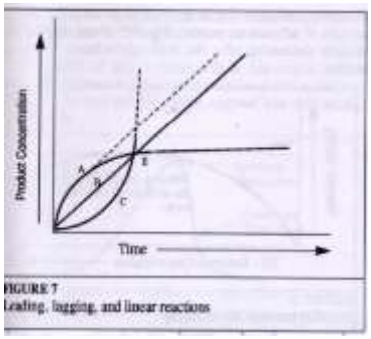


FIGURE 7
Leading, lagging, and linear reactions

B is a straight line representing a zero order reaction which permits accurate determination of enzyme activity for part or all of the reaction time. A represents the type of reaction that was shown in Figure 6. This reaction is zero order initially and then slows, presumably due to substrate exhaustion or product inhibition. This type of reaction is sometimes referred to as a "leading" reaction. True "potential" activity is represented by the dotted line. Curve C represents a reaction with an initial "lag" phase. Again the dotted line represents the potentially measurable activity. Multiple determinations of product concentration enable each curve to be plotted and true activity determined. A single end point determination at E would lead to the false conclusion that all three samples had identical enzyme concentration.

c. Explain cascade system for enzyme regulation

d. Discuss biochemical role of Ascorbic acid

d) Ascorbic acid (Biochemical role)

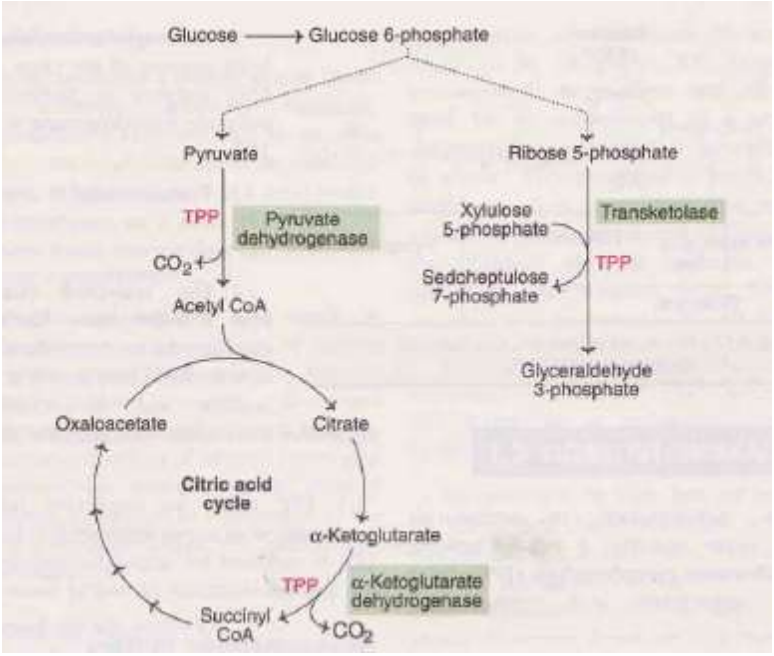
1. Collagen formation
2. Bone formation
3. lron and hemoglobin metabolism
4. Tryptophan metabolism
5. Tyrosine metabolism
6. Peptide hormone synthesis

Q.6 a. Write a note on Vitamin-B1 or Vitamin–B3

a) Vit B_1

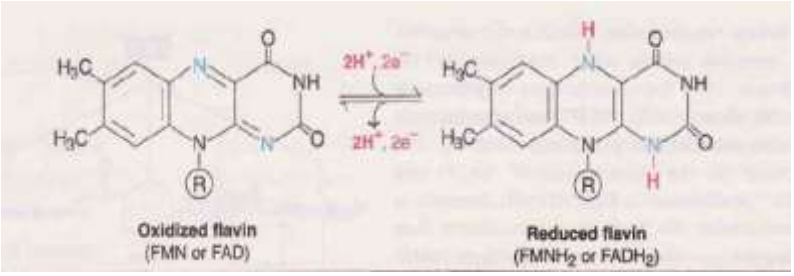
Thiamine contains a pyrimidine ring and a thiazole ring held by a methylene bridge . Thiamine is the only natural
compound with thiazole ring. The alcohol (OH) group of thiamine is esterfied with phosphate (2 moles) to form the
coenzyme, thiamine pyrophosphate.

1. The enzyme pyruvate dehydrogenase catalyses (oxidative decarboxylation) the irreversible conversion of pyruvate to acetyl CoA.
2. Transketolaseis dependent on TPP. The branched chain a-keto acid dehydrogenas catalyse oxidative decarboxylation of valine, Leucine.



Vit B_2

Riboflavin is stable to heat but sensitive to light. When exposed to ultra-violet rays of sunlight, it is converted to lumiflavin which exhibits yellow fluorescence. The substances namely lactoflavin (from milk), hepatoflavin (from liver) and ovoflavin (from eggs) which were originally thought to be different are structurally identical to riboflavin. Flavin mononucleotide (FMN) and flavin adenine dinucleotide (FAD) are the two coenzyme forms of riboflavin.



b. Explain Post-translational Modification

it is chemical modification of protein after translation

- Phosphorylation- Ser, Thr, Tyr -Control protein activty and structure, as well as protein-protein and protein/nucleic acid interactions -Kinases phosphorylate, phosphatases dephosphorylate -Kinases are major drug targets.
- Glycosylation -Ser, Thr, Asn -regulated by glycosyl transferases -Control protein structure, stability, and trafficking. Regulate protein activity.
- Carboxylation -most common is carboxy-glutamate -Vitamin K, CO2, O2 dependent. ex. Prothrombrin.
- Hydroxylation -Pro, Lys -Proline hydroxylation is important in transcriptional control and protein structure. -Hydroxylation and subsequent cross linking of lysine residues in collagen cause conformational restriction and stabilize the coil-coil structure.
- Acetylation -N-terminus, Lysine side chains -Affects chromatin structure and gene expression

c. Write reaction catalysed and name of an inhibitor for the following enzymes

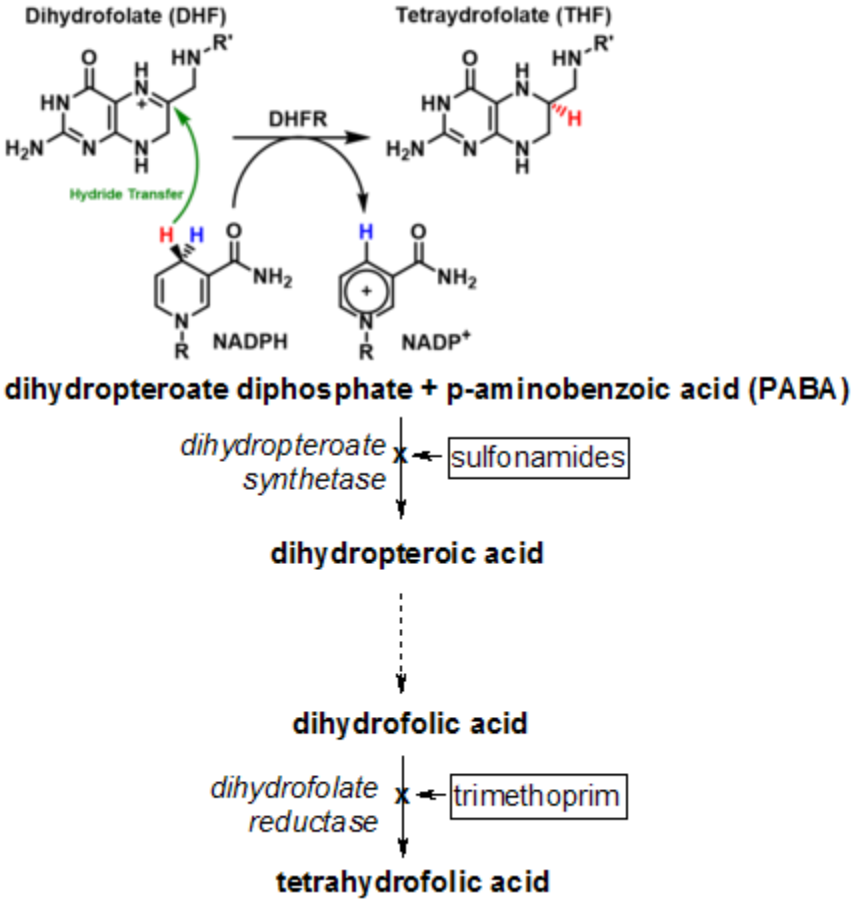
1) Monoamine oxidase

- MAO-A is also found in the liver, pulmonary vascular endothelium, gastrointestinal tract, and placenta.
- MAO-B is mostly found in blood platelets.

MAO-A appears at roughly 80% of adulthood levels at birth, increasing very slightly after the first 4 years of life, while MAO-B is almost non-detectable in the infant brain. Regional distribution of the monoamine oxidases is characterized by extremely high levels of both MAOs in the hypothalamus and hippocampal uncus, as well as a large amount of MAO-B with very little MAO-A in the striatum and globus pallidus. The cortex has relatively high levels of only MAO-A, with the exception of areas of the cingulate cortex, which contains a balance of both. Autopsied brains demonstrated the predicted increased concentration of MAO-A in regions dense in serotonergic neurotransmission, however MAO-B only correlated with norepinephrine.

- rasagiline (Azilect),
- selegiline (Eldepryl, Zelapar),
- isocarboxazid (Marplan),
- phenelzine (Nardil), and.
- tranylcypromine (Parnate).

2) Dihydrofolate reductase



d. Draw structure of Arachidonic acid