CHAPTER-2

CARBOHYDRATES

INTRODUCTION

- Carbohydrates are Compounds containing carbon, hydrogen and oxygen.
- They are commonly known as Saccharides meaning of Sugars.
- Carbohydrates are widely distributed in nature in Plants and animals.
- The important 'Carbohydrates found **in Plant is Starch**.
- The Carbohydrates found in **animals i.e., glycogen**.
- It is a Storage form of carbohydrates present in **Liver and muscles**.

DEFINATION

Carbohydrates are defined as polyhydroxy aldehydes or Ketones and their derivatives which yield one of these Substances on hydrolysis .

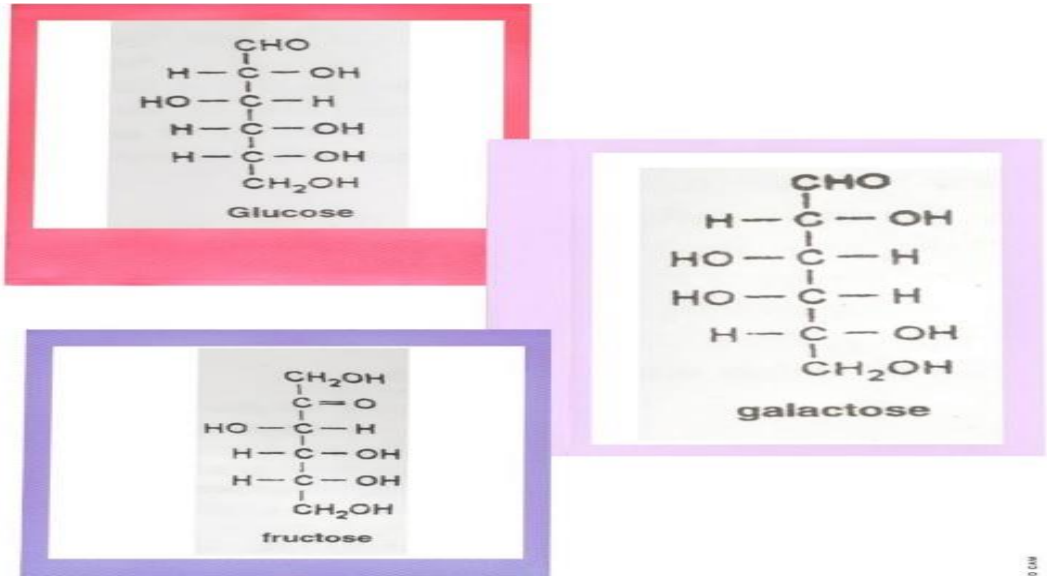
CHEMICAL COMPOSITION-

- The three elements present in Carbohydrates are Carbon ,hydrogen and oxygen.
- Carbohydrates have an empirical formula Cn(H2O)n.

BIOLOGICAL ROLE OF CARBOHYDRATES

- Carbohydrates are the Chief Source of energy.
- Certain Carbohydrates derivatives are used as drugs like cardiac glycosides and antibiotics.
- Lactose is the principal Sugar of milk.
- Carbohydrate provide raw materials for a number of Industries like textile, artificial Silk, Paper, fermentation,cinema films and explosives etc.
- They are essential to form Structural unit of Cell membrane.
- Carbohydrate provide more than half of the energy requirement of the body.
- 1gm of glucose on Oxidation in the biological System Provide 4 Calories of energy.
- Regulation of blood glucose.
- Carbohydrate Such as Sugars and Starch are important food reserve for Plant and food Stuff for man and animals.
- Carbohydrates form a part of DNA and RNA in the form of deoxyribose and ribose sugar.
- Carbohydrates are component of cell organelle like Cell membrane, mitochondria, nucleus, Endoplasmic reticulum etc.
- Carbohydrates are essential constituents of all living things.
- Carbohydrates are structural materials of plasnts.
- Polysaccharides serves for the storage of energy.

- They have role in blood clotting,immunity,fertilization.
- Carbohydrates are formed by green plants from carbon dioxide and water process of photosynthesis.



- They provide structural integrity,mechanical strength in combination with proteins and lipids.

CLASSIFICATION OF CARBOHYDRATES

SUGARS ____1)MONOSACCHARIDES _____1)GLUCOSE,2)FRUCTOSE 3)GALACTOSE

2)DISACCHARIDES ___ 1)MALTOSE 2)LACTOSE 3)SUCROSE

NONSUGARS _____ HOMOPOLYSACCHARIDES – 1)STARCH 2)GLYCOGEN

1)**MONOSACCHARIDE**

Defn- Carbohydrates which can not be hydrolysed to Simpler compound are called as **Monosaccharide.**

- Their general formula is Cn(H2O)n or CnH_{2n} On .
- It is colourless,crystalline compound readily soluble in water,sweet in taste.
- It contain only one molecule of Sugar, So it is called **simple sugars.**
- Glucose general formula **$C_6H_{12}O_6$**

Sources –

- Glucose is found in several **fruit juices, blood of human and Honey.**
- Galactose is a **Part of Lactose**.
- Fructose is found in **several fruits and honey**.
- Commonly used glucose is as dextrose.

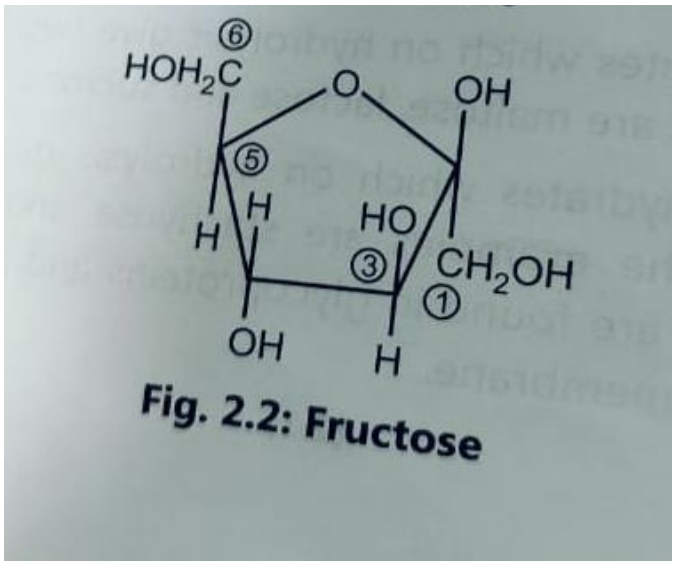
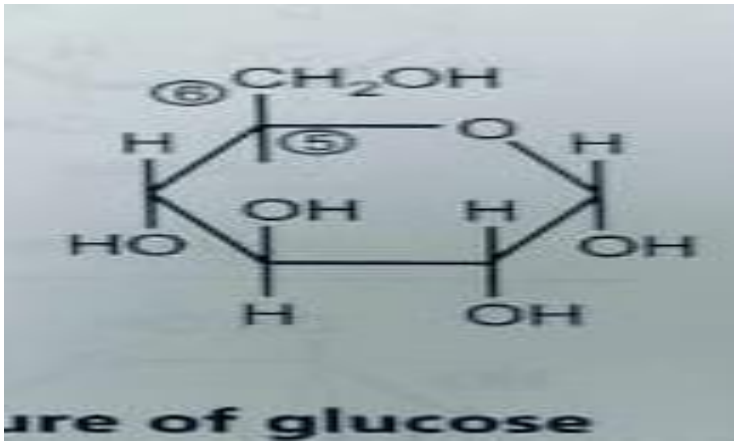
- 

Fig. 2.2: Fructose

- 

ure of glucose

CHEMICALPROPERTIES

1.**HEAT TEST**

When heated dry or with strong sulphuric acid undergo dehydration and charing with a characteristic burning sugar smell (**caramelisation)**

2.ActionwithStrongacid-

When a Carbohydrates is treated with mineral acids, it loses water and forms furfural that may Condense with Phenolic compounds like a-naphthol, thymol to give a Coloured Complex.

3.Molisch'sTest –

Conc H2SO4 is gently Poured along the side of a tube to mixture of Sugar Solution of Molisch's reagent. A red violet ring is produced at the junction of the two layers, indicating the Presence of a Carbohydrate.

***4.Sweliwonff's*Test**

Ketoses gives Cherry Red colour on boiling for half a minute with Seliwanoff's reagent (Resorcinol in HCL Solution) .

5.Actions *with* Alkalies

-On treatment with dilute aqueous alkalies monosaccharides are Changed to “enol” forms called **enediols formation**

-Strong alkalies decomposed the sugars by causing Cleavage of the enediols at the double bond.

6.Oxidation –

The oxidation products of aldoses vary with the nature of the oxidizing agent.
Mild oxidising agents like bromine water the glucose oxidized _CHO TO _COOH to form sugars acids.

7.Reduction

Mono Saccharides can be reduced on the treatment with sodium amalgam or hydrogen under high pressure(in the presence of a catalyst),In the process of reduction,the aldehyde orketone group is converted to an alcohol group.

8.Formation of glycosides

Glycosides are formed when a sugar is heated with an alcohol in presence of HCL as a catalyst.
The non sugars portion is called as aglycone.
If the sugar is present,the compound is called Glucoside.

9.OSAZONE FORMATION

A sugar solution,when heated with phenylhydrazine hydrochloride and sodium acetate in a boiling water bath yields osazone.

(2)DISACCHARIDES

- They yield two molecules of monosaccharides on hydrolysis. They have the general formula **Cn(H2O)n-1**
- $C_6H_{12}O_6+C_6H_{12}O_6 = C_{12}H_{22}O_{11} +H_2O$
  GlycosideBond
- They are formed by linkage between first carbons of one monosaccharides with the second or fourth carbon of another monosaccharide known as **Glycosidic linkage** .
  E.g.**- Sucrose, Maltose, Lactose**
- If the Linkage involves the aldehyde or Ketone group of Only one of the monosaccharide Permits reduction. The resulting Compound is a reducing sugar e.g. Lactose and Maltose.
- They can form osazones.

Maltose =Glucose+ Glucose (Aldehyde group)

Lactose =Glucose + Galactose (Aldehyde group)

- If the linkage occurs between the reducing agent group (aldehyde ore Ketone group) of both the monosaccharides the reducing Properties is lost.
- The resulting compound **is non-reducing Sugar.**

E.g. **Sucrose**

Sucrose = Glucose + Fructose (Ketone group) They don’tform osazones .

Glucose exists two isomeric”pyranoses”(α andβ)

MALTOSE:-

- It Contain 2 molecule of glucose joined by α-1,β-4 glycoside Bond.

→So the aldehyde group of the second glucose molecule is free and available for reduction.

→ So maltose is a reducing Sugar.

→ It Can form osazone with Phenyl hydrazine.

→It is composed of two glucose units.

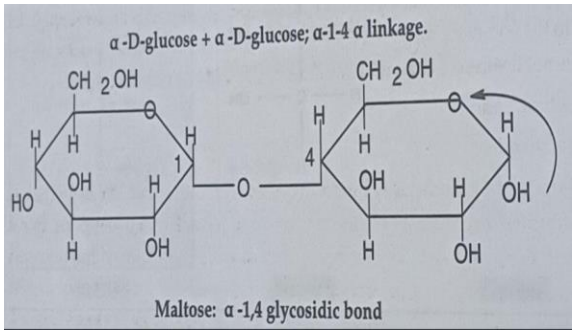
→It is commonly called **Malt Sugar.**

→ It is intermediate Compound in Starch digestion.

→Germinating Cereals and Malt (drying the barley)are the Source of maltose but maltose is not found in nature.

- Maltose reduces the Tollen’s reagent and Fehling’s solution .
- Now malt is used in manufacture of beer and malt whisky .

Structure



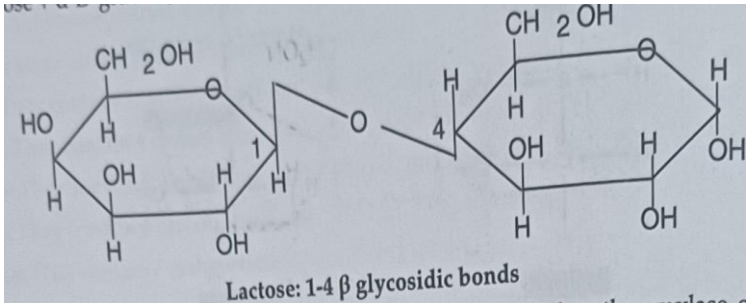
LACTOSE-

- It is present in **milk.**

→ It is commonly called **Milk Sugar.**
→ It contains one Molecule of Glucose and one molecules of galactose.
→The Linkage occurs between α-1glucose andβ-4galactose.
→The aldehyde group of galactose is free and it is available for reduction, So Lactose is reducing Sugar. It can form osazone.

- Lactose is dextrorotary in nature,it is less soluble in water and much less sweet than sucrose.

- Lactose reduces the Tollen's reagent and Fehling's solution .
- So,lactose is reducing sugar.It can form osazone.



Structure –

SUCROSE-

→It is Commonly called **as table Sugar,** also it is as **Cane Sugar.**

→ It is obtained from Sugarcane (30% sucrose), Pineapple, Carrot, beat ,banana, coffee,sugar beat(15-20%) and several roots of ripe fruit.

- Sucrose is present in nectar of flowers.

→It containsα-1glucose and β-2Fructose joined by glyosidic linkage.

→ so the two reducing group are not available for reduction.

→So Sucrose is non-reducing Sugar, it does not formosazone

→ Before hydrolysis **Sucrose is, dextrorotatory**.

On hydrolysis Sucrose gives one moleculeof glucose and one molecule of fructose.

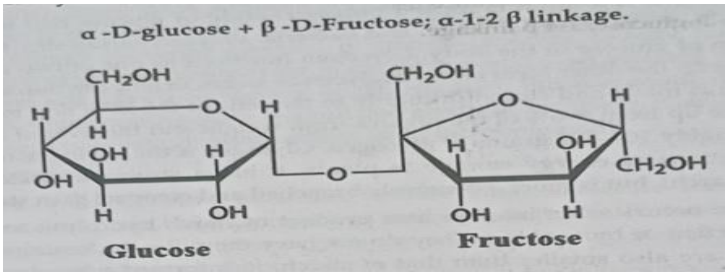
→**Fructose, is Stronglylaevorotatory** but **glucose which is dextrorotary**.

→Laevorotation induced by the presence of fructose is Called inversion.

→The Product of hydrolysis which contain both glucose and fructose is called **invert Sugar.**

- **Sucrose** after the extraction of juice,the left residue which is **known as bagasse** is used as a fuel in paper industry**.**

Structure-



(3)POLYSACCHARIDES

Carbohydrates that give many monosaccharides on hydrolysis are called Polysaccharides.

Properties-

→They are high Molecular Weight Sparingly Soluble in Cold water.

→ They are not Sweetish

→The general formula is (C6H10O5) n

CLASSIFICATION

A. Homopolysaccharides.
- Starch-Heparin
- Glycogen.

B.Heteropolysaccharide/Mucopolysaccharid

-Hyaluronic acid

-Chondrition Sulphate

(a)Homopolysaccharides

- Poly Saccharides which on hydrolysis give Only one type of monosaccharides are called “Homo poly Saccharides.
- They have a high molecular weight.
- Many of them occurs in plants or animals as a reserve food material(starch or glycogen)

1.STARCH-

Starch is Homopolysaccharides of D-glucose. It is widely distributed throughout the vegetable Kingdom one Complete hydrolysis Starch yield glucose.Starch is a major polysaccharide in our food.It is called storage polysaccharide.Starch used in the manufacture of paper,textile,pharmaceuticals.It reserve food material in plants tuber like potato and vegetables.It is present in food grains like rice,wheat.When starch to dry heat,dextrin is formed.

SEQUENCE-Starch _dextrin___Maltose ___ Glucose

Source– Grain, fruits, roots, vegetable,stem,seeds,roots,leaves.

The major constituent of Starch is Amylase, Amylopectin

Amylose

→ Amylose is a straight chain polymer.

→It is contains glucose units linked by α-1,β-4 glycosidic linkage

→ It is water soluble.

-Most of Starch contains 20-30% Amylose.

Amylose has helical coiled secondary structure.

Source:- simple starch (Potato) may have a molecule weight Amylose Produce blue colour with Iodine solution.

AMYLOPECTIN-

→ Amylopectin also is a branched Chain Polymer

→Amylopectin of Starch (rice) may have molecular weight 5 lakh

→Most of Starches contains 70-80% Amylopectin.

→ Amylopectin gives reddish violet Colour with Iodine solution.

- ❖ Amylopectin has a random coil structure .

N.B

Amylose and Amylopectin gives colour reaction with Iodine .During digestion Starch is hydrolysed to glucose by salivary gland and Pancreatic amylase etc. and finally absorbed in blood.

(2) GLYCOGEN (ANIMALSTARCH) –

→ It is known as animal Starch because, it is a storage form of Carbohydrates in animal.

→It Occurs an animal tissue, especially in Liver ,muscle.

→It is highly branched.

→The molecular weight is 500,00,00 (5 core).

-It is water soluble.

-It is also present in yeast and Fungi ,bactria which don't have chlorophyll system bu not in green Plants.

- It is found in insect wings.

Structure of glycogen is similar to that of amylopectin of starch.

Glycogen synthesis and breakdown are controlled by substances called Hormones.

COMPOSITION-

It contains N-acetyl glucosamine molecule linked B1,4Glycosidic Linkage.

QUANTITATIVETESTFORMONOSACCHARIDES

(1) MOLISCH'S TEST-

1 ml of the aqueous Suspension of the Sugar is taken in a test tube To this 2 drops of an alcoholic Solution of alpha napthol is added and Shaken well. Then 2ml of Conc. H_2SO_4 is added carefully by the sides of the test tube. A reddish Violet ring at the junction of the two Layers indicates the presence of Carbohydrates.

(2) FEHLINGS TEST

1ml of the test Solution and 2ml of fehling's Solution and boiled in a test tube for 2 minutes. A brick Red Precipitate indicates the presence of reducing sugar.

(3) BENEDICT'S TEST

1 mi of an aqueous solution of the test Substance and 2ml of Benedict's reagent are boiled in a test tube for 2 min. A brick red precipitate indicates the presence of reducing Sugar

(4) TOLLEN'S TEST

About 0.1 gram of the test Substances is taken in a test- tube To this 2 ml of tollen's, reagent. (ammoniacal Silver nitrate) is added and heated gently. Formation of Silver Mirror indicates the Presence of reducing Sugar

(5) BARFOED'S TEST

10 ml of the test Solution is taken in a test tube. To this 1 mi of Barfoed's Reagent (copper acetate and acetic acid is added). The contents are heated in a water bath for 5 minute. A brick red Precipitate indicates the Presence of Monosaccharides,

(6) SELIWANOFF'S TEST

1 mi of an aqueous solution of the test substances is taken in a test tube To this is added 2ml of Seliwanoffs reagent (which contains resorcinol and Hcl). A Cherry red Colour is formed on

boiling .It indicates the presence of fructose It is a specific test ketoses.It is used as a confirmatory test for fructose .

(7) IODINE TEST

2 mi of test Solution is treated with 1ml of iodine Solution. A blue Precipitate indicates the presence of Starch. Iodine reacts with Starch and to form a Coloured Complex.

IODINETESTFORPOLYSACCHARIDES-

TypesofPolysaccharideColourwith iodine

(1) Starch.	Blue
2)Glycogen	Pink
(2) Amylase.	Deep blue
(3) Amylopectin.	Purple

Osazoneformatioon

To 2mi of the sugar Solution phenyl hydrazine hydrochloride and Sodium acetate are added and heated in a boiling water bath fore 30 minutes and cooled. The osazone forme from different reducing sugars.

(8) MUCIC ACID TEST-

→This test is used fore identification of galactose and Lactose.

-Galactose or lactose + addition with conc. Nitric acid galactosaccharide acid (Mucic acid).

→Mucic acid is insoluble and get crystalled.

→The Crystals are Colourless and broken glass type

(9)ANTHRONE TEST

Add 0.5 -1 ml of the test solution to about 2ml of anthrone reagent of (0.2%. In cone H_2SO_4) and mix thoroughly. Observe whether the colour changes to bluish green .If not exmine the tubes again,keeping them in a boiling waterbath for 10 min.It identify the general test for carbohydrates.It indicates polysaccharide containing glucose .

10)PICRIC ACID TEST –Add 1ml of saturated picric acid to 1ml of sample solution followed by 0.5 ml 10%(sodium carbonate)Na_2Co_3 .Heat the test tube in a boiling water bath.Apperance of red colour would indicates the presense of reducing sugar. .

Disease related to carbohydrate metabolism

1.GLUCOSURIA-When the blood gets saturated with glucose, the same passes to urine which is known as glucosuria due to lack of insulin.

2. FRUCTOSE INTOLERANCE-

One of the normal hexose sugar of fruits(fructose) gets normally metabolized to give energy co2 but defective metabolism of fructose develop in high conc. of this sugar is blood, the disorder known as fructose intolerance.

3. **HYPOGLYCEMIA**

It is a decrease in blood sugar level below the normal.

Blood glucose conc. falls to less than 60 mg%

SYMPTOMS

- Feeling of hunger and headache
- Lack of concentration.
- Tremors
- Sweating
- Convulsions
- Coma

CAUSES-

- Increased production of insulin due to tumours in pancreas.
- Decreased synthesis of diabetogenic hormones.
- Liver damage caused by liver poisons.
- Increased activity of pancreas in newborn children born to diabetic mothers.

NB-Hypoglycemia can be treated by giving sufficient glucose to restore its normal level in blood.

4.GLYCOSURIA-

In this condition when glucose is excreted in urine.

Glucose is normally present in the glomerular filtration in the same conc. as in blood plasma.

All this is reabsorbed in the renal tubes.

So in a normal individual glucose does not appear in urine.

When the blood level of glucose is increased, the glomerular filtrate contains excess of glucose.

This excess glucose is not reabsorbed.

So it is passed in urine to produce glycosuria.

It is classified as a) Hyperglycemia glycosuria

b) Alimentary glycosuria

c) Renal glycosuria

a)HYPERGLYCEMIA GLYCOSURIA

There is an increase in blood glucose level due to

1) Decrease insulin secretion

2) Increased activity of anterior pituitary,thyroid hormone

So excessive glucose is eliminated in urine

DIABETES MELLITUS(HYPERGLYCEMIA)

DEFINITION-Insulin is a protein hormone necessary for carbohydrate metabolism but absent of insulin or the quantity of insulin is not sufficient then there is faulty or wrong carbohydrate metabolism .This leads to increasedin blood sugar level. This condition is called as **diabetes mellitus**

CAUSES OF DIABETES MELLITUS

*Increase absorption of glucose from intestine.
*Decreased entry and oxidation of glucose in muscles and other tissues.
*Decreased glycogen formation in the liver.
*Increased glycogen breakdown in the liver.
***Host factor** a)Age b)Genetic factor c)Obsity
***Environmental factor** i)Life style and lack of exercise

ii)Malnutrition

iii)Viral infection like rubella and mumps.
***Chemical factor**

i) High intake of cyanide producing foods may destroy β cells of pancreas.

ii) Stress and surgery

iii)Alcohol Abuse

***Social factor**

a)Occupation b)Martial status c)Education d)Economic status

TYPES OF DIABETES

1.PRIMARY DIABETES

a)Insulin dependent diabetes mellitus(Type-1)

b)Non-Insulin dependent diabetes mellitus(Type-II)

2)SECONDARY DIABETES

3) GESTITIONAL DIABETES

4) PREDIABETES

1.Primary diabetes

1)Insulin dependent diabetes mellitus(Type-1)

SIGN AND SYMPTOMS

Polyphagia-Increased appetite,Poly dypsia-Increased thirst,Polyuria-Increased urine output, Loss of weight, General weakness and fatigue, pain in the legs, lack of concentration, delayed wound healing.

Type-1

causes

It is usually seen in young individual less than 40 years of age.

In this type the pancreas produces very little or no –insulin

So administration of insulin is required

So it is called insulin dependent diabetes mellitus (IDDM).

10% of all cases

b)Non-Insulin dependent diabetes mellitus(Type-II)

sign and symptoms

1.Increase urination, increase thirst and appetite, Slow healing of wounds, Weight loss, Blurred vision,tiredness,fatigue,Weakness,Drowsiness.

TYPE-II

It occurs in middle aged and old people.

It can be controlled by adequate treatment.

In this type diabetes, the pancrease produce in adequate amount of insulin.

This type of diabetes can be controlled by dietary control alone and light exercise.

2)SECONDARY DIABETES

PANCRETIC DIABETES-It occurs due to impaired secretion of insulin.

INSULIN ANTAGONISTS-Diabetes may occur in condition when abnormal conc. of growth hormone likes adrenocortical hormones antagonists to the action of insulin in circulation causing diabetes.

3) GESTITIONAL DIABETE

Hyperglycaemia occurs temporarily during pregnancy**.**

4) PREDIABETES

Blood sugar level in border line may progress or not progress

POSSIBLE COMPLICATION OF DIABETES

Slow blood circulation inlegs,Parasthesia, Heart disease, Feeling of pins and needles, Kidney failure,Lossof sensation, Poor vision, impaired wound healing, nerve damage


s

PREVENTION AND TREATMENT OF DIABETES MELLITUS

*****Intake of a low carbohydrate and high protein diet.
*Diabetes cannot be cured but can be effectively controlled.
*The diabetic cause should be detected as early possible
*A diabetic should not marry to another diabetic otherwise their children will also be diabetic.
*The patient should try to avoid emotional and social stress and strain in life and can enjoy life, feel, hale and hearty.
*Oral anti-diabetic drugs for mild diabetes.
*Injection of insulin for severe causes of diabetes.
*Avoidance of risk factors like smoking, alcohol and oral contraceptives.

*Regular check up of urine sugar and blood sugar should be done.
*Obesity should be reduced by restricting the diet and going for normal physical exercise.
*Yoga and meditation is also beneficial.

b)ALIMENTARY GLYCOSURIA

It is a temporary condition when a high amount of carbohydrate is taken, it is rapidly absorbed in some cases where a part of the stomach is surgically removed.This Excessive glucose appears in urine.

c)RENAL GLYCOSURIA

In this condition, there is no increase in blood glucose level. Bsut there is a defect in the tubular mechanism of glucose reabsorption.So glucose is not reabsorbed in the renal tubules and it is excreted in urine.

QUESTIONS

1.Multiple Choice Questions

1) What is the general formula of carbohydrate?
    a) C_2 (H_2 O) c)CnH2n
    b) CnH2n+2. d)CnH2n-2
2) Name the non-reducing sugar.
    a) Maltose
    b) Mannose
    c) Sucrose
    d) Lactose
3) What is the colour of precipitate formed when non-reducing sugars react with Benedict's reagent?
        A) Silver mirror colour
    b) Blue colour
    c) Yellow-red colour
    d) Colourless
4) Which forms of sugars are classified on the basis of functional groups?
        A) Aldose and ketoseC) Reducing and non Reducing
    b) Both (a) and (b) d) None of the above
5) What is the chemical name of Tollen's reagent?
    a) Cuprous oxide solution
    b) Bromine water solution

C) Silver ammonia ion solution

D) Iodine solution

6) Which type of carbohydrates gives Molisch's Test?
    a) Monosaccharides,
    b) Polysaccharides

C)Disaccharides

d)All the above

7)IUPAC naming of sugar glucose is

a)1,3,4,5,6 pentahydroxyhexan-2-one

b)2,3,4,5,6-pentahydroxyhexanal

c) 1,3,5-trihydroxypentanal
d)None of the above

(8)What is meaning of inversion of sugar?

d) Hydrolysis of sucrose with specific rotation from dextrorotation to laevorotation.
e) Hydrolysis of sucrose with specific rotation from aldose to ketose.
f) Hydrolysis of sucrose with specific rotation from carboxylic to aldose.
g) Hydrolysis of sucrose with specific rotation from glucose to fructose.

(9)Name the precursor molecule to obtain fructose:

h) Starch
i) Inulin
j) Sucrose
k) Hydroxylamine

(10)Name the epimer of carbohydrates

l) Pyranose and furanose
m) A-D-glucose and ß-D-glucose
n) Glucose and fructose

D)Hemiacetal and hemiketonal

(11)Emil Fischer determining the configurations of glucose is

o) (-)-Glucose
p) (-)-Arabinose
q) (-)-Mannose. D)(+)-Glucose

ANSWER:

1.a

2.c

3.d

4.a

5.c

6.d

7.b

8.a

9.b

10.c

11.d

2. VeryShortAnswerTypeQuestions

Definethefollowing

(i)Mutarotation

(ii)Reducing sugar

(iii)In Non-reducing sugar

iv) Epimer

V) Anomers

2) Define:

(i)Disaccharides

(ii)Monosaccharides

(iii)Molisch test

(iv)Chemical nature of glycogen

v) Carbohydrates

3) Givethestructureof

(i)Glucose

(ii)Fructose

iii) Starch

iv) Galactose

4) Wire the name of disaccharides.

5) Draw the cyclic structure of sucrose and maltose.

6)Draw open chain structure of glucose and fructose.

7)Enlist the physical properties of glucose?

8)Give any two important characteristics of polysaccharides.

9)Draw the general formula of polysaccharides.

10)Which is the main sugar for energy purpose?

11)Name a milk sugar.

3.LongAnswerTypeQuestions

1) Write a detailed note on classification, chemical nature, and qualitative tests of carbohydrates.

2) Establish the open chain structure of D-(+)-glucose. Site the evidences leading to cyclic structure of D-(+)-glucose. Draw Haworth projection formulae of a- and B-D- (+)-glucose.

3) Give a descriptive note on any one of the following:

- i) Glucose
- ii) Disaccharides
- iii) Fructose
- iv) Mechanism of mutarotation
- v) Polysaccharides

4.What are carbohydrates?

5.What are oligosaccharides? Give example of Non-reducing disaccharides what their hydrolysis product

6..Discuss the role of carbohydrates.

7.Give the biological importance of carbohydrates.

8.Discuss the physical properties of carbohydrates.

9.Write physical properties of monosaccharides, disaccharides and polysaccharide and give their structure.

10.Give properties, structure and uses of lactose.

11.Give properties, structure and uses of sucrose.

B. **SHORTANSWERTYPEQUESTIONS**

1. What is the difference between glucose linkages in starch and cellulose?
2. What are two forms of starch?
3. What are the oligosaccharides ?
4. Name the three important disaccharides.
5. What is milk sugar?
6. Why cellulose is not digested by humans ?
7. What is optical activity?
8. Name a ketopentose and a ketohexose.
9. What is the most abundant organic substance in nature ?
10. Name the storage polysaccharide of liver and muscle.

CHAPTER -2

PROTEINS

INTRODUCTION:-

→The word protein is derived from the Greeks word ‘Protios’ which means “of first important.

→They are the Fundamental Structural and Functional components of human body.

→Highest percentage of protein are found in hair, bones and Other organs and tissues with a low water content.

DEFINITION:-

Proteins are Polymers of amino acids that are Linked by peptide bonds.

→proteins are high molecular weight polypeptide containing Alpha-amino acids Joined together by peptide linkage. (-CO-NH).

COMPOSITION:-

→ proteins molecular weight ranges from 6000 to many millions.

→They contain the elements carbon, hydrogen, oxygen, nitrogen and sometimes phosphorus and Sulphur.

→protein are made of amino acids.

→Carbon 50-55%, Nitrogen 13-19%, Hydrogen 6-7%, Sulphur 0-4%, Oxygen 19-24%.

BIOLOGICAL ROLE OF PROTEIN:-

→proteins are the essence of life process.

→Enzymes are made up of proteins.

→They are involved in blood clotting through thrombin, fibrinogen and other protein factor.

→They perform hereditary transmission by nucleoproteins of the cell nucleus.

→They act as the defence functions. They act against bacterial or viral infections eg. Immunoglobulin.

→proteins are involved in transport of substances in the Body.Eg Haemoglobin.

→Some of the hormones are proteins They control biochemical events. They control Sugar level.Eg Insulin.

→Proteins serves as nutrients. They involved in storage function Eg. Casein of milk is a nutrient

→proteins act as a buffer. E.g. plasma protein.

→Proteins can be catabolised to release energy .

→ Some proteins are Structural components of tissues' 2-keratin and epidermis.

→protein exert osmatic pressure which helps in maintaining electrolyte and water balance.

→Contractile proteins e.g. Activemyosin are necessary for muscle contraction.

→Plasma protein maintain blood volume.

●Classification of protein based on composition and solubility with examples:-

Proteins are classified into the Fallowing groups .

(1)Simple proteins

(2)Conjugated proteins.

(3)Derived Proteins.

These three groups are further classified into a number of subgroups as follows.

(1)SIMPLE PROTEINS:-

a.Albumin.

b.Globulin.

c.Glutelin.

d.prolamine

e.Scleroproteins.

f.Histones.

g.protamines.

(2) CONJUGATED PROTEINS:-

a.Nucleoproteins

b.phosphoproteins

c.Glycoproteins

d.Lipoproteins

e.Metallo protein

f.Chromo proteins

(3)DERIVED PROTEINS

(i)Primary derived proteins

a.Proteins

b.Metaprotein

C.Coagulated proteins

(ii) Secondary derived proteins

a.Proteases

b.Peptones

c.peptides

(1)SIMPLE PROTEINS

On hydrolysis they give only Alpha-amino acids.Eg- Insulin

(I)ALBUMIN:-

→They are soluble in water they coagulate on heating.

→It is a globular protein It is spherical or oval in Shape.

Eg egg albumin (egg white)

Serum albumin (blood plasma)

Lactalbumin (milk)

(ii) GLOBULIN:-

•They are insoluble in water and they coagulate on heating.

e.g. Serum globulin

ovoglobulin in egg yolk

Seed globuline.

(iii) GLUTELIN:-

They are plant protein.

→They are insoluble in water but soluble in dilute acid and alkalis.

→They can be coagulated by heat.

Glutelin absent in animal.

Eg:-Oryzenin from rice.

Glutelin from wheat

(iv)PROLAMINES:-

→It is a globular protein. They are plant protein.

→They contain a high concentration of amino acid proline. (So it is called prolamines).

→They are insoluble in water and alcohol.

Eg:- Horden from Barley,Zein from coon.

(V)SCLEROPROTEINS:-

→They are fibrous protein. They are insoluble in water and dil. Acid and alkalis.

→They have greaterstability. So they form supporting Structure of animals.

Eg:-keratin of hair and nails, horn Collagen of bone and skin.

(Vi) HISTONES:-

→They are basic proteins. They contain a high concentration of the amino acid histidine.

They are soluble in water and dilute acids or alkali. But not dilute ammonium hydroxide solutions.

→They are not coagulated by heat e.g. Nucleohistones, globin of haemoglobin.

(Vi)PROTAMINES:-

→They are simplest of proteins.

→They have smallest molecule.

→They contain 8 amino acids. It is reach in arginine but not contain cysteine, tyrosine and tryptophan.

→They are soluble in water and dilute acid and alkali's.

→They are not coagulated by heat.

Eg:- sperm ripe spermatozoa of fish.

Cells of certain fish.

(2)CONJUGATED PROTEINS/COMPOUND PROTEIN

On hydrolysis yield amino acid and non-protein group (prosthetic group).

(i) NUCLEOPROTEIN:-

→Water Soluble and basic in nature.

→Those proteins which combination with nucleic acld are called nucleoprotein.

→They contain nucleic acid as the prosthetic group.

Eg. Virus protein, ribosome, chromatin

(ii)PHOSPHOPROTEIN:-

→They contain phosphoric acid as the prosthetic group.

→The proteins which contain phosphoric acid as group are called as phosphoprotein. Prosthetic

Eg. Cassein of milk(milk protein) vitelline of egg (egg yolk protein)

(iii)GLYCOPROTEIN:-

→They contain carbohydrate as prosthetic group.

→The protein which contain carbohydrates (heteropolysaccharide mucopolysaccharide) (e.g.) Heparin natural anti-coagulant) as their prosthetic group is called Glycoprotein.

Eg:-Blood group Substance, mucin of Saliva, blood plasma, ovamucin, (egg white), asomucoid (from bone).

(iv)LIPOPROTEIN:-

•They contain lipids (like fatty acid phospholipids, cholestrol as prosthetic group.

The protein contain lipids.

Ex:-Lipoproteins of blood, cell Plasma. Egg yolk,

(V)METALLOPROTEIN:-

→They contain metal ions as prosthetic group.

Eg. Fe, Zn, Mg, cuco etc.

→Ferritin which contain irons, cytochromes, ceruloplasmin which contain copper.

Enzyme synthesized in the liver

. (ceruloplasmin carries more than 95% of the total copper in healthy human plasma).

(Vi)CHROMOPROTEINS:-

•They contain coloured substances (like porphyrine) as the prosthetic group.

e.g. Haemoglobin and Cytochrome, Flavoprotein.

•The protein which contain colour pigments (porphyrin).

(3)DERIVED PROTEINS

•Derived proteins are formed from simple and conjugated proteins by physical or chemical factors or enzyme action.Derived proteins are classified as:

1. Primary (or denatured) derived proteins: They are denatured products of proteins. They are formed by the action of heat, acid or alkalies on proteins. Denaturation occurs without hydrolytic cleavage of the proteins molecule.

Primary derived proteins include:

I) Proteans

ii) Metaproteins

iii) Coagulated proteins

i) Proteans: These are products of proteins formed by the action of water, dilute acids and enzymes.

Examples: fibrin from fibrinogen myosan from myosin

ii) Metaproteins: They are formed by the action of slightly

stronger acids and alkalies on proteins.It is a second stage product.

Ex:-acid and alkali albuminates ,acid meta protein, alkali meta protein.

iii) Coagulated proteins: They are insoluble products formed by the action of heat or alcohol on proteins.

Examples: cooked egg albumin

alcohol precipitated proteins

2. Secondary derived proteins: They are formed by hydrolytic cleavage of proteins at their peptide linkage.

Examples: proteoses, peptones and peptides.

-:AMINO ACIDS:-

→Amino acids are the simplest units (monomer) of proteins.

→About 300 amino acids are present in nature but only 20 are present in plant animal or microbial. So, it is called as Standard amino acid.

All amino acids contain at least one amino group and at least carbocyclic group in the molecule but bath the amino group and carbocylic group are attached to the same carbon atom.

→So, all amino acids of proteins are amino acids.

→proteins are built up from 20 different amino acids.

→The general formula of an amino acids is as follows

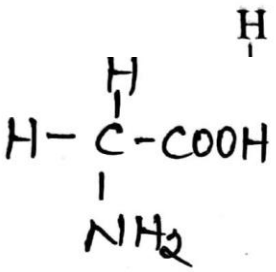
-:Classification of amino acids:-

Amino acids are classified in different ways. The following Classification based on the properties of side of chains is convenient.

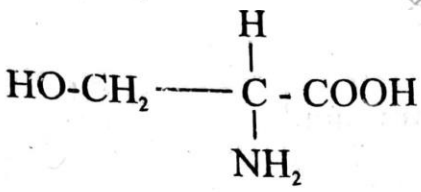
(1) NEUTRALAMINOACIDS

2. Alanine

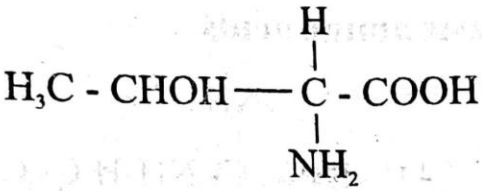
(1) Glycine



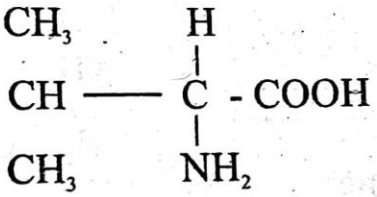
3. Serine



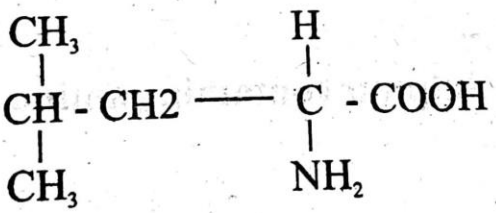
4. Threonine



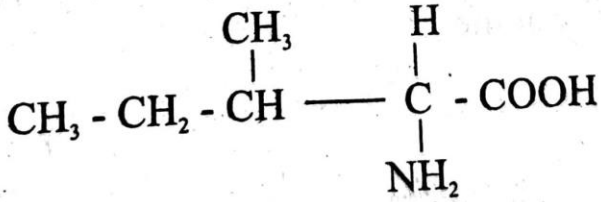
5. Valine



6. Leucine



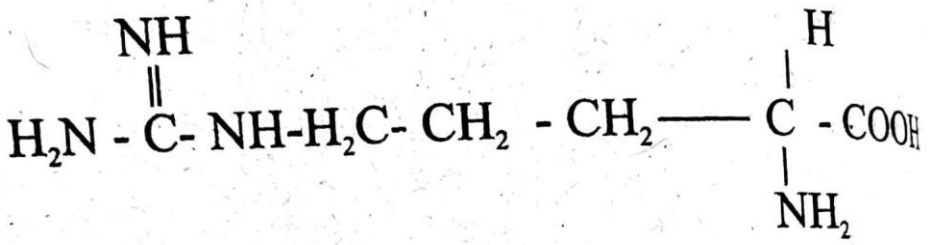
7. Isoleucine



(2)ACIDIC AMINO ACIDS

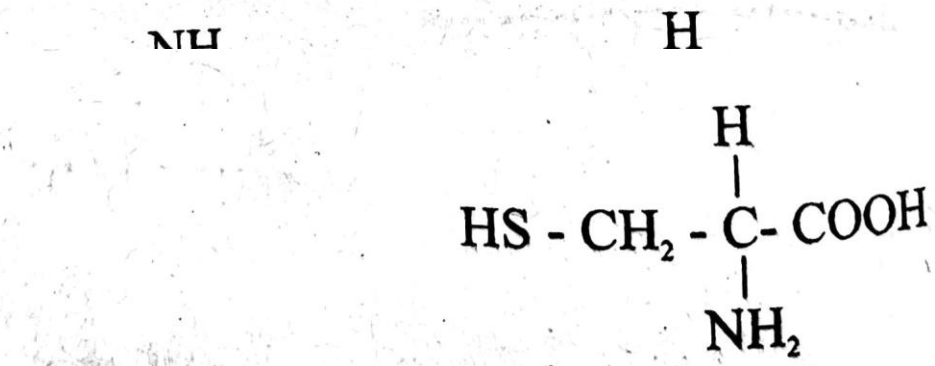
(3)BASIC AMINO ACIDS

1. Arginine

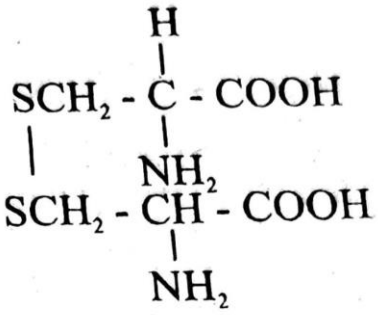


(4)SULPHUR CONTAINING AMINO ACIDS

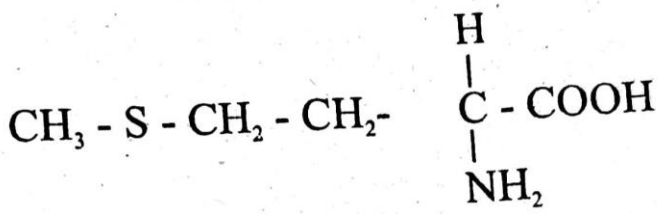
1. Cysteine



2. Cystine

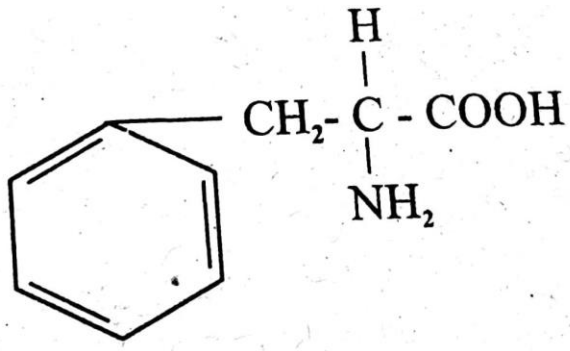


3. Methionine

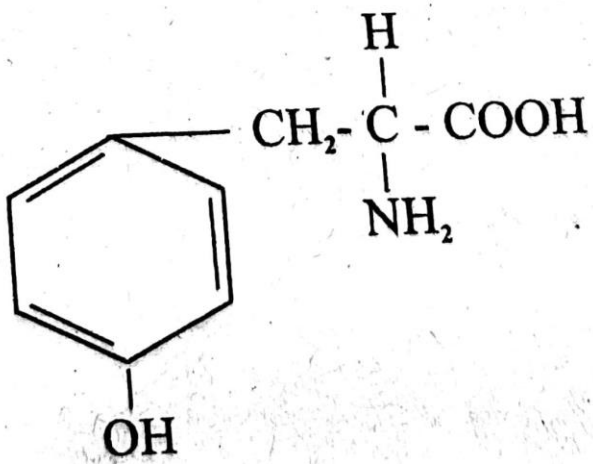


(5)AROMATIC AMINO ACIDS

1. Phenylalanine

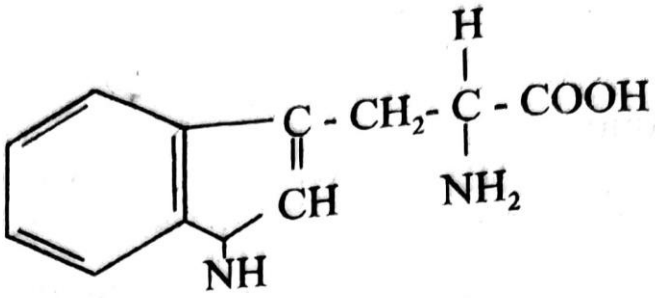


2. Tyrosine

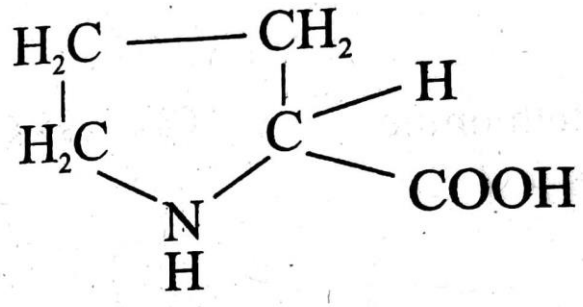


(6) HETERO CYCLIC AMINO ACID

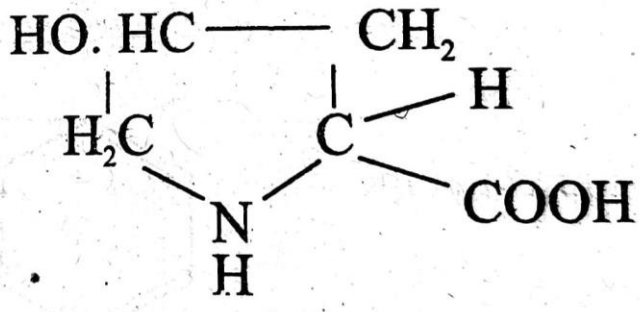
3. Tryptophan



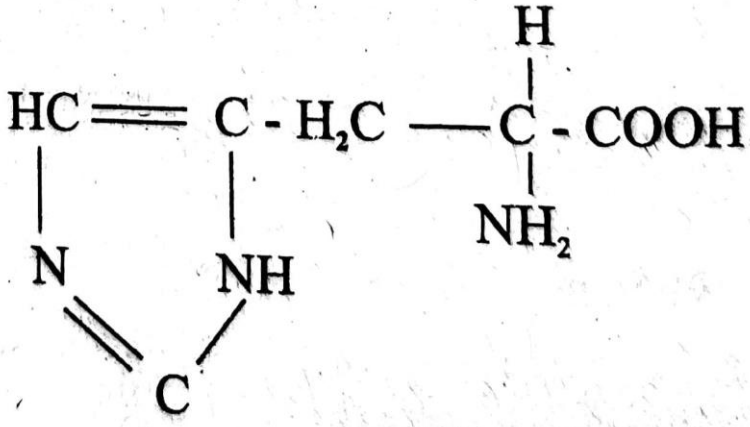
1. Proline



2. Hydroxyproline



3. Histidine



ESSENTIAL AMINO ACIDS

These are amino acids which are not Synthesized in the body. So they must be supplied in adequate amount through diet. The Following are the 8 essential amino acids.

(1) Tryptophan

(2) Phenyl alanine
(3) Lysine
(4) Theonine
(5) Valine
(6) Methionine
(7) Leucine
(8) Iso-Leucine

→All these 8 amino acids or Essential for normal growth and maintenance of nitrogen equilibrium.

→The nutritional value of a protein depends on the amount of essential amino acids present in it.

→Casein in milk contains all these essential amino acids. So it is a complete protein.

→So, it is on incomplete protein.

BIOLOGICAL ROLE OF AMINO ACIDS

→Some amino acids like glycine and alanine are converted to Carbohydrates in the body.

→Certain amino acids are necessary for detoxification of toxic Substances. E.g. Glycine and cysteine .

→Some amino acids are found in free form in human blood.

→peptides have many important biological rote functions. Some of them are hormone. Some of them are used as antibiotics and anti-tumour agents.

→Tryptophan is a neurotransmitter serotonin.

→ phenylalanine is a precursor of tyrosine in humans.

→Arginine is a precursor of nitric oxide.

STRUCTURE OF PROTEINS

The structure of proteins is very complex but well organized. The structure of proteins can be convenient considered under the following different levels of organization.

(1)PRIMARY STRUCTURE:-

Primary refers to the sequence of ameno acids which are linked through peptide bonds. The peptides bond occurs between the Carboxyl (COOH) group of one amino acid and amino group (NH2) Of another.

NH2-CH2-CONH-CH2-COOH

-Thus a number of amino acid can be linked by peptide bonds in a sequence as shown below,

Ala-Gly-His-Gly- Lev.

Any change in Sequence is abnormal and it may affect the functions properties of proteins.

The primary Structure becomes as

Primary structure

(2)SECONDARY STRUCTURE OF PROTEINS

→The special annangement of proteins by twisting of the peptide chain

→These are known as Helix formation.

→Proteins of high molecular weight do not form a continous chain but are coiled may ways.

→some protein chain are annanged parallel to each other giving Fibrous appearance

eg. Hair, skin, nail

→in other chain arranged in ball giving a geobular appearance

eg. Albumin,Globulin etc.

Secondary Structure of protein:----

Two types of secondary structure are possible.

(a)ALPHA HELICAL STRUCTURE

→A peptide chain forms regular coils called Alpha-helix

→The alpha -helix (ie the twisting) can be right handed on left handed.

→Left handed Alpha-helix is less stable than right handed helix

e.g :-Protein and keration of skin, hair and nail is rich in alpha helical structure.

→Each turn coil carries 3-6 amino acids residue and each amino acid residue is placed 0.15nm from the next.

→ The hydrogen bond is most important.

The coil are strengthened by hydrogen bond

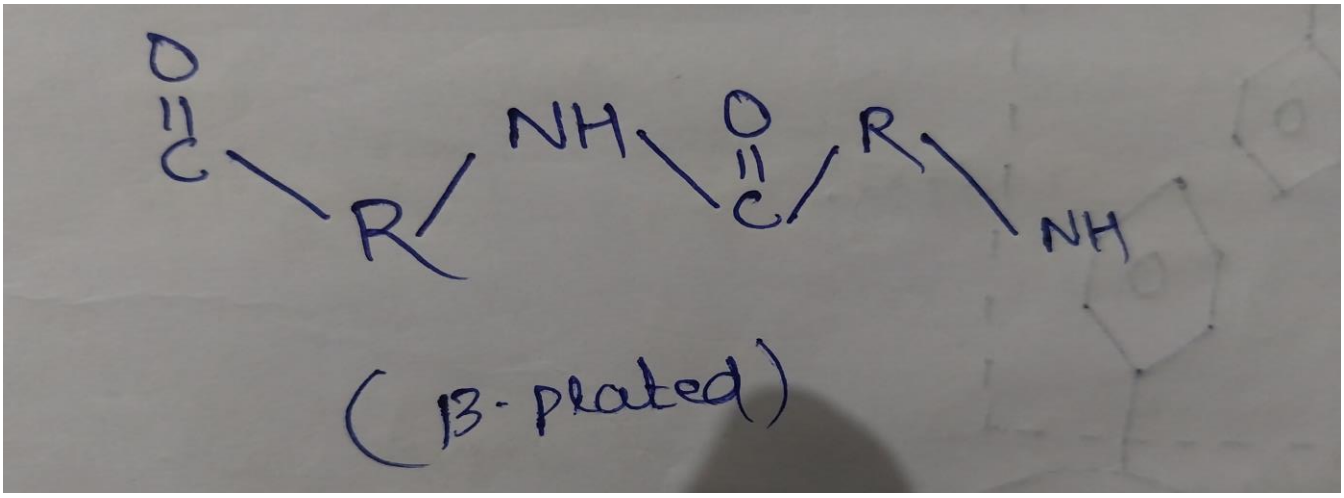
(b)BETA-PLATED STRUCTURE :-

in this structure a number of polypeptide chains occure side by by side

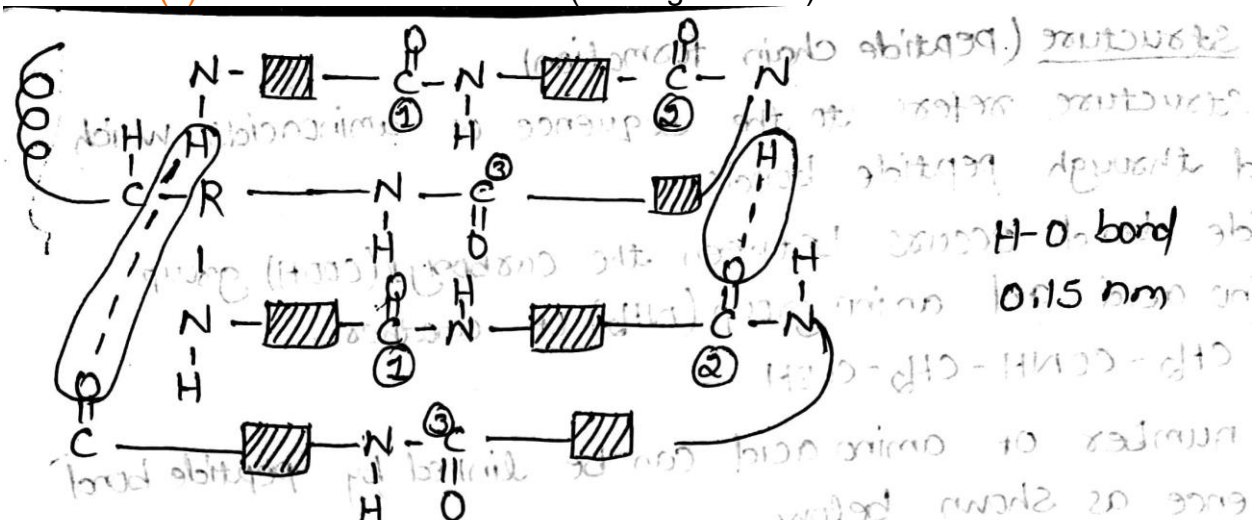
The plated structure may be parallel or anti-parallel.

The anti-parallel B-shaped is more stable due to the more well alighed hydrogen bonds.

e.g silk and synthetic fibre-nylon.



(3)TERTIARY STRUCTURE (Folding of chain)



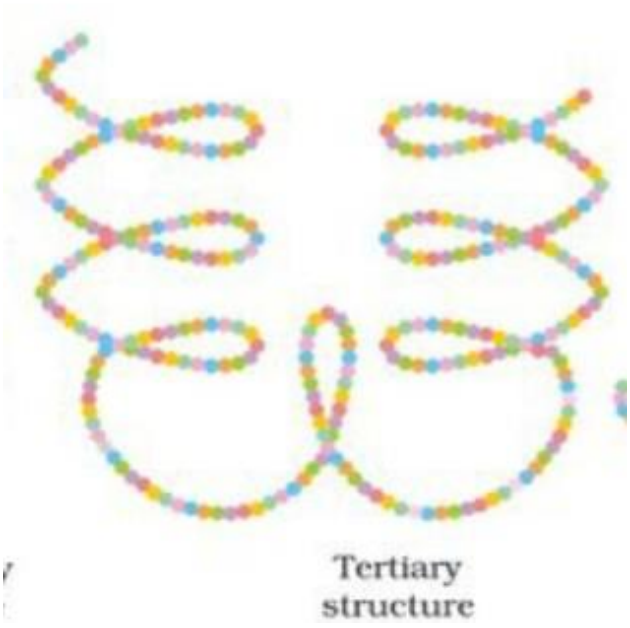
Tertiary structure refers to the folding of the protein chain to form a tight and compact three dimensional structure.

Or

Three dimensional folding of polypeptide chain is called as tertiary structure.

Ex:- Haemoglobin.

Protein in this confirmation is called native protein



The structure is further strengthened by the followerg forces:-

(1) Hydrophobic interactions

(2) Hydrogen bonds

(3) Ionic bonds

(4) Disulfide bonds.

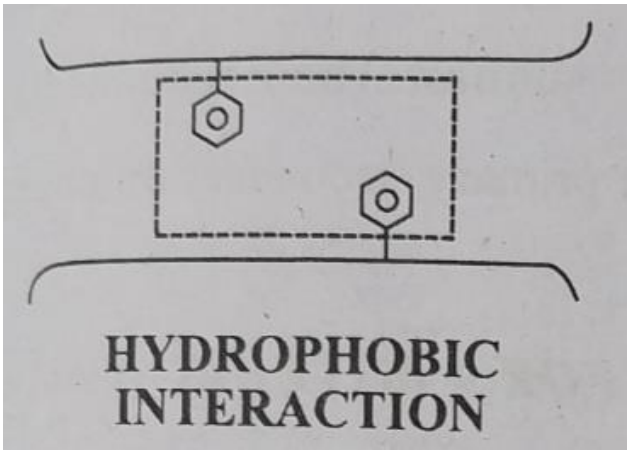
(1)HYDROPHOBIC INTERACTIONS:-

-They occure between non-polar side chain of amimo acids.

These are called as hydrophobic interactions.

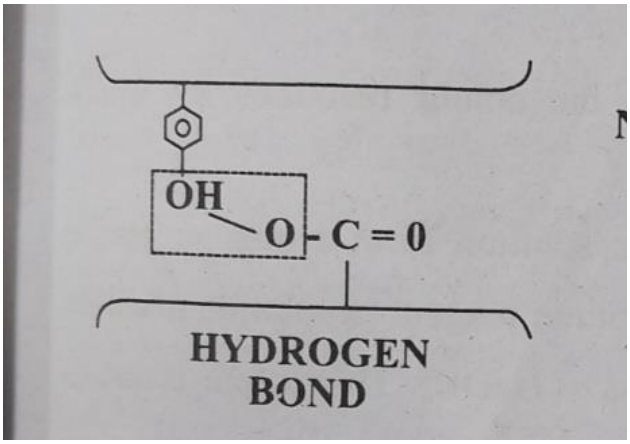
- Hydrophobic have the tentency to came togethere just like small droplets of oils.

-Floting water tenols to come together to forms a droplet this are no true bond.



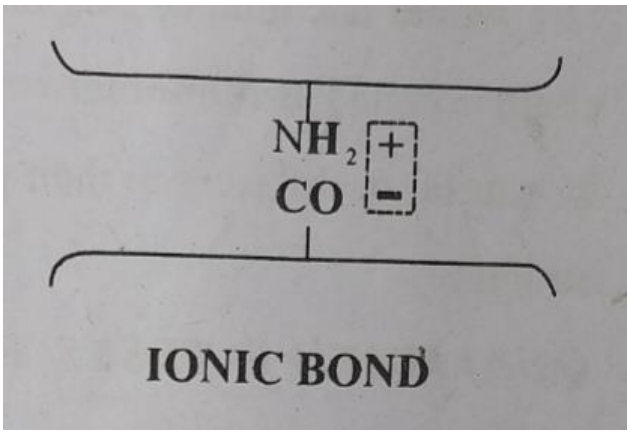
(2)HYDROGEN BONDS:-

They occur between polar Side chain of different amino acid.



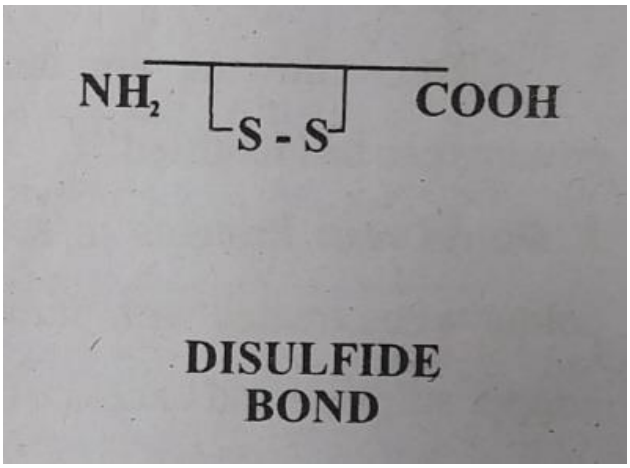
(3)IONIC BONDS:-

They are formed between oppositely charged polar Side chains of amino acids like acidic and basic amino acids.



(4)DISULPHIDE BONDS:-

They are the s-s bonds between the SH group of two Cysteine molecule.



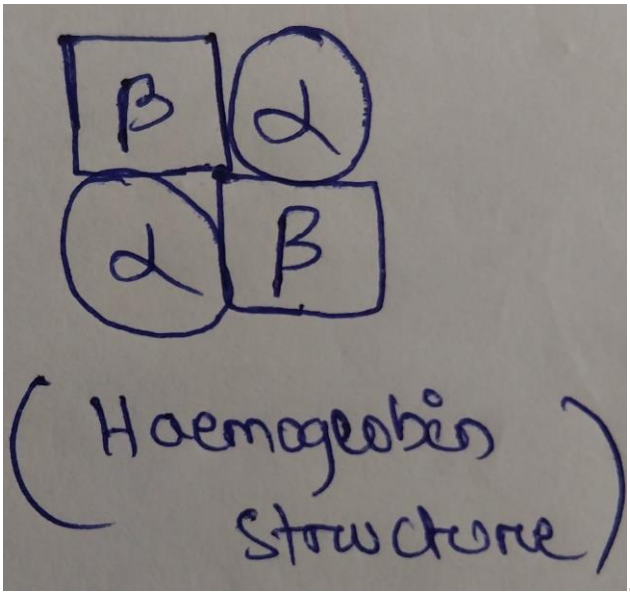
(4)QUATERNARY STRUCTURE:-

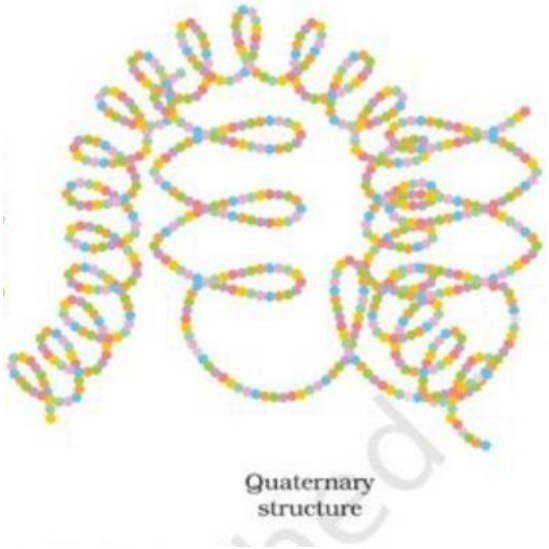
-It is the fourth levels of organization in protein Structure.

-It is known as protein-protein interaction.

-In this structure protein containing more than one polypeptide chain Called Subunits.

Ex-Insulin,Haemoglobin.





QUALITATIVE TEST FOR PROTEIN:--

(1)HEAT TEST:-

→when protein Solutions are boiling in water bath then its gets coagulated by choosing their biological activity thermal denaturation of protein.

(2)BIURET TEST:-

→ when protein solution is treated with biuret reagent (a Solution of dilute copper Sulphate and excess of NaOH). A pink colour indicate the presence of at least two peptide bonds

(3)NINHYDRIN REACTION:-

→ proteins on warming with Ninhydrin Solution. A purple or violet colour indicate the presence of amino acid in protein.

(4)XANTHOPROTEIN REACTION:-

→ when protein is treated with xanthoproteic reagent (conc HNO3) a white precipitated (meta protein) is formed this turns yellow on heating.

(5)MILLON'S TEST:-

→A few drops of the Millon's reagent (10% mercuros us chloride in H□SO□) are added with the test solution, which is then heated gently. A white precipitate indicate the presence of tyrosine.

(6)LEAD ACETATE TEST:-

→ proteins on boiling with strong alkali, the amino acid split out Sulphur, which combine with lead acetate forming a black precipitate of pbs.

(7)SODIUM NITROPUSIDE TEST:-

→This test is answered by proteins containing cystine. It gives a red colour with an ammonical solution of Sodium nitropruside.

(8)HOPKIN'S COLE TEST:-

→Take 2ml of protein solutions and 2ml of Hop-kins-cole glyoxic acid reagent then mix inclined the best tube and add 3 ml of Concentrated Sulphuric acid along the wall of the test tube make the test tube upright and rotate then The reddish violet ring are the junction of the two fluid indicates presence of Tryptophan.

(9)SAKAGUCHI REACTION:-

→take 3ml of protein Solution in a test tube add Sakaguchi reagent (sodium hydrochloride and ALPHA-napthole) gives red colour indicates the presence of Arginine in protein.

(10) HELLR'S TEST:-

Take 3ml of concentrated nitric acid into a test tube incline the test tube and 3ml of the protein solution along the wall of the test tube. A white precipitate appear at the Junction of the Two Fluids indicating that the protein is precipitated by nitric acid.

(11)SULPHASALICYLIC ACID TEST:-

→Take 5ml of protein Solution in a test tube add Sulphosalicylic acid drop by drop mining after each addition. A white precipitate or turbidity appears indicating that the protein is prepare by Sulphasalicylic acid.

-:DISEASE RELATED TO MALNUTRITION OF PROTEINS

→Various diseases are caused by the dietary deficiency of proteins and amino acids.

→Some diseases are caused by abnormal metabolism of protein.

Mainly 2 types of disease are formed.

(1) Dietary deficiency of proteins.
(2) Abnormal metabolism of proteins.

(1)DIETARY DEFICIENCY OF PROTEINS

→Deficiency of protein in diet produces the important diseases in children.

→ They are mainly 3 types.

(a) Kwashiorkor
(b) Marasmus
(c) Nutritional odema

(a)KWASHIOKER:-

→It is a qualitative and quantitative deficiency of protein results in disease.

→It occurs in children, when they change from breast feeding to a low diet of proteinis children

→It occurs to the children between 1-4 years

The features are:-

(a)Retarded growth

(b)Liver enlargement

(c)skin changes like pigmentation, thickening cracks and ulceration.

(d)Stools contain much undigested food.

(e) Mental changes

(f) Hair is thin and spance. The colour is reddish to grey.

(g)Poor apetite

(h)Hair loss

(i) vomitting and diarrhoea

(J)Moon like face

(k)Anaemia.

FACTOR:-

(1) Large family size.

(2)Over diluted cow's milk

(3)Poor environment condition

(4)Due to poor health, the children may be come to a secondary infections by parasites.

TREATMENT:-

Diet rich in proteins like milk, egg and soyabean are helpful in the treatment of Kwashioriser.

(b)MARASMUS:-

→It occurs around age of 1 year.

→ It occurs due to diet, very low in protein and calories.

→ It occurs due to early determination of breast feeding and feeding with very dilute cow's milk.

The features are:-

(a)Growth retardation

(b) Mental retardation

(c) The child is very thin

(d) Head is large and limbs are thin like sticks.

(E)weight of the child reduced.

(F) Diarrhoea and dehydration

(g)Vomiting

(h) Disease of heart, lungs, Kidney and urinary bladder.

(i)Lower immunity

(J) Respiratory infection

TREATMENT:-

→Marasmus is treated in the same way of Kwashiorisor by providing a diet rich in protein.

C) NUTRITIONAL ODEMA:-

• It occurs mainly adult due to protein deficiency.

Feature:-

(a)Loss of weight

(b)General lethargy

(c) Anaemia

(d)Loose fats

(e)Delay in healing of wound.

(2)ABNORMAL METABOLISM OF PROTEIN

Some diseases are caused by abnormal metabolism of proteins.

(a)Phenylketonuria

(b)Alkaptonuria

(C.)Alibinism

(d) Tyrosinosis

(a)PHENYLKETONURIA:-

It is a metabolic disorder.

→It occurs due to absence of the enzyme phenyl alanine Hydroxylase.

→So this leads to increased secretion of phenyl alanine.

→Tyrosine constituents on essential amino acid in these patient's and must be avoided in the diet.

→ Early diagnosis after birth and strict intake of phenylalanine is an effective preventive measure.

SYMPTOMS:----

-Mental retardation

-Diminshed pigmentation of hair and skin

-Eczema.

TREATMENT:--

→It is treated by giving a diet with very low levels of Phenyl alanine.

(b)ALKAPTONURIA:-

→It inherited metabolic disorder found in infant

→It is metabolic disorder associated with abrormal metabolism of tyrosine.

→It is caused by the absence of the enzyme homogentistic oxidise.

→ So, homogentistic acid accumulates in the tissues and blood.

→It appears in urine, kidney stone, discolouration of earwax.

→Urine containing homogentistic acids turns black in colour due to oxidation, when exposed to air

→Kidney Stone.

TREATMENT:--

→Large doses of ascorbic acid. (Vitamin-c) sometimes for Recommended treatment of Alkaptonuria.

→Pain Killers and anti-inflammatory agents can help to relive Pain and Swelling.

(C.) ALIBINISM:-

It is inherited disorders.

→ It is characterised by little or no melanin production.

→This condition increase the risk of Skin cancer.

→Albinism tissues are state of pigment in the superficial tissues in the body.

SYMPTOMS:--

-Most of the people have pale skin.

-Eye Sensitive

-Sensitive to the skin.

TREATMENT:--

-Sun protective clothy

-corrective lens

-contact lens

(d) TYROSINOSIS:-

→ A condition characterised by fallowing metabolism of tyrosine.

→In which on intermediate product para hydroxy phenyl pyruvic acid .

→phenyl pyruvic acid appears in the urine

EXERCISES

1.Multiple Choice Questions

(1) The monomer unit of protein is_____

a) Hydrochloric acid. b)Nucleic acid

c) Amino acid. d)Acetic acid

2) The most common secondary structure of proteins is:

a) a-helix and B-helix structures. b)alpha helix and BETA-pleated structure

c) Right and left hand twisted structures. d)Globular and fibrous structures

3) The most basic amino acid is_____

a) Arginine. b)Glycine

c) Histidine. d)Glutamine

4) The chains containing less than_____are called peptides.

a) 10 amino acids. b) 30 amino acids

c)50 amino acids. d)70 amino acids

5) Cells containing locomotory organs are_____

a) Cilia. b)Flagella

c) Ricin. d)Both (a) and (b)

(6) who determination the complete sequence of amino acids of insulin protein.

a) David Agard. b)Dennis J.selko

c) Frederick Sanger. d)James D.watson

(7)mRNA is further read by the ribosome in a process known as

a) Replication. b)Translation

c)Termination. d)Transcription

8) PER stands for:

a) Protein Efficacy Routine. b)Poison Efficiency Ratio

c) Protein Energy Ratio. d)Protein Efficiency Ratio

(9)Which of the following colours give ninhydrin test?

a) Blue to violet colour. b)Blue to brown colour

c) Blue to green colour. d)Blue to black colour

10) Kwashiorkor is also known as

a) Edematous malnutrition. b)Marasmus

c) Chronic diarrhoea. d)Grey baby syndrome

Answers:

1) c 2) a 3) c 4) c 5) d 6) c 7) b 8) d 9) a 10) a

Long Answer Questions:

1. Discuss the role of proteins.
2. What are proteins? Briefly explain their biological functions.
3. How are proteins classified?
4. Define and classify proteins giving suitable examples.
5. Give classification of amino acids.
6. Give structure of three amino acids of each class.
7. What are essential amino acids? Give their biological importance.
8. Describe the structure of proteins.
9. State and explain qualitative tests for proteins.
10. Explain colour reactions of proteins.
11. Discuss denaturation of proteins.
12. What are peptides and polypeptides? Give physiological importance of peptides.
13. Discuss physical properties of amino acids.
14. Differentiate between essential and non-essential amino acids.
15. Discuss different protein deficiency diseases.

Short Answer Questions:

1. Define protein.

2. Name any two sulphur containing amino acids.

3. Write short notes on:

(a) Biuret test

(b) Millions reagent test

(c) Sakaguchi test

(d) Xanthoprotein test

(e) Ninhydrin test

(f) Heat coagulation test

(g) Phenylketonuria

(h) Alkaptonuria

(i) Kwashiorkor

(j) Marasmus

(k) Peptide bond

(L)Disulphide bond

Very Short types Questions

1) Define the following:

i) Peptides

iii) Indispensable amino acids

ii) Conjugated proteins

iv) Non-essential amino acids

v) Globular proteins

2) Define:

i) Polypeptides

iii) Quaternary proteins

ii) Hydrogen bonding

iv) Interferons

v) Amino acids

3) Write any three biological functions of amino acids.

4) Give any three properties of a-helical structure of protein

5) Write any three important functions of amino acids.

6) Give the tertiary structure of protein.

7) Mention any three biological functions of proteins.

8) Give any one qualitative tests of proteins.

9) Write the correct formula of protein efficiency ratio and biological value.

10) Mention one example of conjugated protein.

11) Mention two identification tests for protein.

12) Explain any one protein deficiency disease.

13) Give the structure of the following:

i) Alanine

ii) Proline

iii) Glycine

iv) Tyrosine