1. Provide detailed mechanisms for the following transformations:

a. (10 pts)

b. (10 pts)

Product of the first step.
2. Predict the major product(s) of the following reactions:

a. (8 pts)

\[
\begin{align*}
\text{R-CH(OH)C(NH}_2\text{)} & \xrightarrow{1. \text{NaNO}_2, \text{H}_2\text{SO}_4} \text{R-CH(OH)CH(OH)Br} \\
& \xrightarrow{2. \text{KBr}} \text{R-CH(OH)CH(OH)Br} \\
& \xrightarrow{3. \text{CH}_2\text{N}_2} \text{R-CH(OH)CH(OH)Br}
\end{align*}
\]

b. (8 pts)

\[
\begin{align*}
\text{H-CO-CH(OH)} & \xrightarrow{1. \text{HCN, KCN}} \text{H-CO-CH(OH)C(OH)CH(OH)} \\
& \xrightarrow{2. \text{H}_2, \text{Pd}} \text{H-CO-CH(OH)C(OH)CH(OH) + H-CO-CH(OH)C(OH)CH(OH)} \\
& \xrightarrow{3. \text{H}_3\text{O}^+} \text{H-CO-CH(OH)C(OH)CH(OH) + H-CO-CH(OH)C(OH)CH(OH)}
\end{align*}
\]

c. (8 pts)

\[
\begin{align*}
\text{H-CO-CH(OH)NMe} & \xrightarrow{\text{H}^+, \text{NaBH}_3\text{CN}} \text{H-CO-CH(OH)NMe} \\
& \xrightarrow{\text{(As much as you want)}} \text{H-CO-CH(OH)NMe}
\end{align*}
\]
3. Provide the reagents necessary to accomplish the following transformations:

(More than one step will be required.)

a. (7 pts)

\[
\begin{align*}
\text{O} & \quad \text{O} \\
\text{Me} & \quad \text{Me}
\end{align*}
\]

1. NaH (or any other appropriate base), Mel
2. NaOMe, MeOH
3. H_3O^+

Direct alkylation will not work here because the desired enolate will not form. But the reversibility of the Dieckmann condensation gives us a way out. First alkylate between the carbonyls and then do a retro-Dieckmann-Dieckmann sequence.

b. (7 pts) (Hint: Strecker.)

\[
\begin{align*}
\text{O} & \quad \text{H} \\
\text{HO} & \quad \text{CN}
\end{align*}
\]

1. SOCl₂
2. NaN₃
3. Δ, H₂O
4. O₃, Zn
5. HCN
6. H₃O⁺

This is another problem where it is extremely helpful to be able to work backward from the product. In order to do that you must be familiar with the Strecker synthesis of amino acids.

c. (7 pts)

\[
\begin{align*}
\text{BnO} & \quad \text{O} \\
\text{BnO} & \quad \text{BnO}
\end{align*}
\]

1. Me₂CCO
2. iPrOH, ZnCl₂
3. H₂, Pd

\[
\begin{align*}
\text{OH} & \quad \text{OH} \\
\text{HO} & \quad \text{Me}
\end{align*}
\]
4. (10 pts) Provide a Fischer projection and a classification (e.g., D-aldotetrose) for the following carbohydrate:

![Fischer Projection]

L-ketohexose
Classification

b. (10 pts) Provide a clear drawing of the most stable \( \beta \)-PYRANOSE form of the following ketohexose.
5. Consider the following reaction sequence (known as the Arndt-Eistert Homologation). In the first part, a carboxylic acid is transformed into an acid chloride, and the acid chloride is then treated with diazomethane to give a diazo ketone. In the second part (known as the Wolff Rearrangement), the diazo ketone is treated with a silver salt in the presence of water to give a new carboxylic acid that is one carbon longer than the original.

\[
\begin{align*}
\text{acid chloride} & \quad \xrightarrow{\text{SOCl}_2} \quad \text{acetyl chloride} \\
\text{diazoketone} & \quad \xrightarrow{\text{CH}_2\text{N}_2} \quad \text{acetyl chloride} \\
\text{diazoketone} & \quad \xrightarrow{\text{Ag}_2\text{O} \quad \text{H}_2\text{O}} \quad \text{new carboxylic acid}
\end{align*}
\]

\[\text{CH}_2\text{N}_2 = \begin{bmatrix} 
\text{H}_2\text{C}^+\text{N}^\equiv\text{N} \quad \xrightarrow{\text{H}_2\text{C}^+\text{N}^\equiv\text{N}} \quad \text{H}_2\text{C}^+\text{N}^\equiv\text{N}^- 
\end{bmatrix} \]

(a) (5 pts) Provide a mechanism for the conversion of the acid chloride to the diazoketone.

(b) (10 pts) Given what you know about the Curtius Rearrangement, propose a reasonable mechanism to account for the conversion of the diazo ketone to the product carboxylic acid. You may ignore the silver oxide, but you will need the water at some point in the mechanism.

The only difference is that there is a carbon substituted for a nitrogen in this case.