School of Chemistry

Aims and Objectives: Session 2022-2023

Module CH3613: Carbohydrate and Nucleic Acid Chemistry

Duration: 15 hours

Lecturers: Dr G. J. Florence and Dr E. R. Kay*

(*Module Convenor)

Aims: The aim of this module is to cover aspects of the chemistry of carbohydrates and nucleic acids. It will begin with an introduction to carbohydrate chemistry with discussions of structure including conformational and stereoelectronic effects. We will then discuss the enzymes responsible for carbohydrate processing, their mechanisms and how this has influenced inhibitor design. We will then detail fundamental aspects of the chemical synthesis of carbohydrates and carbohydrate-based pharmaceuticals. This will be followed by the structure and function of nucleic acids. How nucleic acids encode the genetic information, and the molecular details of the biological processes responsible for copying and reading this information will be examined. The chemical synthesis of nucleic acids will be examined, followed by a discussion of molecular processes by which DNA can be damaged and the ways in which DNA can be targeted by drugs to treat diseases such as cancer.

Objectives:

1. Provide an introduction to carbohydrates from glyceraldehyde to hexoses, structure, nomenclature and biological significance.

2. Aspects of sugar biosynthesis and natural compounds derived from glucose

3. Enzymatic synthesis and degradation of carbohydrates. Mechanism of glycoside hydrolases and glycosyltransferases.

4. Discussion of inhibition of glycoside hydrolases and glycosyltransferases including the concept of carbohydrate mimics. How inhibitors are used therapeutically as anti-virals and for treating diabetes.

5. The chemical synthesis of monosaccharides – methods to prepare rare and unnatural sugar monomers

6. Chemical synthesis of glycosides. Protecting groups and strategies for sugar synthesis. Controlling glycoside bond formation. Applications in the synthesis of complex glycosides

7. Synthesis of nucleotides for DNA and RNA synthesis, and nucleotide-based drugs.

8. Introduce the structures and nomenclature of the components making up DNA and RNA.

9. Chemical structures (primary and secondary) of DNA and RNA; the role of non-covalent interactions in governing nucleic acid structure and function.

10. Discussion of the molecular principles and enzymatic processes involved in encoding, copying and reading genetic information using the nucleic acids.

11. Discussion of the chemical synthesis of oligonucleotides – disconnections, protecting group strategy, mechanisms, solid-phase strategy; comparison of laboratory and biochemical synthetic strategies.

12. Chemical reactions that lead to DNA damage – both natural processes and examples triggered by mutagenic agents – or deliberate modification of DNA molecular structure. The consequences of mutation in living systems.

13. Discussion of the structures and mechanisms of drugs that target DNA: cross-linkers; intercalators; replication terminators and strand breakers.

14. Introduction to the techniques of molecular biology: DNA sequencing, polymerase chain reaction, cloning.