You are allowed to use any non-human resources you wish (e.g., synthesis texts, journals, reference texts, etc.). You may not communicate with other students, faculty, staff, or outside scientists either directly or indirectly. You are allowed to ask me questions, but only regarding the format of the exam or to inquire as to whether a reagent is allowed or not. Any question I am asked will be sent out (along with my response) via e-mail to the entire class so everyone has equivalent information; whoever asks the question will remain anonymous.

1. Provide reagents that will accomplish the following syntheses. More than one step will be required.

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

2. Provide a complete and detailed mechanism for the following reaction.

\[
\text{Ph} = \text{CO}_2\text{Et} + \text{O} = \text{CO}_2\text{Et} \quad \xrightarrow{1) \text{NaOEt, EtOH}} \quad \text{Ph} \quad \xrightarrow{2) \text{KOH, H}_2\text{O}} \quad \xrightarrow{3) \text{H}_3\text{O}^+ (\text{w/up})} \quad \text{OH}
\]

3. Rationalize the selectivity of the following enolate formations:

\[
\begin{align*}
\text{N(CH}_3)_2 \quad & \xrightarrow{\text{LDA, -78 °C}} \quad \text{N(CH}_3)_2 \\
\text{NCO}_2\text{CH}_3 \quad & \xrightarrow{\text{LDA, -78 °C}} \quad \text{NCO}_2\text{CH}_3
\end{align*}
\]

2:98 ratio

97:3 ratio
4. You must select three (3) of the following molecular targets (A – F). Provide a retrosynthetic analysis and a forward synthesis for each of the three you select. Stereochemistry has been intentionally ignored in these targets; however, you must apply appropriate methods to install the correct alkene isomer wherever applicable.

Your retrosynthetic analysis and forward synthesis must be accompanied by short commentaries (e.g., “enolate formation under kinetic conditions”, “protection of least hindered alcohol”, etc.). Additionally, acknowledging a questionable step and/or stating potential problems may earn you partial credit. For example, if there is a question regarding regioselectivity of a transformation, then letting me know that you are aware of the problem is far better than saying nothing.

Provide (1) the retrosynthetic analysis and (2) the synthesis for three (3) of the following target molecules.

- You may only use simple mono-, di-, and trifunctional aliphatic compounds with five or fewer carbons (not counting the alkoxy carbons of esters, acetics, or protecting groups).
- You can also use cyclopentanol, cyclohexanol, and benzene (or phenyl groups, as in PhBr, PhMe, or PhOH). Do not count the phenyl groups in Wittig reagents, only the number of carbons attached to the P (e.g., Ph₃P=CHCH₂CH₂CH₃)
- You may also use any inorganic reagents.
- You must provide a reference (Text and page number or Journal reference) for any unusual or uncommon reactions or exotic reagents.

![Molecular targets](image)