



INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

SACCHARIDES = CARBOHYDRATES

Carbohydrates are a group of substances that are important in many biological processes. The following questions should help you to state what the biological functions of carbohydrates are.

1. *What are some foods you eat that contain carbohydrates?*
2. *What carbohydrates are present in table sugar, milk, and wood?*
3. *What is meant by a "high-fiber" diet?*

Biological roles of carbohydrates:

-
-
-
-
-

All carbohydrates contain the atoms of,, and, They have the general formula

Classification of carbohydrates:

- monosaccharides = simple sugars
- disaccharides: monosaccharide units
- polysaccharides: monosaccharide units

4. *Indicate the number of monosaccharide units (1, 2, or many) in each of the following carbohydrates.*

Sucrose	Cellulose
Amylose	Maltose
Fructose	Glucose

MONOSACCHARIDES

Monosaccharides are simple sugars. White crystalline solids, dissolve in water because their -OH groups form with water.

They all have the general formula $(CH_2O)_n$, showing that the elements are always present in the same ratio (n can be any number from 3 to 7). Monosaccharides are grouped according to the value of n :



INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

- a. in trioses $n = 3$
 b. in tetroses $n = \dots\dots$
 c. in $n = 5$
 d. in $n = 6$
 e. in $n = \dots\dots$

Chemically, monosaccharides are classified as

- **Aldoses** = polyhydroxyaldehydes
 - **Ketoses** = polyhydroxyketones
5. *What functional groups can you find in them?*

	ALDOSE	KETOSE
$n = 3$	Molecular formula:.....	

*There are conventions for drawing the structure of monosaccharides which often have puckered rings difficult to represent on a 2D piece of paper. They also have centres (= asymmetric C atoms attached to four different groups) so there are rules for representing the different **D and** forms.*

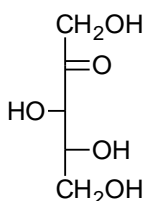
FISHER PROJECTIONS

e.g. Glyceraldehyde

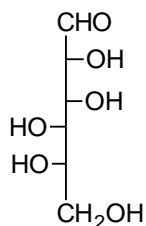
In the D-form the OH group on the bottom chiral centre is on the RIGHT!

Note: Naturally occurring sugars all D-forms!!!!

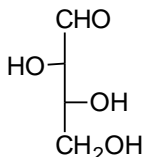
6. *Identify each of the following sugars as the D or L isomer.*



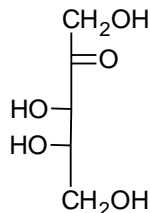
___ - Xylulose



___ - Mannose



___ - Threose



___ - Ribulose

7. Write the mirror image of each of the sugars in the previous task and give the D or L name.

$n = 4$

Molecular formula Let's only consider ALDOTETROSES.

8. Write down the formulae for all possible aldotetroses.

9. How many chiral centres do aldotetroses have?

..... chiral C atoms, it means isomers = **2 pairs of enantiomers**.

$n = 5$

Molecular formula Let's only consider the important ALDOPENTOSE - ribose.

10. Write down both L and D forms of ribose and 2-deoxyribose.

How many chiral centres do aldopentoses have? chiral C atoms, it means
isomers = **4 pairs of enantiomers**.

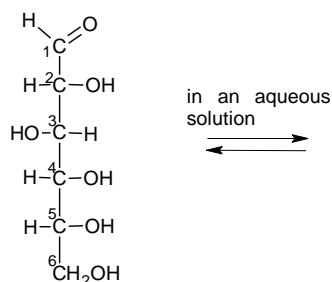
$n = 6$

Molecular formula

ALDOHEXOSES

How many chiral centres do aldohexoses have? chiral C atoms, it means
isomers = **8 pairs of enantiomers**.

The most important isomer is **D-GLUCOSE**.



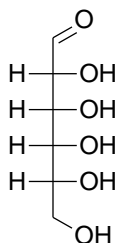
Haworth projection

Importance of glucose:

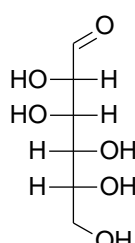
In blood it is in the form of glucose-6-phosphate (ester of)

Industrial use of glucose:

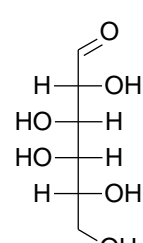
1. Draw Haworth structures for the following aldohexoses:



D-allose



D-mannose

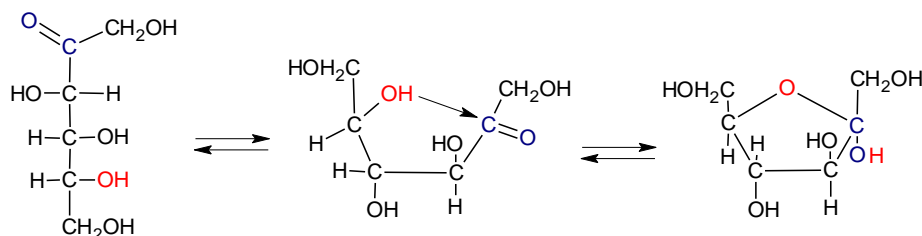


D-galactose

KETOHEXOSES

How many chiral centres do ketohexoses have? chiral C atoms, it means isomers = **pairs of enantiomers.**

The most important isomer is **D-FRUCTOSE**



2. What anomer of fructose is shown above? Draw the structure of the second possible anomer.

Properties and occurrence:

DISACCHARIDES

Disaccharides are two monosaccharide units joined together by a **glycosidic bond**.

monosaccharide(1) + monosaccharide(2) → disaccharide+ H₂O

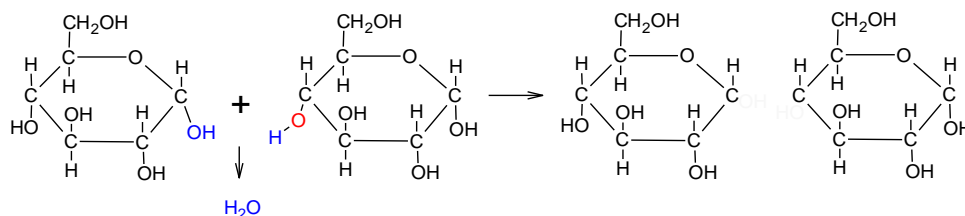
= CONDENSATION REACTION

..... + → SUCROSE + H₂O

In the most common disaccharides, maltose, lactose and sucrose, there is at least one glucose unit.

MALTOSE

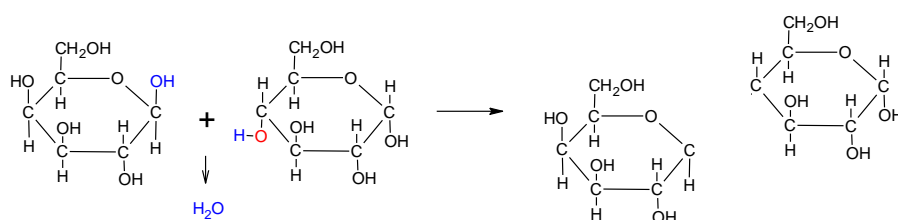
Two glucose units are linked by α-1,4 glycosidic linkage. The numbers 1, 4 indicate that the –OH on carbon 1 was bonded to the –OH on carbon 4 of the other glucose molecule. The symbol α indicates that



Note: end anomeric carbon corresponds to –CHO in the open chain. It is a **reducing sugar**.

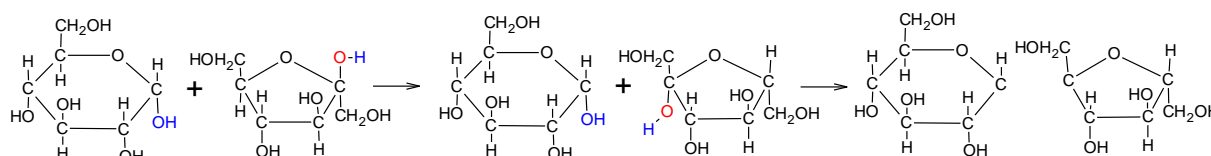
Maltose is an intermediate in the breakdown of starch – happens during the sprouting of barley – important in production.

LACTOSE



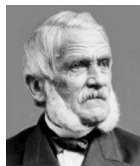
Note: Free anomeric carbon. Therefore a **reducing sugar**.

SUCROSE



Testing for reducing sugars

1. FEHLING'S TEST



Hermann von Fehling (1812 - 1885) was a German chemist, famous as the developer of Fehling's solution used for estimation of sugar.

2 cm³ of solution Fehling I (.....)
+
2 cm³ of solution Fehling II (.....)
+
Reducing sugar

}

2. TOLLENS' TEST



Bernhard Christian Gottfried Tollens (1841 – 1918) was a German chemist.

2 cm³ of Tollens'solution (.....)
+
Reducing sugar

}

POLYSACCHARIDES

Polysaccharides are of monosaccharide units. The most common monosaccharide unit is

STARCH

Reserve food in plants, stored in granules.

- By complete hydrolysis glucose can be made.
- By partial hydrolysis we can prepare dextrans or maltose.

Used in food industry, production of alcohol – fermentation.

With solution (.....) it gives characteristic colour.

Starch consists of **amylose**, an unbranched chain of glucose; and **amylopectin** which is a branched polymer of glucose.

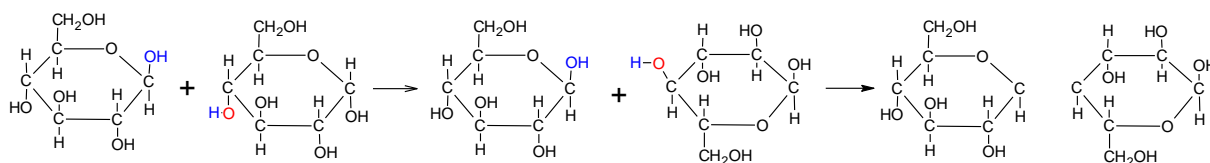
GLYCOGEN, the storage form of glucose in animals (animal starch), is similar to amylopectin with more branching.

It is present in liver and muscles.

- It helps maintain proper amount of glucose in blood by removing and storing the glucose.

CELLULOSE is also a polymer of glucose, but in cellulose the glycosidic bonds are β bonds rather than α bonds as in the starches. Humans can digest starches to obtain energy, but not cellulose.

However, cellulose is important as a source of fiber in our diets.



- Every second molecule flipped over \rightarrow chains
- Hydrogen bonds between chains \rightarrow and structure
- Component of cell walls
- Ruminants can digest it as they possess rumen =

Uses of cellulose:

<http://www.youtube.com/watch?v=yz8qDxkLG2A> = synthesis of nitrocellulose