Accessibility statement

UNIVERSITY of York

Chemical & Synthetic Biology - CHE00037M

« Back to module search

- **Department**: Chemistry
- **Module co-ordinator**: Prof. Gideon Davies
- **Credit value**: 10 credits
- **Credit level**: M
- **Academic year of delivery**: 2020-21
  - See module specification for other years: 2019-20

Module summary

A module that first introduces the techniques used in academia and industry to study the interactions of small molecules such as drugs with target proteins and then unveils the emerging field of **chemical biology** - the use of small molecules to study cellular biology. This is a key area where chemists are now able to make biological breakthroughs leading to new insights and new medicines.

Module will run

Occurrence	Teaching cycle
A	Spring Term 2020-21 to Summer Term 2020-21

Module aims

This module will survey contemporary research in the area of Chemical Biology – using chemical methods to ask questions about biological systems.

Module learning outcomes

- Students will gain an insight into how chemistry can be taken into the cell – in particular considering reactions using bio-orthogonal reagents which are compatible with living systems.
- Students will gain an insight into the physical organic chemistry of enzymes, and learn how core chemistry methods such as Hammett plots and kinetic isotope effects can be applied in a biological setting.
- Students will learn about molecular biophysics methods which can be employed to probe intermolecular interactions. This will span both fundamental studies of the kinetics and thermodynamics of protein-ligand interactions and investigations of individual molecules within the cell.
- Students will learn about a range of experimental methods, such as NOESY, HSQC, surface plasmon resonance, ITC, FRET etc, and will learn to evaluate these methods to decide which is most appropriate to solve a particular problem.

Module content

Current topics in molecular and cell biology	**REH** 2 lectures

These overview lectures will introduce modern methods in cell biology to probe biological processes and systems. This will provide the necessary context to understand how chemical methods have had impact on these areas of biology, where modern research is uncovering remarkable details of how complex organisms function and are regulated.	
Modern Methods of probing biological interactions Recent advances in instrumentation and methods have opened up considerable opportunities to identify and characterise interactions between biological molecules, substrates and inhibitors. These lectures will reinforce and extend earlier lecture courses to discuss the experimental techniques (and their physical basis). This will include Isothermal Titration Calorimetry, Surface Plasmon Resonance, and the multitude of NMR experiments that allow the details of interactions between molecules to be probed.	**REH** 2 lectures 1 x 3h graphics workshop – X-ray structures - learning how to look at protein structure and protein-ligand interactions (not assessed, but examinable)
Chemical Biology. **Physical Organic Chemistry:** Use of TAFT, Hammett plots and kinetic isotope effects to study enzyme action and inspire the design of enzyme inhibitors. (GJD 2 lectures) The concept of using rationally-designed inhibitors in living systems – **Chemical Genetics** - will be introduced (GJD 1). The concept of **bio-orthogonal chemistry** in living systems, in vivo copper-free click chemistry using strained alkynes (GJD 1). The use of **metabolic labelling** - feeding cells with modified carbohydrates and lipids for subsequent reaction will be introduced (LIW 2). **Activity-based protein profiling** (GJD 1) and the use of **bump-and-hole** strategies to define kinase/target pairs (GJD 1). An introduction to the new area of **synthetic biology** in which cells are redesigned to accommodate non-natural amino-acids and bio-orthogonal chemistries (GJD 1). Building upon non-natural amino-acids, we will expand upon the **organic reaction mechanisms** of different bioorthogonal reactions (MAF 1). This will lead into **genome editing** (MAF1) and the use of targeted protein degradation using bifunctional small molecules (**PROTACS**) with the study of the ubiquitin modification as an example (LIW 1).	**GJD** (7 lectures) **MAF** (2 lectures) **LIW** (3 lectures)
The **final workshop** will cover the selection of topics / papers / coordinate files for the assessed workshop.	**REH** 1x3h workshop preparation for assessment

Assessment

Task	Length	% of module mark
24 hour open exam Chemical & Synthetic Biology	N/A	70
Essay/coursework	N/A	30

Assessed workshop

Special assessment rules

None

Additional assessment information

The exam has two compulsory 20-mark questions.

The second workshop is assessed through a project report of 4-5 pages based around a specific paper (and wider related reading) and analysis of the structure(s) on computer graphics. Each student is given a protein(s) and some papers from which they generate a short summary of an area of chemical biology research (3hr workshop; approx. 12-20 hours private study required). The deadline for handing in work is 2 weeks after the assessed workshop.

Reassessment

Task	Length	% of module mark
24 hour open exam Chemical & Synthetic Biology	N/A	70
Essay/coursework Assessed workshop	N/A	30

Module feedback

Closed exam results with per-question breakdown are returned to the students via supervisors within 5 weeks (as per special approval by the University Teaching Committee). Outline answers are made available via the Chemistry web pages when the students receive their marks, so that they can assess their own detailed progress/achievement. The examiners' reports for each question are made available to the students via the Chemistry web pages.

For the continuous assessment, the students receive an annotated mark sheet, with each of the individual sections commented upon individually. Marks are awarded for: Quality of introduction (20%); Quality of images (15%); Relevance of images (15%); Description of what the images show (15%); Summary of experimental strategy including (as appropriate) chemical synthesis, molecular interaction techniques, thermodynamics (35%)

Indicative reading

This is a research-led course so up to date scientific publications will form the majority of the reading