CHE 102 - Practice Exam - Carbohydrates - S22 - ver 1 Score: _____/??

Name: _____ Class: _____ Date: _____

Read each question carefully. Some questions have multiple parts. Answer all questions with complete sentences.

1. What structural feature(s) do all carbohydrates have in common?

   General Formula $C(H_2O)$. They are all polyhydroxy (aldehydes or ketones).

2. Carbohydrates are the most abundant organic chemicals in nature, therefore they must be molecules of exceptional utility and importance. Discuss (ie sentences explaining why) two reasons carbohydrates are an important class of organic molecules.

   see question #3 answers, pick any two.

3. Discuss briefly the 3 most important functions of Carbohydrates for life.

   (a) Section 27.3
   Energy source - Contains carbon, is relatively reactive, is reduced (has less than 4 bonds to oxygen).

   (b) Building materials - water soluable, strong but not brittle. Cellulose is a great example due to the H-bonding between chains.

   (c) Water-soluable - mono and di saccharides are very soluble due to the large number of OH groups, making them very easy for the body to digest and transport.

4. What are the (3) signs that an oxidation reaction has occurred?

   Lose electrons
   Gain bonds to Oxygen
   Lose bonds to Hydrogen

5. What are the (3) signs that an reduction reaction has occurred?

   Gain electrons
   Lose bond to Oxygen
   Gain bonds to Hydrogen

6. While carbohydrates are an important source of energy for the body, lipids (fats) contain more energy then carbohydrates. Give two reasons why.

   Lipids contain a higher percentage of C (75% vs 40%) compared to carbohydrates
   Lipids are more reduced than carbohydrates.

7. What type of bond is formed when two monosaccharides are connected together to form a disaccharide according to (a) chemists, and (b) biologists?

   (a) Ether
   (b) Glycosidic

8. Name either (A) 3 most common monosaccharides (B) 3 most common disaccharides **AND** something important about them.

   Monosaccharides - Glucose, Galactose, Fructose - answers will vary
   Disaccharides - Maltose, Lactose, Sucrose - answers will vary.

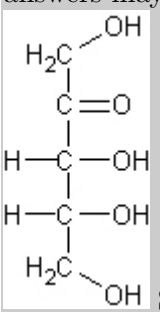
9. Draw an example of each of the following molecules. Answer any additional questions given.

   (a) A D-aldohexose. Circle the part that makes it a D-isomer

Any sugar on the bottom row of the CS. The last chiral carbon from the top having the OH on the bottom makes it a D-isomer

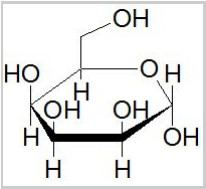
(b) A D-ketopentose. Circle the part that makes it a D-isomer

answers may vary



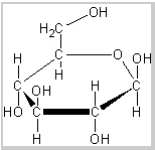
Should be 5 carbons long with a ketone functional group. The last chiral carbon from the top having the OH on the bottom makes it a D-isomer

(c) Draw α-D-Talopyranose. Circle the part that makes it α



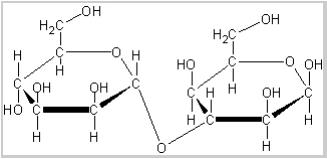
The rightmost OH (one attached to the hemiacetal carbon) being pointed down makes it α

(d) β-D-Glucopyranose (draw an arrow to the hemiacetal carbon)

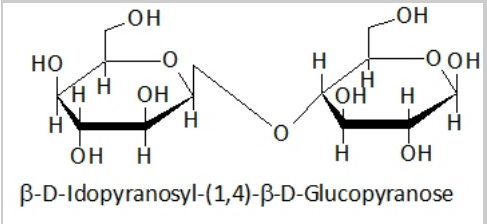


Arrow should point to the rightmost carbon.

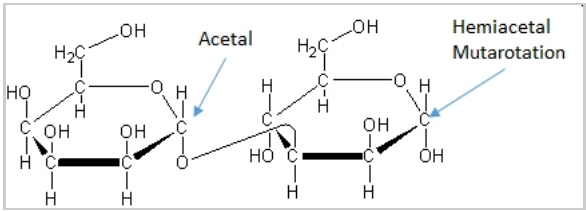
(e) α-D-Mannoyranosyl-(1,3)-β-D-Idopyranose



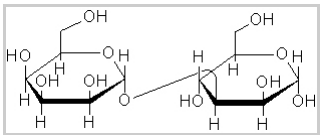
(f) β-D-Iodopyranosyl-(1,4)-β-D-Glucopyranose



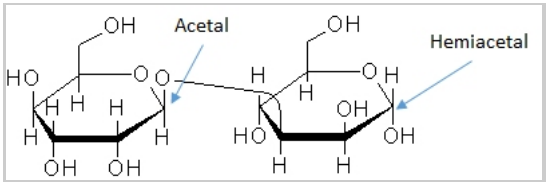
10. Draw a α-D-Iodopyranosyl-(1,3)-β-D-Mannopyranose. Draw and label an arrow pointing to the hemiacetal carbon, the acetal carbon, **AND** the carbon capapble of mutarotation.



11. Draw α-D-talopyranosyl-(1,3)-α-D-mannopyranose.



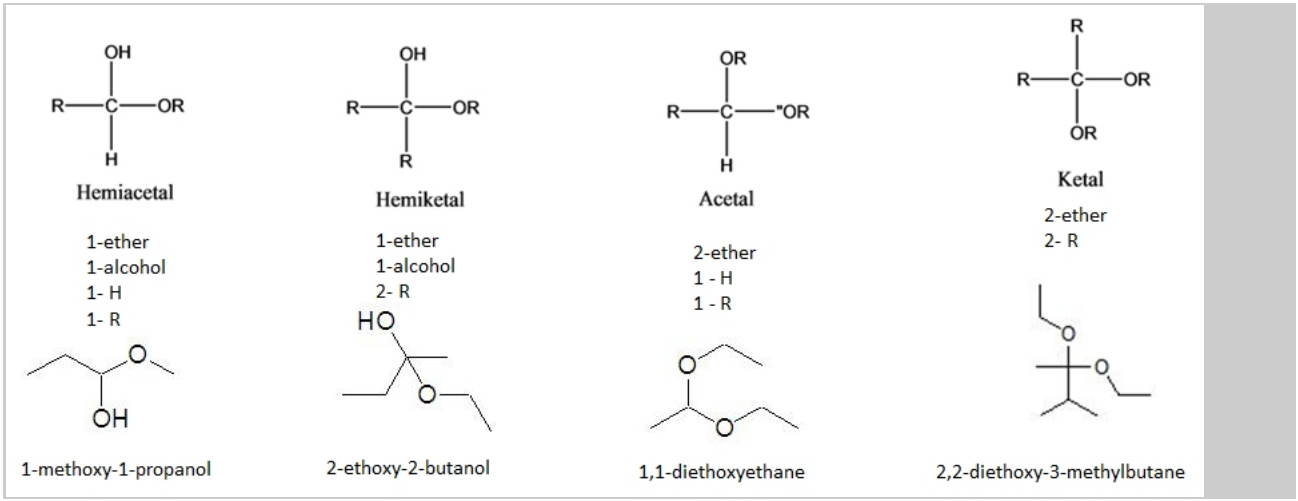
12. Draw the disaccharide β-D-gulopyranosyl-1,3-α-D-mannopyranose. Draw and label an arrow pointing to any carbons that are hemiacetals, acetals, hemiketals or ketals. Is this a reducing sugar? Explain.



13. What type of reaction occurred to form the disaccharide? What functional group is formed (according to chemists? according to biologists?)

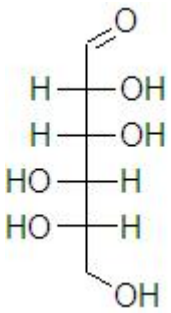
Dehydration
Ether
Glycosidic

14. Draw and Label an example of (a) Hemiacetal (b) Hemiketal (c) Acetal (d) Ketal



15. Circle **ALL** of the following choices that can be used to describe the molecule shown below.

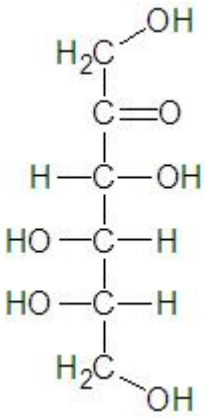
D-isomer, L-isomer, α-anomer, β-anomer, furanose, pyranose, (+), (−), triose, tetrose, pentose, hexose, aldose, ketose.



L-isomer, Pyranose, hexose, aldose

16. Circle **ALL** of the following choices that can be used to describe the molecule shown below.

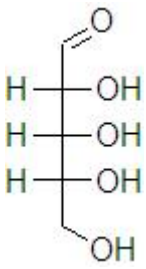
    D-isomer, L-isomer, α-anomer, β-anomer, furanose, pyranose, (+), (−), triose, tetrose, pentose, hexose, aldose, ketose.



L-isomer, pentose, furanose, ketose

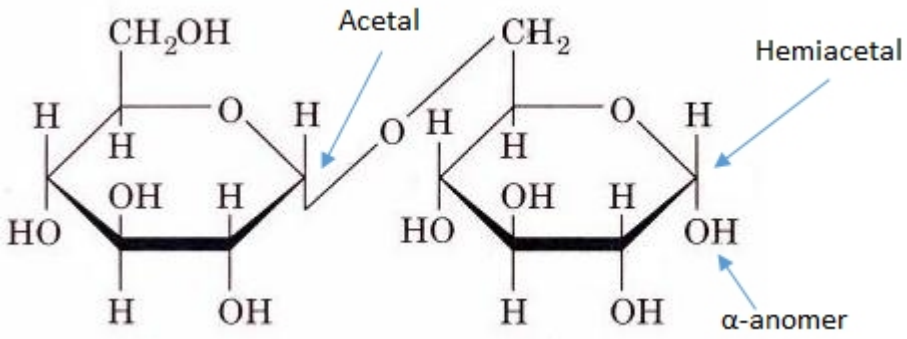
17. Circle **ALL** of the following choices that can be used to describe the molecule shown below.

D-isomer, L-isomer, α-anomer, β-anomer, furanose, pyranose, (+), (−), triose, tetrose, pentose, hexose, aldose, ketose.



D-isomer, furanose, pentose, aldose

18. Answer the following questions about the disaccharide drawn below:



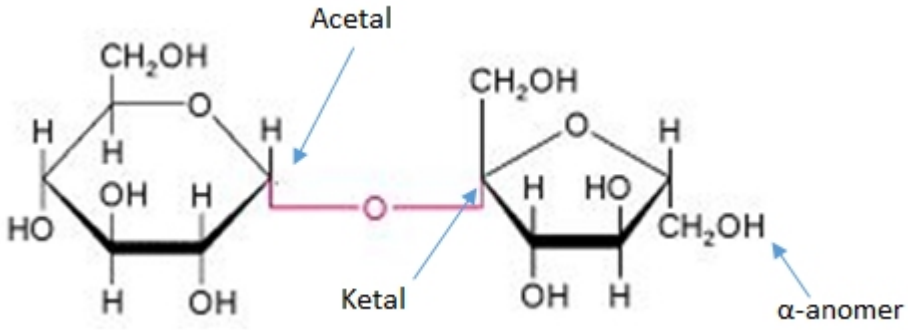
(a) What type of glycosidic bond is between the two molecules? 18(a) **α-1,6**

(b) Draw and label an arrow pointing to any carbons that are hemiacetals, acetals, hemiketals or ketals.

(c) Which anomer of the molecule is shown, α or β? Explain. 18(c) α

(d) Is this a reducing sugar? Explain. 18(d) **Yes - hemiacetal**

19. Answer the following questions about the disaccharide drawn below:



19(a) What type of glycosidic bond is between the two molecules? 19(a) **α-1,5**

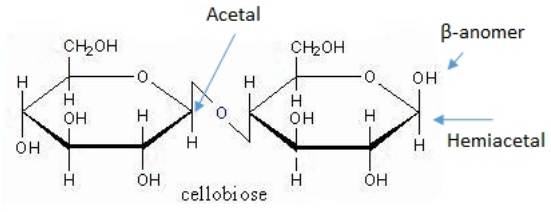
19(b) Draw and label an arrow pointing to any carbons that are hemiacetals, acetals, hemiketals or

ketals. 19(b) _____

19(c) Which anomer of the molecule is shown, α or β? Explain. 19(c) α

19(d) Is this a reducing sugar? Explain. 19(d) **No**

20. Answer the following questions about the disaccharide drawn below:



20(a) What type of glycosidic bond is between the two molecules? 20(a) β**-1,4**

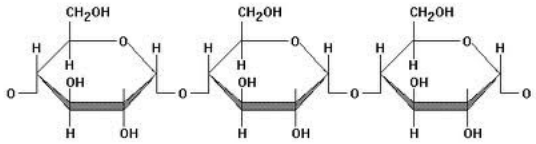
20(b) Place a circle around any carbon atom(s) that are the center of a hemiacetal. 20(b) _____

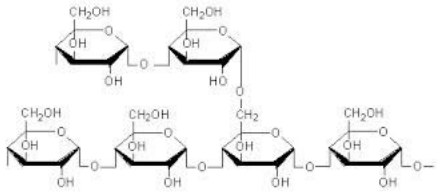
20(c) Place a square around any carbon atom(s) that are the center of an acetal. 20(c) _____

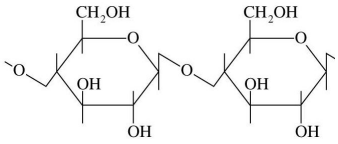
20(d) Which anomer of the molecule is shown, α or β? Explain. 20(d) β

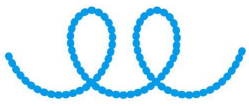
20(e) Is this a reducing sugar? Explain. 20(e) **Yes-hemiacetal**

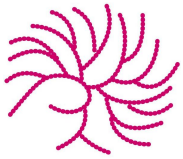
21. Identify the following molecules as (a) Amylose, (b) Amylopectin, (c) Cellulose (d) Not identifiable. Additionally for structures a, b and c tell what type of bond is connecting each molecule together.

(a)  21(a) **a - α-1,4**

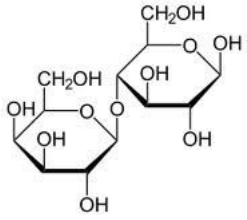
(b)  21(b) **b - α-1,4 and α 1,6**

(c)  21(c) **c - β-1,4**

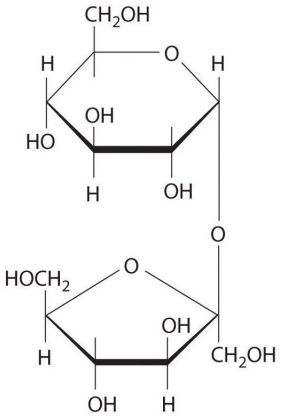
(d)  21(d) **a b/c spirals**

(e)  21(e) **b b/c branches**

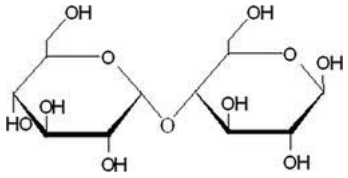
22. Identify the following molecules as (a) Maltose, (b) Lactose, (c) Sucrose (d) Not identifiable. Additionally draw and label an arrow pointing to any hemiacetal carbons.

22(a) 

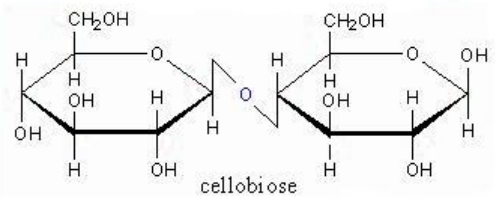
22(a) **lactose**

22(b) 

22(b) **sucrose**

22(c) 

22(c) **maltose**

22(d) 

22(d) **d**

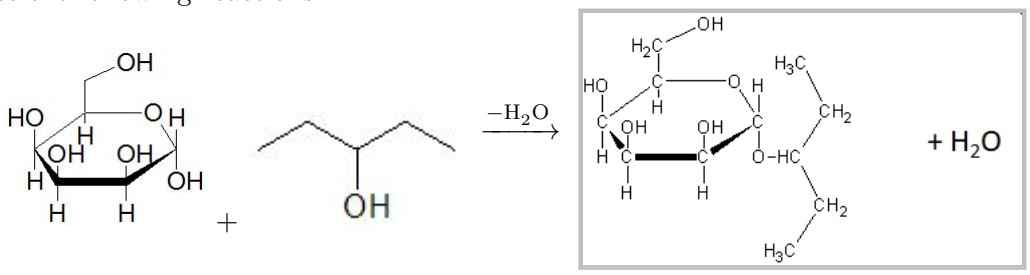
23. What is meant by the term "reducing" sugar? What 3 functional groups give a positive result (name and draw an example of each). What is one chemical test one can perform to determine if a carbohydrate is a reducing sugar, and what is the visual evidence of a positive test?

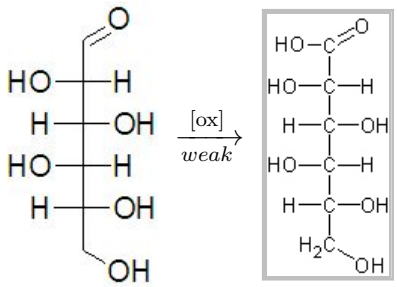
p. 748 - Reducing sugars are capable of oxidizing metal ions (Ag and Cu in lab).
Hemiacetals, α-hydroxyketones and aldehydes. Tollens (Clear $\longrightarrow$ Silver Mirror) or Fehling/Benedict/Barfoeds (Blue $\longrightarrow$ Brick Red ppt)

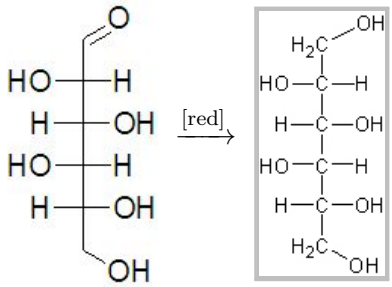
24. What is mutarotation? What functional group must be present for a disaccharide to be capable of mutarotation?

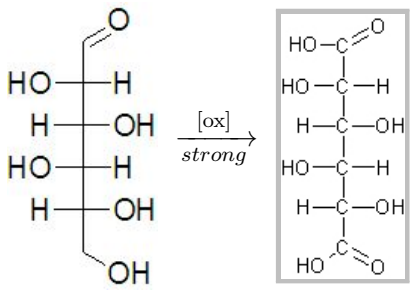
The process by which anomers are interconverted, when forming a ring structure the hemiacetal can open and close, each time it does so it has a 50/50 chance of making the α or β anomer.

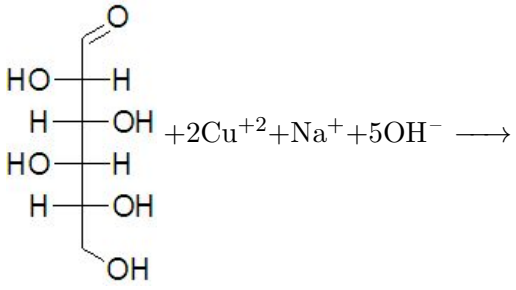
25. Complete the following reactions:

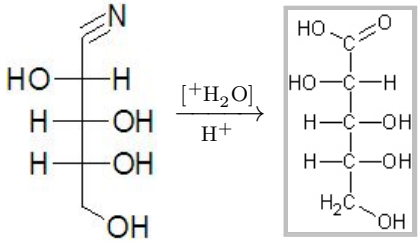
(a) 

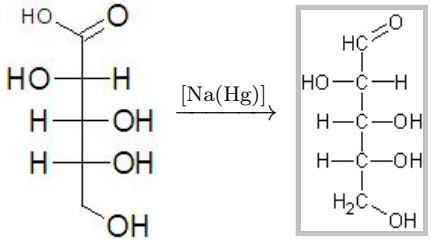
(b) 

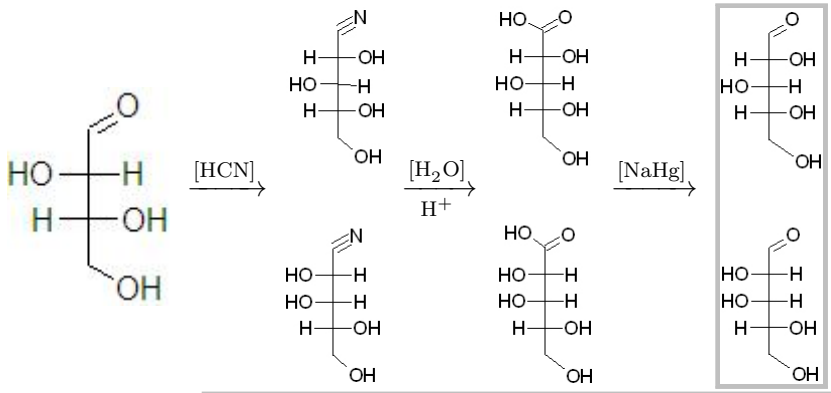
(c) 

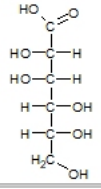
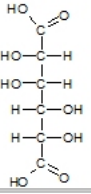
(d) 

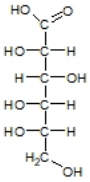
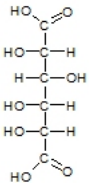
(e) 

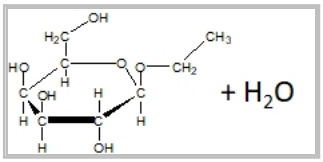
25(f) 

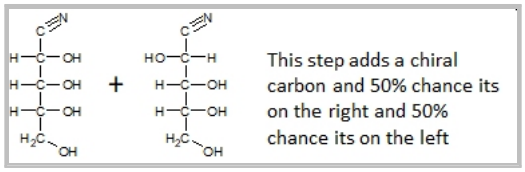
(g) 

(h) 

(i) D-mannose $\xrightarrow{[oxid]}$ If weak oxidation D-mannonic acid  If strong oxidation D-mannaric acid  Poorly worded/written question as it is unclear if weak or strong oxidation. Either answer would be acceptable

(j) L-idose $\xrightarrow{[oxid]}$ jipa If weak oxidation L-idonic acid  If strong oxidation D-idoaric acid  Poorly worded/written question as it is unclear if weak or strong oxidation. Either answer would be acceptable

(k) β-D-galactopyranose + ethanol $\rightleftharpoons$ 

(l) D-erythrose $\xrightarrow{[HCN]}$ 

26. Small changes in the structure of a molecule can have large consequences biologically. Cite one example of this.

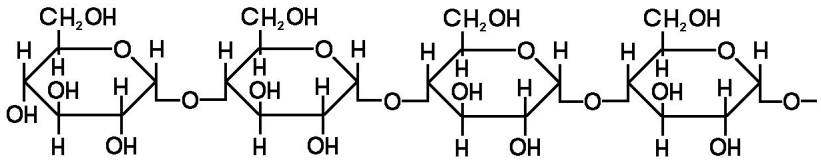
Lots of possible examples:
stereoisomers - THC, Thalidomide
carbohydrates - D vs L isomers, amylose (α-1,4) vs cellulose (β-1,4)
Lipids - cis vs trans, ω-3 vs ω-6 etc

27. Answer the following questions:

27(a) Starch is a mixture of what two polysaccharides?

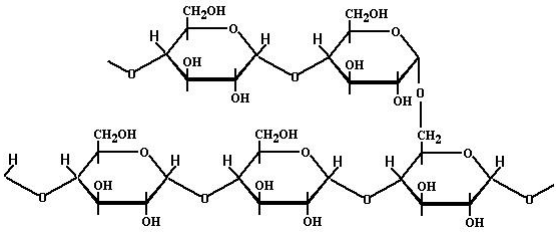
amylose and amylopectin

27(b) The following is a picture of what type of polysaccharide? Explain.



amylose because it is α-1,4 glycosidic bonds only

27(c) The following is a picture of what type of polysaccharide? Explain.



amylopectin because it is α-1,4 and α-1,6 glycosidic bonds

27(d) What is mutarotation? What functional group must be present for a disaccharide to be capable of mutarotation?

Process by which anomers are interconverted. A hemiacetal or hemiketal

27(e) What is the difference between a D and L isomer?

The orientation of the last chiral carbon (furthest from the most oxidized end), if its on the left its the L-isomer and on the right its the D-isomer.

27(f) What is the difference between a furanose and a pyranose?

Furanose = 5 member ring, Pyranose is a 6 member ring

27(g) What is glycogen used for?

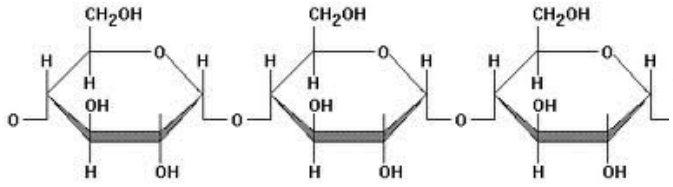
Energy storage form of carbohydrates primarily in animals

27(h) If the molecule in part (b) above where hydrolyzed what would the product be?

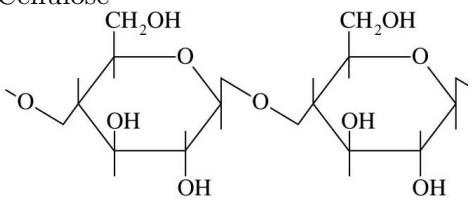
D-Glucose

28. Small changes in geometry can lead to large changes in structure, chemical properties and biological properties. One example given in the book is the differences between starch (amylose) and cellulose.

Amylose



Cellulose



(a) What is the difference in the geometry of the glycosidic bond between starch and cellulose

Amylose α-1,4 glycosidic bonds vs Starch β-1,4 glycosidic bonds

(b) How does this effect the large scale structure/shape?

Amylose - helical/telephone cord like structure vs Celluose - flat sheets

(c) How does this effect the chemical properties of the molecules?

Amylose = water soluble, Cellose is water insoluble

(d) How does this effect the biological properties of the molecules?

Humans can digest amylose but lack the enzyme to break the β-1,4 glycosidic bonds and so can not digest celluose
Amylose is used for energy storage in plants since it is easily hydrolyzed, while cellose is used as a structural component in plants since it has strong hydrogen bonds holding it together and is not easy to hydrolyze.

29. Answer the following question about the Benidicts and Barfords tests.

(a) What three functional groups give a positive result?

+ Aldehydes - Ketones

(b) What is the observed change that indicates a positive test?

Blue to brick red ppt

(c) What chemical change occurs to the carbohydrate to produce the positive test?

The carbohydrate is oxidized

(d) What chemical change occurs to the reagent to produce the positive test?

The metal ion (Cu) is reduced

30. Complete the table below for each test. Include what functional group/feature of the molecule it test positive (+) and negative (-) for and the visual change which indicates each.

Test Name	**Positive for:**	**Visual Change**	**Negative for:**	**Visual Change**
Molisch Test				
Seliwanoff Test				
Benedict Test				
Barfoed Test				
Bial Test				
Iodine Test				