Detailed Mechanism Provide a detailed mechanism [i.e., explicitly show (using curly arrows) EVERY intermediate, formal charge (where relevant), equilibrium, and bond-making and -breaking step] to account for the following transformations:

a) Formation of the tetracycle 2 from the tricycle 1. [Hint: forcing conditions are required to effect the key C–C bond formation because the electrophile is conjugated with an anionic group].

![Chemical structure of 1 and 2](image)

\[ \begin{align*}
1 & \rightarrow 2 \\
{\text{O}} & {\text{NMe}}_2 \quad \text{NaH} \quad \text{DMF, MeOH} \quad \text{r.t. to 155 °C} \quad \text{20 min}
\end{align*} \]

b) The conversion of a substituted aniline 3 to the substituted quinoline 5 in the presence of pyruvic acid 4 and NaOH.

![Chemical structures of 3, 4, and 5](image)

\[ \begin{align*}
3 + 4 & \rightarrow 5 \\
{\text{CHO}} & {\text{Br}} & {\text{OBn}} \quad \text{NaOH} \quad \text{MeOH, 57 °C} \quad 6 \text{ h}
\end{align*} \]

c) The selenium induced cyclization of epoxide 6 to the tricyclic polyether 8 [Hints: the phthalimide selenium reagent 7 is a source of a “soft” electrophilic selenium moiety; hexafluoroisopropanol (HFIP) is a strong hydrogen bond donor.]

![Chemical structures of 6 and 8](image)

\[ \begin{align*}
6 & \rightarrow 8 \\
{\text{EtO}} & {\text{Me}} & {\text{OMOM}} \quad 7 \quad (\text{CF}_3)_2\text{CHOH}
\end{align*} \]
Other Problems

1. When the vinyl ether 9 was heated, the aldehyde 10 was formed as a single diastereomer. Deduce the configuration of the unspecified stereogenic center in structure 10 and provide a careful drawing of the transition state geometry for this Claisen rearrangement.

![Chemical structure](image)

2. Deduce the structures of products 13-17 and 20.

Provide a detailed mechanism for the conversion of bis-chloroformate 18 to dialdehyde 19. The experimental details reveal that carbon dioxide evolution is observed prior to the addition of TEA (i.e., prior to stage ii from 18 → 19).

![Chemical reactions](image)

3. Reaxys Database Search

a. According to the Reaxys database, how many single-step transformations convert any 1,4-disubstituted benzene (containing no alkynes) to a 1,4-dialkynyl benzene?

b. According to the Reaxys database, how many single-step transformations convert any 1,4-disubstituted benzene (containing no alkynes) to a 1,4-dialkynyl benzene use diisopropylamine as a the (co)solvent?