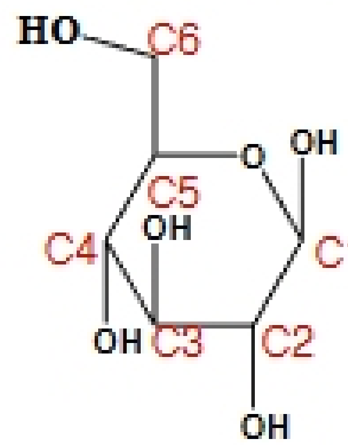
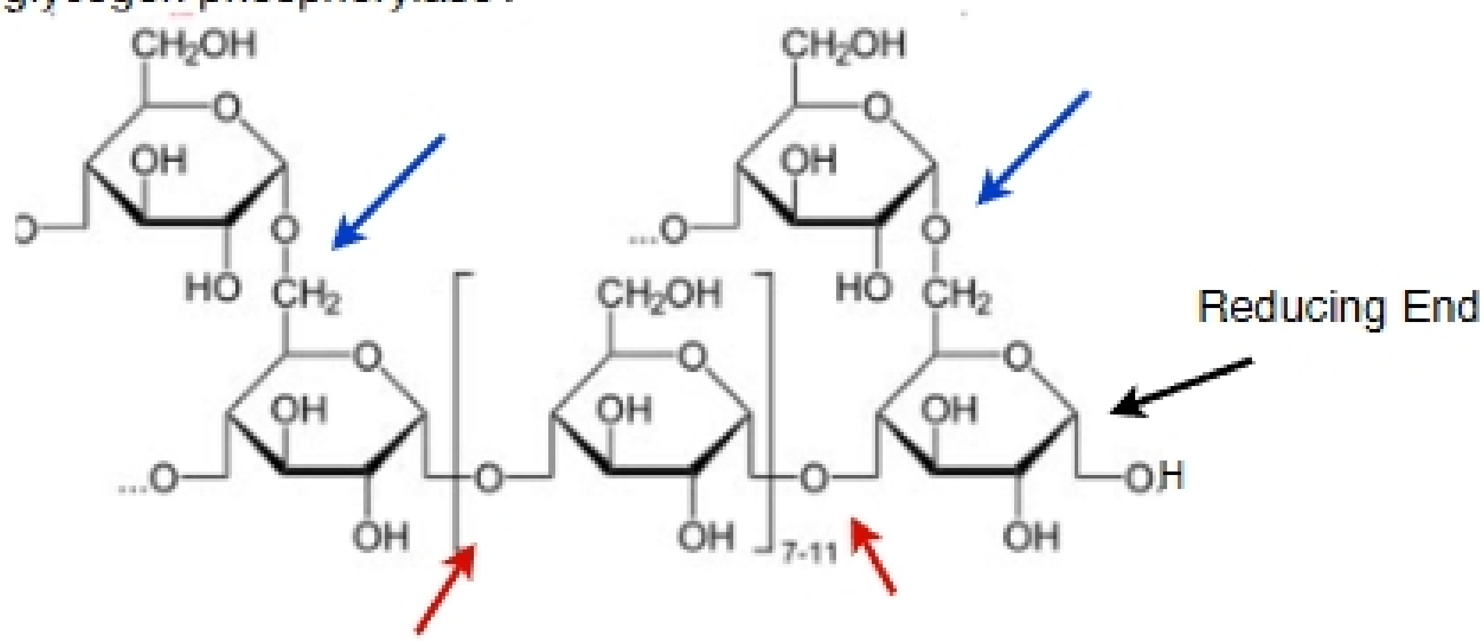
Action Center 11

1. Identify the following features of this D-Glucose:



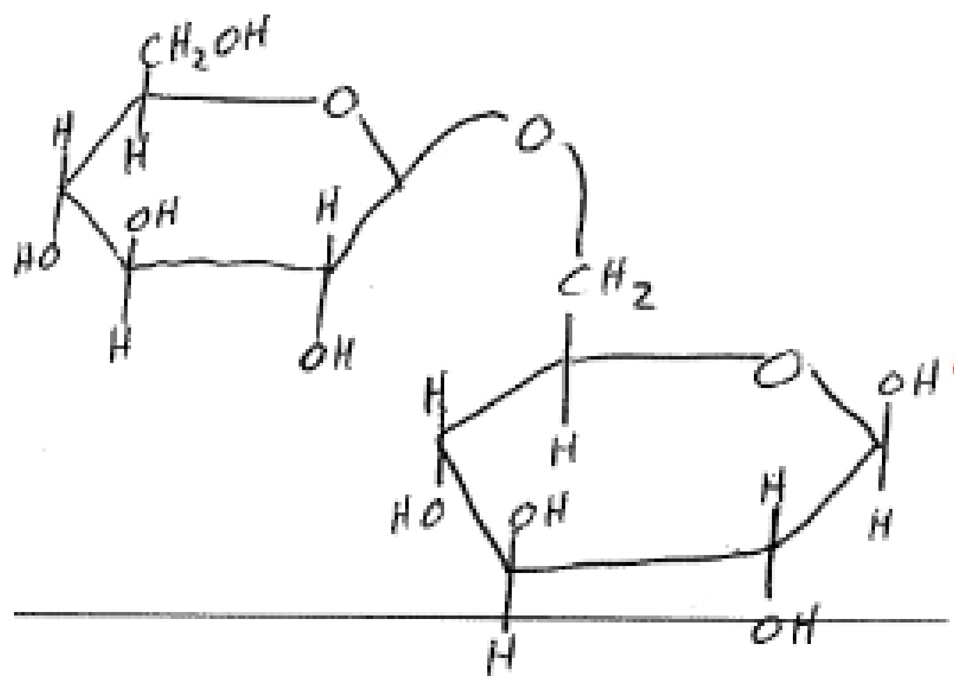
   A) Number all the carbons
   B) Label the anomeric carbon
   The C1 Carbon
   C) Is this alpha or beta glucose
   β-D-Glucose; The OH of C1 is pointing upwards
   D) Is this a reducing sugar? (If so label the reducing end)
   Reducing end is at C1 Carbon

2. In the following structure of glycogen, identify and characterize all of the glycosidic bonds (i.e. β1→6). Does glycogen have a reducing end? Which bond would be cleaved by glycogen phosphorylase?



   α(C1→C6)
   α(C1→C4)
   Glycogen Phosphorylase cleaves the α(C1→C4) glycosidic bond of the α-linked terminal glucose residue (the one that is only connected to one residue through a α(1→6) bond)

3. Gentobiose (D-Glucose (β1→6) D-Glucose is a disaccharide found in some plant glycosides. Draw the structure of gentobiose based on its name. Is it a reducing sugar? (If so label the reducing end)



4. Consider a molecule of glycogen that has a MW of 200,000. What is the average number of branch-point residues that would be present in such a molecule? (Hint: There are branch points every 8-14 residues)
   Average branch point point every 11 residues
   MW of a residue in the glycogen polymer 162 g/mol (C6H10O5)
   200,000g/mol / 162g/mol*res = 1234.5 residues
   1234.5/11 = 112 branch point residues

5. You have a preparation of isolated liver cells and you add to these cells pyruvate and $^{14}CO_2$. After sufficient time, you isolate the glucose that is produced. What atoms of the glucose that is produced would contain ^{14}C atoms?
   None, the incorporated CO_2 is immediately given off in the next step.

6. You label oxaloacetate at the C2 position (the ketone carbon) and let it run through gluconeogenesis. At what position would the label be on the glucose?
   C2 or C5 of glucose

7. How much total energy (in moles of ATP) is required to convert 4 moles of pyruvate to glucose through gluconeogenesis? Assume that 1 mol of NADH yields 2.5 moles of ATP after oxidative phosphorylation.
   Gluconeogenesis:
   2 Pyruvate + 2 NADH + $4H^+$ + 4ATP + 2GTP + $6H_2O$ --> Glucose + $2NAD^+$ + 4ADP + 2GDP + 6 Pi
   For 4 moles of Pyruvate we need:
   4 moles of NADH --> 10 moles of ATP
   8 moles of ATP
   4 moles of GTP --> 4 moles of ATP
   Net: 22 moles of ATP

8. Most of the enzymes involved in glycolysis are also used for gluconeogenesis. Which reactions require different enzymes?
   From Pyruvate to PEP -> require pyruvate carboxylase to form oxaloacetate as intermediate and then phosphoenol pyruvate carboxykinase (PEPCK) to form PEP
   From FBF to F6P -> require fructose bis-phosphatase
   From G6P to Glucose -> require glucose-6-phosphatase

9. For this question, think about the differences between glucose-6-phosphate and glucose-1-phosphate. Why would glucose-1-phosphate be a bad substrate for glycolysis?
   The phosphate on the C1 of glucose would draw electron density away from C1 and thus cause the bond from C1 to the oxygen in the ring to be less polarized (and more stable). This will make it harder for phosphoglucose isomerase to cleave that bond to form Fructose-6-Phosphate.

10. Individuals with McArdle's disease often experience a "second wind" resulting from cardiovascular adjustments that allow glucose mobilized from liver glycogen to fuel muscle contraction. Explain why the amount of ATP derived in the muscle from circulating glucose is less than the amount of ATP that would be obtained by mobilizing the same amount of glucose from muscle glycogen.
    Using glycogen instead of circulating glucose bypasses the phosphorylation of glucose by hexokinase. Since this step consumes 1 mol of ATP per mol of glucose, the net ATP derived from glycogen is more than the net ATP derived from glucose.