Before you begin this exam: First: You are allowed to have a simple model set at your seat. Please put away all other materials. Second: Place your student identification on your desk. A proctor will come around to check everyone’s ID. If you do not have ID, tell the proctor. Third: Read through the entire exam. Your goal, as always, is to score as many points as possible. Do not waste time on problems that you can’t do if there are others that look easy. Fourth: It is critically important that your answers be written in a clear, unambiguous manner. Answers in which your intentions are unclear will not receive credit. Fifth: READ THE INSTRUCTIONS FOR EACH PROBLEM. You have 120 minutes to complete this exam. There will be no extensions, so budget your time carefully.

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Total 100
1. (6 points) Convert the following drawing into a Fischer projection.

![Fischer projection](image)

2. (8 points total)  
   a) (6 points) Convert the Fischer projection below into a zig-zag, wedge-and-dash drawing, like the one given in problem 1. The main chain is drawn for you – simply draw in the remaining –OH groups in the correct stereochemistry.

![Fischer projection](image)

b) (2 points) Is this compound a D-sugar or an L-sugar?

3. (6 points) For the following structure, indicate whether it is a) an aldose or a ketose, b) a furanose or a pyranose, and c) an α-anomer or a β-anomer (3 answers required).

![Structure](image)

a) ________________  
b) ________________  
c) ________________
4. (6 points) Circle the amino acids that do NOT fit the common structural motif of the naturally occurring amino acids:

5. (5 points) In a synthetic peptide chain composed of 10 amino acids, how many stereoisomers are possible? Expressing the answer as an exponential is acceptable.

6. (20 points, 4 pts. each) Predict the products of the reactions below. If a reaction should produce a specific stereochemistry, be sure to indicate that stereochemistry. If you believe that a mixture of isomers will result (like ortho and para isomers), show both. If you believe that no reaction will take place, write “no reaction.” Do any 5 of the following 9.

a)
b) 
\[
\text{CHO} \quad \text{excess} \quad \text{CO}_2\text{Et}
\]

\[
\text{H} - \text{O} - \text{H} \quad \text{CH}_2\text{OH}
\]

c) 
\[
\text{CHO} \quad \text{excess PhNH}_2\text{NH}
\]

\[
\text{H} - \text{O} - \text{H} \quad \text{H} - \text{O} - \text{H} \quad \text{CH}_2\text{OH}
\]

d) 
\[
\text{CH}_2\text{NCO}_2\text{H} \quad \text{H}_2\text{N} - \text{CH}_2\text{N} - \text{CH}_2\text{N} - \text{CH}_2\text{NH}_3
\]

\[
\text{DCC}
\]

e) 
\[
\text{EtO}_2\text{C} - \text{O} - \text{Et} \quad 1. \text{NaOEt (1 eq.)} \quad \text{PhCH}_2\text{Br (1 eq.)}
\]

\[
2. \text{LiAlH}_4 \text{(excess)} \quad 3. \text{H}_2\text{O, HCl}
\]

f) 
\[
\text{NO}_2
\]

\[
\text{Cl} \quad \text{AlCl}_3
\]

g) 
\[
\text{EtO}_2\text{C} - \text{O} - \text{Et} \quad 1. \text{NaOEt (1 eq.)} \quad \text{PhCH}_2\text{Br (1 eq.)}
\]

\[
2. \text{NaOH, H}_2\text{O} \quad 3. \text{H}_2\text{O, HCl}
\]
7. (8 points) Fill in the missing products or reagents in the synthesis of the non-natural amino acid cyclopentylalanine, below (one product or reagent in each box).
8. (16 points) Draw viable mechanisms for any 2 of the 4 following reactions. **Do not add any reagents that are not given in the problem.** Do any 2 of the following 4.

a) ![Chemical Reaction Diagram]

b) ![Chemical Reaction Diagram]
c) 
\[
\begin{align*}
\text{Structure} & \quad \text{HNO}_3 \\
\text{H}_2\text{SO}_4 & \quad \text{Structure}
\end{align*}
\]


d) 
\[
\begin{align*}
\text{Structure} & \quad \text{HCl} \\
\text{Structure} & \quad \text{Structure}
\end{align*}
\]
9. (15 points) One of the many reasons why peptides are not prepared using an acid chloride is shown below. Upon treatment with thionyl chloride, the alanine derivative shown cyclizes to form an oxazolidinone. The acid chloride is a likely intermediate.

\[ \text{N-acetyl alanine} \xrightarrow{\text{SOCl}_2} \text{oxazolidinone} \]

a) (10 points) Draw a mechanism for the conversion of the acid chloride to the oxazolidinone. Start with the acid chloride of N-acetyl alanine.

b) (5 points) Worse still, the oxazolidinone rapidly suffers racemization (shown below). This loss of stereochemical integrity involves formation of the enolate of the lactone, and this happens much more rapidly than with other lactones, such as the second example below. Provide a viable, brief explanation for why formation of the enolate is so favorable in oxazolidinone case. A sentence or two is sufficient.

\[ \text{Oxazolidinone} \]
10. (10 points) Show how the target compounds below can be prepared from the list of reagents given. You do not need to show a retrosynthetic analysis, but working backward from the target is often very helpful. **Do any one of the following three.**

a) From diethyl malonate, benzene, methanol, ethanol, and any inorganic reagents that you may need. You don’t have to prepare NaOEt, or other common bases.

Diethyl malonate is \( \text{EtO} \text{O} \text{Et} \)

b) From benzene, ethyl acetoacetate, ethanol, methanol, and any inorganic reagents that you may need. You don’t have to prepare NaOEt, or other common bases.

Ethyl acetoacetate is \( \text{O} \text{O} \text{OEt} \)
From diethylmalonate, cyclohexene, and any inorganic reagents that you may need. You don’t have to prepare NaOEt, or other common bases. Note: You have stereochemistry to control in this problem.