

## Liverpool John Moores University

Title: BIO-ORGANIC CHEMISTRY  
Status: Definitive  
Code: **6004CHACAP** (113186)  
Version Start Date: 01-08-2011

Owning School/Faculty: Pharmacy & Biomolecular Sciences  
Teaching School/Faculty: Pharmacy & Biomolecular Sciences

| Team             | Leader |
|------------------|--------|
| Raymond Fox      | Y      |
| Mark Wainwright  |        |
| Gillian Hutcheon |        |
| Ian Bradshaw     |        |

**Academic Level:** FHEQ6      **Credit Value:** 24.00      **Total Delivered Hours:** 51.00  
**Total Learning Hours:** 240      **Private Study:** 189

### Delivery Options

Course typically offered: Standard Year Long

| Component | Contact Hours |
|-----------|---------------|
| Lecture   | 24.000        |
| Practical | 21.000        |
| Tutorial  | 3.000         |

**Grading Basis:** 40 %

### Assessment Details

| Category | Short Description | Description  | Weighting (%) | Exam Duration |
|----------|-------------------|--|---------------|---------------|
| Exam     | AS1               | Examination  | 70.0          | 3.00          |
| Report   | AS2               | Coursework: Full details are provided in the module handbook | 30.0          |               |

### Aims

*To provide students with an up-to-date study of biomolecules and stress their importance in nature, research and industry. Emphasis will be given to the*

*biosynthesis, chemical synthesis, structural elucidation and conformation of biomolecules.*

## **Learning Outcomes**

After completing the module the student should be able to:

- 1 Recall the basic biosynthetic pathways leading to biomolecules and appreciate the variety of organic molecules found in nature
- 2 Devise a multi-stage sequence for the chemical synthesis of a given biomolecule.
- 3 Discuss methods for the structural elucidation of biomolecules
- 4 Correlate the structure of biomolecules with biological function.
- 5 Carry out a multi-stage sequence to synthesise a biomolecule and interpret spectroscopic data for structural determination.

## **Learning Outcomes of Assessments**

The assessment item list is assessed via the learning outcomes listed:

|                             |   |   |   |
|-----------------------------|---|---|---|
| Examination                 | 1 | 3 | 4 |
| Practicals and final report | 2 | 3 | 5 |

## **Outline Syllabus**

*Four of the following areas will normally be studied in detail in any one year; amino acids, proteins, enzymes, alkaloids, carbohydrates and nucleic acids. Delivery of up-to-date material will come from staff with active research interests in these areas.*

*Overview of secondary metabolism. Diversity and importance of natural products. Formation of shikimic acid and chorismic acids. Formation of aromatic amino acids. Transamination reactions. Pyridoxal and pyridoxamine. Alkaloids: occurrence and general characteristics. Alkaloids from lysine and ornithine. Pyrrolidine and piperidine alkaloids. Radio-labels. Decarboxylation and methylation reactions. Tropinones. Alkaloids derived from tryptophan, tyrosine and phenylalanine.*

*Brief review of monosaccharides, before dealing with a major topic in carbohydrate chemistry such as synthesis of monosaccharides, synthesis of oligosaccharides or structural analysis of polysaccharides. A typical syllabus for synthesis of oligosaccharides would be: use of protecting groups, acetals; benzoate, acetate and sulphonate esters, benzyl ethers. Strategy for synthesis of oligosaccharides - glycosyl donors and glycosyl acceptors. Activation of glycosyl donor. Methods for formation of glycosidic linkage, 1,2-trans and 1,2-cis glycosidic linkages. Use of imidates for oligosaccharide synthesis.*

*Brief review of amino acids (including synthesis) as the building block for peptides and proteins.*

*Principles of peptides synthesis. Review of protecting groups. Nitrogen (or amino) protecting groups, Z, BOC and FMOC groups. Protection of carboxylic acid group (esters). Side-chain protection. Methods for peptide bond formation. Activation of carboxylic acid group. Coupling reagents. Aspects of strategy in peptide synthesis. Examples of solution phase synthesis. Principles and techniques for solid-phase synthesis. Problems associated with peptide synthesis. Examples of solid phase synthesis. The syllabus may also be extended to glycopeptides.*

*Structure of proteins: Purification, determination of amino acid composition, N-terminal residue determination (Edman degradation), selective hydrolysis, mass spectroscopy.*

*Components of nucleic acids; heterocyclic bases, nucleosides and nucleotides. Phosphate esters. Hydrogen bonding between base pairs. Structure of RNA and DNA. Chemical synthesis of nucleosides/nucleotides. Biological function of nucleic acids; replication, recombination, transcription and translation.*

*Outline of protein structure and function. The use of enzyme catalysed reactions for organic synthesis. Advantages/Disadvantages of enzymes as catalysts. Synthetic and industrial applications. Reaction mechanisms. Immobilisation of enzymes. Enzymes in non-conventional media.*

*General principles of biosynthesis and methods of investigation of biosynthetic pathways will normally be incorporated into one of the main topic areas.*

*The practical sessions involve a multi-stage synthesis of a pheromone (queen bee substance) that comprises the following stages:*

*1 Preparation of carboethoxymethyltriphenylphosphonium bromide.*

*2 Preparation of carboethoxymethylenetriphenylphosphorane*

*3 Preparation of 8-hydroxyoctan-2-one from 5-bromopentyl acetate.*

*4 Isolation of 8-hydroxyoctan-2-one following (following stage 3).*

*5 Oxidation of 8-hydroxyoctan-2-one to 7-oxooctanal.*

*6 Wittig reaction of carboethoxymethyltriphenylphosphorane with 7-oxooctanal to produce the ethyl ester of queen bee substance.*

*7 Isolation of queen bee substance (following stage 6).*

*Review of NMR theory to accompany the interpretation of nmr spectra from the practical project.*

## **Learning Activities**

Lectures, tutorials and practical sessions (to include pre-lab and post-lab discussion).

## References

|                        |  |
|------------------------|--|
| <b>Course Material</b> | Book                                       |
| <b>Author</b>          | Mann, J et al                              |
| <b>Publishing Year</b> | 1994                                       |
| <b>Title</b>           | Natural Products                           |
| <b>Subtitle</b>        | Their Chemical and Biological Significance |
| <b>Edition</b>         |  |
| <b>Publisher</b>       | Longman                                    |
| <b>ISBN</b>            | 0582060092                                 |

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|------------------------|-------------------------|
| <b>Course Material</b> | Book                    |
| <b>Author</b>          | Hecht, SM               |
| <b>Publishing Year</b> | 1996                    |
| <b>Title</b>           | Bioorganic Chemistry    |
| <b>Subtitle</b>        | Nucleic Acids           |
| <b>Edition</b>         |                         |
| <b>Publisher</b>       | Oxford University Press |
| <b>ISBN</b>            | 0195084675              |

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|------------------------|-------------------------|
| <b>Course Material</b> | Book                    |
| <b>Author</b>          | Hecht, SM               |
| <b>Publishing Year</b> | 1999                    |
| <b>Title</b>           | Bioorganic Chemistry    |
| <b>Subtitle</b>        | Carbohydrates           |
| <b>Edition</b>         |                         |
| <b>Publisher</b>       | Oxford University Press |
| <b>ISBN</b>            | 0195084691              |

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|------------------------|-------------------------|
| <b>Course Material</b> | Book                    |
| <b>Author</b>          | Hecht, SM               |
| <b>Publishing Year</b> | 1998                    |
| <b>Title</b>           | Bioorganic Chemistry    |
| <b>Subtitle</b>        | Peptides and Proteins   |
| <b>Edition</b>         |                         |
| <b>Publisher</b>       | Oxford University Press |
| <b>ISBN</b>            | 0195084683              |

|                        |   |
|------------------------|---|
| <b>Course Material</b> | Book                                      |
| <b>Author</b>          | Waldmann, H                               |
| <b>Publishing Year</b> | 2004                                      |
| <b>Title</b>           | Bioorganic Chemistry and Chemical Biology |

|                  |            |
|------------------|------------|
| <b>Subtitle</b>  |            |
| <b>Edition</b>   |            |
| <b>Publisher</b> | Wiley-VCH  |
| <b>ISBN</b>      | 3527307788 |

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|------------------------|------------------------------|
| <b>Course Material</b> | Book                         |
| <b>Author</b>          | Wong, CH and Whitesides, GM  |
| <b>Publishing Year</b> | 1994                         |
| <b>Title</b>           | Enzymes in Organic Synthesis |
| <b>Subtitle</b>        |                              |
| <b>Edition</b>         |                              |
| <b>Publisher</b>       | Pergamon                     |
| <b>ISBN</b>            | 0080359426                   |

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|------------------------|--------------------------------------|
| <b>Course Material</b> | Book                                 |
| <b>Author</b>          | Osborn, H and Khan, T                |
| <b>Publishing Year</b> | 2000                                 |
| <b>Title</b>           | Oligosaccharides                     |
| <b>Subtitle</b>        | Their synthesis and biological roles |
| <b>Edition</b>         |                                      |
| <b>Publisher</b>       | Oxford University Press              |
| <b>ISBN</b>            | 0198502605                           |

|                        |   |
|------------------------|---|
| <b>Course Material</b> | Book  |
| <b>Author</b>          | Lindhorst, TK   |
| <b>Publishing Year</b> | 2003  |
| <b>Title</b>           | Essentials of Carbohydrate Chemistry and Biochemistry |
| <b>Subtitle</b>        |   |
| <b>Edition</b>         | 2nd   |
| <b>Publisher</b>       | Wiley   |
| <b>ISBN</b>            | 3727306641  |

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|------------------------|----------------------------------|
| <b>Course Material</b> | Book                             |
| <b>Author</b>          | Jones, J                         |
| <b>Publishing Year</b> | 2003                             |
| <b>Title</b>           | Amino Acid and Peptide Synthesis |
| <b>Subtitle</b>        |                                  |
| <b>Edition</b>         | 2nd                              |
| <b>Publisher</b>       | Oxford University Press          |
| <b>ISBN</b>            | 0199257388                       |

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## Notes

This module will build upon the material studied in Molecules of Life (PHCCH2015). The biosynthesis, chemical synthesis, structural elucidation and conformation of primary and secondary metabolites will be considered. Experience

of carrying out a multi-stage organic synthesis in the laboratory will be gained