WORKSHOP 8: Carbohydrates and Lipids ANSWER KEY

Use your knowledge of biochemistry to answer the following questions.

1. Consider the structure of sorbose below:

   \[
   \begin{align*}
   &\text{CH}_2\text{OH} \\
   &\text{H} \quad \text{O} \\
   &\text{H} \quad \text{H} \\
   &\text{HO} \quad \text{H} \\
   &\text{CH}_2\text{OH} \\
   \end{align*}
   \]

   sorbose

   A. Identify the sugar as D- or L- sorbose. L

   B. What is the enantiomer for this structure?

   \[
   \begin{align*}
   &\text{CH}_2\text{OH} \\
   &\text{O} \\
   &\text{H} \quad \text{OH} \\
   &\text{HO} \quad \text{H} \\
   &\text{CH}_2\text{OH} \\
   \end{align*}
   \]

   D-sorbose

   C. How does this sugar differ from D-fructose? Carbon-5 has its –OH/–H bonds in the opposite positions.

   D. Draw the cyclic structures for the α and β anomers of L-sorbose. Is the process of mutarotation relevant in this solution? Briefly explain.

   \[
   \begin{align*}
   \text{α} & \quad \text{β} & \quad \text{B}
   \end{align*}
   \]

   Mutarotation is relevant (shown above) as an equilibrium exists between the open- and closed-chain forms.
2. Consider the structure of D-mannose below:

\[ \text{CHO} \]
\[ \text{HO} \quad \text{H} \]
\[ \text{HO} \quad \text{H} \]
\[ \text{H} \quad \text{OH} \]
\[ \text{H} \quad \text{OH} \]
\[ \text{CH}_2\text{OH} \]

D-mannose

A. Draw the cyclic structures for the α and β anomers of D-mannose. Is the process of mutarotation relevant in this solution? Briefly explain.

B. Now react the β-D-mannose anomer with CH\(_3\)OH under acidic conditions. What type of compound and what type of bond is formed? Glycoside is formed via a glycosidic bond. Is the process of mutarotation relevant in this solution? Briefly explain. No, mutarotation is NOT relevant here (the open-chain is not formed).

3. From the compounds shown below, select those that meet the following criteria:

A. Is the L-enantiomer of mannose  \textbf{Compound B}  \\
B. A ketopentose  \textbf{Compound C}  \\
C. An aldopentose  \textbf{Compound A}  \\
D. A ketohexose  \textbf{Compound D}
4. Melebiose is a disaccharide that has a sweetness of about 30 compared with sucrose (= 100).

A. What are the monosaccharide units in melebiose?

B. What type of glycosidic bond links the monosaccharides? \(\alpha(1\rightarrow6)\)

C. Is the compound drawn as \(\alpha\) - or \(\beta\)-melebiose? \(\alpha\)

D. Is this a reducing or a non-reducing sugar? Briefly explain. Reducing sugar due to the –OH group found on the anomeric carbon.

5. Identify the polysaccharide described by each of the following:

A. A polysaccharide that is stored in the liver and muscle tissues glycogen

B. An unbranched polysaccharide containing \(\beta\)-1,4-glycosidic bonds cellulose
C. A starch containing α-1,4- and α-1,6-glycosidic bonds amylopectin and/or glycogen
D. Not digestible by humans cellulose
E. The storage form of carbohydrates in plants starch
F. Contains only α-1,4-glycosidic bonds amylose
G. The most highly branched polysaccharide glycogen

6. Why are lipids important in biochemistry? List and briefly describe the four categories of lipids. (1) store energy within fat cells; (2) separate components of aqueous solution from each other in membranes; (3) serve as chemical messengers.

7. Predict the product(s) for each of the following reactions:
8. Draw the generic structure for the steroid nucleus. Which steroid serves as the biological precursor for all other steroids?

Steroid nucleus

Cholesterol

9. Examine the structures of estradiol and testosterone in your textbook. How are these sex hormones similar and different? Briefly explain. As shown in your textbook, testosterone contains an alkene/ketone, while estradiol contains a phenol group (i.e., benzene with an –OH).

10. How do LDLs differ from HDLs? “Good cholesterol”, or high-density lipoproteins (HDL), consists of approximately 33% protein and 30% cholesterol. “Bad cholesterol”, or low-density lipoproteins (LDL), contains only 25% protein and 50% cholesterol. In general, high LDL content means high cholesterol content in the blood plasma because LDL cannot enter the cells and be metabolized. Therefore, a high LDL level combined with a low HDL level is a symptom of faulty cholesterol transport and a warning for possible atherosclerosis.