



Autumn 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

External Examiner(s) **Professor Richard Taylor**
Internal Examiner(s) **Professor Paul V. Murphy**
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Dr. Peter B. Crowley
Dr. Niall W. A. Geraghty

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

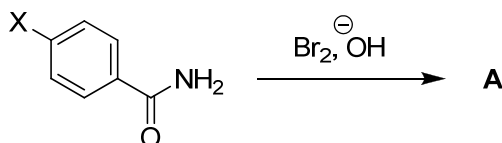
- (a) Discuss rearrangements to electron deficient nitrogen under the following headings:

Curtius rearrangement

Beckmann rearrangement

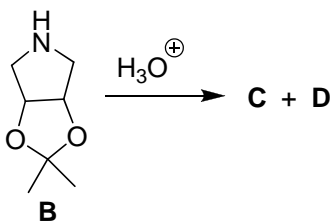
In your answer give one example of each reaction type and provide a detailed mechanism using curly arrows for each reaction. **[8 marks]**

- (b) Give a structure for **A**. Write a mechanism, using curly arrows, for its formation. Would you expect the nature of the substituent X to influence the rate of the reaction? Give the name of the reaction which leads to **A**.



[9 marks]

- (c) Provide a detailed mechanism, using curly arrows, for the acid catalysed hydrolysis of the ketal **B**. Give the structure of the products **C** and **D**.



[8 marks]

2. Answer all parts

- (a) Discuss the role of the following experiments in the study of reaction mechanism.

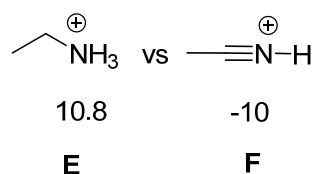
Crossover experiments
Determination of a kinetic isotope effect
Isotope labeling experiment

In each case illustrate your answer with one reaction where the experiment could be productively utilized. When preparing your answer you could select from the following reactions or from another reaction of your choice

Hydrolysis of an ester
Beckmann rearrangement versus Beckmann fragmentation
Elimination reaction
Oxidation of a secondary alcohol
Electrophilic aromatic substitution

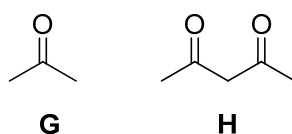
[15 marks]

- (b) Explain the difference in pK_a values between **E** and **F**



[5 marks]

- (c) Which of the following compounds would you expect to be more acidic?
Explain your answer.

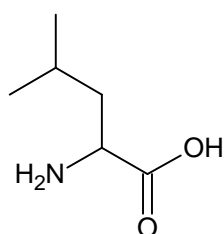


[5 marks]

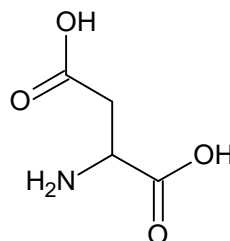
Section B

(Answer *only one question*)

3. Answer all parts:



L



D

- (i) Name the molecules **L** and **D**. Reproduce the structures in your answer script and highlight any chiral centres. **[3 marks]**
- (ii) Draw a dipeptide formed by **L** and **D**, labelling the N- and C-termini. **[4 marks]**
- (iii) With reference to their pK_a values, draw physiologically-relevant structures of the side chains of **L** and **D**. **[5 marks]**
- (iv) Define what is meant by the tertiary structure of a protein. **[6 marks]**
- (v) Consider the **L-D** dipeptide to be part of a tertiary structure. With reference to the hydrophobic effect, describe the likely location of their side chains. **[7 marks]**

4. Answer all parts:

DNA → X → Protein

Scheme I

- (i) In terms of protein biosynthesis, what does **X** in scheme **I** represent? Name the process by which **X** is converted to protein. **[2 marks]**
- (ii) Briefly outline the differences between *Escherichia coli* and CHO cells in terms of protein production. **[10 marks]**
- (iii) A biopharmaceutical company is developing a new protein to bind cholesterol. Name the class of molecules to which cholesterol belongs and discuss briefly its solubility in a biological context. What general feature is required at the protein binding site to favour an interaction with cholesterol? Name and draw the side chains of two amino acids likely to occur in the binding site and explain how they might interact with cholesterol. **[13 marks]**

Section C

(Answer *only one question*)

5. Answer all parts

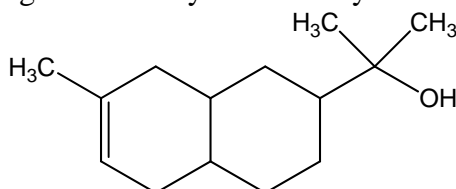
- (i) (a) Explain the difference between a convergent and a linear synthesis.
(b) Why it is preferable, where possible, that a synthesis should be convergent rather than linear?
(c) Determine the overall yield of a linear synthesis involving five steps, three of which gave yields of 70%, and the other two yields of 90% and 50%.

[8 marks]

- (ii) (a) Explain what is meant by a protecting group.
(b) Outline the type of reagents/reaction conditions from which a ketone group would need to be protected and give an example of how this might be done.

[9 marks]

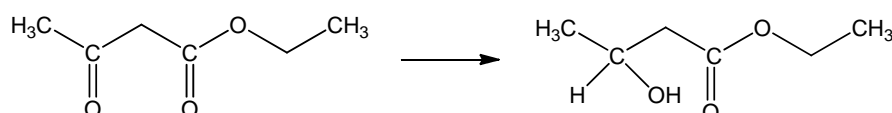
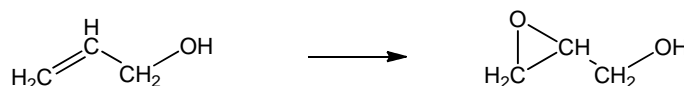
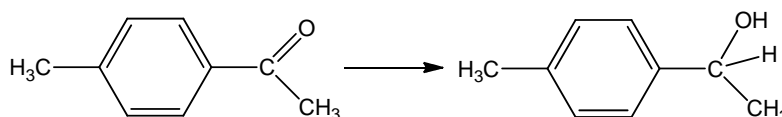
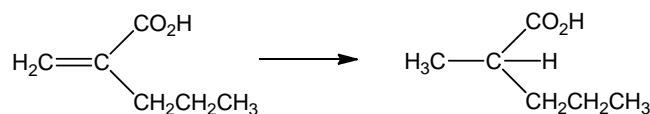
- (iii) Using the following molecule as an example, outline the various steps involved in carrying out a retrosynthetic analysis:



[8 marks]

6. Answer all parts:

- (i) Briefly discuss what is meant by the term **enantioselective synthesis**.
[5 marks]
- (ii) Outline the various approaches (using a chiral starting material, resolution or stereoselective synthesis) that can be adopted in carrying out the enantioselective synthesis of a chiral molecule (asymmetric synthesis) and discuss the advantages/problems associated with each.
[12 marks]
- (iii) Identify the chiral carbon in the product of each of the following reactions and explain how each reaction could be carried out **enantioselectively**: [8 marks]



Section D

(Answer only one question)

7. Answer each of the following:

- (i) Write notes on the chemistry of pyridine and pyrrole, include in your answer a description of bonding, geometry and relative reactivity. **[12 marks]**
- (ii) Propose a synthesis for 4-nitropyridine and pyrrole-2-carbaldehyde from pyridine and pyrrole respectively. Describe one of the aromatic substitutions using a curly arrow mechanism. **[13 marks]**

8. Answer each of the following:

- (i) Write notes on the chemistry of imidazole, include in your answer a description of bonding, geometry and reactivity. **[7 marks]**
- (ii) Propose a synthesis for 2-nitroimidazole from imidazole. Describe the nitration using a curly arrow mechanism. **[6.5 marks]**
- (iii) Draw the two isomeric triazoles and name them. **[4 marks]**
- (iv) Rationalise the acidity of tetrazole using resonance structures, and its use in drug discovery. **[7.5 marks]**