Confirmation that this version of the module specification has been approved by the School Learning and Teaching Committee:

…11th March 2015……………………………………………….

**MODULE SPECIFICATION**

1. **Title of the module**

CH504 - Organic Reaction Mechanisms

1. **School or partner institution which will be responsible for management of the module**

School of Physical Sciences

1. **Start date of the module**

Existing module, next running in 2015-16.

1. **The number of students expected to take the module**

60

1. **Modules to be withdrawn** on the introduction of this proposed module and consultation with other relevant Schools and Faculties regarding the withdrawal

None. Existing module.

1. **The level of the module** (e.g. Certificate [C], Intermediate [I], Honours [H] or Postgraduate [M])

I

1. **The number of credits and the ECTS value which the module represents**

15 (ECTS 7.5)

1. **Which term(s) the module is to be taught in (or other teaching pattern)**

Terms 1 and 2

1. **Prerequisite and co-requisite modules**

CH308 Molecules, Matter and Energy,CH309 Fundamental Chemistry for Physical Scientists, CH314 Introduction to Biochemistry and Drug Chemistry, PS381 Chemical Skills for Forensic Scientists OR CH382 Chemical Skills

1. **The programmes of study to which the module contributes**

Chemistry, Forensic Chemistry, Forensic Science (BSc, BSc with Foundation Year, BSc with Year in Industry, MSci., MChem.).

This is not available as a wild module

1. **The intended subject specific learning outcomes**

Where FS/FC corresponds to Forensic Science and Forensic Chemistry programme specifications and Chem corresponds to Chemistry programme specifications.

* 1. Knowledge and understanding of core and foundation scientific physical and chemical concepts, terminology, theory, units and conventions to chemistry and forensic science. FS/FC A1. Chem A1.
  2. Knowledge and understanding of areas of organic chemistry (organic functional groups, organic materials and compounds, synthetic pathways) as applied to chemistry and forensic science. FS/FC A3. Chem A3.
  3. An ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to organic reaction mechanisms and to apply such knowledge and understanding to the solution of qualitative and quantitative problems. FS/FC B1. Chem B5.
  4. An ability to recognise and analyse novel problems related to organic reactions and plan strategies for their solution by the evaluation, interpretation and synthesis of scientific information and data. FS/FC B2. Chem B6.
  5. Ability to recognise and implement good measurement science and practice and commonly used chemistry and forensic laboratory techniques. FS/FC B4. Chem B4.
  6. Skills in the safe handling of chemical materials, taking into account their physical and chemical properties, including any specific hazards associated with their use and to risk assess such hazards. FS/FC C1. Chem C9.
  7. Skills required for the conduct of standard laboratory procedures involved in synthetic and analytical work in relation to organic systems. The systematic and reliable documentation of the above. The operation of standard instrumentation used in the chemical and forensic sciences in relation to organic systems. FS/FC C2. Chem C10.
  8. Ability to interpret data derived from laboratory observations and measurements in terms of their underlying significance and the theory underpinning them. FS/FC C6. Chem C11.

1. **The intended generic learning outcomes**

Where FS/FC corresponds to Forensic Science and Forensic Chemistry programme specifications and Chem corresponds to Chemistry programme specifications.

1. Problem-solving skills, relating to qualitative and quantitative information, extending to situations where evaluations have to be made on the basis of limited information. FS/FC D2. Chem D15.
2. Information-retrieval skills, in relation to primary and secondary information sources, including information retrieval through on-line computer searches. FS/FC D4. Chem D17.
3. Interpersonal skills, relating to the ability to interact with other people and to engage in team working within a professional environment. FS/FC D6. Chem D19.
4. Time-management and organisational skills, as evidenced by the ability to plan and implement efficient and effective modes of working. Self-management and organisational skills with the capacity to support life-long learning. FS/FC D7. Chem D20.
5. Study skills needed for continuing professional development and professional employment. FS/FC D9. Chem D21.
6. **A synopsis of the curriculum**

This module will expand upon the basic organic and physical chemistry covered in CH309 and CH308 and provide an introduction to a more in-depth study of organic reactions and materials encountered in organic chemistry. In particular this module will place emphasis on classes of compounds and aspects (synthesis, properties) of organic chemistry not encountered (or not encountered in detail) by the student in CH309. Building upon the knowledge and skills obtained from CH309 fundamental reaction mechanisms will be expanded upon and in combination with a survey of the common organic compound classes, this will lead to the application of carbon-carbon bond forming reactions.

**Reaction mechanisms:** Revision of electrophilic addition. Detailed study of SN1, SN2, E1 and E2 reactions including effects of solvent, molecular structure, temperature, nucleophilic strength and nucleophile basicity; functional group interconversion via substitution and elimination reactions. Introduction to multi-step syntheses.

**Alcohols and ethers:** Properties of common and simple alcohols; synthesis inc. acid catalysed hydration of alkenes; oxymercuration-demercuration; hydroboration. Synthesis of metal alkoxides (e.g. Na and NaH). Properties of common and simple ethers. Ether synthesis inc. Williamson ether synthesis using alkoxides. Reactions of ethers.

**Carbon-carbon Bond Forming Chemistry:** Introduction to retrosynthesinthetic concept: planning a synthesis, synthons, disconnections, FGI and region- and chemo-selectivities. Logical and illogical disconnections. Aldol-type nucleophilic addition reactions - reactions at the  carbon; enolate chemistry - reactions at the  carbon. Carbon acidity, ionization, thermodynamic stability. Grignard reactions.

**Organic Transformations:** Alkenes: ozonolysis to yield alcohol or aldehyde/ketone or carboxylic acid; epoxidation reactions; syn and anti dihydroxylations. Synthesis of cis-alkene; and trans alkenes; Wittig reaction.Reactions of alkenes: Hydrogenation. Epoxidation reactions; dihydroxylations, syn and anti. Bromination; hydrobromination; hydroboration; hydration; oxymercuration. Diels-Alder reactions; [2 +2], Heck reaction. Ozonolysis to yield alcohol or aldehyde/ketone or carboxylic acid.Oxidations: Alcohols: PCC and PDC oxidations to yield aldehydes and ketones. Chromate solution (Jones reagent) yields carboxylic acids. Ketones. Bayer-Villeger oxidation – migration priorities of alkyl groups.Reductions: Reduction of carbonyl derivatives. LiAlH4, NaBH4, DIBAL, etc. Wolf-Kishner, Clemmenson, hydrogenolysis of dithiane derivatives.

**Aromatic Chemistry:** Benzene, structure and stability; other commonly encountered aromatic systems; reactions of aromatic rings, mechanism, reactivity and directing effects in basic electrophilic aromatic substitution reactions. Synthesis of benzene derivatives via diazonium salt intermediate.

**Protecting groups:** Protecting group strategies, common protecting groups for alcohols and amines. Temporary vs permanent protecting groups. Orthogonal protecting groups.

1. **Indicative Reading List**

**Compulsory text:**

*Organic chemistry* - Solomons, T. W. Graham, Fryhle, Craig B., Snyder, S. A. 2013

Book: Core text. Past editions (since 2000) of this text entirely SUITABLE.

**Recommended text** :

*March's advanced organic chemistry: reactions, mechanisms, and structure* - Smith, Michael, March, Jerry, MyiLibrary c2007 (electronic resource).

E-Book: Recommended text.

*March's advanced organic chemistry: reactions, mechanisms, and structure* - Smith, Michael, March, Jerry, 7th edition, Wiley-Blackwell, 2013. Past editions of this text entirely SUITABLE.

Book: Recommended text.

1. **Learning and Teaching Methods,** including the nature and number of contact hours and the total study hours which will be expected of students, and how these relate to achievement of the intended module learning outcomes

24 hours of lectures

6 laboratory days

2 hours of example classes

2 hours of revision sessions

Total study hours 150

Achievement of module learning outcomes:

* Lectures (11.1, 11.2, 11.3, 11.4, 11.5, 11.6, 11.7, 11.8, 12.1)
* Laboratories (11.1, 11.5, 11.6, 11.7, 11.8, 12.1, 12.2, 12.3, 12.4, 12.5)
* Example classes (11.1, 11.2, 11.3, 11.4, 12.1, 12.5)
* Revision session (11.1, 11.2, 11.3, 11.4, 12.1, 12.4, 12.5)
* Independent study (11.1, 11.2, 11.3, 11.4, 12.1, 12.2, 12.3, 12.4, 12.5)

1. **Assessment methods** and how these relate to testing achievement of the intended module learning outcomes

Coursework: 30%.

2 Assignments

Learning outcomes related to individual assignments:

11.1, 11.2, 11.3, 11.4, 12.1, 12.2, 12.4, 12.5.

Learning outcomes related to laboratory write-ups:

5 Laboratory write-ups 11.1, 11.2, 11.3, 11.4, 11.5, 11.6, 11.7, 11.8, 12.1, 12.2, 12.4, 12.5.

Examination (length 2 hours) : 70%

Learning outcomes related to examination:

11.1, 11.2, 11.3, 11.4; 12.1, 12.2 and 12.3.

1. **Implications for learning resources**, including staff, library, IT and space

None. Existing module.

1. The School recognises and has embedded the expectations of current disability equality legislation, and supports students with a declared disability or special educational need in its teaching. Within this module we will make reasonable adjustments wherever necessary, including additional or substitute materials, teaching modes or assessment methods for students who have declared and discussed their learning support needs. Arrangements for students with declared disabilities will be made on an individual basis, in consultation with the University’sdisability/dyslexia support service, and specialist support will be provided where needed.
2. **Campus where module will be delivered:**

Canterbury