BCHE2030 22-23
Tutorial 1

Lynn (CMBI 4)

Content

Water:

Different bondings between biomolecules

Henderson-Hasselbalch Equation

Carbohydrate:

Stereoisomer

Reducing property

Glycosidic bond

Polysaccharides

Q: Would there be any in class exercise? Is there any assignment or exercise?

A: Yes, there will be in class exercises.

2 questions will be asked at random time points during the tutoiral.

Attempt to answer these two questions via chatbox will be counted as your attendance.

(as long as you try to answer, mark will be given; no matter your answer is right or wrong)

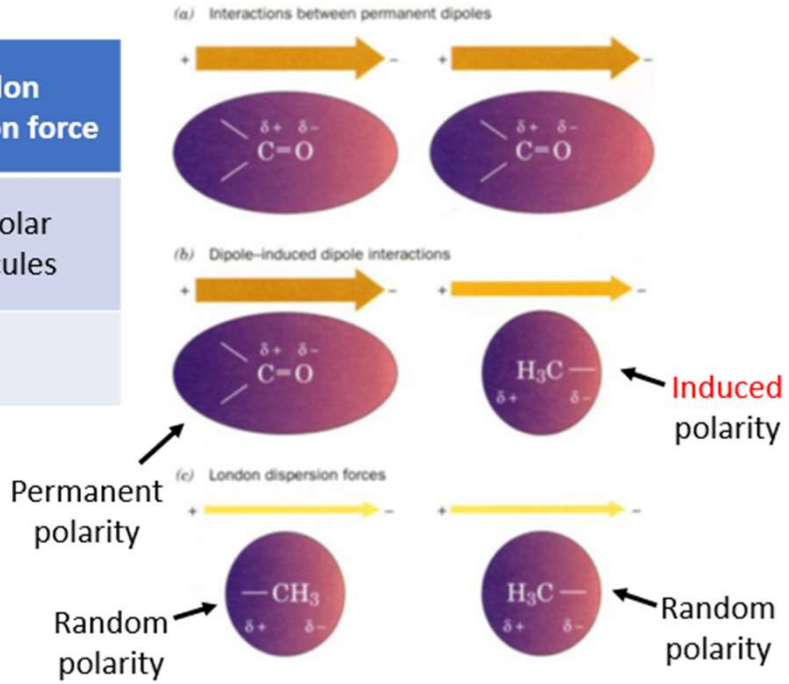
Please ensure your network is stable.

More exercises may be given depends on the content.

We do not set any assignment because we believe every student has their own learning pace. We encourage students to revise regularly and ask questions through the question pool.

Q: I want to know how to distinguish the intermolecular force between water and other molecules.

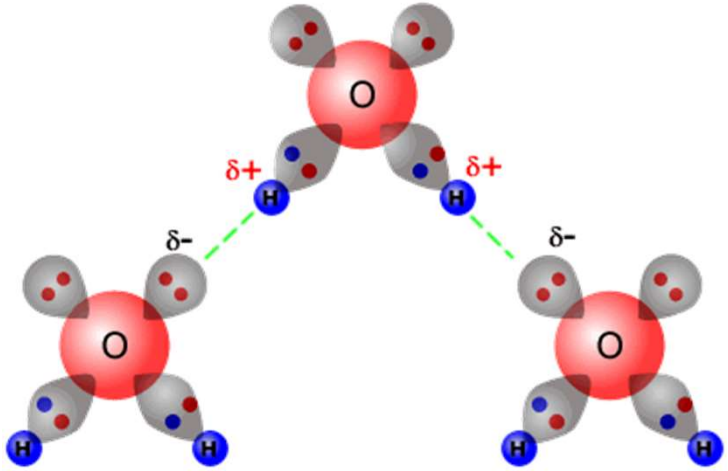
	Permanent dipoles	dipole-induced dipole interaction	London dispersion force
Partner	Polar molecules	Polar and nonpolar molecules	Nonpolar molecules
Strength (Big to small)	1	2	3



Since water is a polar molecule, it can only form permanent dipole-dipole interaction, dipole-induced dipole interaction or hydrogen bonds with other molecules.

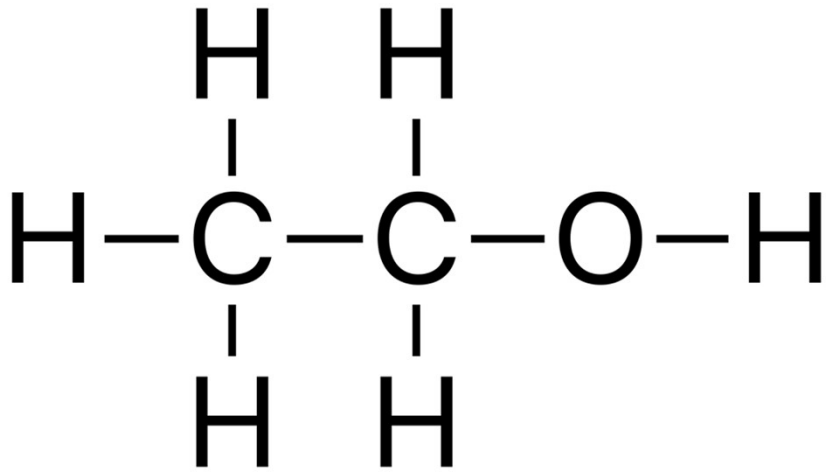
You may research for electronegativity if you would like to know more about these interactions.

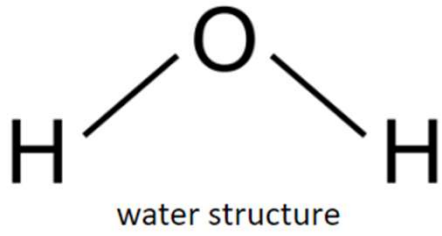
Hydrogen bonds



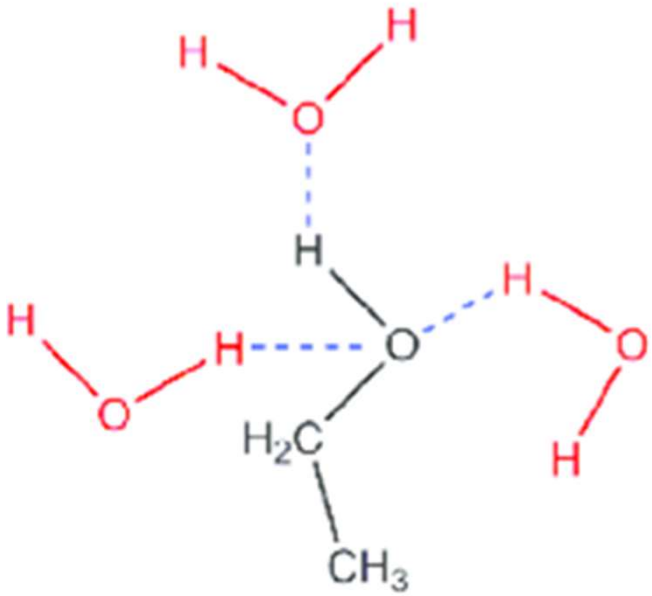
To test your understanding, let's examine the following molecule (ethanol) together:

When mix with water, how many hydrogen bond(s) can the below molecule form with water molecule(s)?





water structure



Ethanol

Henderson-Hasselbalch Equation

$$pH = pK_a + \log \frac{[conjugate\ base]}{[weak\ acid]} \text{ (for weak acid)}$$

$HA \rightleftharpoons A^- + H^+$ (in aqueous solution)

HA is the weak acid

A^- is its conjugated base

$$\text{Derived from Ka} = \frac{[A-][H+]}{[HA]}$$

$$\log Ka = \log[H+] + \log\frac{[A-]}{[HA]}$$

$$-\log Ka = -\log[H+] - \log\frac{[A-]}{[HA]}$$

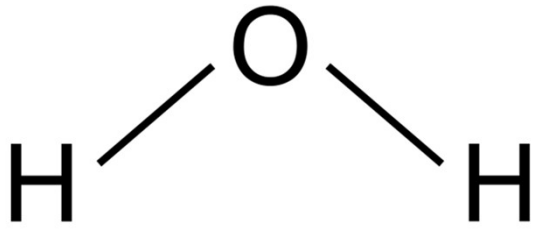
$$pKa = pH - log\frac{[A-]}{[HA]}$$

$$pKa = pH + (-1)\, log\frac{[A-]}{[HA]}$$

$$pKa = pH + log\left(\frac{[A-]}{[HA]}\right)^{-1}$$

$$pKa = pH + log\frac{[HA]}{[A-]}$$

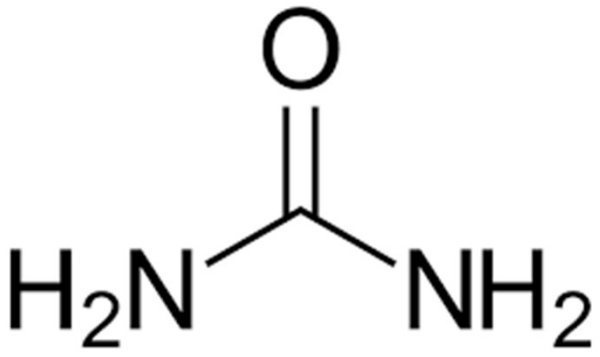
Quiz 1



water structure

When mix with water, how many hydrogen bond(s) can the below molecule form with water molecule(s)?

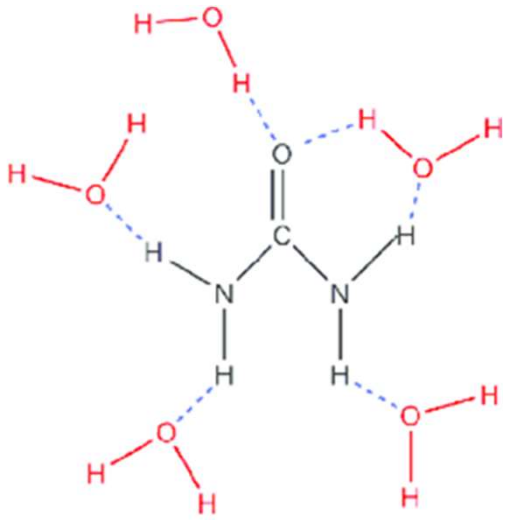
A. 3
B. 4
C. 5
D. 6
E. It cannot form any hydrogen bond.



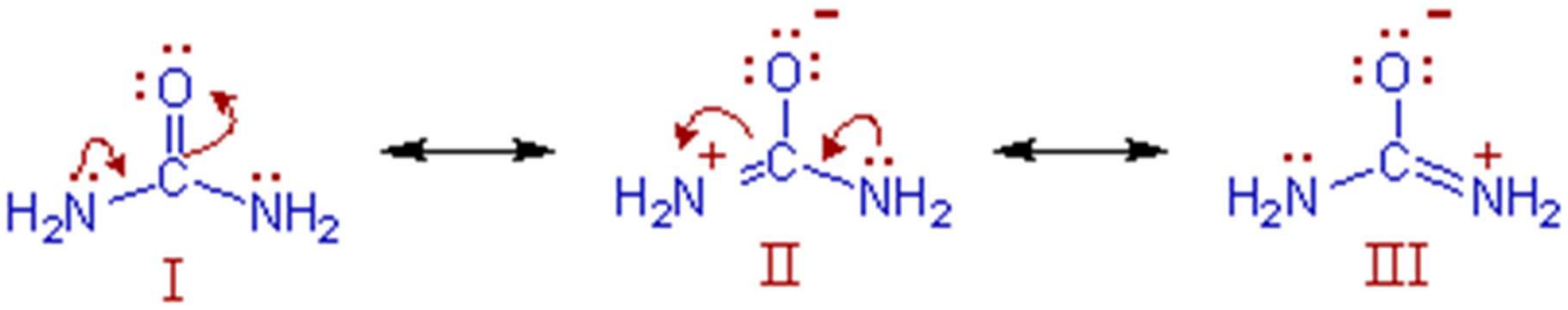
Quiz 1 (answer)

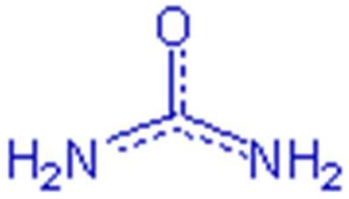
When mix with water, how many hydrogen bond(s) can the below molecule form with water molecule(s)?

Answer: D. 6



Urea





Resonance hybrid

Reducing sugar

sugars that contain a free aldehyde or ketone group which can reduce ferric (Fe3+) or cupric (Cu2+) .

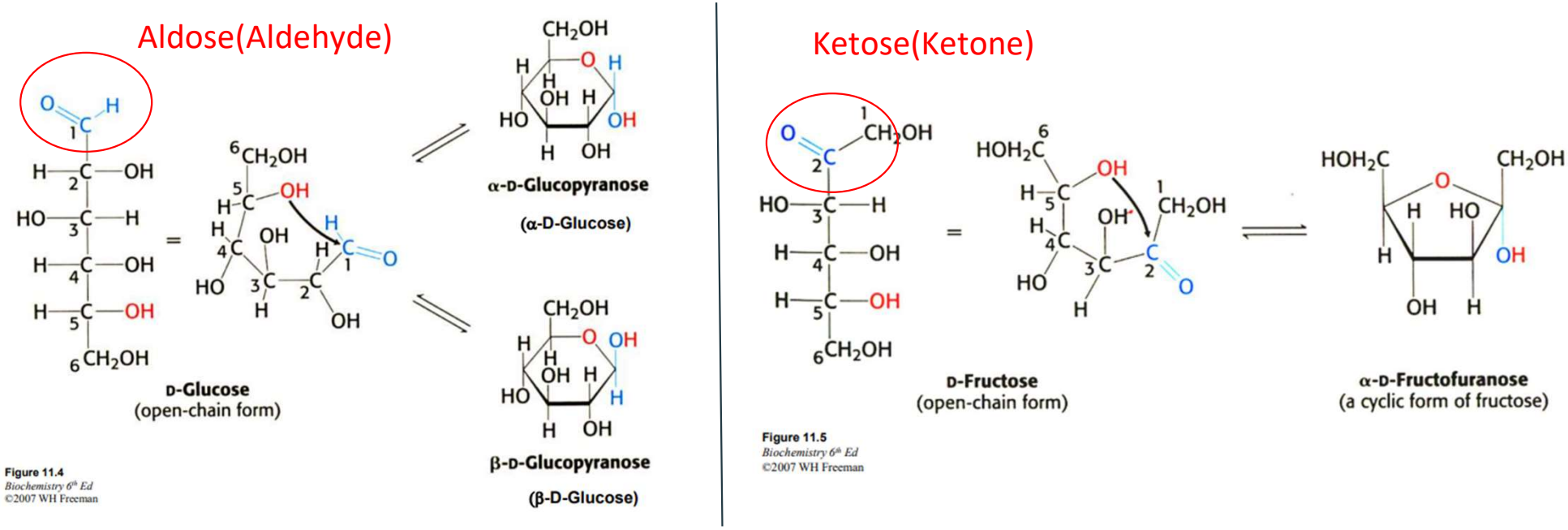
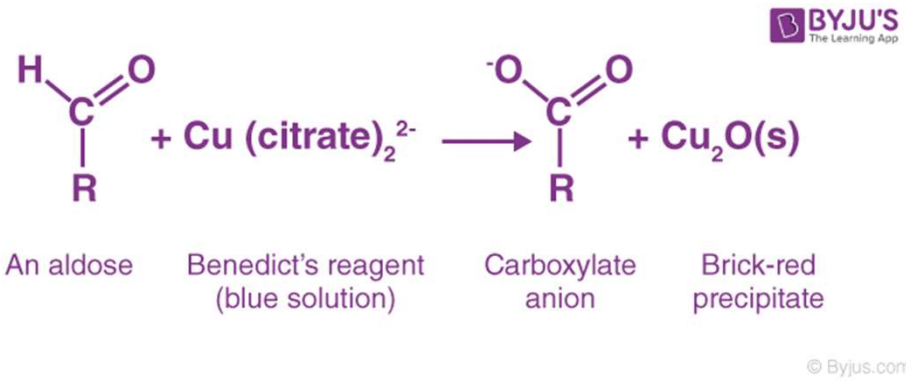


Figure 11.4
Biochemistry 6th Ed
©2007 WH Freeman

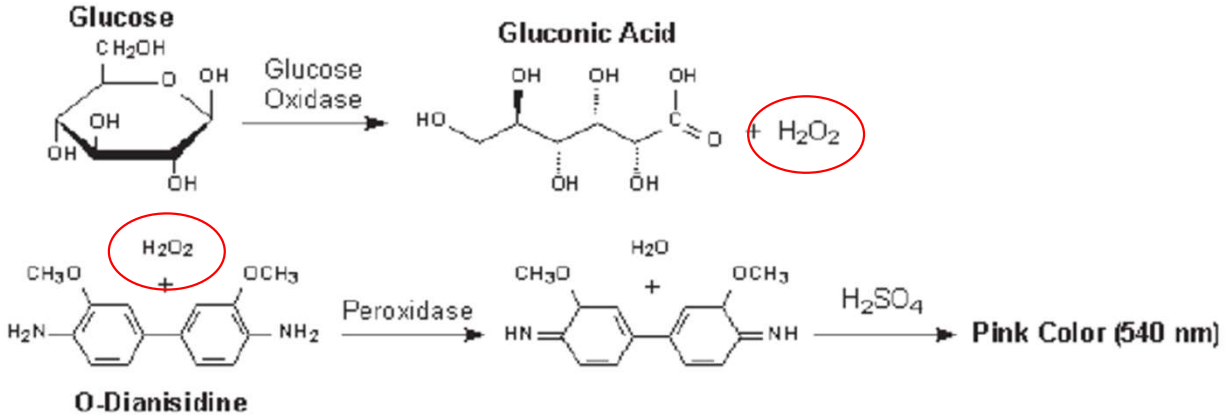
Figure 11.5
Biochemistry 6th Ed
©2007 WH Freeman

Reducing sugar Detected by blue benedict solution

result: (Blue -> Red)



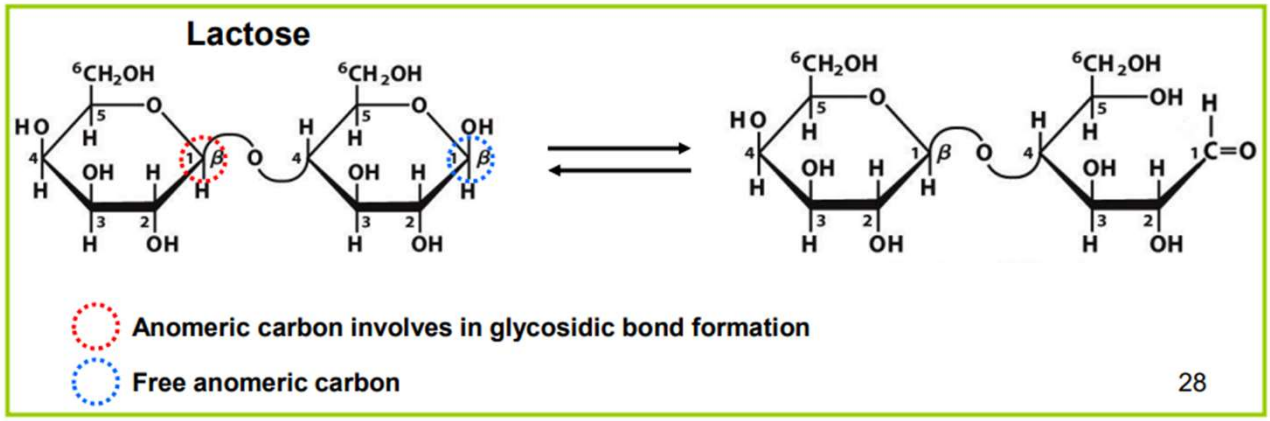
Glucose is detected by Colorimetric analysis through glucose oxidase, H2O2 & peroxidase (coupled reaction to form colored product)



Why sucrose is not reducing sugar?

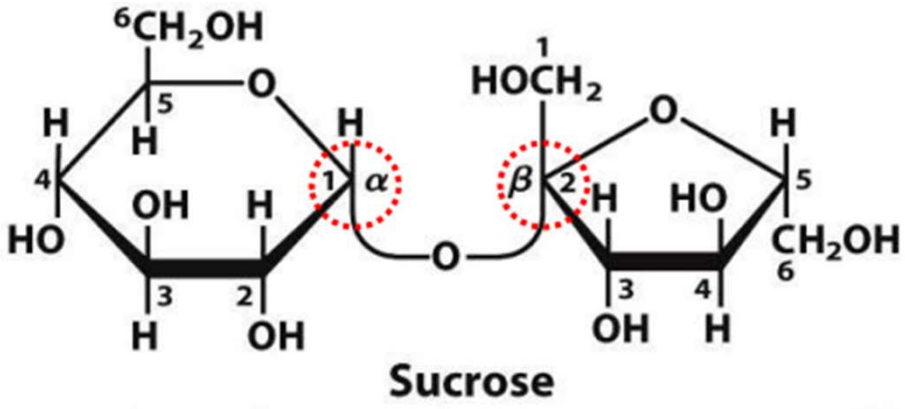
Reducing sugar

involve isomerization of anomeric carbon to become aldehyde or ketone group

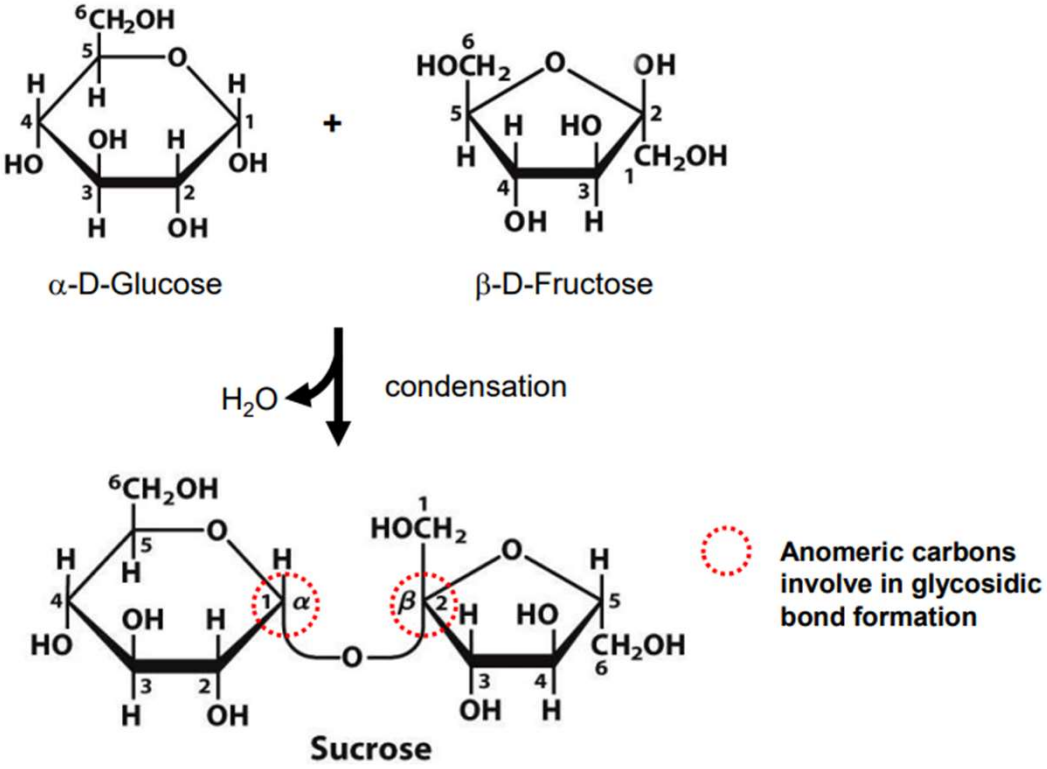


Non-reducing sugar

anomeric carbon is link together by glycosidic bond
✗glucose isomerizing to aldehyde
✗fructose isomerizing to α-hydroxy-ketone form



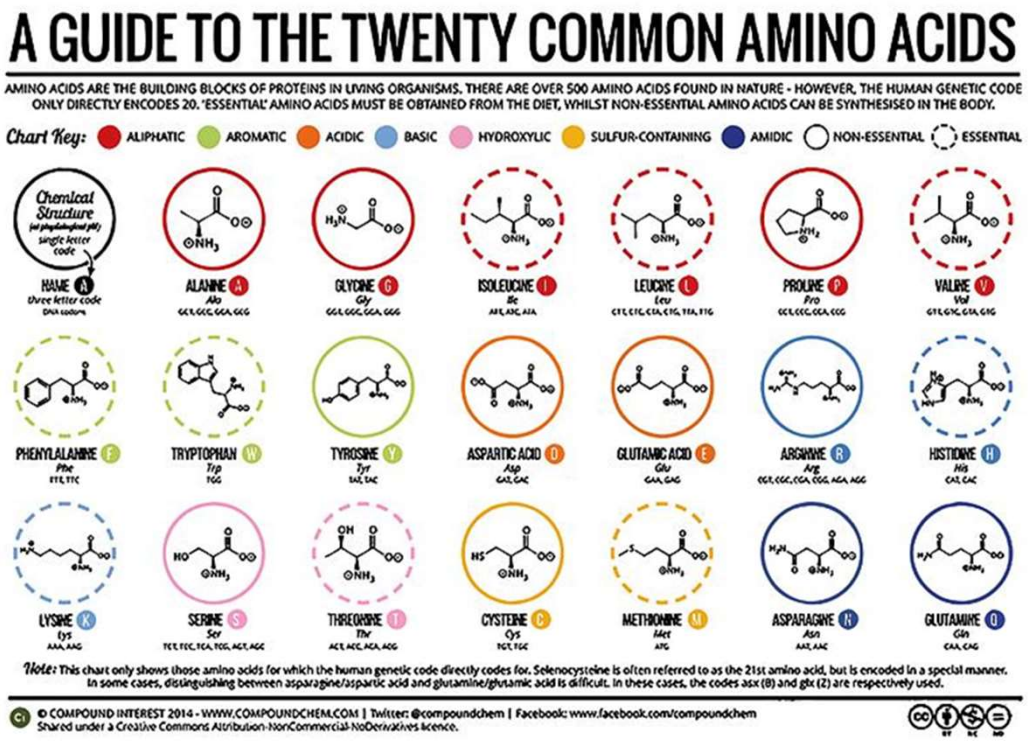
Q: What is the difference between fructose and sucrose?



Fructose is the composition of sucrose

Sucrose	**Fructose**
diassacharide	monossacharide
non-reducing sugar	reducing sugar

Q: Should we remember all the chemical structures and distinguish the protein structures? Any cheat sheet for the midterm?

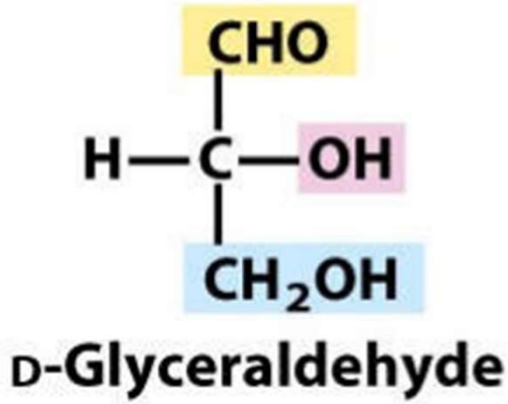


Stereoisomer

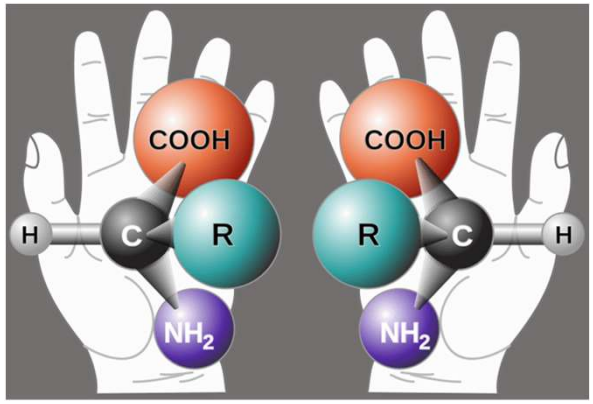
- Carbohydrate: at least one chiral carbon (asymmetric center) → same chemical formula, different atomic arrangement

- Enantiomer
- Diastereomer
- Epimer
- Anomer (α or β)

No. of stererisomer = 2^(n) (n= number of chiral carbon)



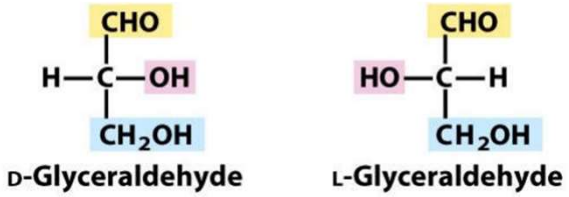
Enantiomer

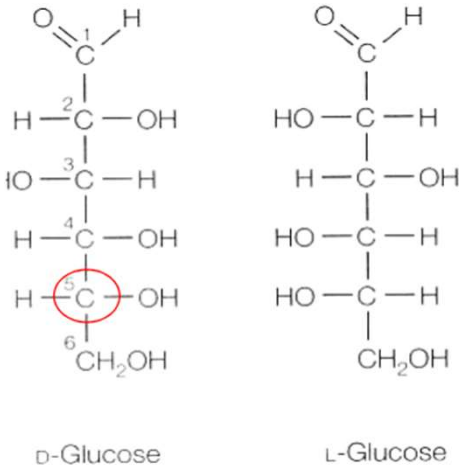


- Mirror image (left hand and right hand), non-superimposable
- In carbohydrate, D and L form are enantiomers

D-glucose: (3R,4S,5S,6R)-6-(hydroxymethyl)oxane-2,3,4,5-tetrol

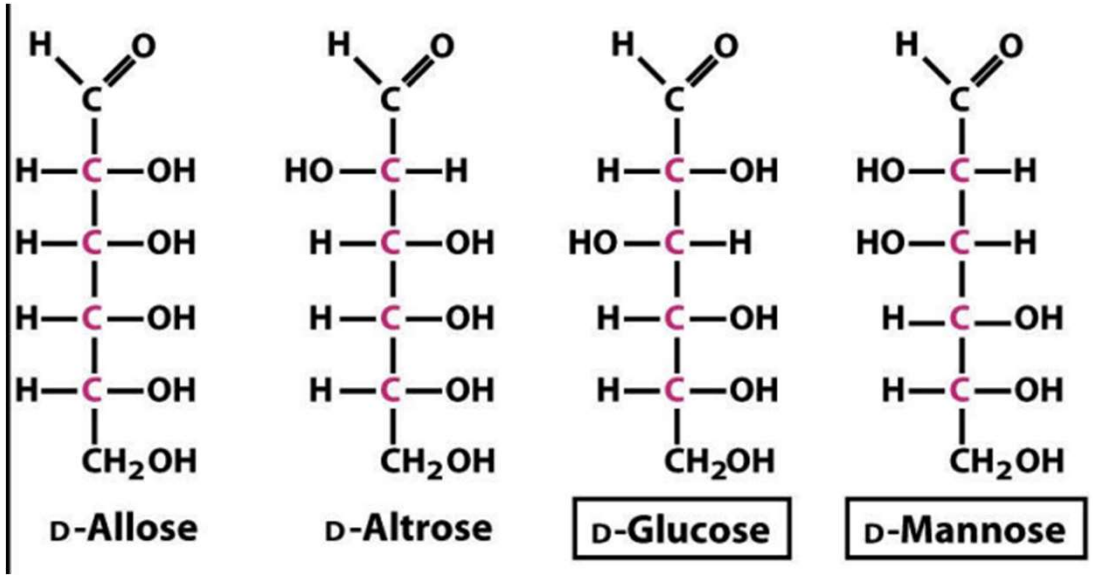
L-glucose: (3S,4R,5R,6S)-6-(hydroxymethyl)oxane-2,3,4,5-tetrol





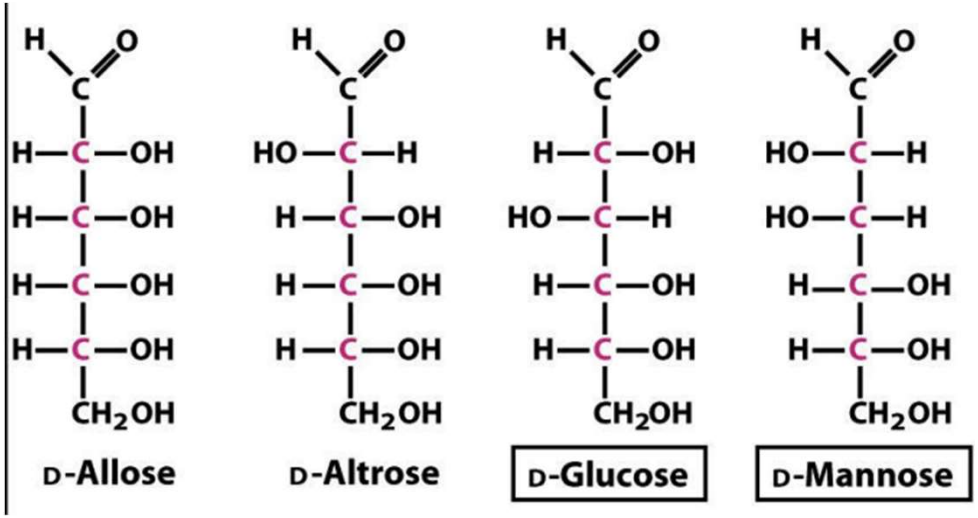
Diasteromer

- all stereoisomers except enantiomers (not mirror image)

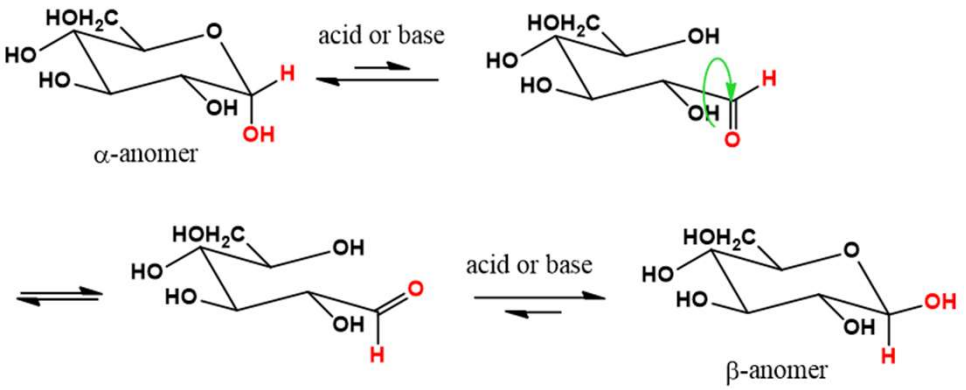


Epimer

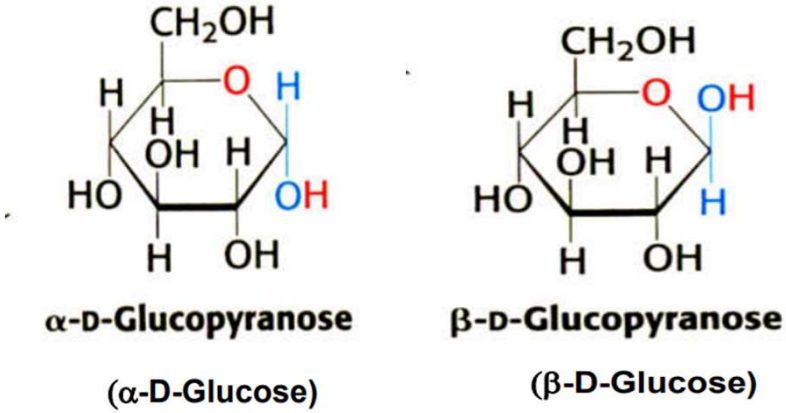
- Diastereomers that differs in the position of one carbon only
- Specify position (C-2 epimer)



Anomer



- only exist in cyclic carbohydrate
- interconvertible
- alpha: always down, beta: always up



Quiz 2

What is the relationship between D-lyxose and D-xylose

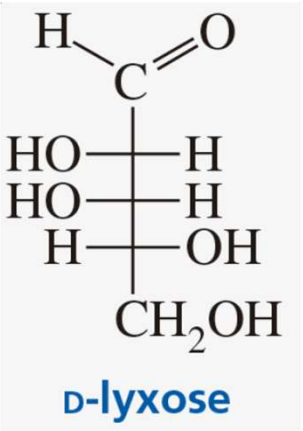
i) Enantiomer

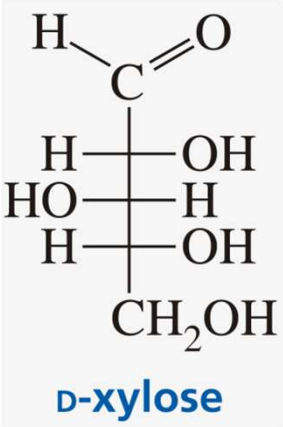
ii) Diastereomer

iii) Epimer

iv) Anomer

A) i and ii only
B) ii and iii only
C) i and iii only
D) iv only
E) all





Quiz 2

What is the relationship between D-lyxose and D-xylose

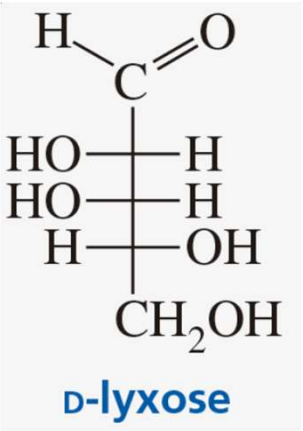
i) Enantiomer

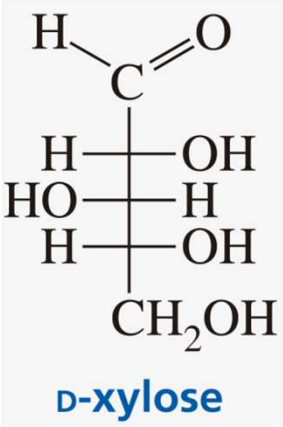
ii) Diastereomer

iii) Epimer

iv) Anomer

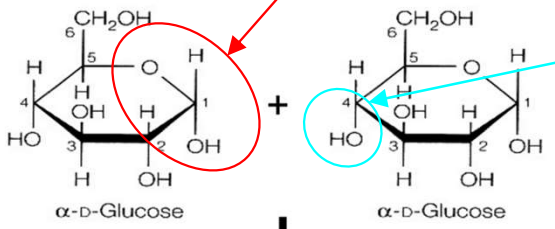
A) i and ii only
B) ii and iii only
C) i and iii only
D) iv only
E) all



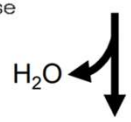


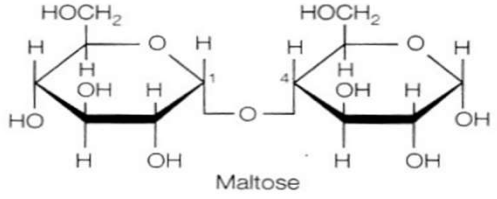
O-Glycosidic Bond

- between the **hemiacetal or hemiketal group** of a saccharide and the **hydroxyl group of another compound** (not necessarily another saccharide)

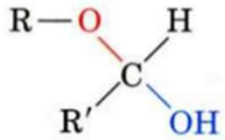


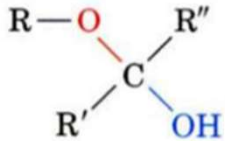
+

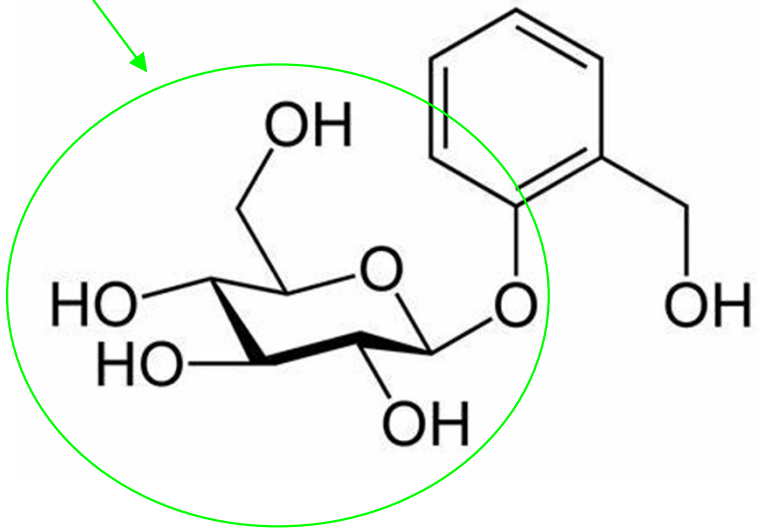




α1→4 glycosidic bond

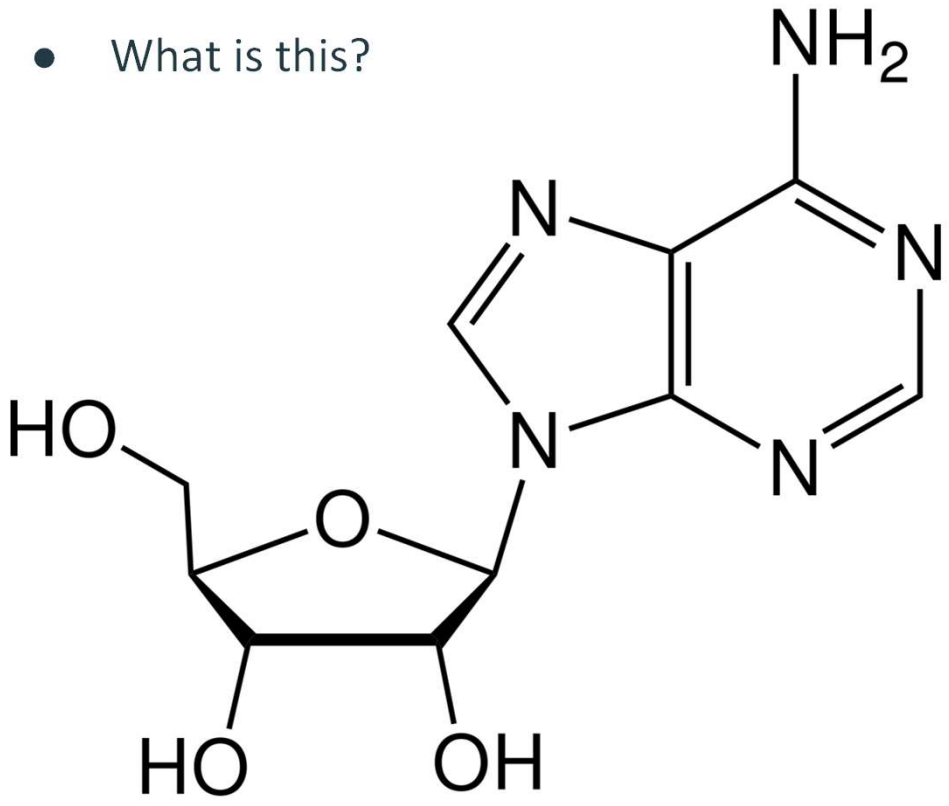






Glycosidic Bond

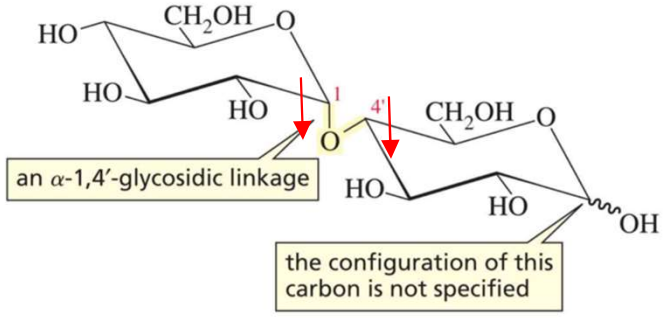
- What is this?

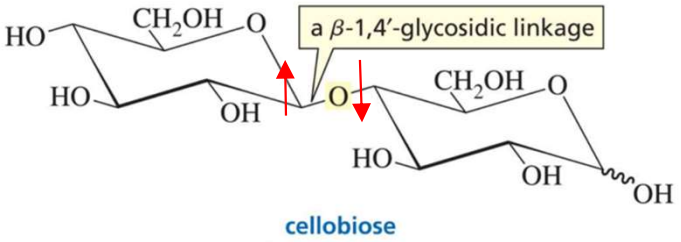


Answer:
Adenosine!
The component of RNA results from the sugar ribose and adenine via the formation of an **N-glycosidic bond**.
(Generally, there are S-, N-, C-, and O-glycosidic bonds. Among them, O-glycoside may be the most familiar one to us :))

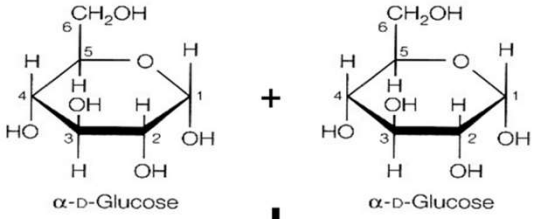
Glycosidic Bond

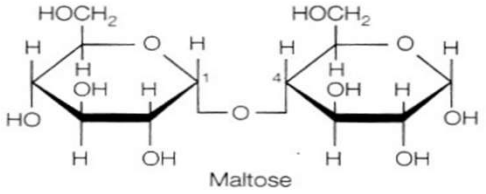
- Disaccharides: consist of two monosaccharides joined by a glycosidic bond
- **alpha glycosidic bond**: C->O, both ends point down / both ends point up
- **beta glycosidic bond**: C->O, one points up and one points down (zig-zag)





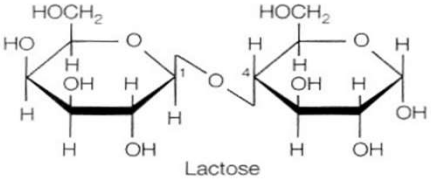
cellobiose





Maltose

α1→4 glycosidic bond

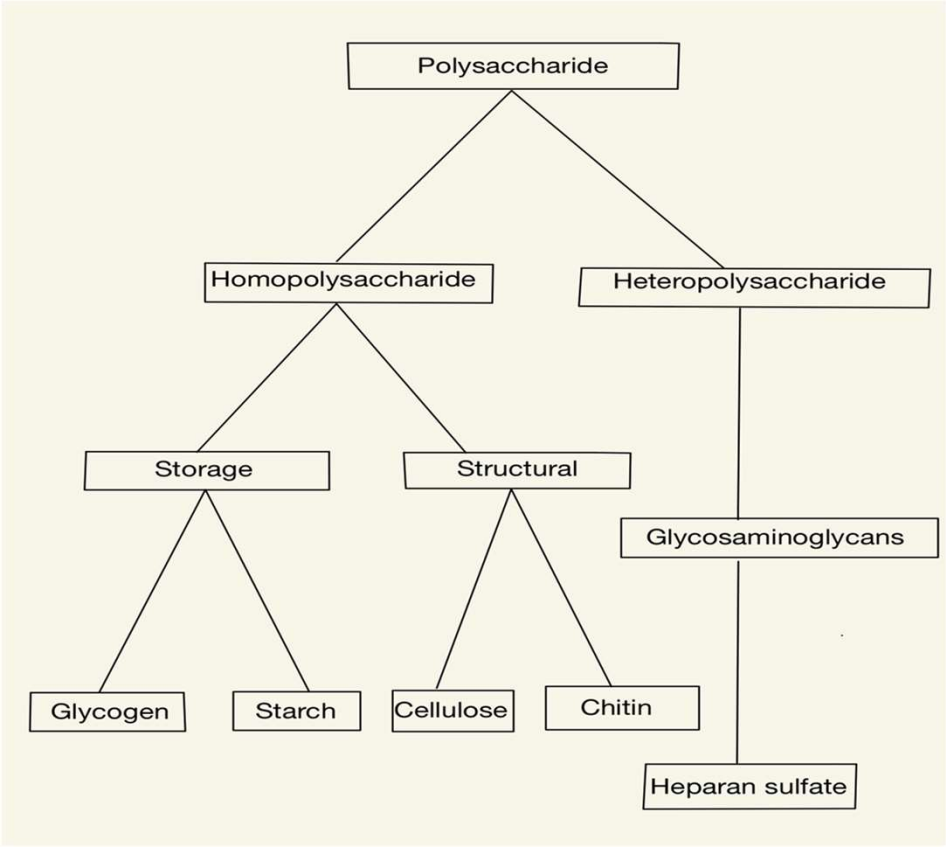


Lactose

β-D-galactose D-glucose

β1→4 glycosidic bond

Polysaccharides



Starch and Cellulose

Starch

Amylose: linear polymer of D-glucose joined by alpha 1-4 bonds

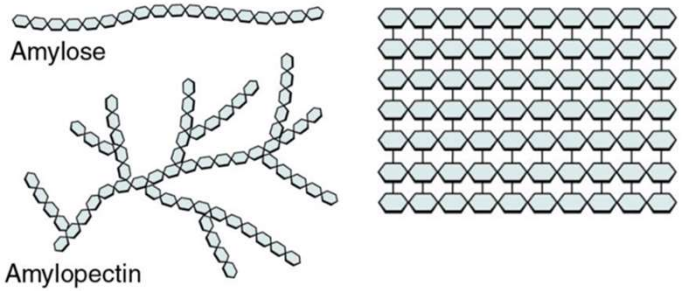
Amylopectin: branched polymer of D-glucose linked by

alpha 1-4 and alpha 1-6 bonds

Cellulose

unbranched linear polysaccharide of D-glucose linked by beta 1-4

glycosidic bonds



structures_fig8_343185753

Achieving Net Zero Carbon Dioxide by Sequestering Biomass Carbon - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/Fig-SI9-The-difference-between-starch-and-cellulose-packing-

Glycosaminoglycans (GAGs)

- Linear polysaccharides composed of repeating disaccharide units (at least one of them is an amino sugar)
- Example

  Hyaluronate: Glycosaminoglycan disaccharide consisting of D-glucuronate (GlcA) and N-Acetylsglucosamine (GlcNAc)