

# CARBOHYDRATES



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# CARBOHYDRATES

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## Contents:

- History of carbohydrates.
- Occurrence of carbohydrates.
- Classification of carbohydrates.
- Isolation of carbohydrates.
- Physical and chemical properties of carbohydrates.
- Identification tests for carbohydrates.
- Pharmaceutical importance of carbohydrates.
- Pharmacognostic study of individual drugs.

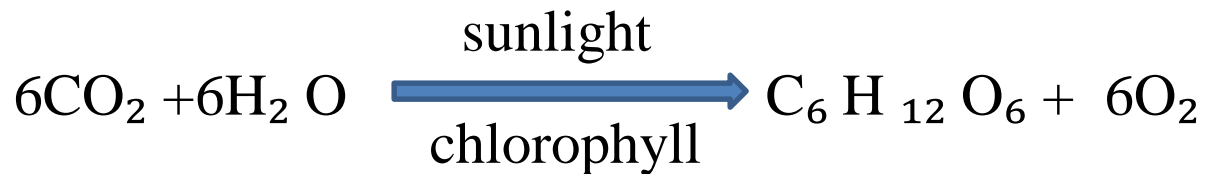
## History:

- Formerly, carbohydrates were defined as a group of compounds composed of **Carbon, Hydrogen and Oxygen**.
- The later 2 elements are in the same proportion as in water and were expressed by a formula  **$C_n(H_2O)_n$** .
- The word carbohydrates can be traced back to Germans, who called them “**Kohlenhydrates**”. It was then termed **Carbohydrates** in English.

- The definition is not valid as it was misleading few compounds like Acetic acid ( $C_2H_4O_2$ ), lactic acid ( $C_3H_6O_3$ ) which are not carbohydrates.
- To accommodate a wide variety of compounds, the carbohydrates are now-a-days broadly defined as **polyhydroxy Aldehydes or Ketones.**
- Carbohydrates are much abundant in plants, rather than in animals.

## Occurrence of carbohydrates

- Carbohydrates are widely distributed in plants and animals and also found in green plants by the process of **Photosynthesis**.
- This process occurs with the presence of Chlorophyll Pigment.



- These carbohydrates utilized by the animals in the form of food.
- Well known carbohydrates are **Glucose** ( $C_6H_{12}O_6$ ) , **Sugar** ( $C_{12}H_{22}O_{11}$ ), **Starch** ( $C_6H_{10}O_5$ ) & **Cellulose** ( $C_6H_{10}O_5$ )<sub>n</sub> used by human beings & animals.
- Animals can synthesize Carbohydrates from Fat & protein.

# CLASSIFICATION





# CARBOHYDRATES

Simple sugars(Saccharide's)

Polysaccharides  
(Non-sugars)

Monosaccharide's

Oligosaccharide's

Biose

Triose ( $C_3H_6O_3$ )  
[ex- **Glyceraldehyde**]

Tetrose ( $C_4H_8O_4$ )  
[ex- **Erythrose**]

Pentose( $C_5H_{10}O_5$ ) [ ex- **Arabinose**]

Hexose  $C_6H_{12}O_6$  (ex :**Glucose**)

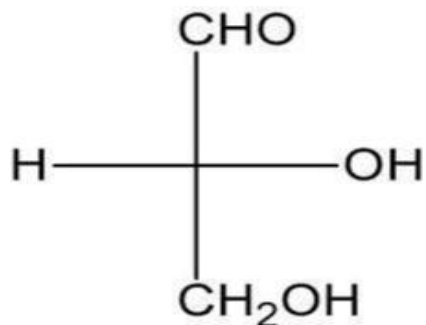
Heptose (**ex- Glucoheptose**)

Disaccharide  
Eg: **Sucrose**  
**Maltose**

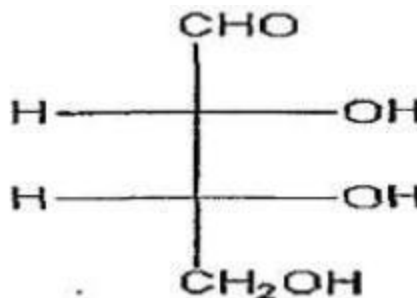
Trisaccharide  
Eg:  
**Raffinose,**  
**Rhaminose**

Tetrasaccharide  
Eg: **Stachyose**

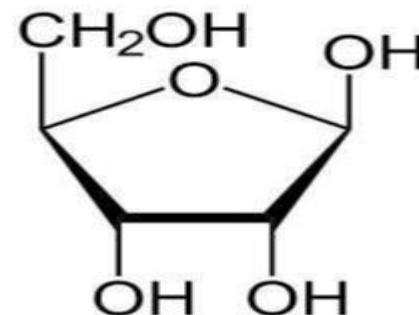
**Monosaccharide's:** can't be further hydrolyzed to simple sugars



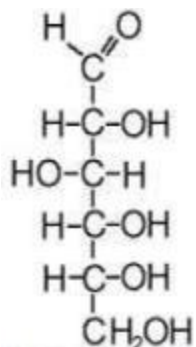
Triose: **Glyceraldehydes**



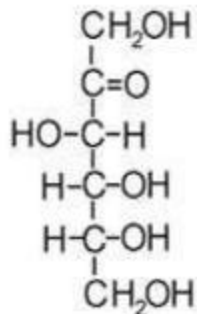
Tetrose : **Erythrose**



Pentose's : **Ribose's**

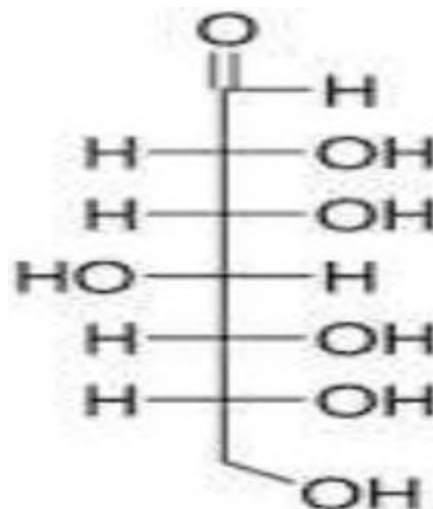


**Glucose**



**Fructose**

Hexose : **Glucose , Fructose**



Heptoses : **Glucoheptose**

❖ **Disaccharides(C<sub>12</sub>H<sub>22</sub>O<sub>11</sub>):**

on hydrolysis yields **2 molecules** of Monosaccharide's.

**Eg:** Sucrose  $\longrightarrow$  Glucose + Fructose.

Maltose  $\longrightarrow$  Glucose + Glucose.

❖ **Trisaccharides (C<sub>18</sub>H<sub>32</sub>O<sub>16</sub>):**

• On hydrolysis yields **3 molecules** of Monosaccharide's.

**Eg:** Raffinose  $\longrightarrow$  Glucose + Fructose + Galactose.

Rhaminose  $\longrightarrow$  Rham + Rhamnose + Galactose.

❖ **Tetrasaccharides ( C<sub>24</sub>H<sub>42</sub>O<sub>21</sub>):**

• On hydrolysis yields **4 molecules** of Monosaccharide's.

**Eg:** Stachyose  $\longrightarrow$  Glucose + Fructose + Galactose + Galactose.

## ❖ POLYSACCHARIDES (C<sub>6</sub>H<sub>10</sub>O<sub>5</sub>)<sub>n</sub>:

- On hydrolysis it produce **Indefinite no. of Monosaccharide's** molecules called as **Glycans**.
- Common Polysaccharides of biological significance are Starch , Glycogen(Animal starch),Cellulose , Inulin.
- Starch-Glucose units joined by  **$\alpha$ -1,4 &  $\alpha$ -1,6 linkages**.  
Cellulose-Glucose units joined by  **$\beta$ -1,4 linkages**.
- Important derivatives-Gums & Mucilage's
- **Gums**- consists of Ca , K & Mg salts of complex substances called Polyuronides. on prolonged boiling with dilute acids they yields sugar and uronic acids. **Mucilage's** – Sulphuric acid esters.

# ISOLATION OF CARBOHYDRATES



## Extraction of monosaccharide's

Fresh plant material



Homogenized with 4parts of dis.water for 15 min



filtration



Conc. In vaccum to 1/10<sup>th</sup> of its volume



Allowed to crystallize in refrigerator

## Extraction of oligosaccharides

Fresh plant material



Homogenized with 6-8 parts of hot water at 90° c for 15min



Filter the solution through celite while hot



Conc. in vaccum to 1/10<sup>th</sup> of its volume



Allowed to crystallize in refrigerator

## Extraction of polysaccharides

Plant material



Extraction with ethanol (remove low Mol.wt constituents)



Extract with Ethanol ; followed by Ether : Benzene(1:1)

Filter & collect residue



**Lipids**

Extract with 1% NaCl solution(or) Boiling water

Filter & collect residue



**Neutral H<sub>2</sub>O soluble  
polysaccharides**

Extract with 0.5% Ammonium Oxalate Solution

Filter & collect residue



**Pectin**



Extract with 1% NaCl at 70 ° C for 1hr , Filter & collect residue

Lignin

Extract with 7-12% NaOH under N<sub>2</sub> at room temp for 24hr ,filter

Filtrate

Residue

Acidification

Hemi cellulose

Wash & Dry

To achieve complete extraction(7-12% NaOH)

Pure Cellulose

Should repeat 2times

Purify by precipitating in Ethanol

# PHYSICAL AND CHEMICAL PROPERTIES OF CARBOHYDRATES



### ❖ **Monosaccharides:**

- Crystalline compounds.
- Soluble in water.
- Sweet to taste .
- Needs digestion in-order to be absorbed in blood stream.

### ❖ **Disaccharides:**

- Crystalline compounds.
- Soluble in water

- Sweet to taste.
- Must be digested to monosaccharide's before absorbed and used for energy.
- ❖ **Polysaccharides:**
  - Amorphous compounds.
  - Not Soluble in water.
  - Not Sweet to taste.
  - They form colloidal suspensions instead of solution & must be digested before being absorbed.

# IDENTIFICATION TESTS FOR CARBOHYDRATES

# MOLISCH'S TEST

Compound

+

conc.H<sub>2</sub>SO<sub>4</sub>

+

α- naphthol



Purple colored ring  
(at junction of two  
phases)

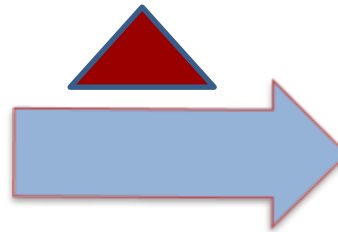
# REDUCTION OF FEHLINGS SOLUTION



Solution of  
Carbohydrate



Equal Quantities of  
Fehling's solution  
A&B



Brick Red  
Precipitate

# OSAZONE FORMATION TEST

Sugar solution

+

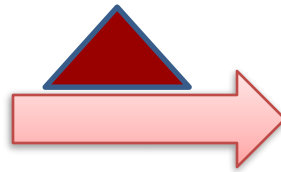
Phenyl hydrazine  
Hydrochloride

+

Sodium acetate

+

Acetic acid



Yellow Crystals





# RESORCINOL TEST FOR KETONES

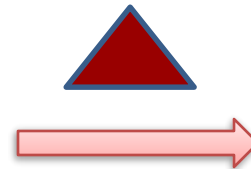
Crystal of Resorcinol

+

Sugar solution

+

Equal Volumes of  
Conc.Hcl



Rose Color  
(Due to Ketone)

# TEST FOR PENTOSES

Sugar solution



Equal Volume of Hcl  
containing little  
Phloroglucinol

Red Color



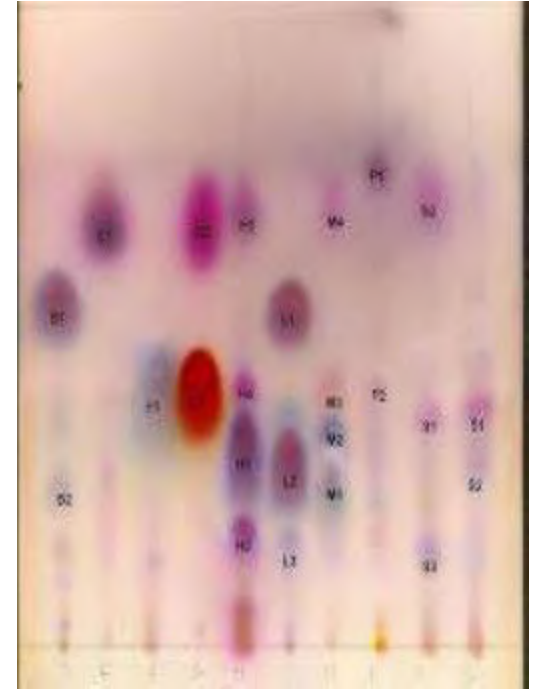
# CHROMATOGRAPHY

R.F values of different sugar ranges between  
**0.09-0.37**

Sugars are subjected to Thin layer (or) Paper Chromatography

Unknown samples are spotted along with Authentic Sugars

The colored spots are identified by Aniline - Hydrogen Phthalate which is a Detecting Agent



# PHARMACEUTICAL IMPORTANCE OF CARBOHYDRATES

## STARCH

Excipient.  
Binder.

Diluent.  
Disintegrate.

## GLUCOSE

Cellular Respiration.  
Production of ATP.

Granulating  
& Coating agent.  
Sweetener .

## LACTOSE

Anhydrous lactose-  
Filler & Binder.

Lactose mono hydrate  
-Filler(or) Diluent.

## SUCROSE

Binding agent.  
Bulking agent.

Sweetener.  
Tablet coating agents.

## MANNITOL

Diluent,  
plasticizer

Excipient in  
Chewable tablets.  
Diagnostic agent for  
Kidney function.

## SORBITOL

Diluent.  
Chewable tablets.

Stabilizer for drug.  
Prevent crystallization.

## **CAR BOXY METHYL CELLULOSE(CMC)**

- Binder,.
- Diluent.
- Disintegrant.
- Suspending agent.

## **POWDERED CELLULOSE**

- Diluent & Capsule filler.
- Reduce sedimentation rate.
- Suspending agent.
- Powder base in powder dosage form

## **MICROCRYSTALLINE CELLULOSE**

- Binder
- Diluent
- Lubricant
- Disintegrant


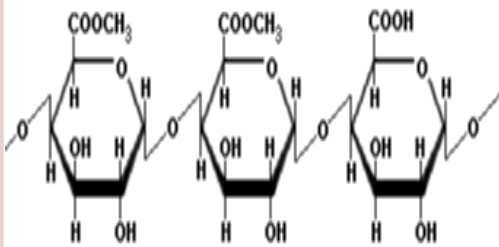
## **HYDROXY PROPYL CELLULOSE**

- Thickening agent.
- Transdermal patches , Ophthalmic preparations.
- Cosmetics ,Food products.

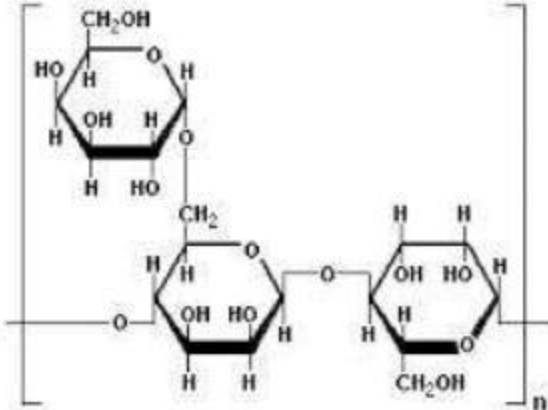


# **Pharmacognostic study of individual drugs**

# PECTIN


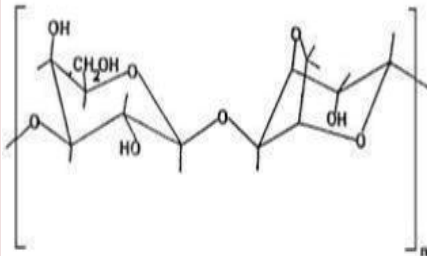
Synonym	Biological source & Family	Chemical constituents	Uses
<ul style="list-style-type: none"> <li>•Pectin</li> </ul> 	<ul style="list-style-type: none"> <li>•Lemon- <b><i>citrus Limon</i></b> (10-15%)</li> <li>•Orange, Guava, Papaya, Mangoes etc...</li> </ul> <p>Family-<b>RUTACEAE</b></p>	<ul style="list-style-type: none"> <li>•Hydrolysis of pectin</li> </ul> <p style="text-align: center;">↓</p> <p>D- galactouronic acid + Methyl alcohol+ Galactose + Arabinose.</p> 	<ul style="list-style-type: none"> <li>•Emulsifier.</li> <li>•Gelling agent.</li> <li>•Thickening agent.</li> <li>•Anti diarrheal formulations.</li> <li>•Plasma substitute.</li> </ul>

# GUAR GUM


Synonym	Biological source & Family	Chemical constituents	Uses
<ul style="list-style-type: none"> <li>•Guar flour</li> <li>•Jaguar gum</li> </ul>	<p><b><i>Cyamopsis Tetragonolobus</i></b> <i>Linn</i></p> <p>Family- <b>Leguminosae</b></p>	<p>Water soluble fraction-85% of gum <b>(Guaran)</b></p> 	<ul style="list-style-type: none"> <li>•Protective colloid</li> <li>•Binder &amp; disintegrant</li> <li>•Bulk laxative</li> <li>•Peptic ulcer therapy</li> <li>•Emulsifying agent</li> </ul>




# AGAR

synonym	Biological source & Family	Chemical constituents	uses	Substituent and adulterants
<ul style="list-style-type: none"> <li>• Agar-Agar</li> <li>• Vegetable gelatin.</li> </ul> 	<p><b><i>Gelidium amansii.</i></b></p> <p>Family- <b>Gelidaceae</b></p>	<p><b>Agarose</b>-gel strength of agar.</p> <p><b>Agaropectin</b>-viscosity of agar solution.</p>  <p><b>Agarose</b></p>	<ul style="list-style-type: none"> <li>• Laxative</li> <li>• Good emulsifying agent</li> <li>• Preparation of jellies</li> <li>• Preparation of Suppositories &amp; pessaries</li> </ul>	<ul style="list-style-type: none"> <li>• Danish agar</li> <li>• Indian agar</li> </ul>


# ACACIA

Synonym	Biological source & Family	Chemical constituents	Uses	Substitutes & adulterants
<ul style="list-style-type: none"> <li>• Gum acacia.</li> <li>• Gum Arabica.</li> </ul> 	<p><b>Acacia</b> <b>Arabica.</b></p> <p>Family- <b>leguminosae</b></p>	<p><b>Arabin-</b> ca,mg &amp; k salts of Arabic acid.</p> <p><b>Enzymes-</b> Oxidase &amp; Peroxidase</p>	<ul style="list-style-type: none"> <li>• Demulcent, Emollient.</li> <li>• Suspending agent.</li> <li>• Emulsifying agent.</li> <li>• Binding agent.</li> <li>• Stabilizing agent.</li> </ul>	<ul style="list-style-type: none"> <li>• Talka gum.</li> <li>• Mogador gum.</li> </ul> <p>Starch , Tragacanth , Dextrin ,Sterculia gum Gum Ghatti <b>(adulterants)</b></p>


# HONEY

Synonym	Biological source	Chemical constituents	uses	Adulterant
<ul style="list-style-type: none"> <li>•Madhu.</li> <li>•Honey purified.</li> <li>•Mel.</li> </ul> 	<p><b><i>Apis mellifera</i></b> <b><i>Apis dorsata</i></b></p> <p>Family- <b>Apidae</b></p>	<p>Glucose(35%) Fructose(45%) Sucrose(2%)</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <math display="block">  \begin{array}{c}  \text{H} \\    \\  \text{C}=\text{O} \\    \\  \text{H}-\text{C}-\text{OH} \\    \\  \text{HO}-\text{C}-\text{H} \\    \\  \text{H}-\text{C}-\text{OH} \\    \\  \text{H}-\text{C}-\text{OH} \\    \\  \text{CH}_2\text{OH}  \end{array}  </math> <p>Glucose</p> </div> <div style="text-align: center;"> <math display="block">  \begin{array}{c}  \text{CH}_2\text{OH} \\    \\  \text{C}=\text{O} \\    \\  \text{HO}-\text{C}-\text{H} \\    \\  \text{H}-\text{C}-\text{OH} \\    \\  \text{H}-\text{C}-\text{OH} \\    \\  \text{CH}_2\text{OH}  \end{array}  </math> <p>Fructose</p> </div> </div>	<ul style="list-style-type: none"> <li>•Demulcent.</li> <li>•Sweetening agent.</li> <li>•Antiseptic.</li> <li>•Vehicle for Ayurvedic formulations.</li> <li>•In cough Mixtures</li> </ul>	<p>Artificial invert sugar.</p>

# ISAPGOL:


synonym	Biological source	Chemical constituents	uses	substitutes
<ul style="list-style-type: none"> <li>•Isapghula.</li> <li>•Isabgul.</li> <li>•Indian psyllium.</li> </ul>	<p><b><i>Plantago ovata</i></b></p> <p>Family- <b>Plantaginaceae.</b></p>	<ul style="list-style-type: none"> <li>•Husk &amp; seeds contain mucilage</li> <li>•Pentosans &amp; aldobionic acid. •Amoebic</li> <li>•Fixed oils and proteins.</li> </ul>	<ul style="list-style-type: none"> <li>•Demulcent</li> <li>•Laxative</li> <li>•Emolient</li> <li>•Chronic constipation</li> <li>dysentery</li> </ul>	<ul style="list-style-type: none"> <li>•Plantago purshii</li> <li>•Plantago aristata</li> <li>•Plantago asiatica</li> </ul>
				

# Tragacanth:

Synonym	Biological source	Chemical constituents	Uses	Substitutes & Adulterant
<ul style="list-style-type: none"> <li>•Gum tragacanth.</li> <li>•Tragacanth.</li> </ul>	<p><b><i>Astragalus Gummifer.</i></b></p> <p><b>Family- Leguminosae</b></p>	<ul style="list-style-type: none"> <li>•H<sub>2</sub>O soluble portion- <b>Tragacanthin</b> (8-10%)</li> <li>•H<sub>2</sub>O insoluble portion- <b>Bassorin</b> (60-70%).</li> <li>•15% of <b>methoxy group</b> swells in water.</li> </ul>	<ul style="list-style-type: none"> <li>•Demulcent.</li> <li>•Emollient.</li> <li>•Suspending agent.</li> <li>•Emulsifying agent.</li> <li>•Used in lotions &amp; spermicidal jellies.</li> </ul>	<ul style="list-style-type: none"> <li>•Hog tragacanth.</li> <li>•Citral gum.</li> <li>•Shiraj gum.</li> </ul>
				



# STERCULIA GUM

synonym	Biological source & Family	Chemical constituents	Uses
<ul style="list-style-type: none"><li>• Sterculia gum.</li><li>• Karaya gum.</li><li>• Indian tragacanth.</li></ul> 	<p><b><i>Sterculia urens</i></b> <b>Roxburgh.</b></p> <p><b>Family-</b> <b>Sterculiaceae</b></p>	<p>Hetero polysaccharide like sugars &amp; uronic acids.</p>	<ul style="list-style-type: none"><li>• Bulk laxative.</li><li>• Emulsifying agent.</li><li>• Thickening agent.</li><li>• Stabilizing agent.</li><li>• Food products.</li></ul>

# STARCH:

- **Synonym:** *Amylum*.
- **Biological source:** grains of Maize(*Zeamays linn*),  
Rice(*Oryza sativa*),  
Wheat(*Triticum Aestivum Linn*)

FAMILY - **SOLANACEAE.**

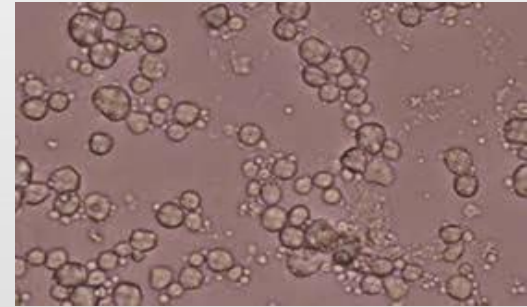
- **Microscopical Features:**

**Rice starch:** Simple---- Polyhedral-2-12 $\mu$  in size.

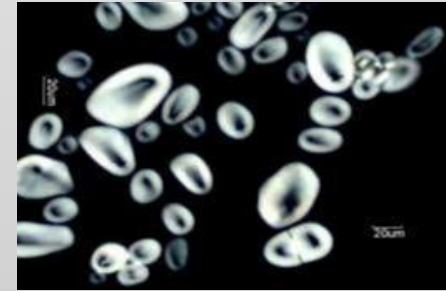
Compound---12-30 $\mu$ \*7-12 $\mu$  in size.



- **Maize starch: Granules-**  
Polyhedral (or) Rounded  
5-31 $\mu$  in Diameter



- **Potato starch: Spherical**  
Flattened  
Irregularly Ovoid in shape(30-100 $\mu$ )

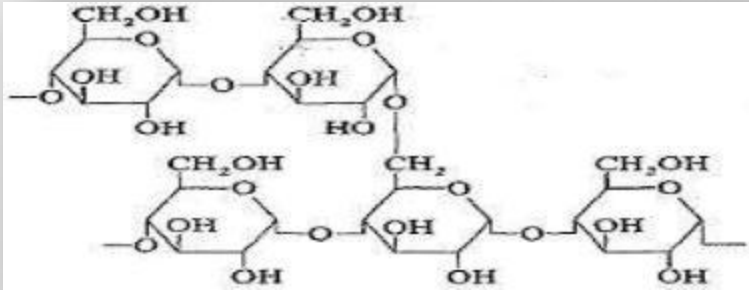


- **Wheat starch: Simple Lenticular Granules-**  
Circular (or)Oval compound granules  
2-4 Components

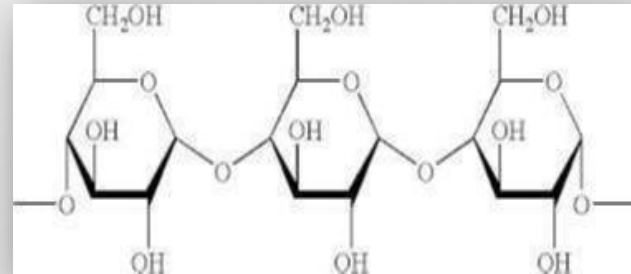


✓ **Chemical constituents:** Amylose(water-soluble).

Amylopectin(water insoluble) .



**Amylopectin**



**Amylose**

✓ **.Uses:**

- Demulcent , protective, absorbent
- Dusting talcum powder preparation.
- Disintegrant , Diluent.

✓ **Substitutes & adulterants:**

- Topica starch(or)cassava(or)Brazilian arrow shoot

# Macroscopic characters of Individual drugs

COMPOUNDS	AGAR	GUAR GUM	ACACIA
COLOUR	Yellowish grey(or)white	Colourless (or)pale yellowish	Tears-cream brown to red . Powder-light brown
ODOUR	odourless	characteristic	odourless
TASTE	mucilaginous	gummy	Bland & mucilaginous
SHAPE	Stripes, sheets, flakes		Irregular brown tears
SIZE	Sheets(45- 60cmlong) Stripes(4mm w)		varying

HONEY	ISABGOL	PECTIN	STERCULIA
pale yellow to yellowish brown	pinkish grey to brown	cream (or) yellowish powder	light pink to very dark
characteristic, pleasant		odourless	vinegar
sweet and faintly acidic		mucilaginous	mucilaginous
	Ovate cymbiform		Irregular masses
	10-35mm length 1-1.75mm width		

## CONCLUSION

- ◉ Carbohydrates are the 1<sup>o</sup> Metabolites which are stored in the form of Starch grains ,after 1<sup>o</sup> utilization by the plant itself it is considered to be an Important Precursor for Biosynthesis of various 2<sup>o</sup> Metabolites which are Medicinally Important.
- ◉ Later on scientific evaluation leads to usage of carbohydrates as pharmaceutical aid such as Binders, Diluents , Lubricants & Emulsifying agent.
- ◉ Now-a-days the synthetic chemicals are incompatible with various pharmaceutical formulations which are replaced by natural agents like carbohydrates .
- ◉ Here I conclude evaluation of different natural agents which are applicable for the preparation of various pharmaceutical dosage forms in necessary for the future.



## ❖ REFERENCES:

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*Thank*  
YOU