Key
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Carbohydrate Review Supplemental Homework

1. Match each carbohydrate with its primary role.

E	Primary form of energy storage in animals.	A. glucose
B	Branched form of energy storage in plants.	B. starch
D	Structural support for insects, crustaceans, & fungi.	C. cellulose
A	Primary energy source for most organisms/cells.	D. chitin
C	Structural support for plants.	E. glycogen

2. The first step of catabolism converts polysaccharides into their monomeric forms via a hydrolysis reaction.

3. These various monomers can be converted to the primary energy source for most cells. This monosaccharide is glucose.

4. The second step of catabolism involves the further breakdown of glucose into pyruvate

5. Pyruvate can be converted to acetyl-CoA which enters the citric acid cycle to produce reduced coenzymes

6. The reduced coenzymes initiate the electron transport chain to assist in the generation of ATP.

7. What is the general molecular formula for a carbohydrate? How is the name 'carbohydrate' evident from the formula?

C H_2O

carbo → ← hydrate

8. What is the general name for a 5-carbon sugar with a ketone functional group?

ketopentose

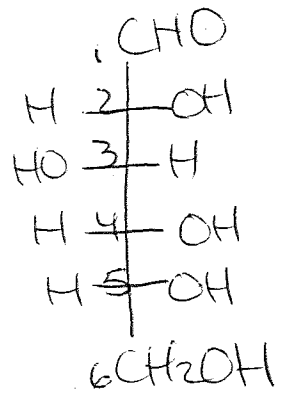
9. What is the general name for a 6-carbon sugar with an aldehyde functional group?

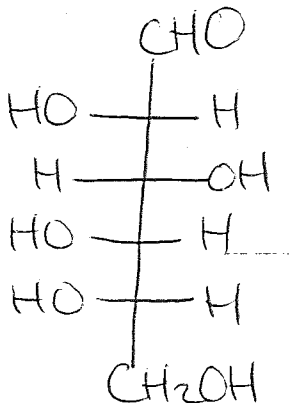
aldohexose

10. Define enantiomer: one of two stereoisomers that are non-super imposable mirror images

11. Draw the open-chain structure (Fischer projection) of D-glucose below, along with its enantiomer.

D-glucose





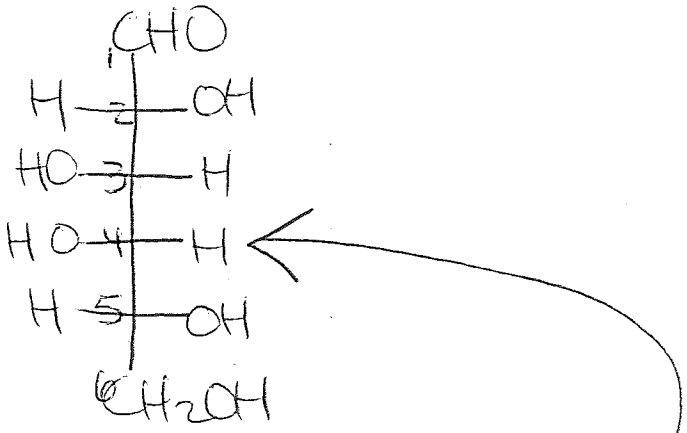
L-glucose

12. What is the name of the enantiomer of D-glucose? L-glucose

13. Which enantiomer of glucose is the one commonly found in nature? D-glucose

14. Define diastereomer: stereoisomers that are NOT non-superimposable mirror images

15. Draw the open-chain structure (Fischer projection) of D-galactose below.



16. How does it differ from the structure of D-glucose above?

The -OH grp on C-4 is switched

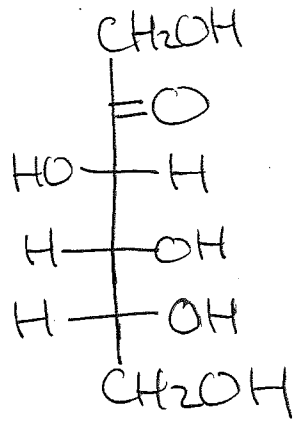
17. What is the term to describe the relationship between D-glucose and D-galactose?

diastereomers

18. Define structural isomer. What is the other name for structural isomers? constitutional isomers

cpds w/ the same chemical formula but different atomic connections (bonding patterns)

19. Draw the open-chain structure (Fischer projection) for D-fructose below.



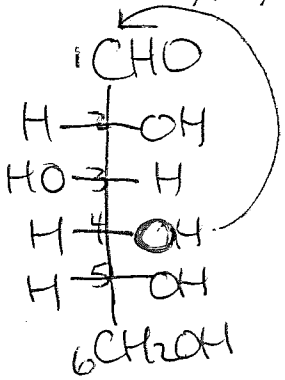
20. What is the relationship between D-galactose and D-fructose?

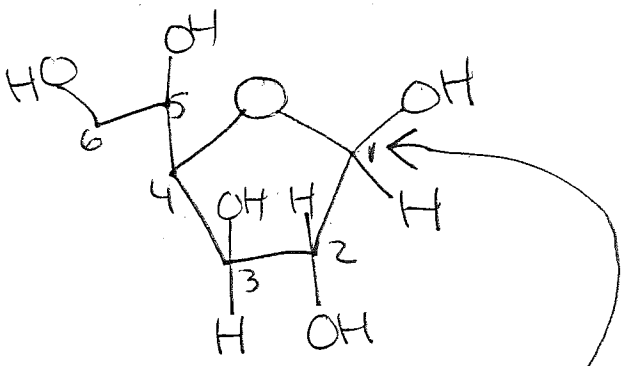
structural isomers

21. What classification of enzyme could catalyze the inter-conversion of galactose and fructose?

isomerase

22. Monosaccharides are able to form cyclic structures through the reaction of a backbone –OH group with the sugar's aldehyde or ketone functional group. Draw the β-Haworth (cyclic) structure of D-glucose whose C-4 hydroxyl group has reacted with the C-1 aldehyde group.

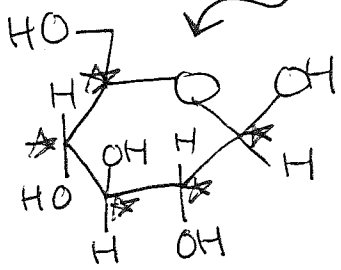


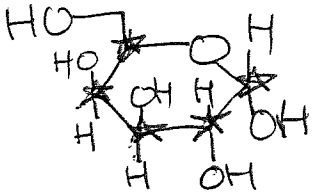


23. Define anomeric carbon and point an arrow to the anomeric carbon in the question above.

The anomeric carbon was the carbonyl carbon of the open chain form of the sugar. It is bonded to 1 ether grp & 1 hydroxyl grp or 2 ether grps.

24. Draw the structures of β-D-glucopyranose and α-D-galactopyranose below.





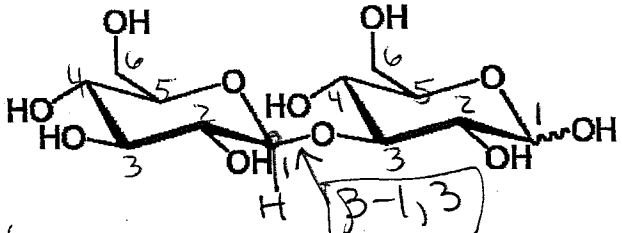
25. Once formed, how many asymmetric (chiral) carbons each do β-D-glucopyranose and α-D-galactopyranose contain? Star them above. 5 each

26. What would happen to a pure sample of β-D-glucose or α-D-galactose if you let it sit for a few days?
It would become an equilibrium mixt of the open chain & α & β anomers.

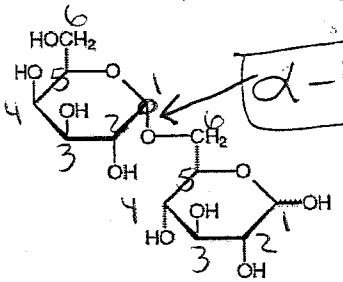
27. What is the name of the process that occurs in the previous question? mutarotation

28. Glycosidic bonds are formed between linked saccharides or saccharides linked to other biomolecules. Their formation results from the interaction of an anomeric carbon of one sugar (on left) with the hydroxyl group of another sugar or biomolecule (on right). Various disaccharide depictions are shown below. Determine the type of glycosidic linkage in each.

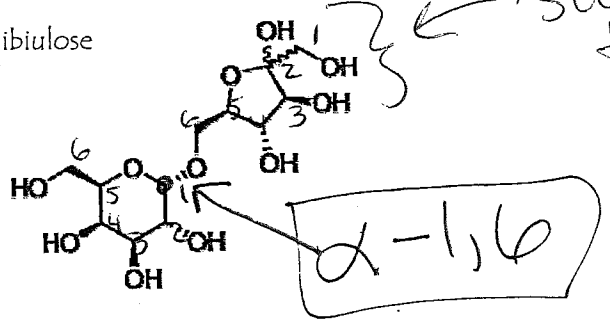
a) Laminaribiose



b) Melibiose



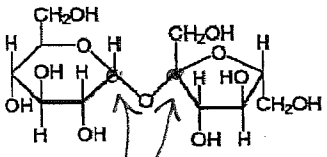
c) Melibiulose



remember that sugars are #'d in their open chain form

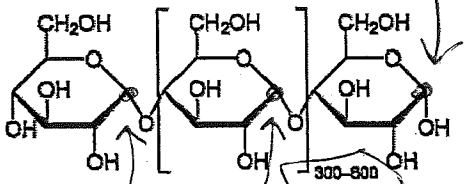
29. Reducing sugars are carbohydrates that contain a free aldehyde group. Cyclic sugars with one hydroxyl group at the anomeric carbon are able to interconvert with their linear forms and become oxidized. However, anomeric carbons with two ether linkages are locked to prevent free aldehyde formation, so they can not be oxidized and are considered non-reducing.

Show/explain why sucrose (left) and starch (right) are considered non-reducing sugars:



both anomeric C's have 2 ether grps

only this ring can open



essentiall ALL anomeric C's are locked w/ 2 ether linkages

30. What is the end product of glycolysis? How many are produced from one glucose molecule?

2 pyruvate

31. What is the fate of this molecule in aerobic conditions? In anaerobic conditions?

pyruvate $\xrightarrow{O_2}$ acetylCoA aerobic

pyruvate $\xrightarrow{no\ O_2}$ lactate anaerobic

33. Refer to the glycolysis pathway from your video tutorial lecture notes, activity packet, or text book to help answer the following questions.

a) In the energy-investment phase of glycolysis, how many molecules of ATP are used?

2 ATP invested

b) In the energy-payout phase of glycolysis, how many molecules of ATP are produced?

4 ATP produced

c) What is the direct net ATP output of glycolysis per molecule of glucose?

2 ATP net output

d) What is the other "energy currency" product produced during glycolysis?

2 NADH & 2 pyruvate

e) What is the fate of the molecule listed above?

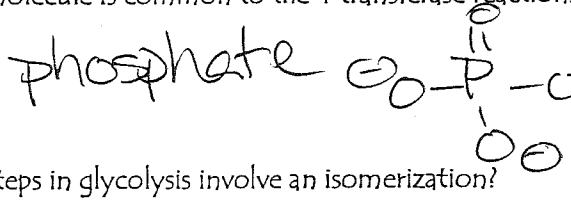
NADH → ETC electron transport chain

pyruvate $\xrightarrow{O_2}$ acetylCoA

f) Which steps in glycolysis involve a transferase reaction?

steps 1 & 3 & 7 & 10

g) Which molecule is common to the 4 transferase reactions listed above?

phosphate  (PO_4^{3-})

h) Which steps in glycolysis involve an isomerization?

steps 2 & 5 & 8

i) These isomerization reactions involve the conversion between what type of isomers?

structural isomers

j) Which steps in glycolysis are examples of lyase reactions? Which type of bond is cleaved or formed for each?

Step 4 The bond btwn C3 & C4 is broken. Note: A C=O forms the double bond flas for lyase

k) There is a single oxidoreductase reaction in glycolysis. Which step is this? Which cofactor is involved?

Step 6 NAD^+ / NADH

l) Overall, have the carbons in glucose been oxidized or reduced? How can you tell?

Oxidation b/c the # of C to O bonds has increased & the # of H atoms has decreased.

32. Match the metabolic roles of glucose with the correct name.

B Hydrolysis of glycogen to produce glucose.

D Breakdown of glucose to form pyruvate and ATP/NADH.

C Synthesis of glycogen from glucose.

A Synthesis of glucose from other metabolic intermediates.

✓ A. gluconeogenesis

✓ B. glycogenolysis

✓ C. glycogenesis

✓ D. glycolysis