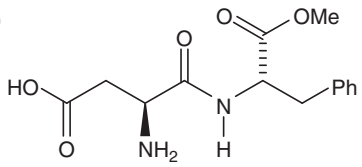
11 Organic chemistry 1: functional groups

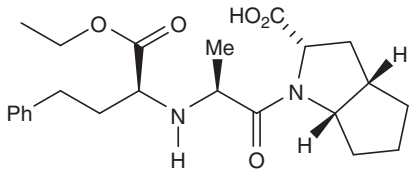
11.1 Identify the functional groups present in the following molecules.

(a)



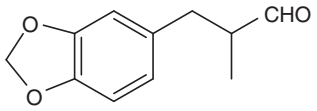
Aspartame – an artificial sweetener

(b)



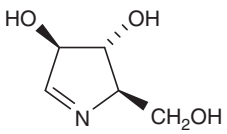
Ramipril – used to treat hypertension and congestive heart failure

(c)



Tropional – a key ingredient in Chanel's perfume *Allure*

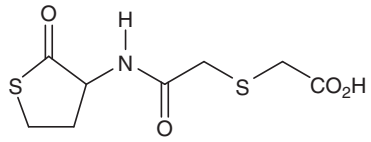
(d)



Nectrisine – an antibiotic

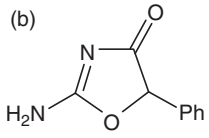
11.2 Copy the structures of each of the following molecules and identify the functional group level of each of the carbon atoms in them.

(a)



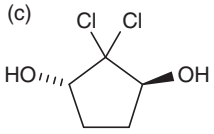
Erdosteine – breaks down mucus to help ease breathing

(b)



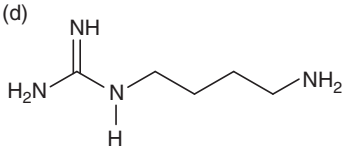
Pemoline – a stimulant of the central nervous system

(c)



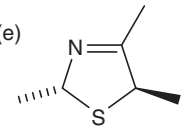
Caldariomycin – an antibiotic

(d)



Agmatine – a component of octopus muscle and herring semen

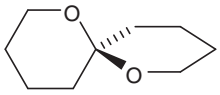
(e)



A component of the faeces of the red fox, and a flavour of cooked meats

11.3 Draw the structures of the products formed in the following hydrolysis reactions.

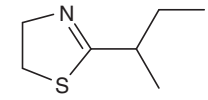
(a)



A sex pheromone of the olive fly

$\xrightarrow{H_3O^{\oplus}}$ $C_9H_{18}O_3$

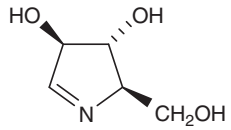
(b)



A mouse pheromone

$\xrightarrow{H_3O^{\oplus}}$ $C_5H_{10}O_2 + C_2H_7NS$

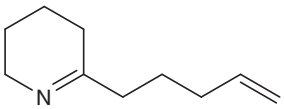
(c)



Nectrisine – an antibiotic

$\xrightarrow{H_3O^{\oplus}}$ $C_5H_{11}NO_4$

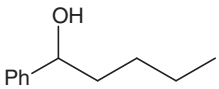
(d)



A component of ant venom

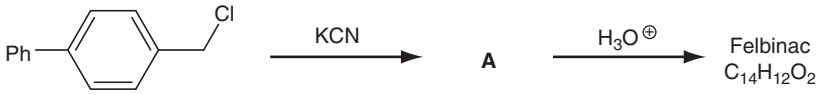
$\xrightarrow{H_3O^{\oplus}}$ $C_{10}H_{19}NO$

11.4 The drug *Fenipentol*, shown below, is synthesized by the reaction between butylmagnesium bromide and an aldehyde. Draw the structure of the aldehyde and give the mechanism for the reaction.

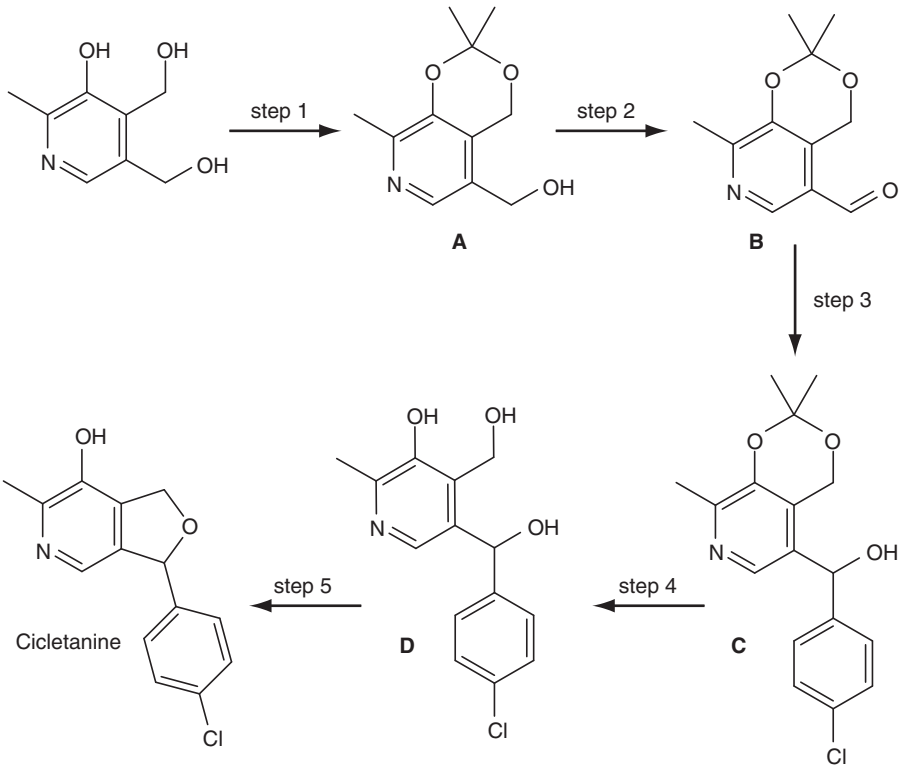


Fenipentol

11.5 A synthesis of the anti-inflammatory drug *Felbinac* is shown below. Suggest a structure for the intermediate **A** and give a mechanism for its formation. Give a mechanism for the hydrolysis of **A** to Felbinac.



11.6 Consider the following scheme for the synthesis of the drug *Cicletanine*, which is used as a diuretic and antihypertensive.



(a) Give the reagents needed to form acetal **A** in step 1 and draw a mechanism for this step.

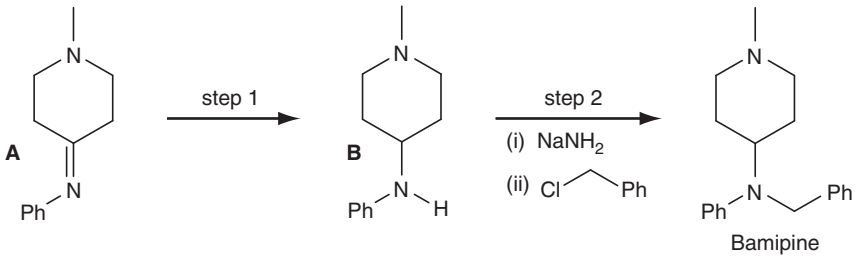
(b) What sort of reaction is step 2: a reduction; an oxidation; or a nucleophilic substitution?

(c) Give the reagent needed for step 3 and draw a mechanism for this step.

(d) Steps 4 and 5 occur under the same conditions. What conditions are needed for the hydrolysis of acetal **D**? Give a mechanism for this step.

(e) What sort of reaction is step 5: a reduction; an oxidation; or a nucleophilic substitution?

11.7 The synthesis of the antihistimine drug *Bamipine* is given below.

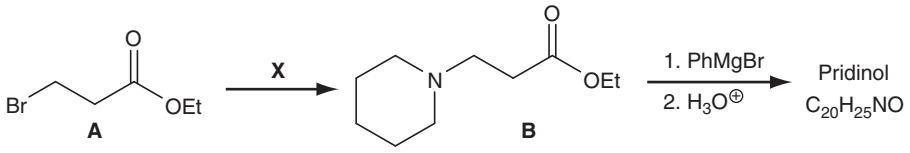


(a) What sort of reaction is step 1: a reduction; an oxidation; or a nucleophilic substitution?

(b) What is the role of the $NaNH_2$ in step 2? Draw mechanisms for the reactions in step 2.

(c) The imine **A** is formed by the reaction of $PhNH_2$ with another reagent. Identify this reagent, and give a mechanism for its reaction with $PhNH_2$ to form **A**.

11.8 A synthesis of the antiparkinsonian drug *Pridinol* is outlined below.

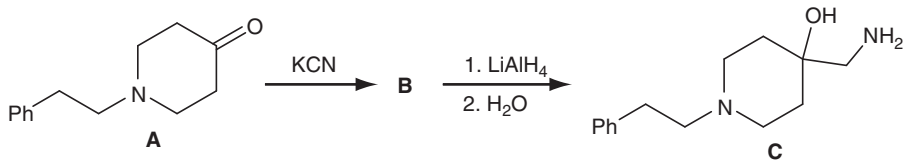


(a) At which *two* sites could bromoester **A** react with a nucleophile? Name the key orbitals involved in each case.

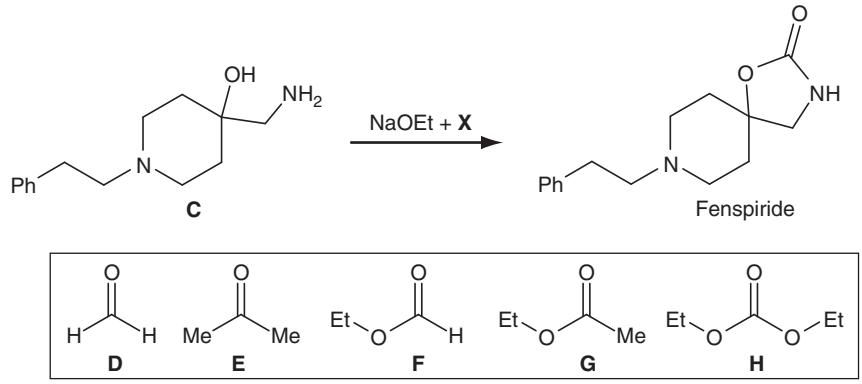
(b) Suggest a reagent **X** to form **B** from **A** and give a mechanism for the reaction. Explain why **X** reacts in the manner shown, rather than at the alternative site identified in (a).

(c) Intermediate **B** reacts with excess phenylmagnesium bromide to give Pridinol. Suggest a structure for Pridinol and give a mechanism for its formation.

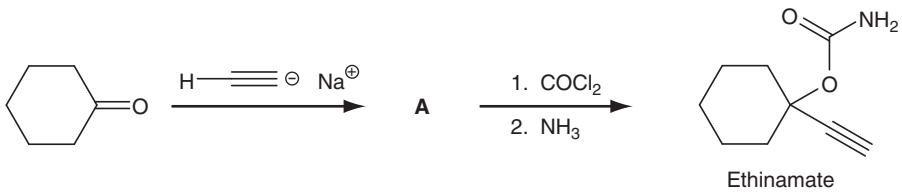
11.9 Part of the synthesis of the antiasthmatic drug *Fenspiride* is shown below. Identify the structure of the intermediate **B** and give a mechanism for its formation. Give a mechanism for the reduction of **B** to **C**.



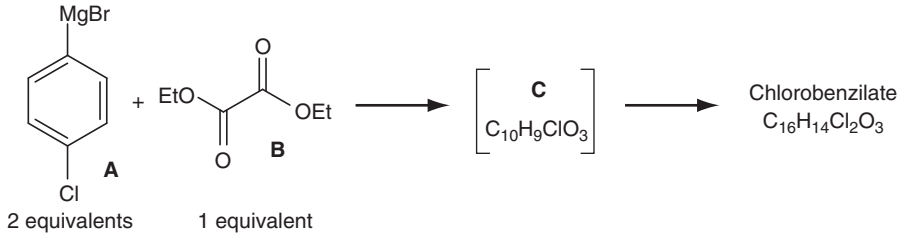
The drug Fenspiride is prepared from intermediate **C** by reacting it with the base NaOEt and compound **X**. **X** is one of the compounds shown in the box below. By considering the functional group levels, suggest which one of the compounds **D–H** is **X** and give a mechanism for the formation of Fenspiride.



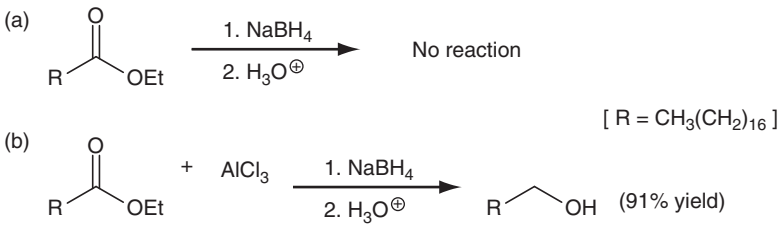
11.10 A synthesis of the sedative *Ethinamate* is shown below. Suggest a structure for the intermediate **A** and draw a mechansim for its formation. Give mechanisms for the formation of Ethinamate from **A**.



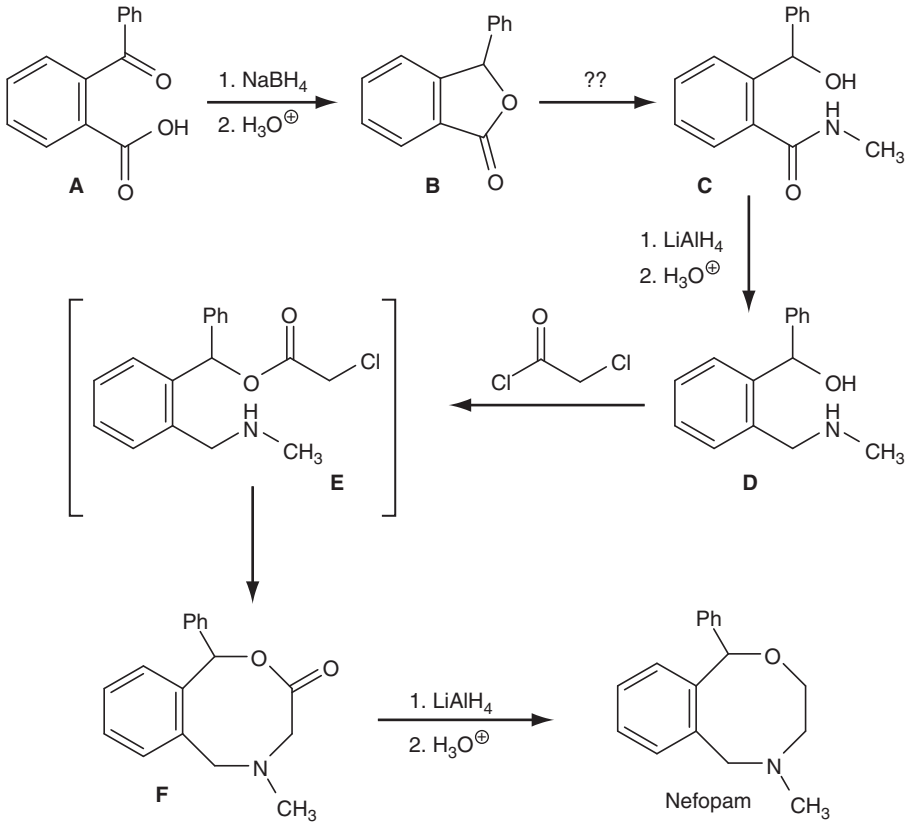
11.11 A synthesis of the mite and spider killer *Chlorobenzilate* is shown below. When the Grignard reagent **A** is added slowly to a solution of diethyl oxalate **B** at low temperatures, the intermediate **C** is first formed, but this reacts with further Grignard reagent to form, after work-up in aqueous acid, Chlorobenzilate. Suggest a structure for the intermediate **C** and give a mechanism for its formation. Give a mechanism for the reaction of the intermediate **C** with the Grignard reagent **A** and explain why the addition of the second Grignard reagent occurs at the position it does.



11.12 Explain the following. When sodium borohydride is added to a solution of an ester, as shown in (a), no reduction takes place. However, on addition of aluminium trichloride, as shown in (b), the reduction readily takes place.



11.13 A synthesis of the muscle relaxant *Nefopam* is shown below.



(a) Which of the carbonyls in compound **A** is reduced by the borohydride? Draw a mechanism for this reduction and for the subsequent formation of **B**.

(b) Suggest a suitable reagent for the conversion of **B** to **C** and draw a mechanism for this step.

(c) Give a mechanism for the reduction of **C** to **D**.

(d) The cyclyzation of intermediate **E** to give **F** is an example of an intramolecular nucleophilic substitution reaction. Will this proceed via an S_N1-like mechanism or an S_N2- like mechanism? Explain your answer.

(e) Draw a mechanism for the reduction of **F** and the subsequent formation of Nefopam which takes place in acid.

(f) Explain why $NaBH_4$ is the reducing agent of choice for the first step, but $LiAlH_4$ for the later two reductions.