Take notes while watching the following video tutorials to prepare for the "Carbohydrates Activity".

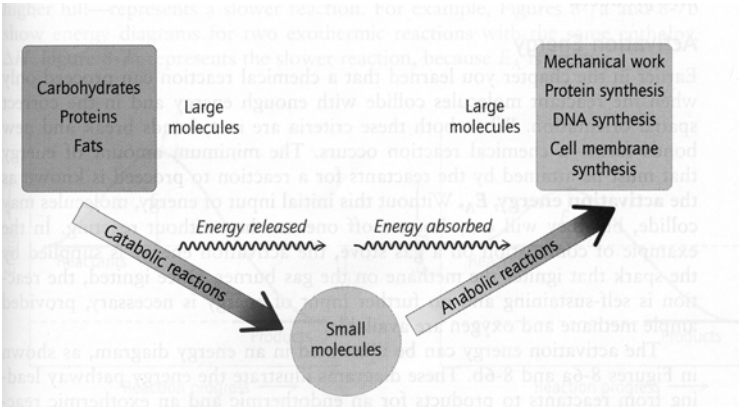
Introduction to Proteins, Carbohydrates, Lipids, and Bioenergetics

Metabolism and Bioenergetics

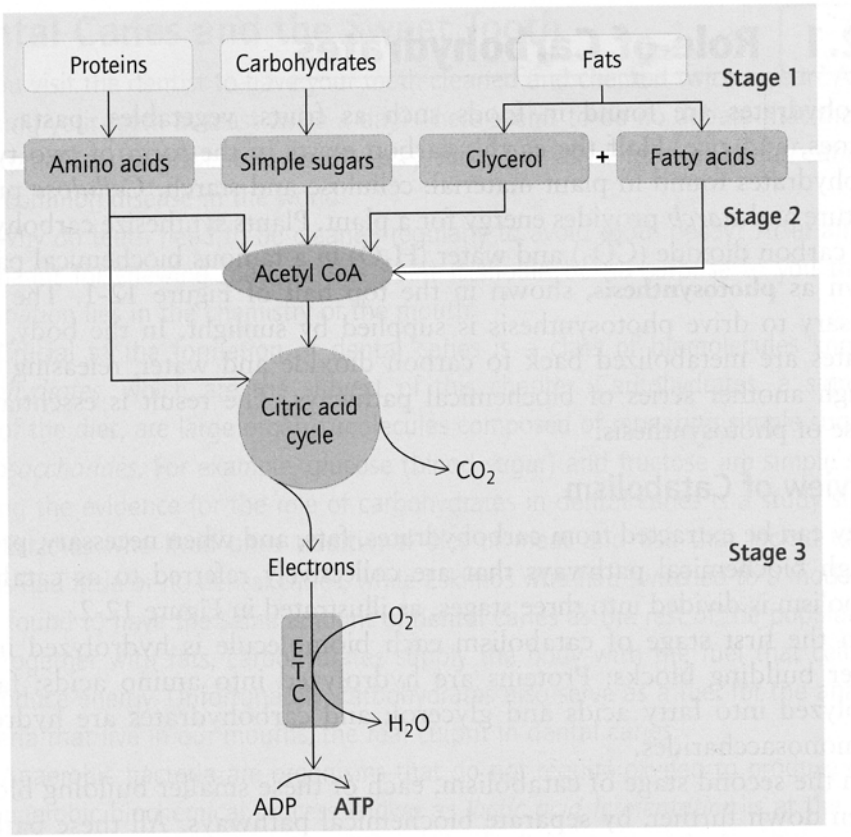
Metabolism – ALL biochemical reactions involving the use, production & storage of energy

Anabolism – Synthetic (reductive) metabolic reactions that require energy

Catabolism – Degradation (oxidative) metabolic reactions that produce energy



Overview of Catabolism



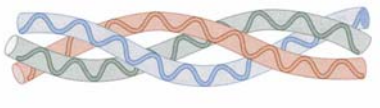
Proteins: Structure and Function

Proteins perform many important functions:

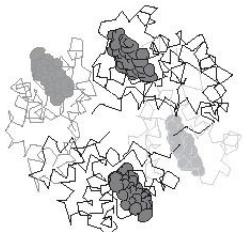
Type	Function	Examples
Structure	Shape / Support	Collagen – provides structure to tendons & cartilage
Enzymes	Catalysis	Enzymes aid in biochemical reactions (Amylase begins digestion of carbohydrates by hydrolysis.)
Hormones	Regulate body functions	Insulin – facilitates use of glucose for energy generation
Storage	Make essential substances	Myoglobin – stores oxygen in muscles
Contraction	Do mechanical work	Actin & myosin – govern muscle movement
Protection (Immunity)	Defend body against foreign matter	Immunoglobulin – aids destruction of invading bacteria
Transport	Carry substances through body	Hemoglobin - transports O_2 in blood Membrane proteins - perform active transport

Proteins are made of long chains of amino acids bonded together and folded into a particular shape. Proteins can be described as fibrous, globular, or membrane. The specific shape of each protein is individualized to help it perform a specific function.

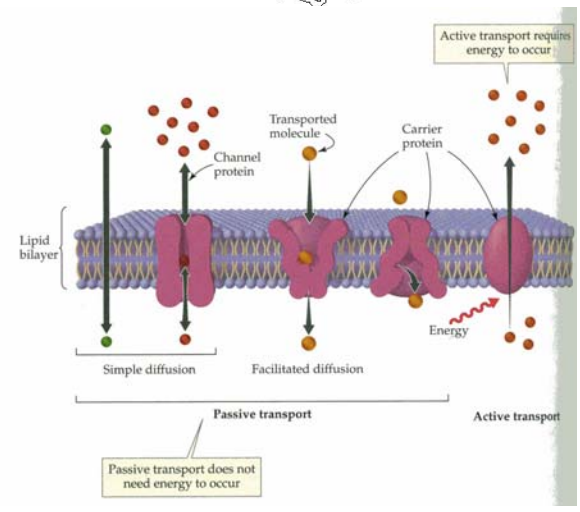
Fibrous Proteins
primarily found in structural proteins



Globular Proteins
enzymes, immunity, transport



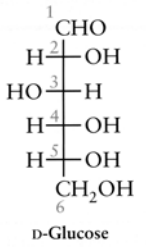
Membrane Proteins
help transport substances
in & out of cell
through the cell membrane

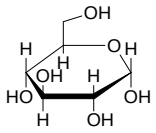


Carbohydrates: Structure and Function

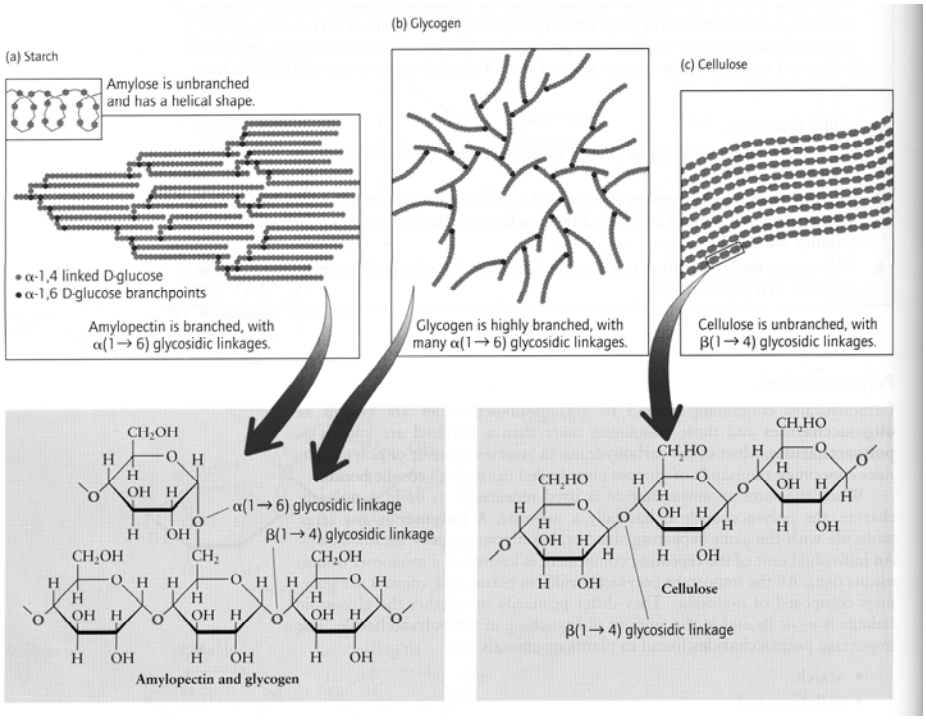
Carbohydrates are a class of biomolecules w/ a variety of functions.

1. energy source & storage as starch or glycogen

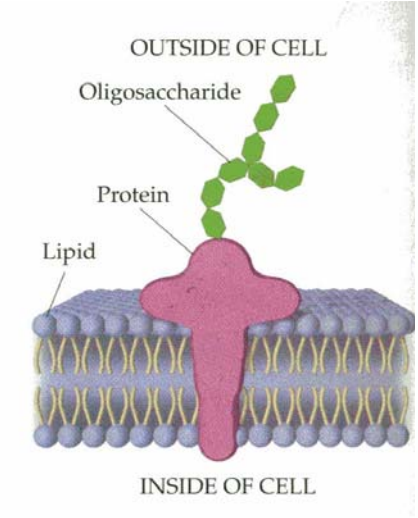




2. create structural support for plants and animals

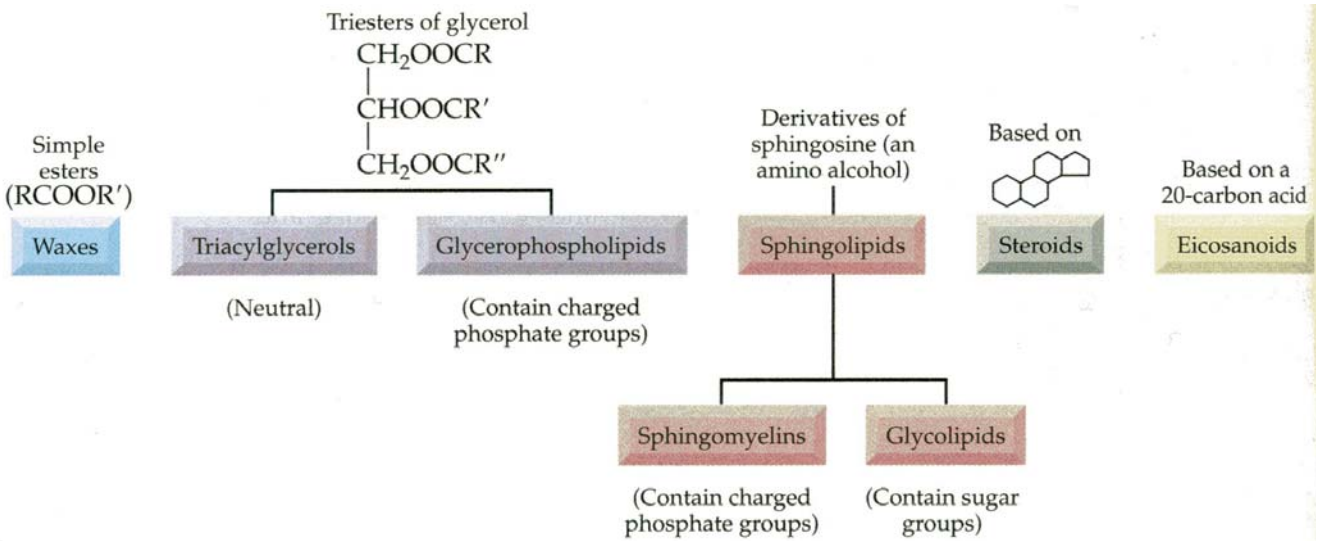


3. Glycoproteins –receptors on cell membranes.



Lipids: Structure and Function

Lipids are naturally occurring molecules from plants or animals that are NOT soluble in water. Lipids are classified by a combination of their structure and function.



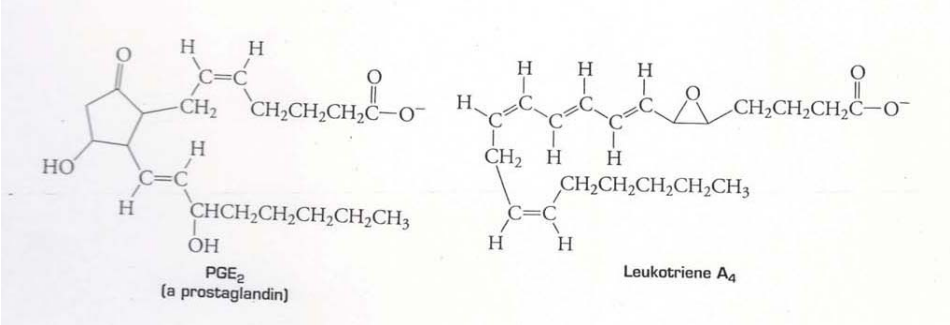
Waxes: water barrier

Triglycerides: long term energy storage

Phospholipids & glycolipids: cell membranes

Steroids: cholesterol and its derivatives (bile acids, vitamin D, and sex hormones)

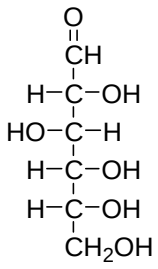
Eicosanoids: compounds involved in our body's inflammatory response to trauma and infection

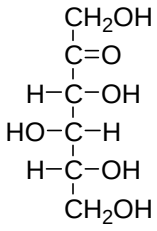


Carbohydrates Part 1: Introduction & Monosaccharides

Carbohydrates are polyhydroxyaldehydes, polyhydroxyketones, or compounds that yield them after hydrolysis.

Circle the aldehyde or ketone in each structure below.





Video Error Correction

This ketohexose is D-sorbose, NOT D-fructose as stated in the video.

classification

classification

What is the molecular formula for each structure above?

Hypothesize the origin of the term carbohydrate.

Carbohydrate Vocabulary & Classification

Carbohydrates are classified by the number of simple sugars bonded together.

Monosaccharides

Disaccharides

Oligosaccharides

Polysaccharides

Aldose

Ketose

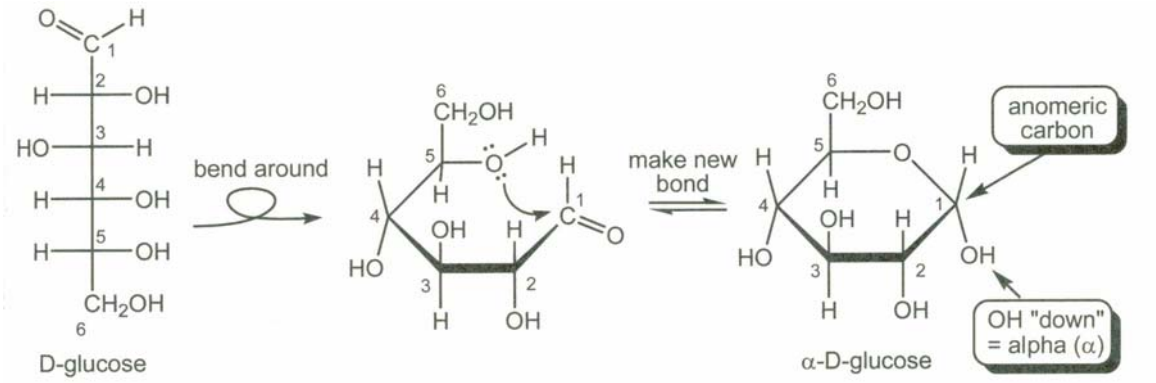
Pentose

Hexose

The terms aldose, ketose, pentose and hexose can be mixed to describe sugars (carbohydrates). Use these terms to characterize the two monosaccharides at the top of this page.

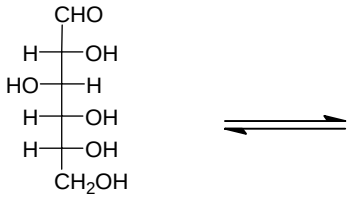
Monosaccharides – Cyclic Structure

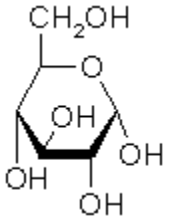
Simple 5- and 6-carbon sugars can react with themselves to make cyclic structures.

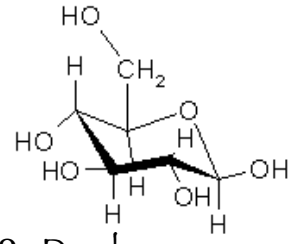


There are several ways to show cyclic monosaccharides.

Fischer Projection Haworth Projection Chair Conformation

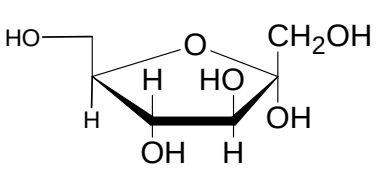




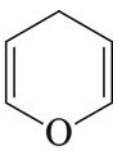


D-glucose α-D-glucopyranose β-D-glucopyranose

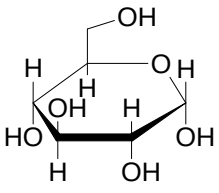
Sugars exist almost exclusively as five and six-membered rings that include 1 oxygen atom in the ring so they are named after furan and pyran.



Furan



Pyran



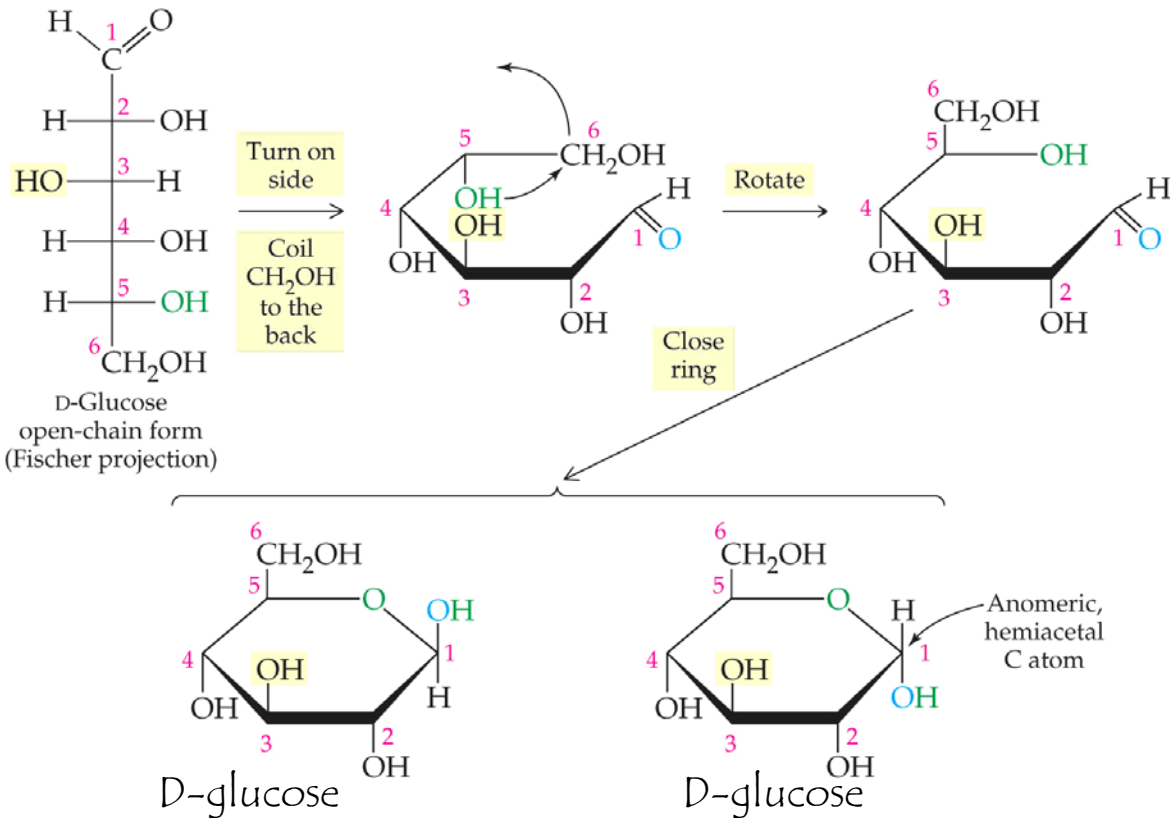
Anomeric Carbons: carbon atoms that are bonded to two different oxygen atoms in a carbohydrate

The anomeric carbon gets the lowest possible number.

Anomeric Carbons – two orientations

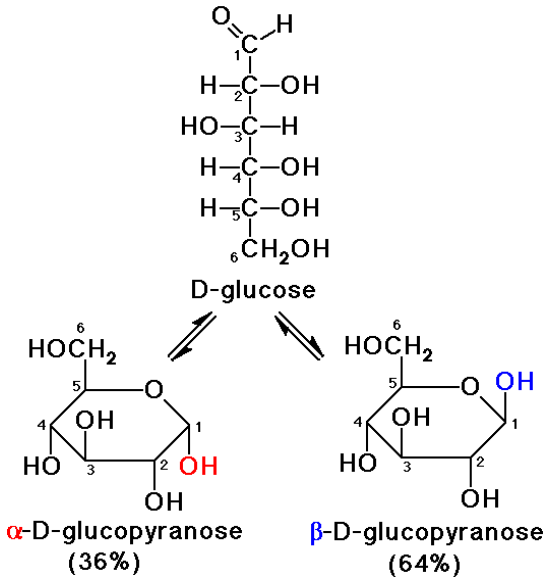
β-anomer:

α-anomer:



Are the anomeric carbons chiral?

Mutarotation: a pure form of an α or β carbohydrate is converted to a mixture of the two forms



Point an arrow to the anomeric carbons in the structures above.

Simple sugars are constantly converting back and forth from the open chain to the closed ring.

The furanose and pyranose names are frequently omitted from the sugar name, because it is assumed that we all know sugars are primarily found in their cyclic form.

Monosaccharides to Know

Glucose – the most widely occurring monosaccharide.
D-glucose is a source of energy to fuel biochemical reactions.

Fischer Projection

Haworth projection (α-D-glucose)

Galactose – the widely distributed in plant gums and pectins and is found in milk sugar (the disaccharide lactose). It is also synthesized in the body from glucose as a component of glycolipids & glycoproteins.

Fischer Projection

Haworth projection (β-D-galactose)

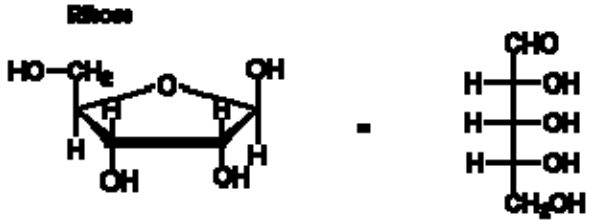
Monosaccharides to Know

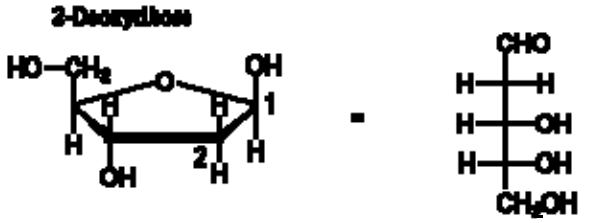
Fructose – found in honey, fruit, table sugar (the disaccharide sucrose), and sweeteners (high fructose corn syrup).

Fischer Projection Haworth projection α-D-fructose

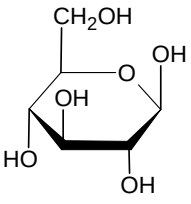
Modified Monosaccharides

Ribose & Deoxyribose – These two sugars are found in biomolecules such as ATP, coenzyme A, & nucleic acids (DNA & RNA).

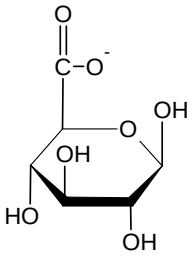




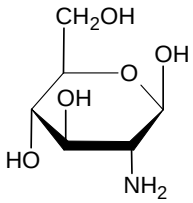
Other Modified Monosaccharides found in the fluids that lubricate joints



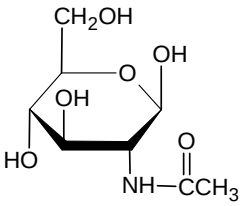
β-D-glucose



β-D-gluconate



β-D-glucosamine

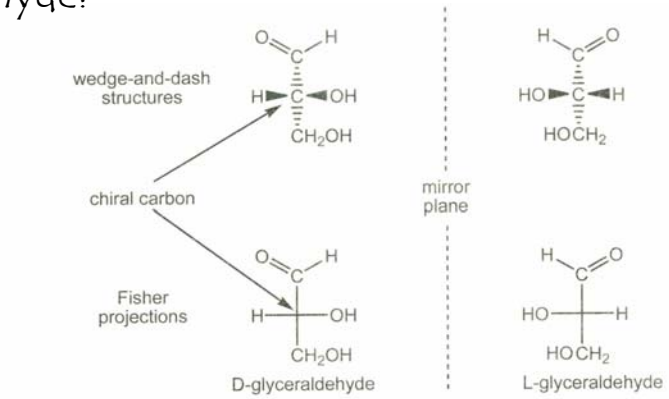


N-acetyl-β-D-glucosamine

Carbohydrates Part 2: Stereochemistry of Monosaccharides

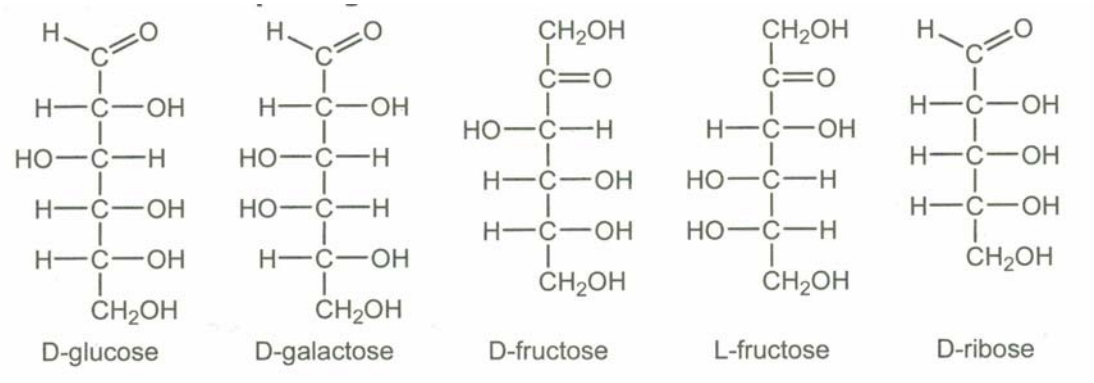
Glyceraldehyde – the simplest sugar

What is the relationship between the two possible structures for glyceraldehyde?



Note: 1) Most common sugars of biological significance have the D configuration.
2) Fischer Projections – another way to show stereochemistry

Star each chiral carbon in the following common sugars.



Enantiomers: non-superimposable mirror images

Diastereomers: non-superimposable stereoisomers that are NOT mirror images

What is the relationship between the L & D isomers of fructose?

What is the relationship between D-glucose & D-galactose?

What is the relationship between D-glucose & D-fructose?

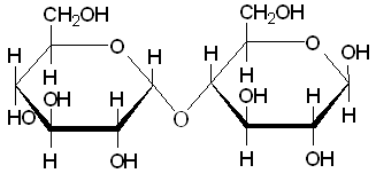
Carbohydrates Part 3: Disaccharides & Glycosidic Bonds

Glyco- is a prefix used to indicate the presence of sugars in biological molecules

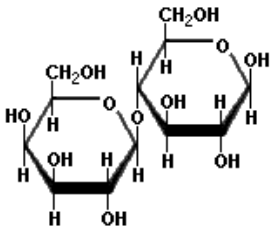
Glycosidic bonds link monosaccharides into disaccharides, oligosaccharides, and polysaccharides or link saccharides to other biological molecules through their hydroxyl groups. Glycosidic bonds always form between the anomeric carbon of the sugar on the left and the hydroxyl group of another sugar or biological molecule on the right. Glycosidic bonds are classified by the configuration of the anomeric carbon (α or β) and the location of the other hydroxyl group.

Practice Classifying Glycosidic bonds of these Disaccharides

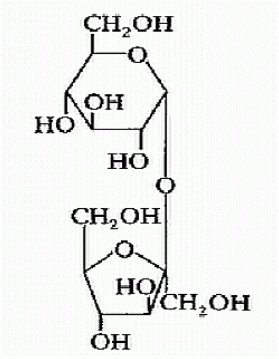
Maltose



Lactose

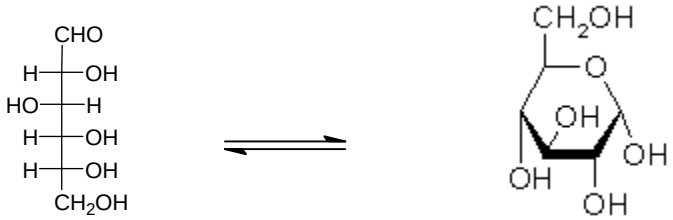


Sucrose

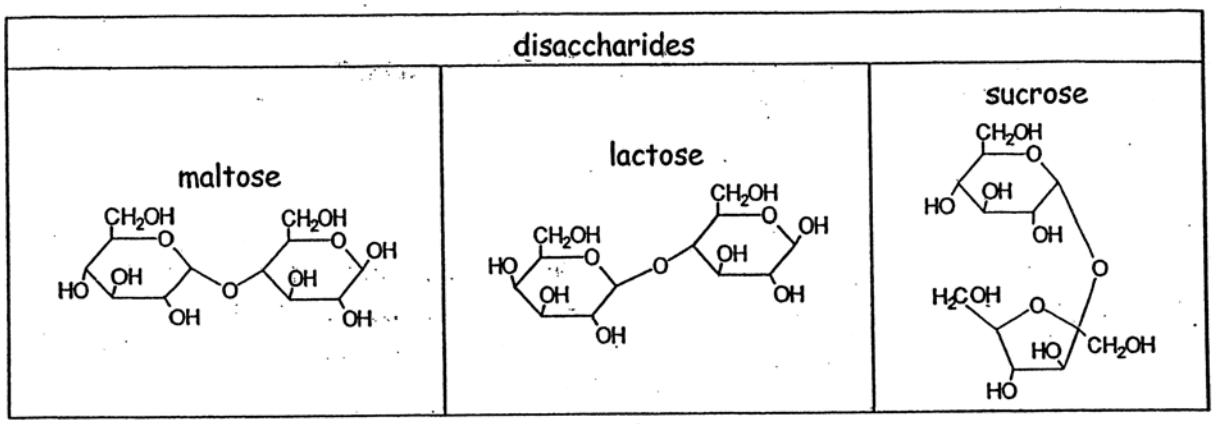


Reducing Sugars

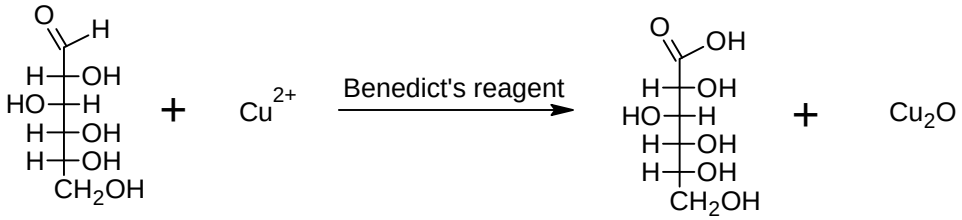
Not all sugar rings can open. Only the anomeric carbons that are bonded to one hydroxyl group can open. Anomeric carbons bonded to two ether groups are locked closed.



Identify which of the following rings can open. Find the anomeric carbons and draw arrows to the glycosidic bonds in the compounds below.



When the ring can open the sugars can be oxidized, and the sugars are described as reducing sugars in the same way we use the term reducing agent.
Which of the sugars above are reducing sugars?

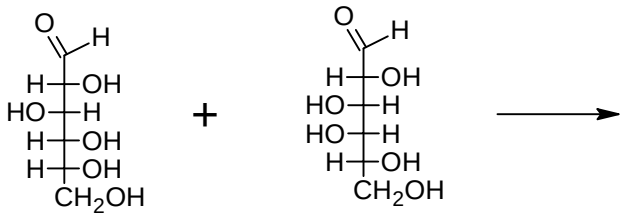


Name the two monosaccharides below.

Draw each monosaccharide in its β form using a Haworth projection.

Draw the disaccharide formed by a β-(1,4) glycosidic bond using Haworth projections.

Is the resulting disaccharide a reducing sugar?

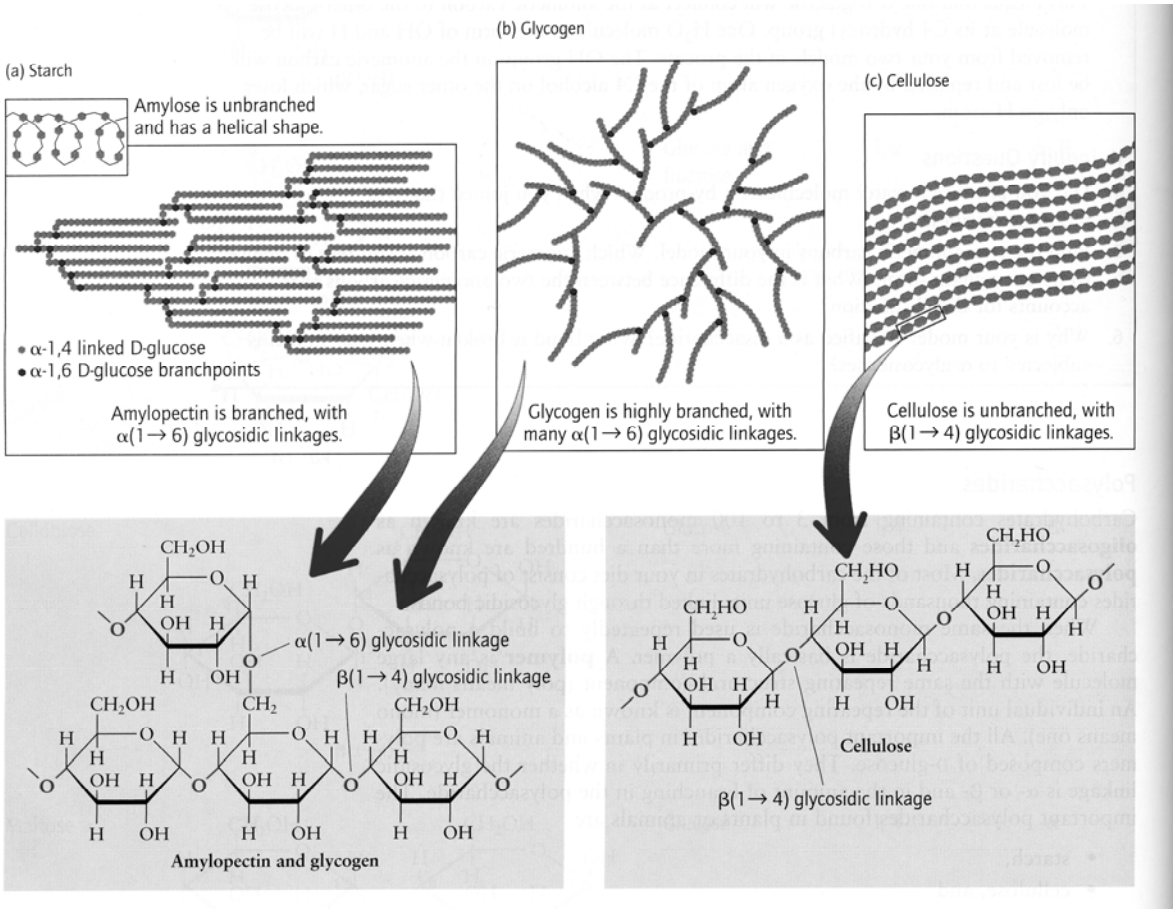


Carbohydrates Part 4: Polysaccharides

Polysaccharides are polymers containing > 100 monosaccharides. They are not soluble in water but their many hydroxyl groups become hydrated and form thick suspensions.

Important Polysaccharides to know

Starch & Glycogen vs Cellulose



Starch is comprised of amylose and amylopectin.

This spacer page supports 2-sided copying of our Video Tutorial Lecture Outline Packet.