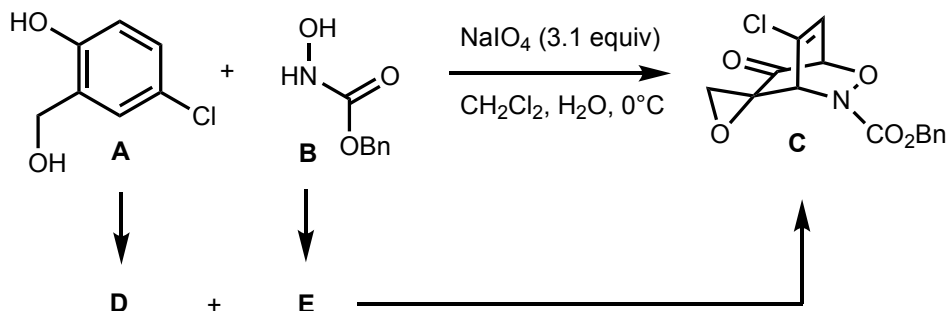


# Organic Cumulative Exam (March 7, 2019)

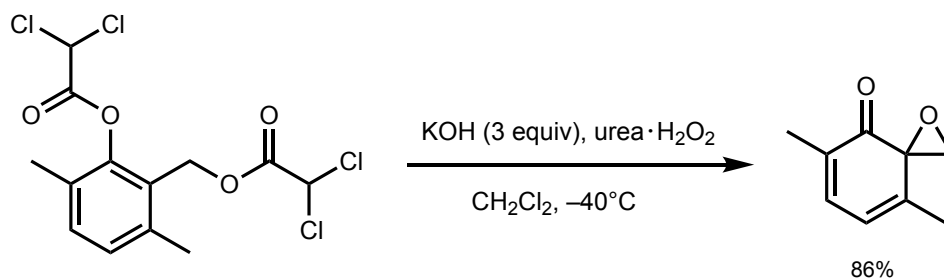
## Daesung Lee

1. (20 Points) The following transformation was reported by Johnson and coworkers (*J. Am. Chem. Soc.* **2017**, *139*, 12422). In the overall process, two independent oxidative transformations ( $\mathbf{A} \rightarrow \mathbf{D}$  and  $\mathbf{B} \rightarrow \mathbf{E}$ ) set for the following intermolecular reaction between  $\mathbf{D}$  and  $\mathbf{E}$  to generate  $\mathbf{C}$ .



- (a) (10 Points) Draw the structure of **D** and a reasonable arrow-pushing mechanism for the conversion of **A**  $\rightarrow$  **D**.
- (b) (5 Points) Draw the structure of **E** and a reasonable arrow-pushing mechanism for the conversion of **B**  $\rightarrow$  **E**.
- (c) (5 Points) Draw a transition state structure that will lead to the observed product **C** and rationalize the regiochemistry and stereochemistry.

**2. (25 Points)** A new epoxide forming reaction of o-hydroxymethyl phenols has been developed by Johnson and coworkers (*J. Am. Chem. Soc.* **2019**, *141*, 2645). In terms of its reaction mechanism, this epoxidation is very different from the transformation of **A** → **D** in the previous reaction.

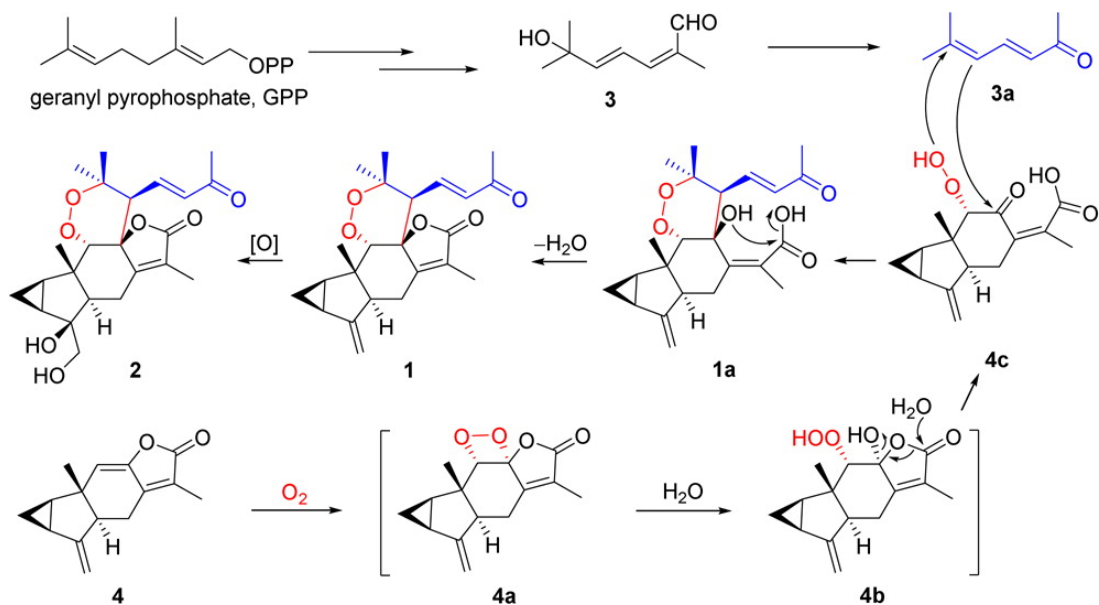


**(a) (10 Points)** The two esters in the starting material will undergo saponification with a significantly different reaction rate. Between the two esters, which ester will be cleaved preferentially? Provide a rationale for your answer.

**(b) (5 Points)** Draw the structure of the intermediate that undergoes epoxidation reaction.

**(c) (10 Points)** Draw a reasonable mechanism for the overall transformation shown above.

**3. (25 Points)** The following mechanism for the biosynthesis of sarglaperoxides A and B was proposed by Luo and coworkers (*Org. Lett.* **2016**, *18*, 832). In this mechanism, the pathway following  $4\mathbf{a} \rightarrow 4\mathbf{b} \rightarrow 4\mathbf{c}+3\mathbf{a} \rightarrow 1\mathbf{a} \rightarrow 1 \rightarrow 2$  is less likely and an alternative pathway involving a different intermediate following  $4+\text{O}_2 \rightarrow \mathbf{X}+3\mathbf{a} \rightarrow 1$  seems to be more reasonable.



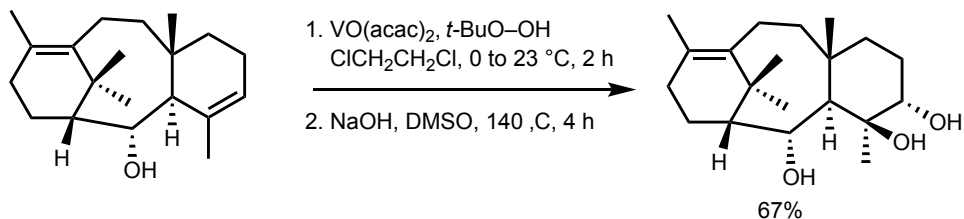
**(a) (10 Points)** Draw a reasonable mechanism for the reaction between **4** and O<sub>2</sub> to generate **X**. (Keep in mind that **X** should be a precursor to generate **4a** or **4b** in the presence of H<sub>2</sub>O).

**(b) (5 Points)** Propose a mechanism by which **X** reacts with **3a** to generate **1**.

**(c) (5 Points)** Draw a mechanism to show how **4a** is converted to **4b**.

**(d) (5 Points)** The mechanism for the conversion of **4b** to **4c** with the indicated arrow-pushing is less likely. Draw an alternative mechanism and explain why this alternative mechanism is more reasonable.

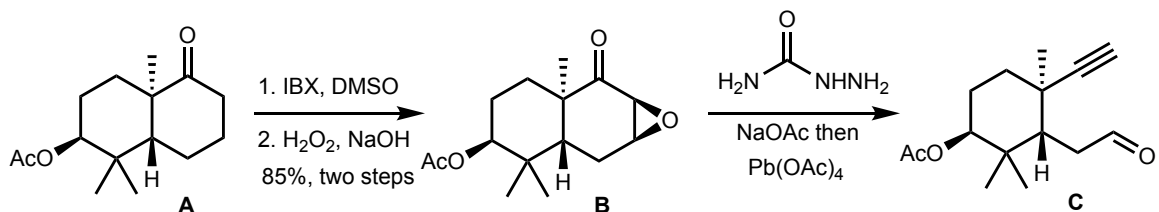
4. (20 Points) The following metal-catalyzed epoxidation followed by opening of the epoxide provided the corresponding triol product with indicated stereochemistry (*Angew. Chem. Int. Ed.* **2016**, 55, 8280). Based on the typical intramolecular nature of the chelated oxygen delivery in the metal-catalyzed epoxidation, the stereochemical outcome of this epoxidation seems to be counterintuitive.



(a) (10 Points) Draw a reasonable three-dimensional structure with proper conformation of the taxane skeleton that will allow for the epoxidation.

(b) (10 Points) On the basis of the three-dimensional structure in (a), draw a mechanism of the epoxidation that can rationalize the observed stereochemistry.

5. (10 points) In the total synthesis *ent*-kaurenoids by Ding and coworkers (*J. Am. Chem. Soc.* **2017**, 139, 6098), the following oxidative transformations were employed. Provides mechanisms of the transformation **A** → **B** and **B** → **C**.



(a) (5 Points) Draw a reasonable mechanism for the transformation **A** → **B**.

(b) (5 Points) Draw a reasonable mechanism for the transformation **B** → **C**.

