1. Predict the products formed in the following reactions. If you predict no products are formed, indicate by writing N.R. by the reaction. (4 points)

(a) 

(b) 

2. Give a detailed mechanism for the following reaction. Do the cyclization steps follow Baldwin’s rules? (Indicate the types of cyclization: e.g. 4-exo-dig) (8 points)

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

\[
2M \text{HCl} \rightarrow
\]

\[
\begin{align*}
\text{O} & \quad \text{N} \\
\text{OEt} & \quad \text{OEt} \\
\end{align*}
\]
3. Acid-catalyzed reaction of 2,2,3,3-tetramethoxybutane with quinic acid yields BBA-protected quinic acid. In the structure of BBA-protected quinic acid provided below, indicate where the two methoxy groups and two methyl groups are attached. CLEARLY indicate whether each substituent is axial or equatorial. HINT: Take the anomeric effect into consideration. (4 points)

```
quinic acid

+-------------------+-------------------+
| CH_2O | OCH_3 | CH_2O | OCH_3 |
|       |       |       |       |
+-------------------+-------------------+
| OH |   | OH |   |
|   |   |   |   |
+-------------------+-------------------+
| CO_2H | OH | CO_2H | OH |
```

BBA-protected quinic acid

4. In the structure provided below: (4 points)

```
OH
```

(a) Are the methyl groups homotopic, enantiotopic or diastereotopic?

(b) Will the methyl groups, in theory, give one or two singlets in the ^1H NMR?

5. Treatment of 1 with n-BuLi and then ethyl iodide does not produce 2. Only propanedithioic acid 3 was isolated. Draw a mechanism to account for the formation of 3. Based on this mechanism predict what other product(s) must have formed in this reaction. (5 points)

```
1) n-BuLi
2) EtI
3) H_2O

1

2

3

not observed

isolated
```