SNS COLLEGE OF ALLIED HEALTH SCIENCES

SNS Kalvi Nagar, Coimbatore - 35

Affiliated to Dr MGR Medical University, Chennai

DEPARTMENT OF CARDIAC TECHNOLOGY

COURSE NAME : BIOCHEMISTRY

TOPIC : CARBOHYDRATES

INTRODUCTION

- Carbohydrates, or carbs, are sugar molecules.
- Along with proteins and fats, carbohydrates are one of three main nutrients found in foods and drinks.
- Our body breaks down carbohydrates into glucose.
- Glucose, or blood sugar, is the main source of energy for your body's cells, tissues, and organs.
- Glucose can be used immediately or stored in the liver and muscles for later use.

3 types of carbohydrates:

Sugars: Simple carbohydrates, added as the sugar in candy, desserts, processed foods, and regular soda.

Found naturally in fruits, vegetables, and milk.

Starches: Complex carbohydrates, which are made of lots of simple sugars strung together.

Body breaks starches down into sugars for energy.

Starches include bread, cereal, and pasta and also include certain vegetables, like potatoes, peas, and corn.

Fiber: Complex carbohydrate. Help prevent stomach or intestinal problems, such as constipation, lower cholesterol and blood sugar.

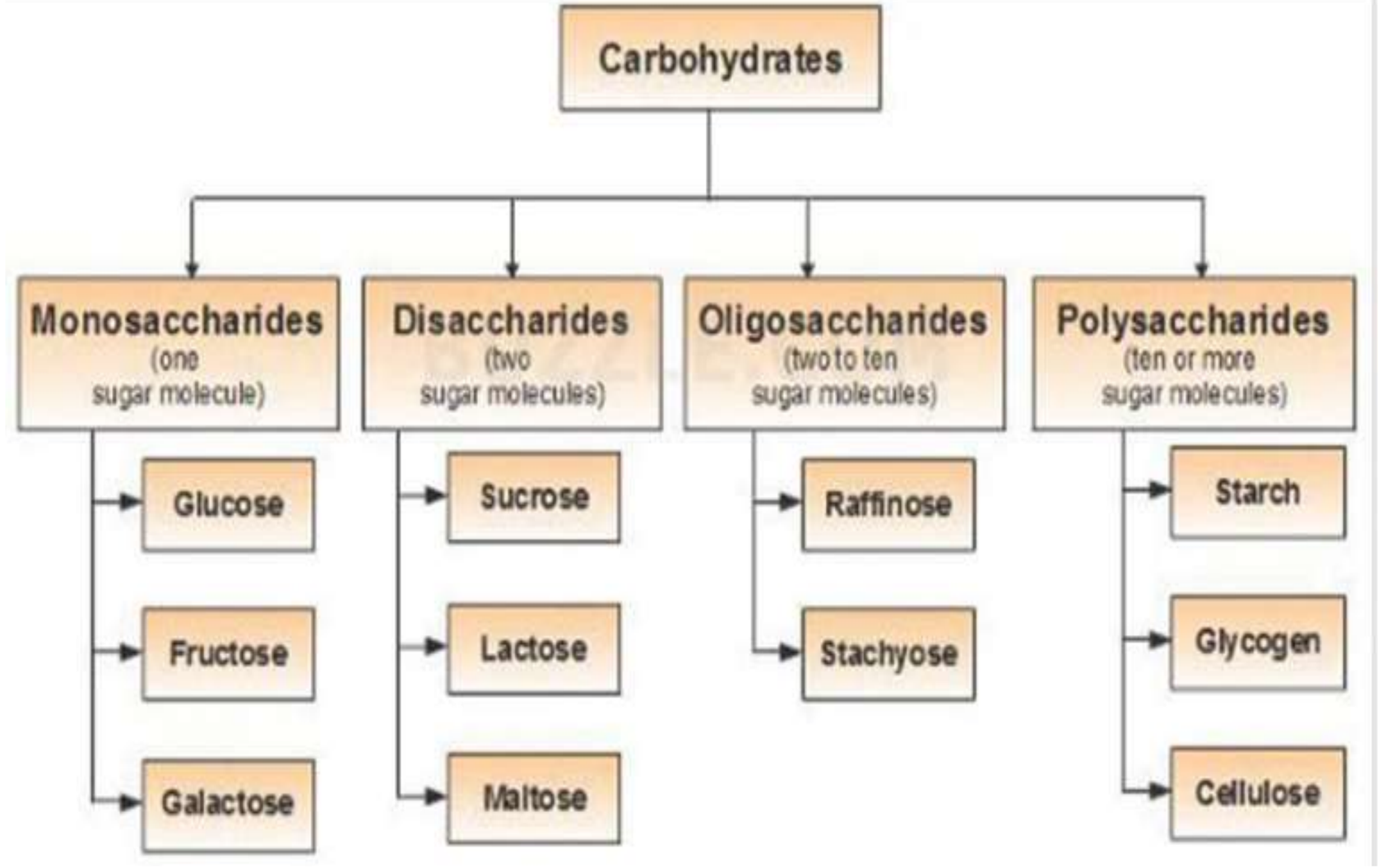
- Common foods with carbohydrates include:

- Grains, such as bread, noodles, pasta, crackers, cereals, and rice
- Fruits, such as apples, bananas, berries, mangoes, melons, and oranges
- Dairy products, such as milk and yogurt
- Legumes, including dried beans, lentils, and peas
- Snack foods and sweets, such as cakes, cookies, candy, and other desserts
- Juices, regular sodas, fruit drinks, sports drinks, and energy drinks that contain sugar
- Starchy vegetables, such as potatoes, corn, and peas

Structure of Carbohydrates

- Consist of carbon, hydrogen, and oxygen.
- Empirical structure for carbohydrates is (CH20)n.
- Organic compounds organized in the form of aldehydes or ketones with multiple hydroxyl groups coming off the carbon chain.
- The carbohydrates can be structurally represented in any of the three forms:
- Open chain structure
- Hemi-acetal structure
- Haworth structure
- **Open chain structure -** Long straight-chain form of carbohydrates.
- **Hemi-acetal structure -** Here the 1st carbon of the glucose condenses with the -OH group of the 5th carbon to form a ring structure.
- **Haworth structure -** Presence of the pyranose ring structure.

Classification of Carbohydrates



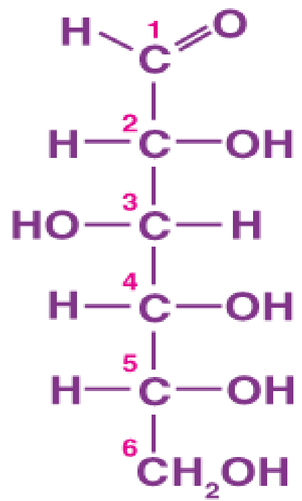
Monosaccharides

- The building blocks of all carbohydrates
- Can be a polyhydroxy aldehyde (aldose) or a polyhydroxy ketone (ketose).
- Cannot be hydrolyzed further to give simpler units of polyhydroxy aldehyde or ketone.
- If a monosaccharide contains an aldehyde group then it is called aldose and on the other hand, if it contains a keto group then it is called a ketose.
- Glucose - most important
- **From Sucrose**: If sucrose is boiled With dilute acid in an alcoholic solution then we Obtain glucose and fructose.
- **From Starch**: We can obtain glucose by hydrolysis of starch and by boiling it with dilute H2S04 at 393K under elevated pressure.

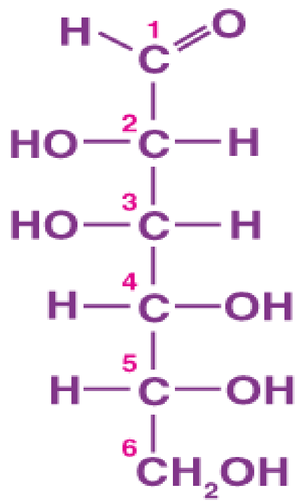
Glucose

- Glucose is also called aldohexose and dextrose and is abundant on earth.
- Named as D (+)-glucose, D represents the configuration whereas (+) represents the dextrorotatory nature of the molecule.
- The ring structure of glucose can explain many properties of glucose which cannot be figured by open- chain structure.
- The two cyclic structures differ in the configuration of the hydroxyl group at C1 called anomeric carbon.
- Such isomers i.e. α and β form are known as anomers.
- The cyclic structure is also called pyranose structure due to its analogy with pyran.

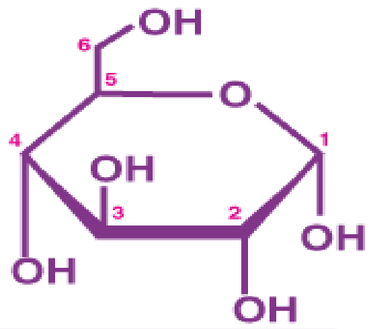
The cyclic structure of glucose is given below:



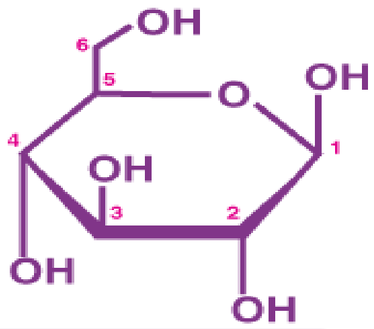
D Glucose



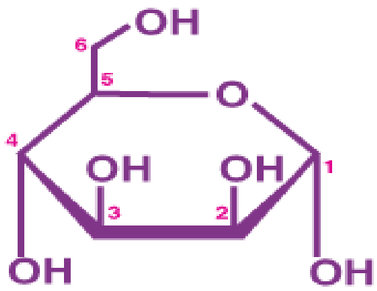
D Mannose



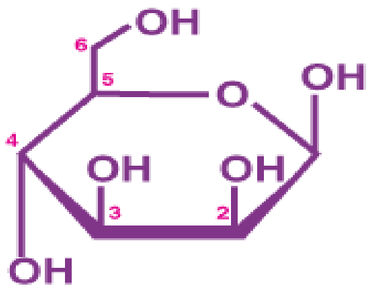
α D Glucose



β D Glucose



α D Mannose

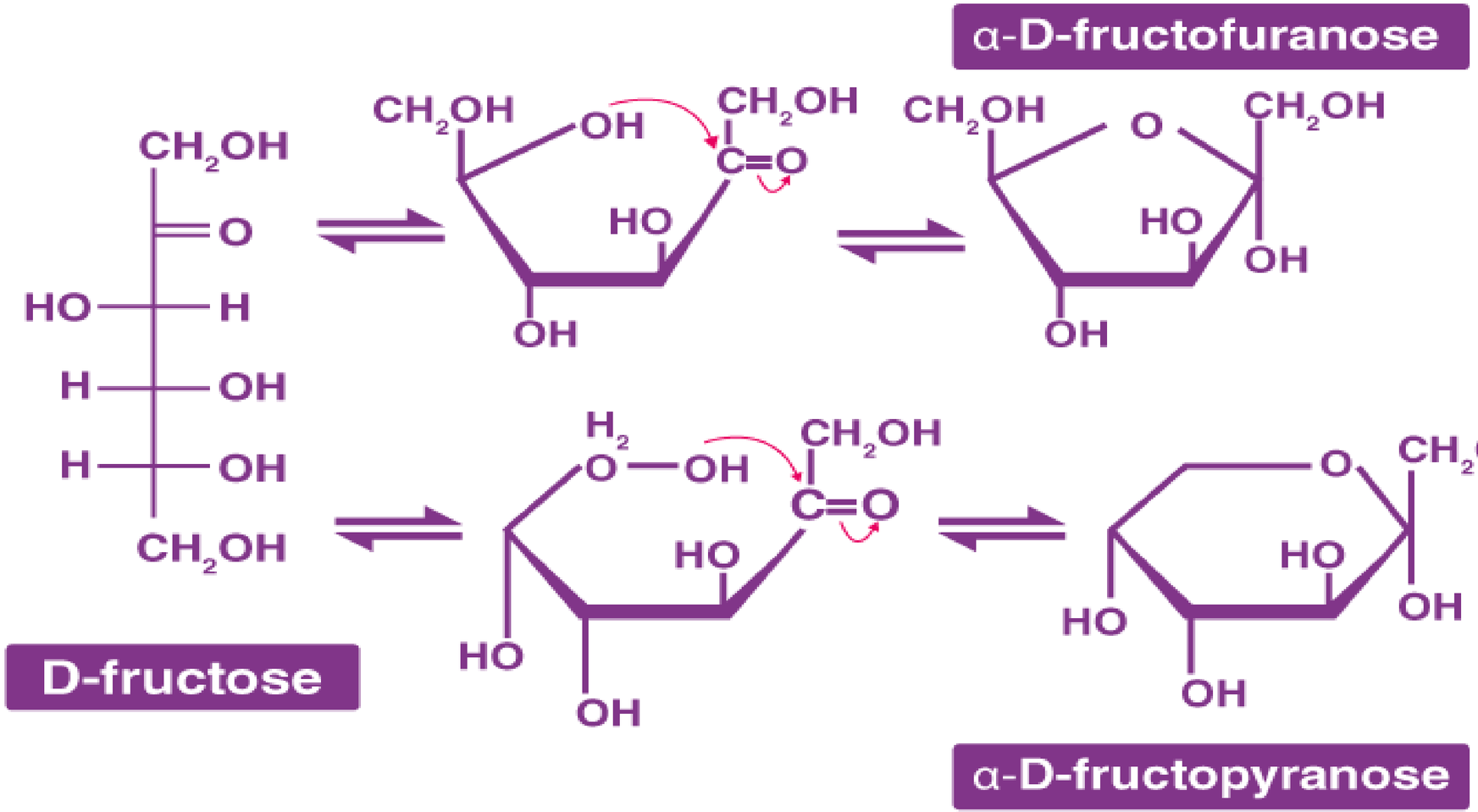


β D Mannose

Fructose

- It is an important ketohexose.
- The molecular formula of fructose is C6H1206 and contains a ketonic functional group at carbon number 2 and has six carbon atoms in a straight chain.
- The ring member of fructose is in analogy to the compound Furan and is named furanose.

The cyclic structure of fructose is shown below:



Disaccharides

- On hydrolysis, disaccharides yield two molecules of either the same or different monosaccharides.
- The two monosaccharide units are joined by oxide linkage which is formed by the loss of water molecule and this linkage is called glycosidic linkage.
- Sucrose is one of the most common disaccharides which on hydrolysis gives glucose and fructose.
- Maltose and Lactose (also known as milk sugar) are the other two important disaccharides.
- In maltose, there are two a-D-glucose and in lactose, there are P-D-glucose which are connected by an oxide bond.

Polysaccharides

- Polysaccharides contain long monosaccharide units joined together by glycosidic linkage.
- Most of them act as food storage for e.g. Starch.
- Starch is the main storage polysaccharide for plants.
- It is a polymer of a glucose and consists of two components-Amylose and Amylopectin.
- Cellulose is also one of the polysaccharides that are mostly found in plants.
- Polysaccharides are also called "glycans".
- Polysaccharides contain more than 10 monosaccharide units and can be hundreds of sugar units in length.

- They may be **homopolysaccharides/ Homoglycans,** containing monosaccharides of the same type (Contains more than 10 same repeating units.)
- Examples are starch, glycogen, cellulose, pectin.

- **Heteropolysaccharides/ Heteroglycans** i.e., monosaccharides of different types (Contains more than 10 different repeating units.)
- Examples are Hyaluronic acid, Chondroitin.

HOMOPOLYSACCHARIDES

- Homopolysaccharides are chemical compounds that are composed of a single type of monomer
- Composed of the same repeating unit
- Single type of monosaccharide is involved in the formation
- Have simple structures when cornpared to heteropolysaccharides

HETEROPOLYSACCHARIDES

- Heteropolysaccharides are polysaccharides made out of two or more different monosaccharides
- Composed Of different repeating units
- Different types of monosaccharides are
- involved in the formation
- Have complex structures

Oligosaccharides

- Oligosaccharides are compound sugars that yield 2 to 10 molecules of the same or different monosaccharides on hydrolysis.
- The monosaccharide units are joined by glycosidic linkage.
- Based on the number of monosaccharide units, it is further classified as a disaccharide, trisaccharide, tetrasaccharide, etc.
- Oligosaccharides yielding 2 molecules of monosaccharides on hydrolysis is known as a disaccharide, and the ones yielding 3 or 4 monosaccharides are known as trisaccharides and tetrasaccharides respectively, and so on.

Examples: Disaccharides include sucrose, lactose, maltose, etc.

Trisaccharides are Raffinose, Rabinose.

Functions of Carbohydrates

- Widely distributed molecules in plant and animal tissues.
- Important energy sources required for various metabolic activities, the energy is derived by oxidation.

Some of their major functions include

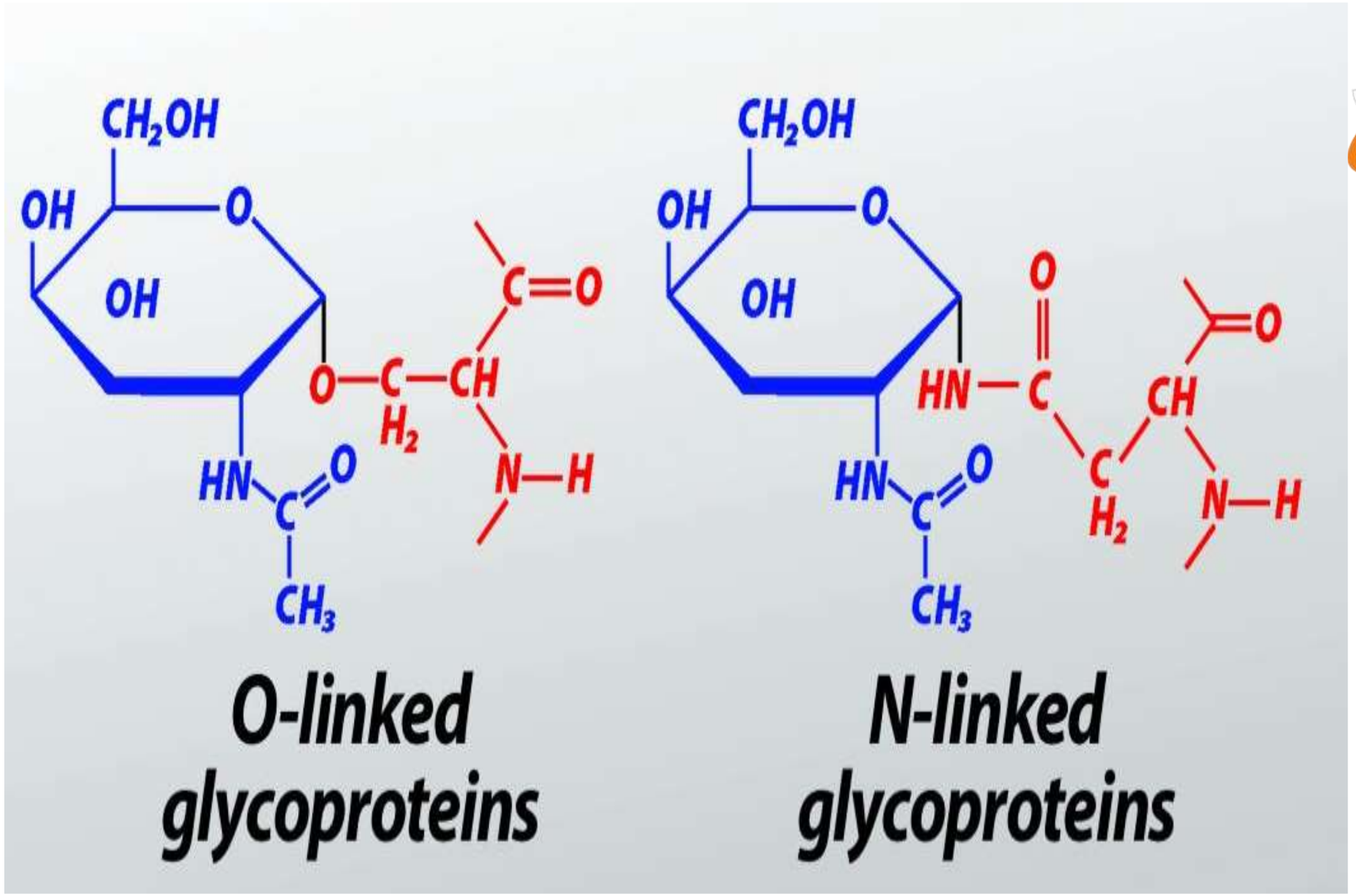
- Living organisms use carbohydrates as accessible energy to fuel cellular reactions.
- They are the most abundant dietary source of energy (4kcal/gram) for all living beings.
- Glucose is broken down by glycolysis/ Kreb's cycle to yield ATP, it serve as energy stores, fuels, and metabolic intermediates.
- It is stored as glycogen in animals and starch in plants.
- Stored carbohydrates act as an energy source instead of proteins.

Glycoproteins

- Any protein molecule with a carbohydrate attached is known as a glycoprotein.
- The protein’s polypeptide side chains are covalently joined to the carbohydrate, an oligosaccharide chain (glycan).
- Glycoconjugates are formed when carbohydrates are linked to proteins and lipids.
- They exist in three forms: glycoproteins, glycolipids and proteoglycans.
- Glycoproteins are formed when the protein component predominates in the combination of carbohydrates and proteins.
- It is referred to as a proteoglycan if the association comprises more carbohydrates than proteins.
- Glycolipids are formed when a carbohydrate combines with lipids.
- The primary site of glycoprotein and glycolipid synthesis is the Golgi apparatus.

Structure

- Glycoproteins are proteins containing glycans attached to amino acid side chains.
- Glycans are oligosaccharide chains; which are saccharide polymers, that can attach to either lipids (glycolipids) or amino acids (glycoproteins).
- Typically, these bonds are formed through a process called glycosylation.
- A sugar component (glyco) linked to a protein describes the structure of glycoproteins. Covalent bonds are used to bind the two components together.


CH2OH
OH
O
OH
O
C=O
O—C—CH
H2
HN
C=O
CH3
N—H
CH2OH
OH
O
OH
HN
O
C
CH
O
HN
C=O
CH3
C
H2
N—H
O-linked glycoproteins
N-linked glycoproteins

Functions

- They play various roles in immune systems, physical protection, cell-to-cell communication, and reproductive systems.
- They can operate in the aqueous environment due to their hydrophilic character, which plays a role in chemical bonding and cell-cell recognition.
- Cell surface glycoproteins are crucial for cross-linking proteins (such as collagen) and cells to strengthen and stabilise a tissue.
- Plants can resist gravity because of glycoproteins found in their cells.
- The glycoproteins thrombin, prothrombin, and fibrinogen are necessary for blood coagulation.
- Due to their ability to facilitate sperm cell attachment to the egg’s surface, glycoproteins are essential for reproduction.

Assessment

1. Carbohydrates and its structure formula?
2. Its Classification?
3. Difference between Glucose and Fructose?
4. Polysaccharides and is types?
5. Functions of Carbohdrates?
6. Glycoprotein structure?

THANK YOU