

B.SC.SEM-1 PAPER NAME:- CELL BIOLOGY AND  
BIODIVERSITY

PAPER CODE :- US01CBIO21  
Unit-2 Biomolecules

# Biomolecules(જૈવિકઅણુઓ)

- All forms of life are composed of biomolecules only. Biomolecules are organic molecules especially macromolecules(ખાસ કરીને મહાઅણુઓ) like carbohydrate, proteins in living organisms. All living forms bacteria,algae,plant and animal are made of similar macromolecules that are responsible for life. All the carbon compounds we get from living tissue can be called biomolecules.

- Definition of Biomolecules:-

It is term used for molecules or ions , which are normally present in organism as an essential(આવશ્યક) component(દ્રવ્ય,ઘટક) of living organism.

- Characteristics of Biomolecules:-

Most of them are organic compounds.(તેમાના મોટા ભાગના કાર્બનિક દ્રવ્યો છે.)

They have specific shapes and dimensions(ચોક્કસ આકાર અને કદ ધરાવે છે.)

Functional group (કાર્યકારી સમૂહ)determines their chemical properties(રાસાયણિક ગુણધર્મ નક્કી કરે છે.).

Many of them are asymmetric(અસમીતીય)

Macromolecules(મહાઅણુઓ) are large molecules(મોટા કદના અણુઓ) and are constructed from small building blocks molecules(બંધારણીય અણુઓ).

Building block molecules (બંધારણીય અણુઓ)have simple structure.

Biomolecules (જૈવિકઅણુઓ) first grow chemical evolution.

- Important Biomolecules of life:-

- Water:- Water being the universal solvent(સર્વ સામાન્ય દ્રાવક) and major constituents (60%) of any living body water being without which life is impossible. It acts as media for the physiological and biochemical reactions in the body itself. It maintains the body in the required turgid condition(જરૂરી આશુનતા ની સ્થિતિ ની જાળવણી કરે છે.)

- Carbohydrate:- It is very important source of energy for any physical body function.

- Proteins:- These are very important from body maintenance point of view , help in tissue , cell formation.

- Lipids:- These are very important from energy source as well as human nutrition point of view.
- Nucleic acid:- Nucleic acids are very important as DNA carries the hereditary information and RNA helps in protein formation for the body.
- Enzymes:- Enzymes are simple or combined protein acting as specific catalysts (ନିର୍ଦ୍ଦିଷ୍ଟ ଉତ୍ପ୍ରେରକ) and activates the various biochemical and metabolic processes within the body.

## Table:- Fundamental Biological molecules(Biomolecule)

| Sr.No | Small Molecule        | Atomic Constituents | Derived Macro - Molecule   |
|-------|-----------------------|---------------------|----------------------------|
| 1     | Amino Acid            | C , H , O , N(S)    | PROTEINS                   |
| 2     | Sugars                | C , H , O           | STARCH , GLYCOGEN          |
| 3     | Fatty Acid            | C , H , O           | FATS , OILS                |
| 4     | Purine and Pyrimidine | C , H , O , N       | NUCLEIC ACIDS              |
| 5     | Nucleotide            | C , H , O , N , P   | NUCLEIC ACID (DNA AND RNA) |

- All the carbon compounds that we get from living tissues can be called “Biomolecules”.
- The organic compound(કાર્બનિક ઘટકો) such as amino acid , nucleotides and monosaccharides serve as the monomeric unit(એકાકી અણુ,સરળ ઘટકો ) or building blocks(બંધારણીય ઘટકો) of complex biomolecules – protein , nucleic acids (DNA and RNA) and polysaccharides.
- The macromolecules (મહા અણુઓ)(protein , lipid , nucleic acid and polysaccharides) form supramolecular assemblies(ઉચ્ચ કક્ષા નું જોડાણ રચીને) (e.g. membranes) which in turn organize (વ્યવસ્થિત રચનાવાળું બનાવવું) into organelles , cells , tissue , organs and finally the whole organism.

# Nomenclature of Carbohydrate (કાર્બોહાઈડ્રેટો નું નામકરણ)

- Carbohydrate are the most abundant(પુષ્કળ) organic molecules in nature.
- They are primarily composed of the elements carbon , hydrogen and oxygen. The name carbohydrate literally(વાસ્તવિક રીતે) “hydrate of carbon” (કાર્બનના હાઈડ્રેટસ).
- Some of the carbohydrates possess the empirical formula(સામાન્ય સુત્ર)  $(C.H_2O)_n$  where  $n=3$ ; satisfying that these carbohydrate are in fact carbon hydrates.
- However , there are several non-carbohydrate compounds (e.g. .acetic acid ,  $C_2H_4O_2$ , lactic acid  $C_3H_6O_3$ ) which also appear as hydrates of carbon.
- Further , some of the genuine carbohydrate(વાસ્તવિક કાર્બોહાઈડ્રેટ) (e.g. rhamnohexose ,  $C_6H_{12}O_5$  and deoxyribose  $C_5H_{10}O_4$  do not satisfy(ખાતરી થતી નથી) the general formula.

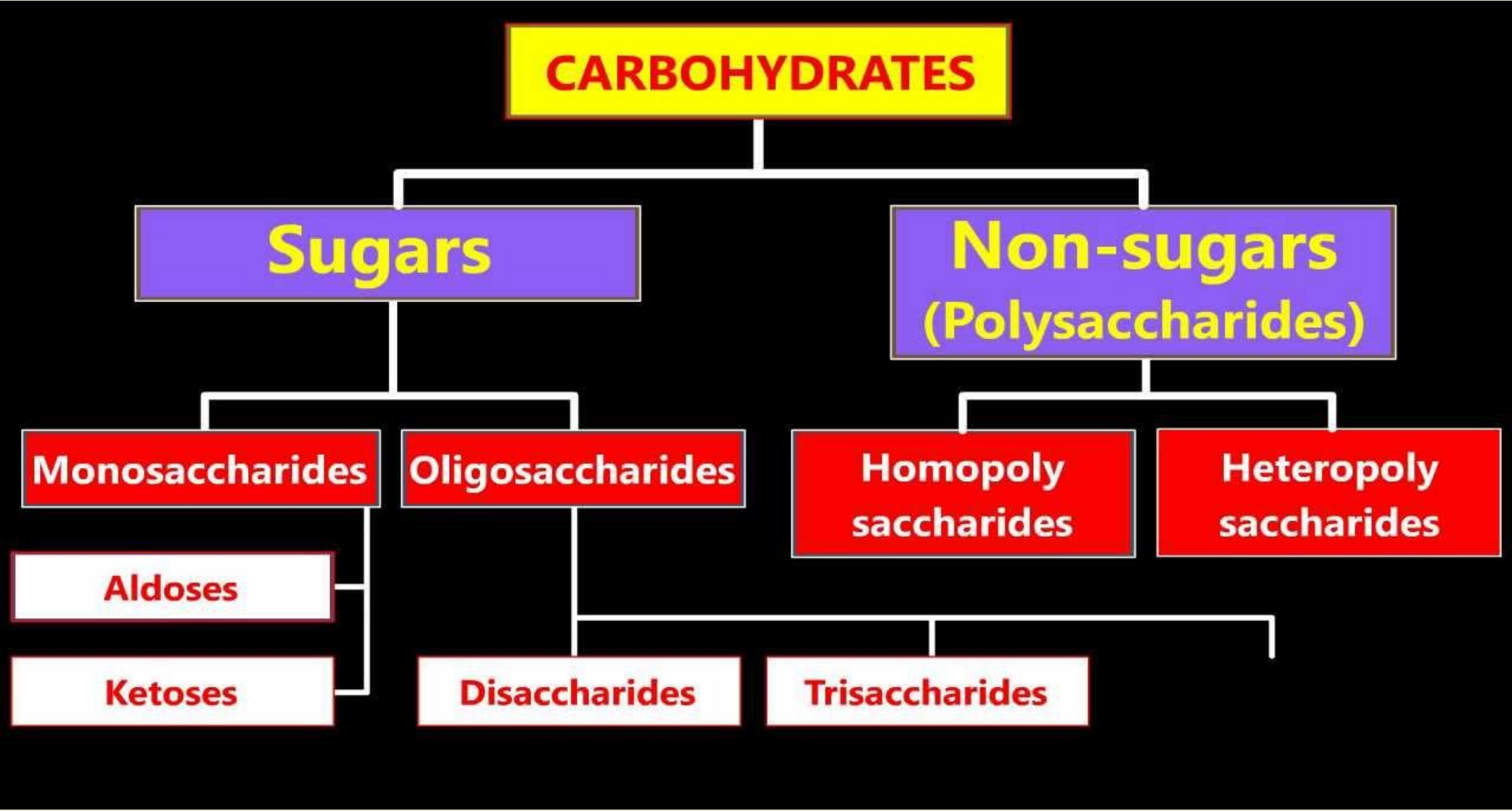
- Hence carbohydrate cannot be always considered as hydrates of carbon.
- Carbohydrate may be defined as polyhydroxy aldehydes or ketones or compound which produce them on hydrolysis(જલવીભાજન).
- The term “sugar”(શર્કરા) is applied to carbohydrate soluble in water and sweet to taste.(પાણીમાં દ્રાવ્ય અને સ્વાદે ગળ્યા)

# Classification of Carbohydrate:-

- Carbohydrates are often (અવારનવાર) referred to as saccharides(શર્કરા)
- ( Greek: Sakcharon—sugar).They are broadly classified into three major groups – monosaccharides , oligosaccharides and polysaccharides.
- This categorization is based on the number of sugar units.Mono and oligosaccharides are sweet to taste , crystalline in character and soluble in water, hence they are commonly knowns as sugars.

- Monosaccharides:-
- Monosaccharides (Greek: mono-one) are the simplest group of carbohydrates are often(વારંવાર) referred to as simple sugars. They have the general formula  $(C_n(H_2O)_n)$  and they cannot be further hydrolysed (તેનું જલવીભાજન શક્ય નથી) .
- The monosaccharides are divided into different categories , based on the functional group and the number of carbon atoms.
- Aldoses:- When the functional group in monosaccharides is an aldehyde they are known as aldose e.g. glyceraldehyde , glucose.

# CARBOHYDRATES



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graph TD; A[CARBOHYDRATES] --> B[Sugars]; A --> C["Non-sugars (Polysaccharides)"]; B --> D[Monosaccharides]; B --> E[Oligosaccharides]; D --> F[Aldoses]; D --> G[Ketoses]; E --> H[Disaccharides]; E --> I[Trisaccharides]; C --> J[Homopoly saccharides]; C --> K[Heteropoly saccharides];
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## Sugars

### Monosaccharides

Aldoses

Ketoses

### Oligosaccharides

Disaccharides

Trisaccharides

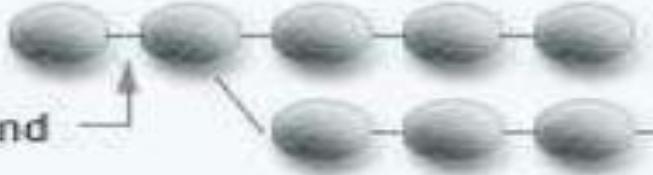
## Non-sugars (Polysaccharides)

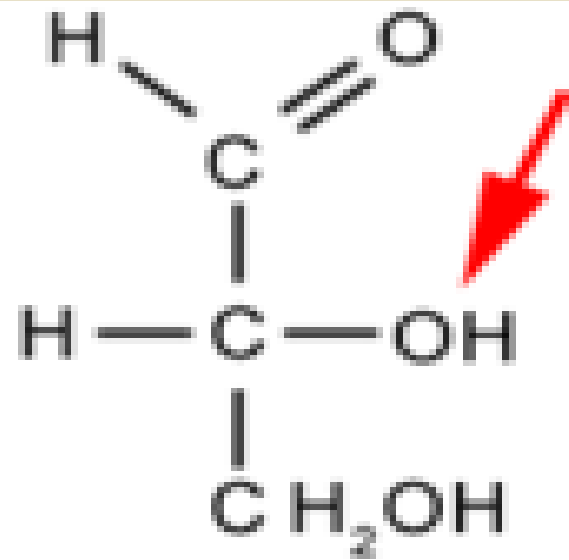
Homopoly  
saccharides

Heteropoly  
saccharides

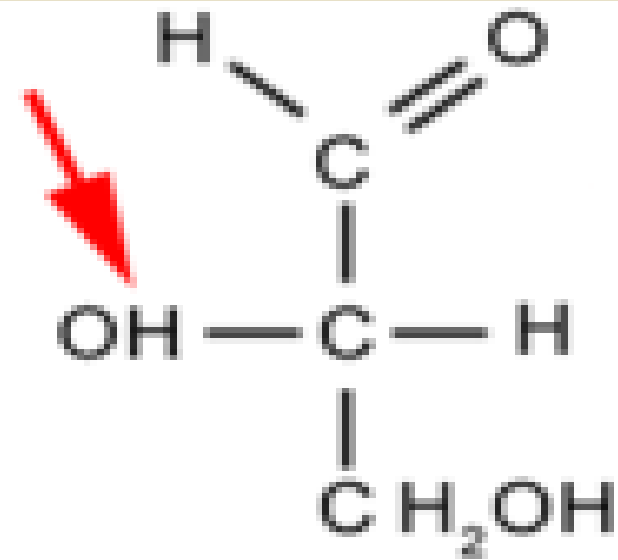
# CLASSIFICATION OF CARBOHYDRATES

## CARBOHYDRATES

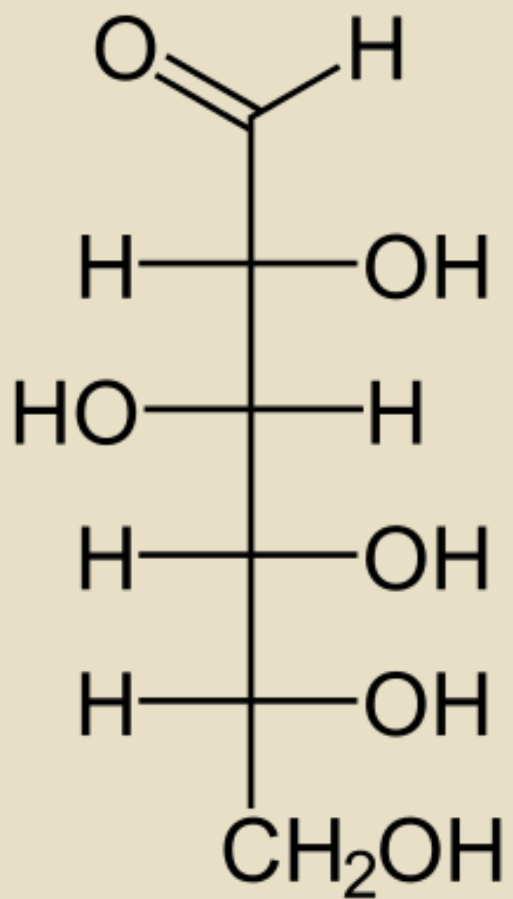
|                             |                                                                                                                                |                                                                                     |                                                                                                                              |
|-----------------------------|--------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
|                             | <div>Saccharides<br/>(Sugars)</div>                                                                                            |                                                                                     | <div>Polysaccharides<br/>(Complex sugars)</div>                                                                              |
| Physical Properties         | <ul style="list-style-type: none"> <li>* Low molecular weight</li> <li>* Soluble in water</li> <li>* Sweet to taste</li> </ul> |                                                                                     | <ul style="list-style-type: none"> <li>* High molecular weight</li> <li>* Insoluble in water</li> <li>* Tasteless</li> </ul> |
| Composition                 | <div>Monosaccharides<br/>Simple sugars</div>                                                                                   | <div>Disaccharides<br/>Double sugars</div>                                          | <div>Multiple sugars</div>                                                                                                   |
| Diagrammatic representation |                                               |  |                                           |
| General formula             | $(CH_2O)_n$ When $n=3$ to $7$                                                                                                  | $C_{12}H_{22}O_{11}$                                                                | $C_x(H_2O)_n$                                                                                                                |
| Common examples             | Glyceraldehyde, Glucose<br>Fructose, Galactose,<br>Ribose sugar                                                                | Maltose, Sucrose<br>Lactose                                                         | Starch, Glycogen<br>Cellulose, Lignin, Chitin                                                                                |



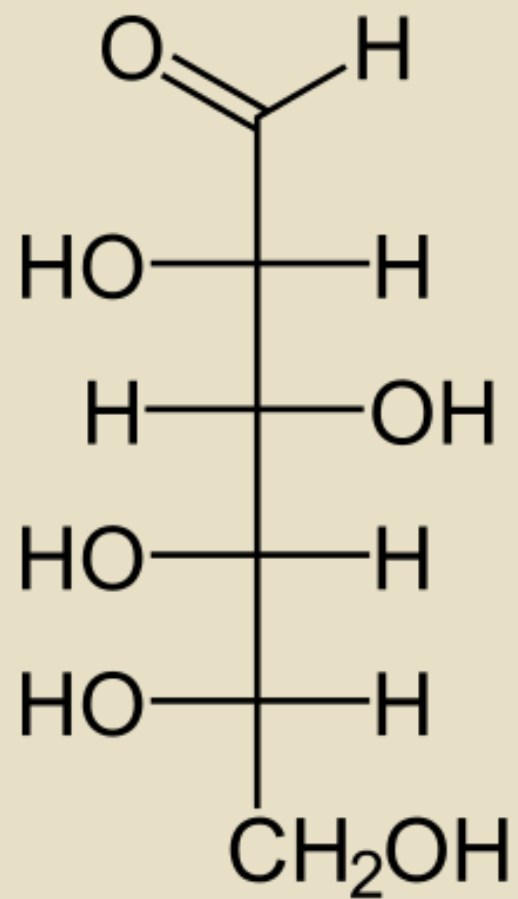
D-Glyceraldehyde



L -Glyceraldehyde



D-Glucose



L-Glucose

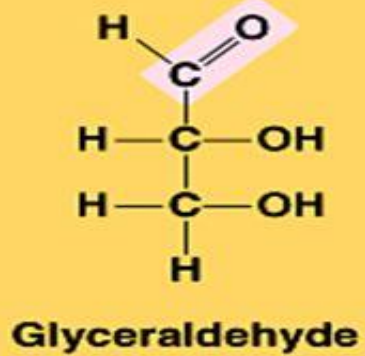
- D – Glucose rotates plane polarized (ପୃച്ഛିତ) light clockwise whereas L- Glucose plane polarized light Anti – clockwise
- Ketoses:- when the functional group is a keto group , they are referred to as ketose e.g. dihydroxyacetone , fructose. Based on the number of carbon atoms , the monosaccharides are regarded as trioses (3C) , tetroses (4C) , pentoses (5C) and hexoses (6C) and heptoses (7C). These terms along with functional groups are used while naming monosaccharides , for instance , glucose is an aldohexose while fructose is a ketohexose.

## Classification of monosaccharide with selected example

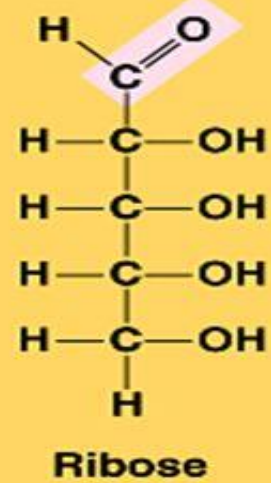
| Monosaccharides<br>(empirical formula) | Aldose                              | Ketose                                 |
|----------------------------------------|-------------------------------------|----------------------------------------|
| Trioses( $C_3H_6O_3$ )                 | Glyceraldehyde<br>(ગ્લીસરાલ્ડીહાઇડ) | Dihydroxyacetone (ડાયહાઇડ્રોક્સીકીટોન) |
| Tetroses( $C_4H_8O_6$ )                | Erythrose (એરીથ્રોઝ)                | Erythrulose (એરીથ્રુલોઝ)               |
| Pentoses ( $C_5H_{10}O_5$ )            | Ribose (રીબોઝ)                      | Ribulose (રીબ્યુલોઝ)                   |
| Hexoses ( $C_6H_{12}O_6$ )             | Glucose (ગ્લુકોઝ)                   | Fructose (ફ્રુક્ટોઝ)                   |
| Heptoses ( $C_7H_{14}O_7$ )            | Glucoheptose<br>(ગ્લુકોહેપ્ટોઝ)     | Sedoheptulose (સેડોહેપ્ટુલોઝ)          |

**Triose sugars  
(C<sub>3</sub>H<sub>6</sub>O<sub>3</sub>)**

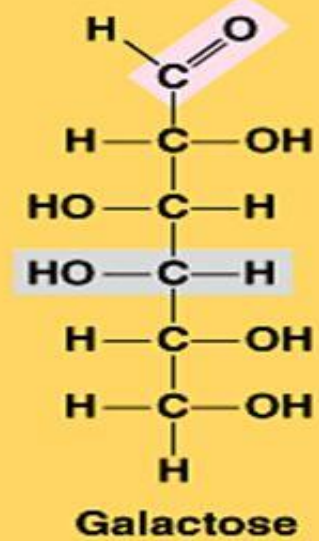
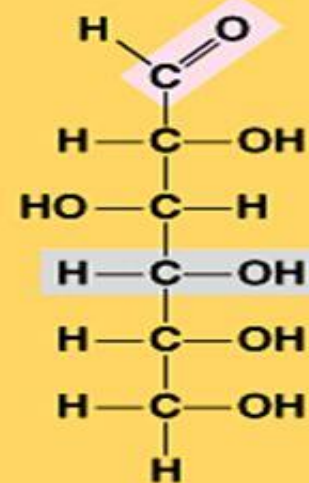
**Aldoses**



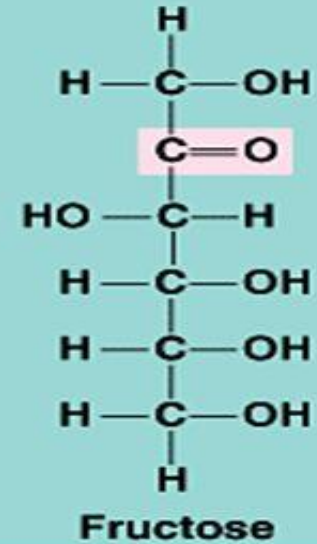
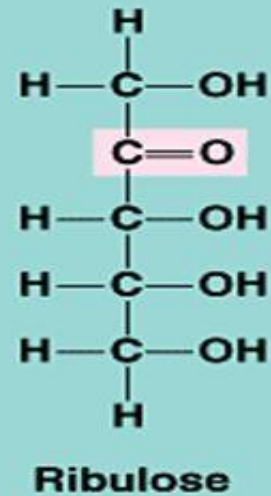
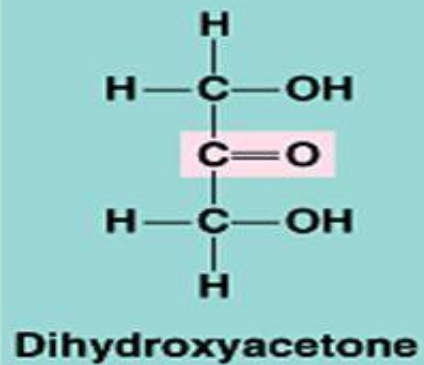
**Pentose sugars  
(C<sub>5</sub>H<sub>10</sub>O<sub>5</sub>)**



**Hexose sugars  
(C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>)**



**Ketoses**



# Oligosaccharides:-

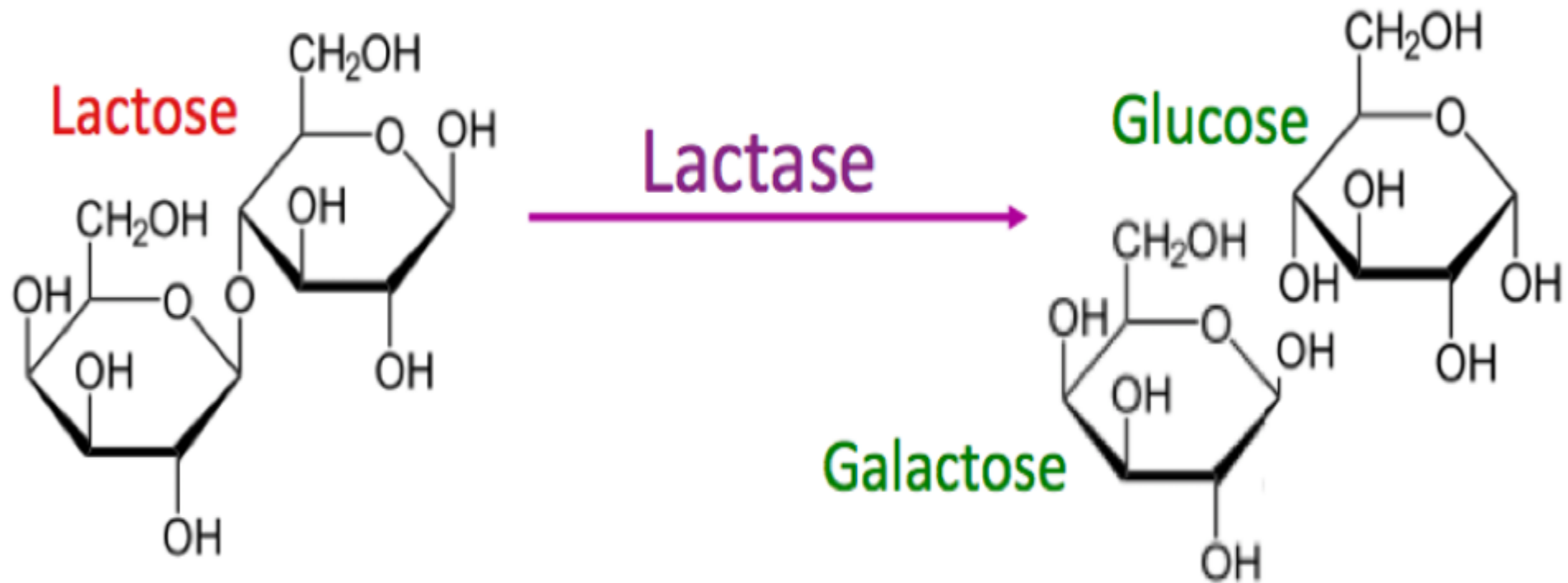
- Oligosaccharides (Greek: oligo –few) contain 2-10 monosaccharide molecules which are liberated(મુક્ત) on hydrolysis(જલવિભાજન). Based on the number of monosaccharide units present, the oligosaccharide are further subdivided to disaccharides , trisaccharides etc.
- Disaccharides:- As is evident from name , a carbohydrate consists of two monosaccharide units (similar or dissimilar) held together by a glycosidic bond. They are crystalline , water-soluble and sweet to taste. The disaccharides are two types.
- Reducing disaccharides with free aldehyde or keto group e.g. maltose , lactose.
- Non-Reducing disaccharides with no free aldehyde or keto group e.g. sucrose , trayhalose
- ( ટ્રાયહેલોઝ )

- Carbohydrates containing free aldehyde and keto functional group are thus **reducing sugars**.  
Example: **Maltose**, lactose. **Non-reducing sugars**: If the groups are not free, then they do not **reduce**
- જે કાર્બોદીતોમાં મુક્ત કાર્યકારી આલ્ડીહાઇડ કે કીટો ગ્રુપ આવેલા હોય તેને રીડ્યુસીંગ સુગર કેહવામાં આવે છે.દા.ત.ઝલુકોઝ અને લેક્ટોઝ
- જે કાર્બોદીતોમાં આલ્ડીહાઇડ કે કીટો ગ્રુપ મુક્ત કાર્યકારી ગ્રુપ તરીકે આવેલા ન હોય તેને નોન રીડ્યુસીંગ સુગર કેહવામાં આવે છે.દા.ત. સુક્રોઝ,ટ્રાયહેલોઝ

# Lactose:-

- Lactose is disaccharide , It is a sugar composed of galactose and glucose subunits and has the molecular formula  $C_{12}H_{22}O_{11}$ , Lactose makes up around 2-8% of milk (by weight). The name comes from lac( gen.lactis ), the Latin word for milk plus the suffix –ose used to name sugars. The compound is a white , water soluble , a mildly sweet taste. It is used in the food Industry.
- ફક્ત પ્રાણીઓમાં નિર્માણ પામતો ડાયસેકેરાઈડ (મીલ્ક સુગર પણ કહેવામાં આવે છે.)

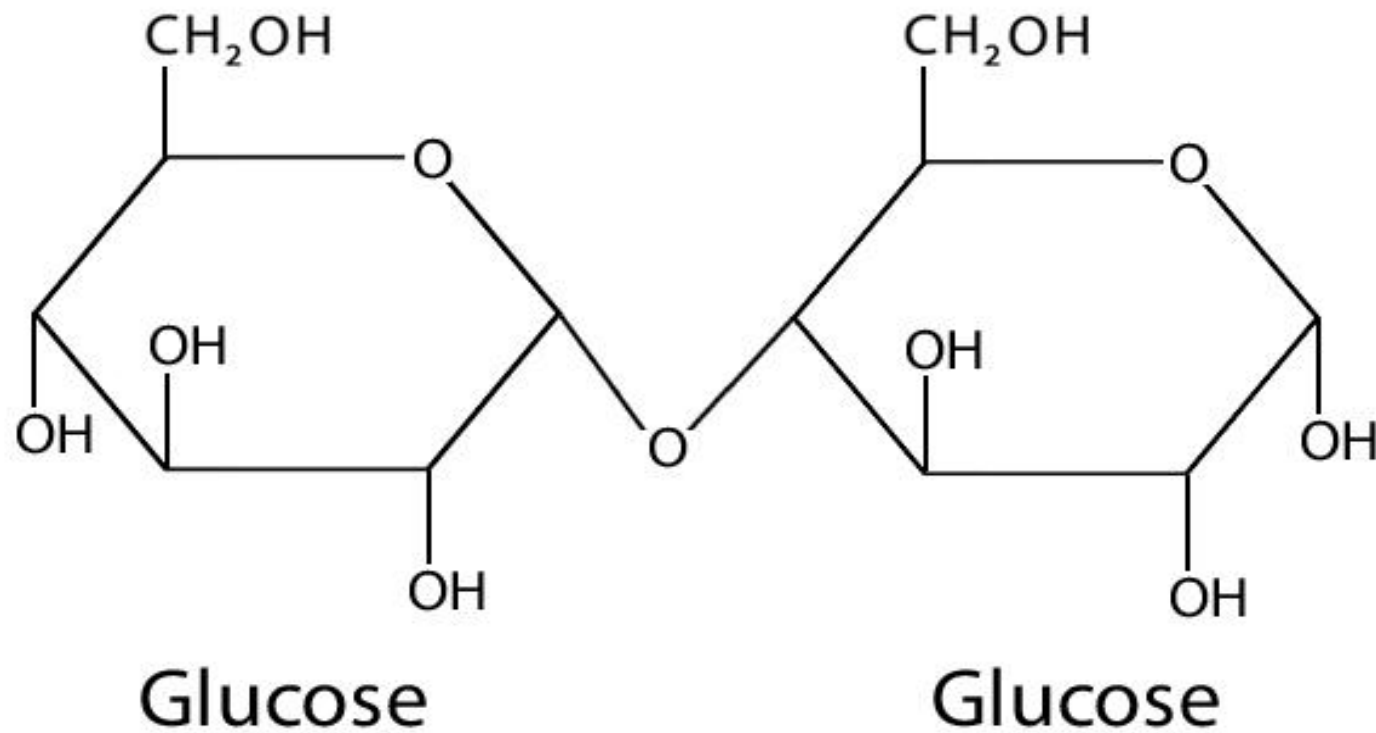
# Lactose



# Maltose:-

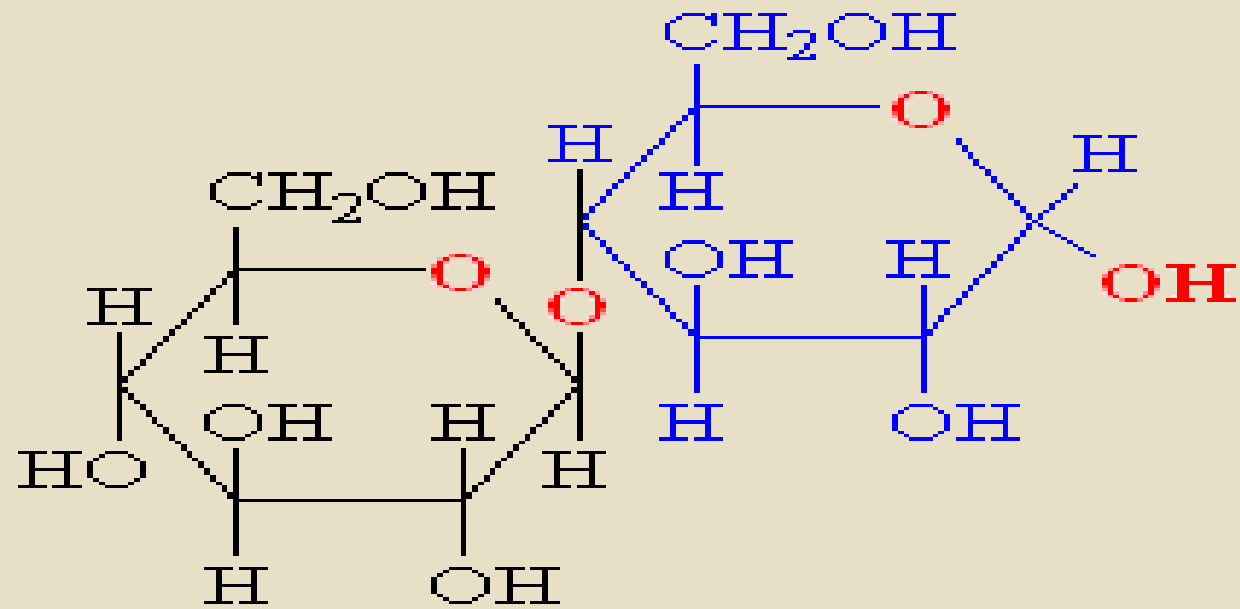
- Maltose:- Maltose is disaccharide , Maltose , with two sugar units , is an oligosaccharides , specifically (વિશિષ્ટ રીતે) a disaccharides, because it consists of two glucose molecules , glucose is hexose: a monosaccharides containing six carbon atoms.
- Maltose is a component of malt , a substance which is obtained in the process of allowing grain to soften in water and germinate(અંકુરણ).અંકુરણ પામતા બીજ મા સૌથી વધુ પ્રમાણ મા પ્રાપ્ત થાય છે.
- It also present in highly variable(પરિવર્તનશીલ) quantities in partially hydrolysed (જલવીભાજન , પાચન) starch produce like maltodextrin.(માલટો ડેક્ષ્ટ્રીન)
- સ્ટાર્ચ ના પાચન દરમ્યાન પણ માલટોઝ, માલટો ડેક્ષ્ટ્રીન સ્વરૂપે પ્રાપ્ત થાય છે.

# Maltose



# Cellobiose:- (સેલોબાયોઝ)

- Cellobiose is a disaccharide with the formula  $C_{12}H_{22}O_{11}$ , Cellobiose a reducing sugar, Consists of two Beta – D glucose molecules, Cellobiose produce during the digestion of cellulose.

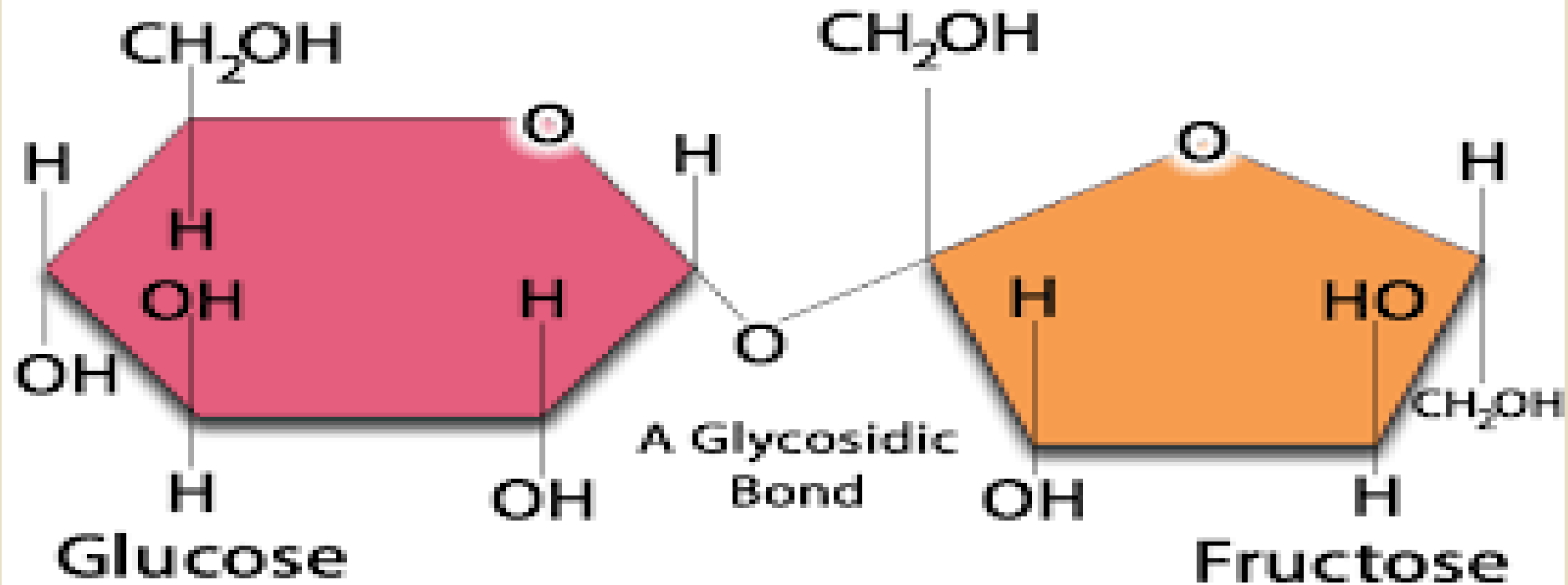


**cellobiose**

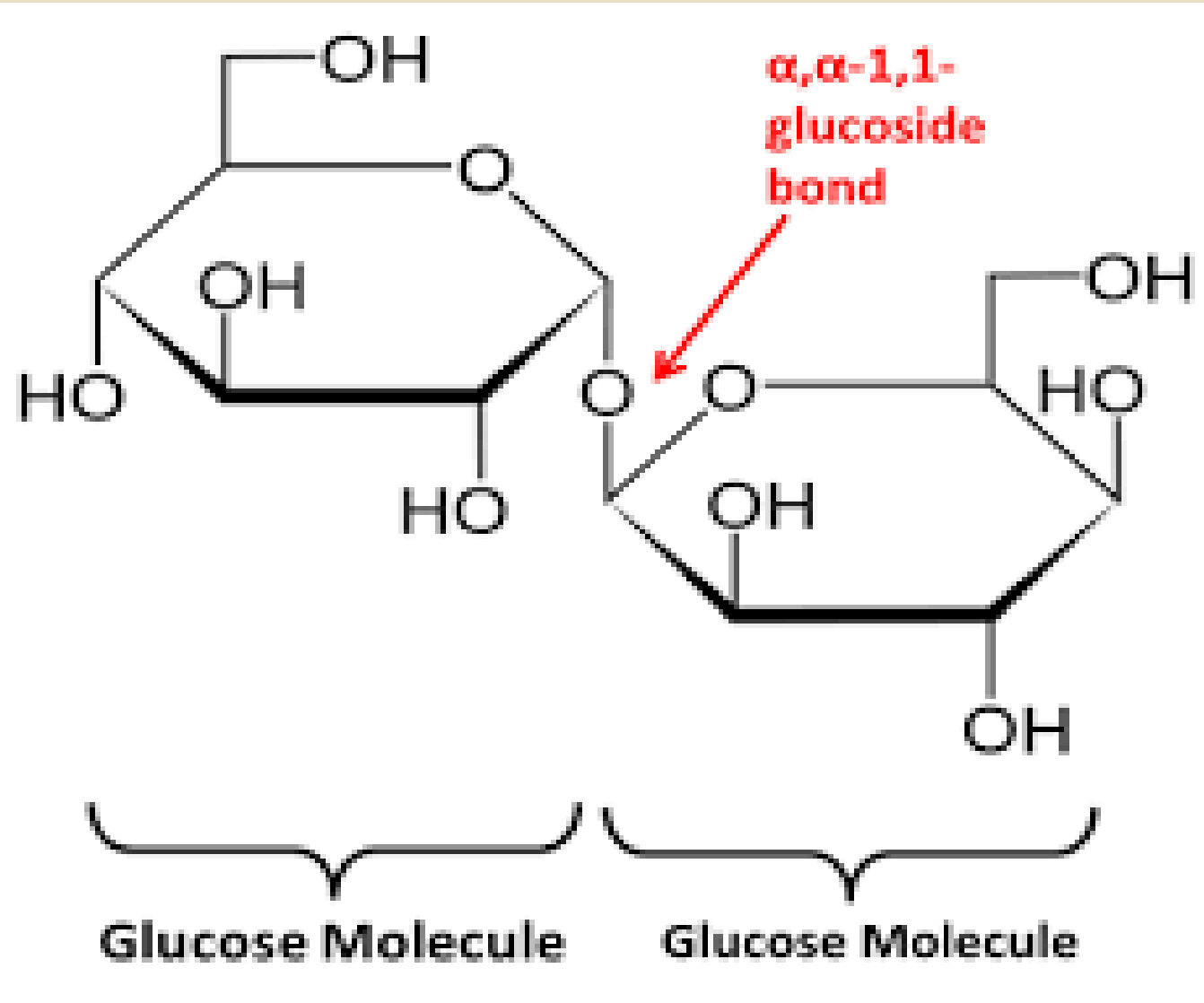
**4-( $\beta$ -D-glucopyranosyl)-D-glucose**

- Sucrose:- Sucrose is common sugar. It is a disaccharide , a molecule composed of two monosaccharides , glucose and fructose, sucrose is produced naturally in plants , from which table sugar is refined. It has molecular formula  $C_{12}H_{22}O_{11}$ .
- For human consumption sucrose is extracted(બહાર કાઢવું , નીચોડ) , and refined (શુદ્ધ) from either sugar cane or sugar beet.
- (Non Reducing sugar)

# Sucrose



- Trehalose:- Trehalose is a non reducing sugar consisting of two molecules of glucose. Some bacteria , fungi , plants and Invertebrate animal synthesize it as source of energy, and to survive freezing and lack of water.



## Polysaccharides:-

- Polysaccharides ( or simply glycan's) consist of repeat units of monosaccharides or their derivatives(વ્યુત્પન્નો) , held together by glycosidic bonds. They are primarily concerned with two important functions-structural and storage of energy (બંધારણીય ઘટકો અને ઉર્જાના સ્ત્રોત સાથે સંકળાયેલ છે.)..
- Polysaccharides are linear as well as branched polymers(having a many parts)(રેખીય કે શાખીત પોલીમર છે.). This is in contrast to structure of proteins and nucleic acid which are only linear polymers(પ્રોટીન અને ન્યુક્લીક એસિડના બંધારણ રેખીય હોય છે, તેથી થી તે પ્રોટીન અને ન્યુક્લીક એસિડ થી અલગ પડે છે,). The occurrence of branches in polysaccharides is due to the fact that glycosidic linkages can be formed at any one of the hydroxyl group of a monosaccharide(પોલીસેકેરાઈડ માં શાખાનું નિર્માણ મોનોસેકેરાઈડના કોઈપણ હાઈડ્રોક્સિલ સમૂહમાં ગ્લાયકોસીડીક બંધ થવાથી થાય છે.).

- Polysaccharides are two types:-
- Homo(સમ,સરખા)polysaccharides on hydrolysis yield(જળ વિભાજન થવાથી માંથી મળવું) only a single type of monosaccharide. They are named based on the nature of monosaccharides(મોનોસેકેરાઈડ ના ગુણધર્મ ઉપર આધારિત છે.). Thus , glucans e.g. Starch are polymers of glucose whereas fructosans e.g. Inulin are polymers of fructose.
- Hetero(વિષમ,એક સરખા નહીં)polysaccharides on hydrolysis yield a mixture of a few monosaccharides or their derivatives(વ્યુત્પન્નો) e.g. Heparin.

# Homopolysaccharides:- Starch

- **Starch** or **amylum** is a polymeric carbohydrate consisting of a large number of glucose units joined by glycosidic bonds. This polysaccharide is produced by most green plants as energy storage. It is the most common carbohydrate in human diets and is contained in large amounts in staple foods like(મુખ્ય ખોરાક જેવાકે) potatoes, wheat(ઘઉં), maize (corn, મકાઈ), rice, and cassava(sweet potatoes , શક્કરીયા).
- Pure starch is a white, tasteless and odorless(સુગંધ વિહીન) powder that is insoluble in cold water or alcohol. It consists of two types of molecules: the linear and helical(પેચદાર ,સ્ક્રુ જેવું) amylose and the branched(શાખામય) amylopectin. Depending on the plant, starch generally contains 20 to 25% amylose and 75 to 80% amylopectin by weight.

◦

# Glycogen:-

- **Glycogen** is a multibranched polysaccharide of glucose that serves as a form of energy storage in animals, fungi, and bacteria. The polysaccharide structure represents the main storage form of glucose in the body.
- Glycogen functions as one of two forms of long-term energy reserves, with the other form being triglyceride stores in adipose tissue (i.e., body fat). In humans, glycogen is made and stored primarily in the cells of the liver and skeletal muscle. In the liver, glycogen can make up 5–6% of the organ's fresh weight, and the liver of an adult weighing 70 kg can store roughly 100–120 grams of glycogen.

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- In skeletal muscle, glycogen is found in a low concentration (1–2% of the muscle mass) and the skeletal muscle of an adult weighing 70 kg stores roughly 400 grams of glycogen. The amount of glycogen stored in the body—particularly (ખાસ કરીને) within the muscles and liver—mostly depends on physical training, basal metabolic rate, and eating habits. Small amounts of glycogen are also found in other tissues and cells, including the kidneys, red blood cells, white blood cells, and glial (સવેદના) cells in the brain.<sup>‡</sup> The uterus also stores glycogen during pregnancy to nourish (પોષણ) the embryo.

# cellulose

- Cellulose is polysaccharide, It is an important structural component of the primary cell wall of green plants, many forms of algae and the oomycetes. Some species of bacteria secrete it to form biofilms. Cellulose is the most abundant organic polymer on Earth. The cellulose content of cotton fiber is 90%, that of wood is 40–50%, and that of dried hemp(શણ) is approximately 57%.
- Cellulose is mainly used to produce paperboard and paper. In human nutrition, cellulose is a non-digestible constituent(ઘટક) of insoluble dietary fiber(અદ્રાવ્ય ખોરાક નો તંતુ), acting as a hydrophilic bulking agent for feces(મળ) and potentially(સભવંત) aiding(સહાય કરવી) in defecation(મળ બહાર આવવાની વૃત્તિ ).

## Chitin:-

**Chitin** is a large, structural **polysaccharide** made from chains of modified glucose. **Chitin** is found in the exoskeletons of insects, the cell walls of fungi, and certain hard structures in invertebrates and fish.

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- **Inulin's** are a group of naturally occurring polysaccharides produced by many types of plants, industrially most often extracted from chicory(કોફી ને બદલે છોડના મુળીયાનો ભુક્કો ). The inulin's belong to a class of dietary fibers(ખોરાકનો તંતુ) known as fructans. Inulin is used by some plants as a means of storing energy and is typically found in roots or rhizomes(ભુપ્રકાંડ,કંદ મૂળ). Most plants that synthesize and store inulin do not store other forms of carbohydrate such as starch.

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- In the United States in 2018, the Food and Drug Administration approved (વહીવટી વિભાગે માન્યતા આપી) inulin as a dietary fiber(ખોરાકનો તંતુ) ingredient(ઘટક) used to improve the nutritional value of manufactured food products. Using inulin to measure kidney function is the "gold standard" for comparison with other means of estimating glomerular filtration rate.

# Pectin:-original sugar (Hetero polysaccharides)

- **Pectin** is a structural heteropolysaccharide contained in the primary cell walls of terrestrial plants. It was first isolated and described in 1825 by Henri Braconnot. It is produced commercially as a white to light brown powder, mainly extracted from citrus fruits(ખટાસવાળા ફળ), and is used in food as a gelling agent(જેલી બનવાનું કારક), particularly in jams and jellies. It is also used in dessert fillings, medicines, sweets, as a stabilizer(સ્થિરતા કારક) in fruit juices and milk drinks, and as a source of dietary fiber.

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# Heparin:- Derivatives( Muco saccharides) Hetero polysaccharides

- **Heparin** is a **heteropolysaccharide** (a polysaccharide formed by different kinds of monosaccharides). ... **Heparin** inhibits the coagulation process by inhibiting, indirectly, the action of Thrombin.
- હેપેરીન પરોક્ષ રીતે , થ્રોમ્બીનની ક્રિયાને અવરોધીત કરીને કોઝ્યુલેશન પ્રક્રિયાને અટકાવે છે.