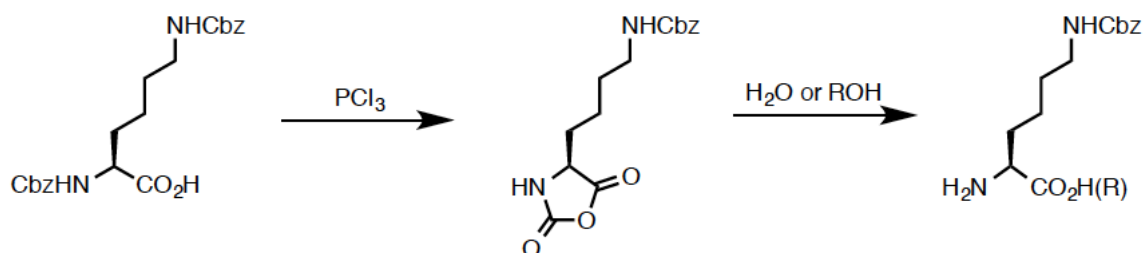


1. (4 points)

a) During the lecture, we discussed the use of carbodiimides (e.g. DCC) as coupling reagents. Make sure that you can draw the mechanism of this reaction. Why does the addition of an external base (e.g. NEt_3) reduce the reactivity of carbodiimides?

b) An alternative method for differentiating functional groups of amino acids is depicted below for the example of a lysine derivative. Which undesired side reaction could happen during this reaction sequence?

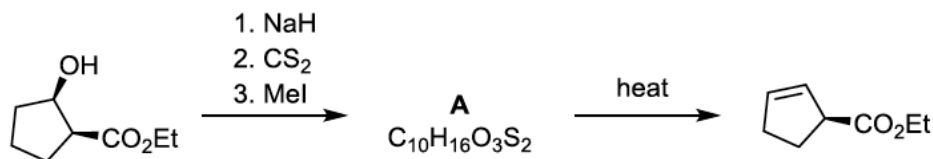


2. (4 points) Naming heterocycles Match the following heterocycles with the names given.

3,8-dimethylisoquinoline	2-bromoindole
4-phenyl-1,2-dihydroquinoline	5-methoxyisoquinolin-1-one
7-bromo-2,3-dihydroindole	2-phenyl-3,4-dihydroquinoline
2,7-dimethylquinoline	2,7-dimethylquinolin-4-one

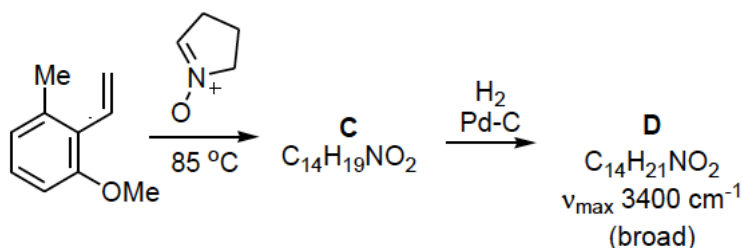
3. (3 points)

Identify intermediate product **A** and draw a mechanism for the elimination (second) step. Comment on the regioselectivity of this particular example of the Chugaev reaction.

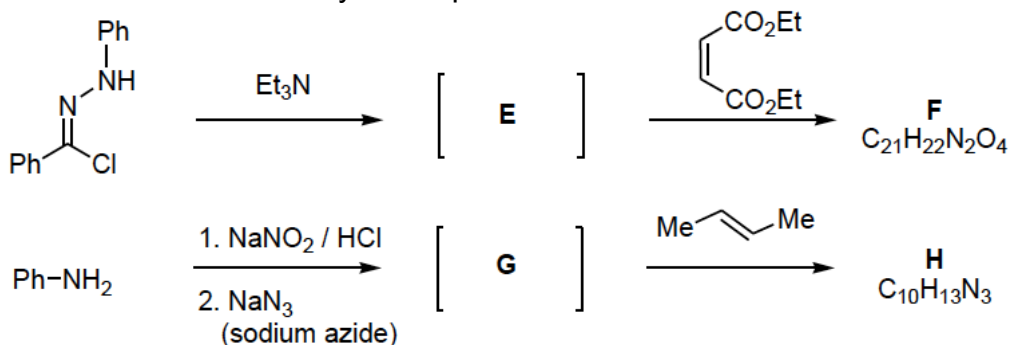


4. (3 points)

a) Consider the following scheme and work out the structures of **C** and **D**.

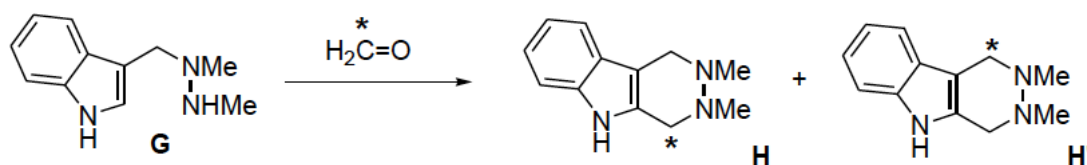


b) For the following cycloaddition reactions involving 1,3-dipoles, identify **EITHER** the structures of intermediate **E** and product **F**, **OR** the structures of intermediate **G** and product **H**. Indicate clearly the relative stereochemistry of the product.

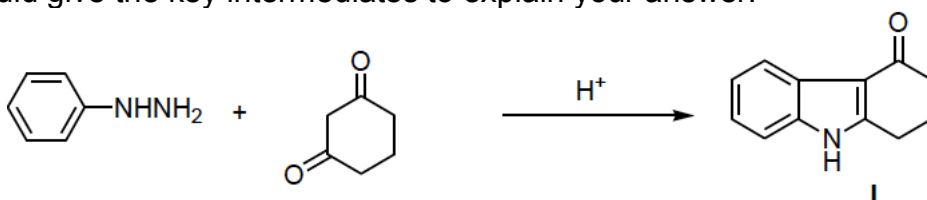


5. (3 points)

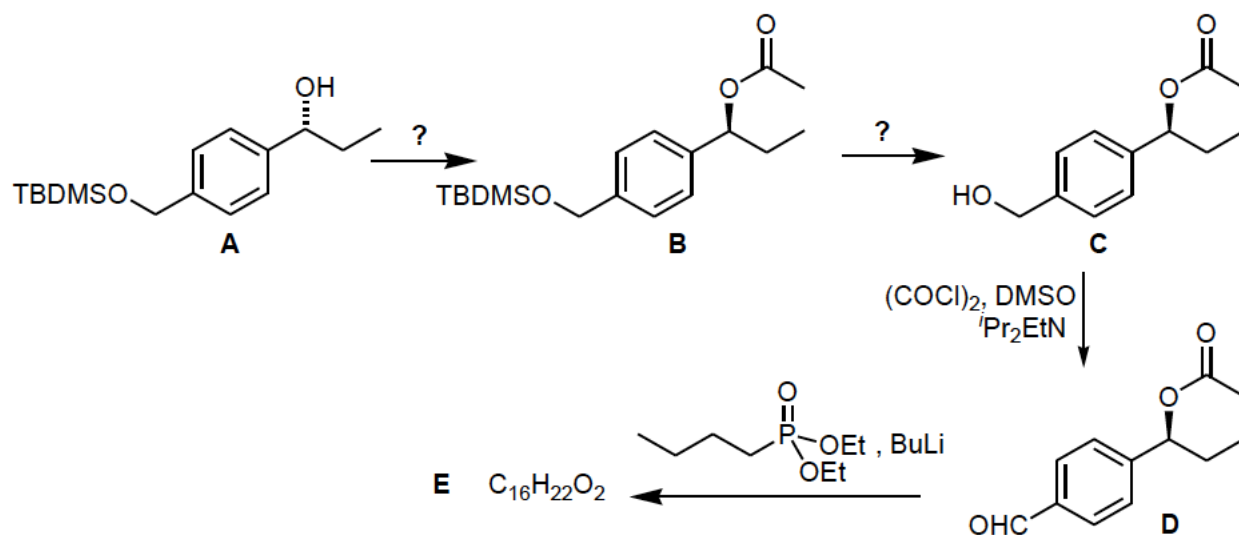
a) When treated with ^{13}C -labelled formaldehyde (methanal, $^*CH_2=O$) the indole derivative **G** undergoes a Pictet-Spengler reaction to give products **H** and **H'** in which the labelled carbon ($*$) is found distributed equally between C1 and C4. Account for this observation.



b) Explain why the reaction of phenylhydrazine with cyclohexa-1,3-dione leads to only one indole product **I**, as shown below. A full mechanism of the Fischer indole synthesis is not required, though you should give the key intermediates to explain your answer.



6. (3 points) Consider the sequence below and answer **all** of the following questions:



- Suggest reagents that may be used to convert **A** into **B**.
- Suggest a reagent that may be used to convert **B** into **C**.
- Alcohol **C** may be oxidised to aldehyde **D** using a Swern oxidation. Give a mechanism for this reaction.
- Elucidate the structure of compound **E**.

7. (9 points) Consider the following electrophilic and nucleophilic reactions of heterocycles and provide the product of each reaction.

