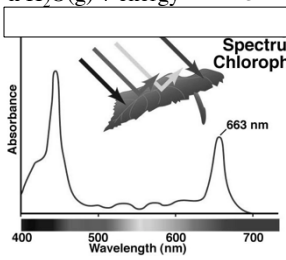
Sugars, Saccharides Carbohydrates

Different Sugars (Carbohydrates)

Photosynthesis

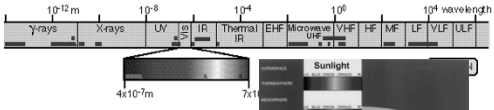
Energy Capture → Carbohydrates

$$n\ CO_2(g) + n\ H_2O(g) + \text{energy} \xrightarrow{\text{Chlorophyll a}} \textbf{CARBOHYDRATES}$$



a complex collection of enzymes

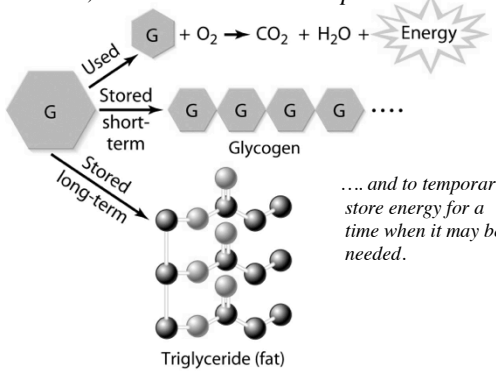
Plants absorb energy; i.e., light that is visible to us.



Plants produce molecules that store the sun's energy through endothermic reactions that form these carbohydrates such as glucose.

http://chemistry.beloit.edu/Stars/EMSpectrum/index.html

Glucose, which animals burn to produce:



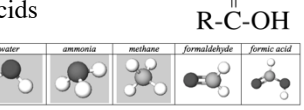
…. and to temporarily store energy for a time when it may be needed.

Carbohydrate (-ose)

- Formed from the action of light and chlorophyll in green plants:
  - $n\ CO_2 + n\ H_2O \longrightarrow C_n(H_2O)_n + n\ O_2$
- Empirical formula = CH_2O
- Monosaccharides (simple sugars)
- C_5 : pentoses – *ribose*
- C_6 : hexoses - *fructose, glucose*
  - Can be either an aldose (aldehyde + alcohols) or ketose (ketone + alcohols)

Sugars (Carbohydrates)

Common Functional Groups

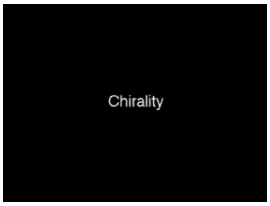
Name	General Formula
Alcohols	R−OH
Ethers	R−O−R′
Amines	$R-NH_2$
Carboxylic Acids	

Sugars (Carbohydrates)

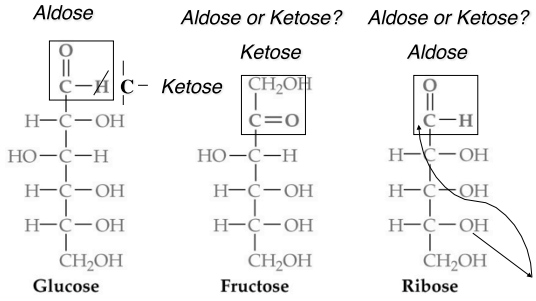
Common Functional Groups

Name	General Formula
Aldehydes	
Ketones	
Carboxylic Acids	
Esters	
Amides	

Chirality & Carbon Atoms



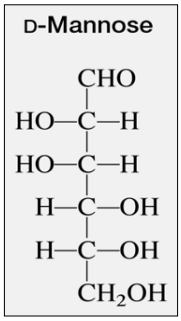
Each carbon atom with four different substituents is chiral. Sugars have many chiral carbon atoms and 2^n possible stereoisomers.



There are 2^n possible stereoisomers, where n = the number of chiral atoms. Glucose? Fructose? Ribose?

Cyclization:

QUESTION



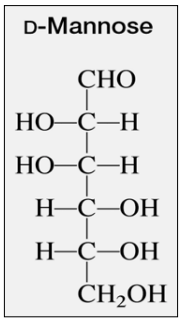
The monosaccharide mannose has how many chiral carbon centers?

A. None
B. Two
C. Four
D. Six

ANSWER

C. correctly reports that there are four chiral carbons in one molecule of mannose. Carbon one and carbon six do not satisfy the basic requirement of having four different attachments to the carbon. Carbon atoms two through four have four different attachments in tetrahedral bonding situations.

QUESTION



The monosaccharide mannose has how many stereoisomers?

A. four

B. six

C. eight

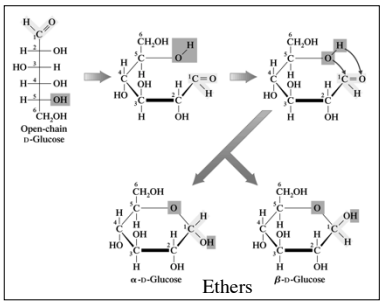
D. sixteen

E. thirty two

ANSWER

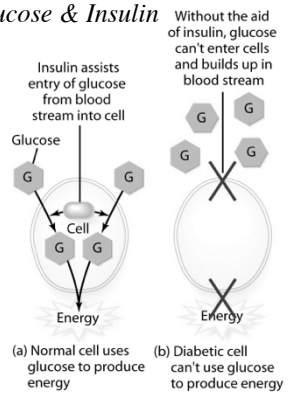
D. There are 2^n possible stereoisomers where n = the number of chiral atoms.
For mannose there are 16 stereoisomers (2^4)

D-glucose can cyclize through an intramolecular reaction



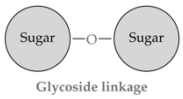
Ethers

Sugars/Glucose & Insulin



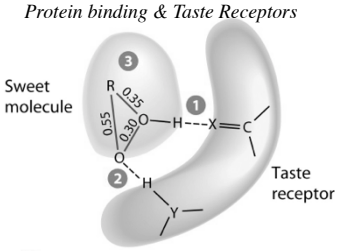
Carbohydrates

- Disaccharides
  - (2 cyclic monosaccharides joined by a "glycoside" linkage [ether])
- e.g. (glucose + fructose) ⟶ sucrose



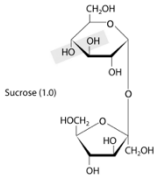
- Polysaccharides
  - (many linked monosaccharide units)
- e.g. starch, cellulose

Protein binding & Taste Receptors

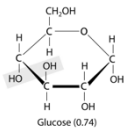


- *Sweet*
- *Sour*
- *Bitter*
- *Salty*
- *Umami*

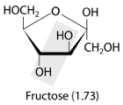
1. —H in OH group on sweet molecule forms hydrogen bond with X— on receptor.
2. O— on sweet molecule forms hydrogen bond with H— in HY group on receptor.
3. Hydrophobic area behind O— atoms on sweet molecule.

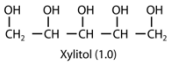


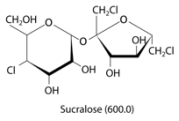
Sweetness factor = 1.0



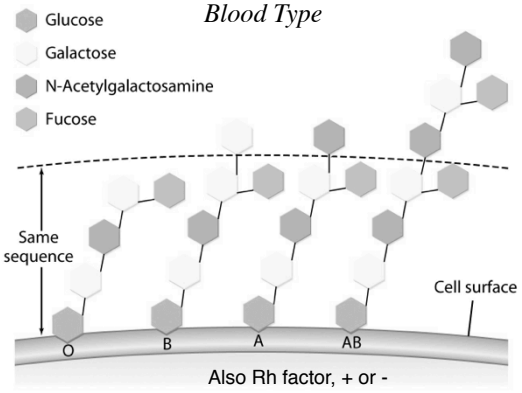
Sweetness factor = 0.74







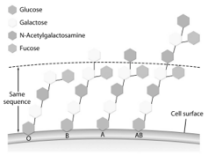
Blood Type



Also Rh factor, + or -

Blood Histocompatibility

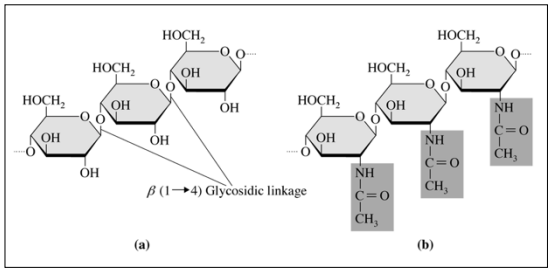
http://anthro.palomar.edu/blood/Rh_system.htm



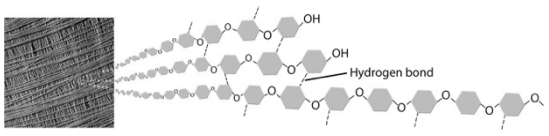
Red blood cell compatibility table[citation]

Recipient[A]	Donor[A]								US	WORLD
	O−	O+	A−	A+	B−	B+	AB−	AB+		
O−	✓								6.6	4.5
O+	✓	✓							37	36
A−	✓		✓						6.4	3.5
A+	✓	✓	✓	✓					36	28
B−	✓				✓				1.5	1.5
B+	✓	✓			✓	✓			8.5	21
AB−	✓		✓		✓		✓		0.6	0.5
AB+	✓	✓	✓	✓	✓	✓	✓	✓	3.4	5

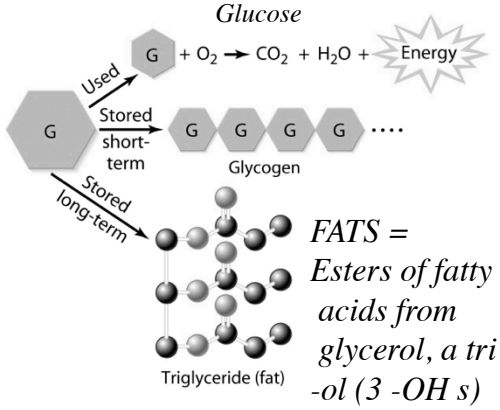
The structures of cellulose (a) and chitin (b). In both substances, all glycosidic linkages are of the β-(1, 4) type.



- *Humans cannot digest cellulose*
- *Goats and termites can*



Glucose



FATS = Esters of fatty acids from glycerol, a tri -ol (3 -OH s)