



Semester I Examinations 2010-2011

Exam Code(s) 3BS9; 3BPM
Exam(s) Third year Chemistry and Third year
Biopharmaceutical Chemistry

Module Code(s) CH311
Module(s) ORGANIC CHEMISTRY

Paper No.
Repeat Paper

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Instructions:

Answer **four** questions from Sections A-D:
One from each Section

Use a separate answer book for each Section.
All questions carry 25 marks distributed as shown.
Leave the first page of the answer book blank and
list on it clearly the numbers of the questions
attempted.

Duration Two Hours
No. of Pages 7
Department(s) Chemistry
Course Co-ordinator(s) Dr. F. Aldabbagh

Requirements:

MCQ Release to Library: Yes No

Statistical/ Log Tables Yes

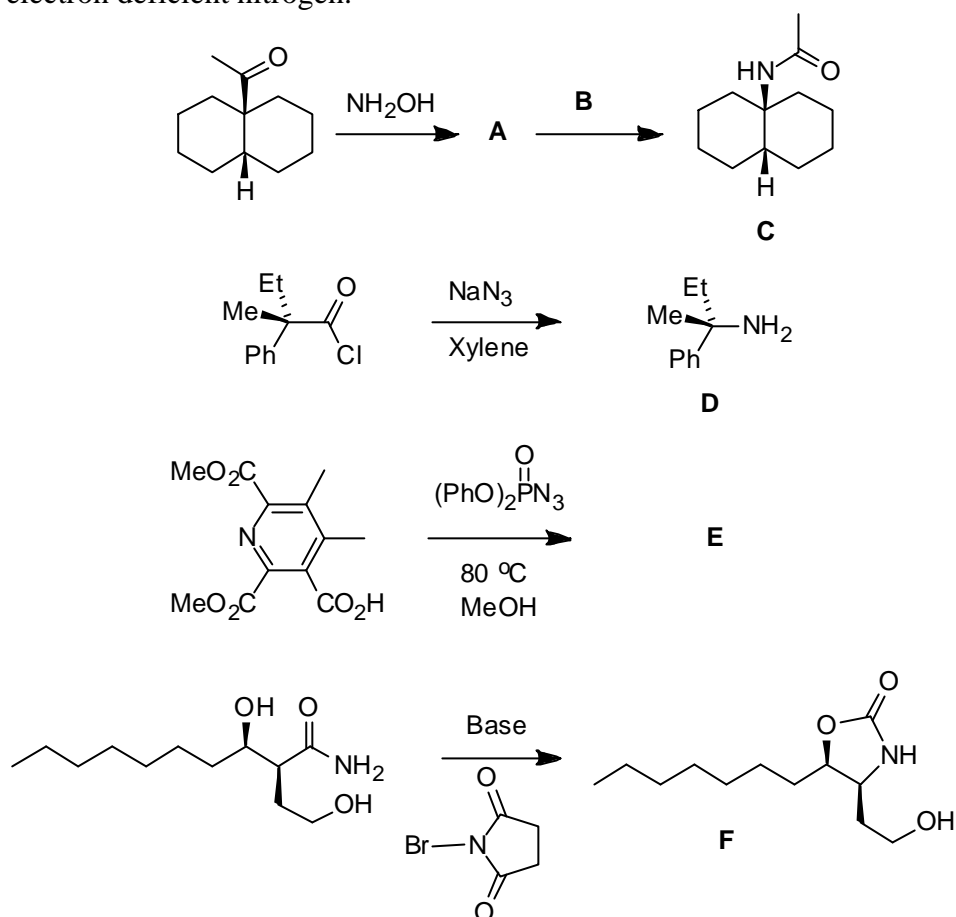
Graph Paper Yes

Section A
(Answer only one question)

1. Answer all parts:

The following questions (i) – (v) refer to the Scheme below.

The formation of compounds **C** to **F** are all based mechanistically on migration to electron deficient nitrogen.



- (i) Write structure for **A** and give the reagent and conditions **B** [4 marks]
- (ii) Suggest a mechanism for the formation of **C** from **A**. Comment on any apparent selectivity. [3 marks]
- (iii) Suggest a mechanism for the formation of **D** [4 marks]
- (iv) Draw a structure for the product **E** and suggest a mechanism for its formation [6 marks]
- (v) Provide a mechanism for the formation **F** [4 marks]
- (vi) Quinuclidine reacts 63 times faster with MeI than does triethylamine (NEt₃). Draw the products from these reactions and give an explanation for the difference in reactivity. [4 marks]

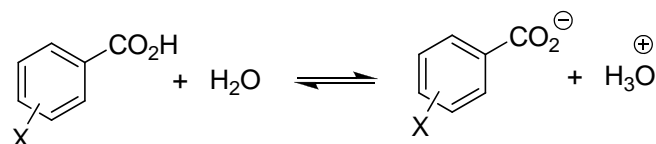


Quinuclidine

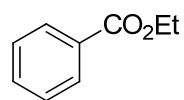
2. Answer all parts

(i) Briefly explain how the Hammett substituent parameter σ_x is obtained? [4 marks]

(ii) The acid catalysed hydrolysis of substituted ethyl benzoates has a Hammett ρ value of 0.14, whereas the base catalysed hydrolysis shows a ρ value of 2.19. How were the ρ values obtained for the hydrolysis of ethyl benzoates? Which reaction is more sensitive to the nature of the substituent? [5 marks]

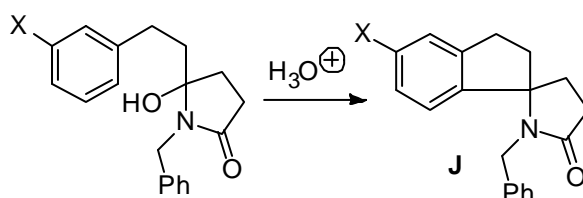


(iii) Describe a mechanism for the acid catalysed hydrolysis of ethyl benzoate. Discuss how evidence for the involvement of a tetrahedral intermediate could be obtained by the use of isotopes. [8 marks]



Ethyl benzoate

(iv) Would you expect the nature of the substituent X to influence the rate of formation of **J**? Describe a mechanism that supports your answer. [8 marks]



Section B

(Answer only one question)

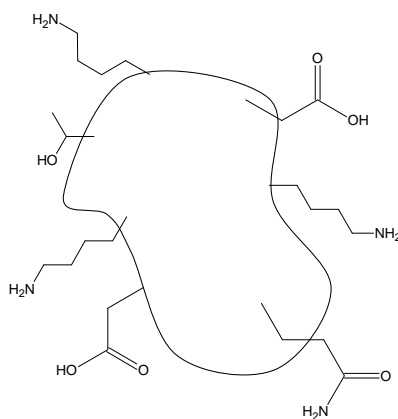
3. Answer all parts:

- (i) Define what is meant by primary, secondary and tertiary structure of proteins. [6 marks]
- (ii) The following sequence of amino acids is known to form an α -helix. Explain, with reference to the types of amino acids present, their likely location in a protein tertiary structure.

-Lys-Ala-Phe-Thr-Leu-Leu-Asp-Ile-Val-Ser-

[6 marks]

- (iii) Draw a tripeptide (with R for side chains). Illustrate the hydrogen bonds that occur when two peptide strands form a parallel β -sheet. [7 marks]
- (iv) The illustration below represents a protein surface. What is the net charge on the protein at (a) pH 7 and (b) at pH 2? Provide a clear explanation for your calculations.

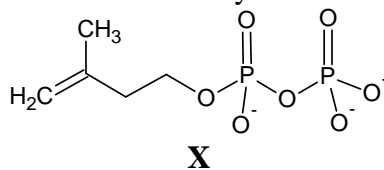


[6 marks]

4. Answer all parts:

- (i) Outline briefly why the bacterium *Escherichia coli* is useful for protein production. [6 marks]
- (ii) Define the terms glycoprotein and lipoprotein and contrast their likely cellular location. [4 marks]

(iii) Molecule **X** is an intermediate in the biosynthesis of which class of molecules?



Name the carbon moiety of **X** and give two roles for the pyrophosphate group.

[4 marks]

(iv) Crystal structure analysis of protein P reveals a binding site for **X**. Describe the overall features of the binding site that will favour an interaction with **X**. Name and draw the side chains of two amino acids likely to occur in the binding site and explain how they interact with **X**.

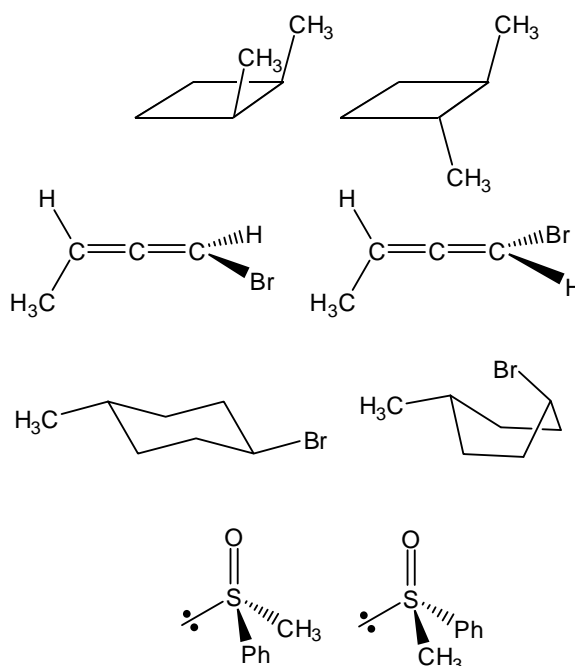
[11 marks]

Section C

(Answer only one question)

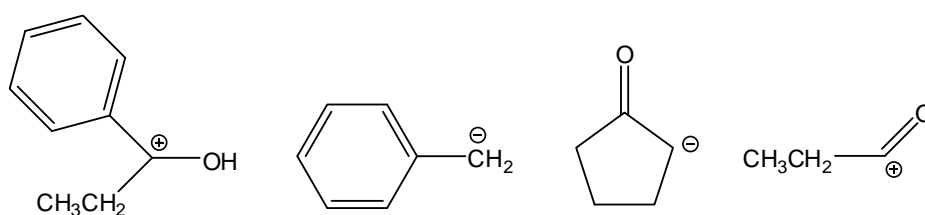
5. Answer all parts:

- (i) Using examples, explain the difference between an enantioselective and a diastereoselective reaction. [6 marks]
- (ii) Explain what is meant by enantiomeric excess and outline **two** methods by which it can be measured [6 marks]
- (iii) A sample of 2-pentanol is labelled “(S)-(+)-2-pentanol”. What information is provided by the descriptors “(S)” and “(+)”? What additional information is provided by the fact that “(S)” and “(+)” are used together for this sample? [5 marks]
- (iv) Identify the relationship (identical, enantiomers, diastereomers or conformational isomers) between each of the following pairs of structures. In each case the reason for your conclusion should be clearly given: [4x2 marks]



6. Answer all parts

- (i) Describe the five categories – for example total synthesis - into which organic syntheses can be divided [8 marks]
- (ii) Outline the retrosynthetic analysis of a molecule of your choice and use it to explain what is meant by the following terms: (a) disconnection, (b) synthon, and (c) synthetic equivalent. [9 marks]
- (iii) Draw the structures of molecules which are synthetic equivalent to each of the following synthons and for any **two** give a reaction in which the molecule behaves like that synthon:



[4x2 marks]

Section D

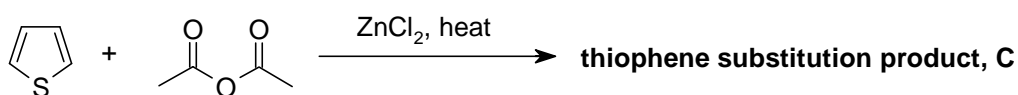
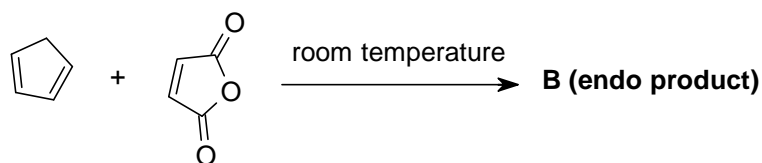
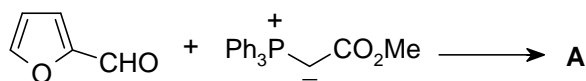
(Answer only one question)

7. Answer each of the following:

- (i) Give reaction conditions and curly arrow mechanisms for the nitration of pyrrole to give 2-nitropyrrole and 3-nitropyrrole. Indicate the major isomeric product from the electrophilic aromatic substitution, and give a mechanistic explanation for your answer. [12 marks]

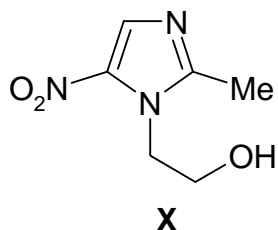
Identify products **A**, **B** and **C**, and give reaction mechanisms using curly arrows for their formation. [13 marks]

- (ii)



8. Answer each of the following:

- (i) Draw all possible isomeric diazoles and triazoles. Name all molecules and draw their *NH*-tautomers (where possible). Rationalise the acidity of tetrazole using resonance structures, and its use in drug discovery.
[13 marks]
- (ii) Describe a concise synthesis of the antiparasitic compound, metronidazole **X** starting from 2-methylimidazole. Give mechanisms for all synthetic steps. Why is it difficult to optimise the yield of **X**.



[12 marks]