1. Deduce the structure of the disaccharide trehalose from the following observations.
   a) Acid hydrolysis yields only D-glucose.
   b) Can be hydrolyzed by α-glucosidase but not by β-glucosidase enzymes.
   c) It is a non-reducing sugar.
   d) Methylation and hydrolysis in acid yields two moles of 2,3,4,6-tetra-O-methyl-D-glucose.

2. When subjected to a Ruff degradation a D-aldopentose, A, is converted to an aldotetrose, B. When reduced with NaBH₄, the aldotetrose B forms an optically active alditol. The ^{13}C NMR spectrum of this alditol shows only 2 signals. The alditol obtained by direct reduction of A with NaBH₄ is not optically active. When A is used as the starting material for a Kiliani-Fischer synthesis, two diastereomeric aldohexoses, C and D, are produced. On treatment with NaBH₄, C leads to an alditol E, and D leads to F. The ^{13}C NMR spectrum of E consists of 3 signals; that of F consists of 6. Propose structures for A-F.
3. Write the Fischer projection of the open-chain form of each of the following

A) \[
\begin{align*}
&\text{HO} \\
&\text{OH} \\
&\text{O} \\
&\text{OH} \\
&\text{OH} \\
&\text{OH} \\
&\text{OH}
\end{align*}
\]

B) \[
\begin{align*}
&\text{OH} \\
&\text{H} \\
&\text{C} \\
&\text{H} \\
&\text{OH} \\
&\text{OH} \\
&\text{OH}
\end{align*}
\]

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

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

4. How many ketopentoses are possible? Draw them. Label them as belonging to the D or L series. Is there a meso compound among them? Theoretically possible \(-\) one meso compound, so there are actually 7.

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

\[
\begin{align*}
&\text{CH}_2\text{OH} \\
&\text{HO} \\
&\text{OH} \\
&\text{CH}_2\text{OH} \\
&\text{D}
\end{align*}
\]

\[
\begin{align*}
&\text{CH}_2\text{OH} \\
&\text{H} \\
&\text{CH}_2\text{OH} \\
&\text{D}
\end{align*}
\]

\[
\begin{align*}
&\text{CH}_2\text{OH} \\
&\text{HO} \\
&\text{CH}_2\text{OH} \\
&meso
\end{align*}
\]

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5. Treatment of D-mannose which is epimeric with D-glucose at C-2 with ethanol and HCl yields four isomeric products. Draw these products showing stereochemistry in 3-D.

![D-mannose and its products diagram]

6. The most stable conformation of most aldopyranoses is one in which the largest group, the CH$_2$OH group, is equatorial. However, D-idopyranose which is epimeric with D-glucose at all stereogenic centers except C-5 exists primarily in a conformation with an axial CH$_2$OH group. Draw both chair conformations of α-D-idopyranose and explain why this is the case.

![Idose and its conformations diagram]