Programme Information		
Programme Title	Programme Code	HECoS Code
Advanced Molecular Synthesis	F1YA	For Registry Use Only

Award	Length of Study	Mode of Study	Entry Point(s)	Total Credits	
				ECTS	CATS
MRes	1 calendar year (12 months)	Full Time	Annually in October	90	180

Ownership			
Awarding Institution	Imperial College London	Faculty	Faculty of Natural Sciences
Teaching Institution	Imperial College London	Department	Chemistry
Associateship	Diploma of Imperial College (DIC)	Main Location(s) of Study	White City Campus & South Kensington Campus

External Reference	
Relevant QAA Benchmark Statement(s) and/or other external reference points	Master's Degree in Chemistry
FHEQ Level	Level 7 - Master's
EHEA Level	2nd Cycle

External Accreditor(s) (if applicable)			
External Accreditor 1:	N/A		
Accreditation received:	N/A	Accreditation renewal:	N/A

Collaborative Provision			
Collaborative partner	Collaboration type	Agreement effective date	Agreement expiry date
N/A	N/A	N/A	N/A

Specification Details	
Programme Lead	Dr James Bull and Professor Mimi Hii
Student cohorts covered by specification	2023-24 entry
Date of introduction of programme	October 18
Date of programme specification/revision	August 23

Programme Overview

The ability to make any molecule at will, and on a meaningful timescale, is the key to unlock hitherto unimagined opportunities for future scientific advances that address societal challenges. Currently, the efficiency and speed of synthesis (including scale-up) remain a bottleneck in the development of healthcare, agrochemicals, molecular optics, smart materials and other emerging fields. Recent advances in synthetic methodologies include many interdisciplinary elements (e.g., photochemistry, flow chemistry), which require modern synthetic chemistry to move towards a more data-driven discipline. Accordingly, this places a demand on training in skills that are not currently provided in traditional synthetic chemistry training in academic education.

This MRes course serves to promote the rational design of both organic and inorganic compounds with an emphasis on modern approaches and techniques, as well as the hardware and software tools, afforded by the Centre for Rapid Online Analysis of Reactions (ROAR).

The core of the Advanced Molecular Synthesis (AMS) MRes is an extended research project. All projects will have specific synthesis objectives. In addition, you will undertake modules on Fundamental Reactive Intermediates, with an organic chemistry focus, as well as Chemical Kinetics and Data Analytics. These will include topics such kinetic analyses, reactor performance (in batch and flow reactors) and machine learning that will provide a data-led approach to synthesis. You will be introduced to the python programming language. You will also undertake non assessed courses, for example in Advanced Catalysis, and Advanced Stereochemistry, Synthesis and Biosynthesis, and including a workshop in Design of Experiments (DoE). Together, this will aid the efficient design and understanding of synthetic processes, as well as provide training to bridge the skills of academic and industrial research laboratories. Academics who work closely with industry and partners from industry will guide you through journal clubs and workshops to critically analyse the benefits and drawbacks of a range of approaches to synthesis. This training will be accompanied by hands-on use of the state-of-the-art, world-leading facilities available within the Molecular Science Research Hub at the White City campus. Graduates of this course can expect to have the necessary skills and experience to apply cutting edge synthetic approaches in either commercial or academic laboratories, the research project in particular equipping them for PhD studies.

Learning Outcomes

Upon successful completion of the programme you will be able to:

1. Critically analyse core and specialised concepts in synthesis (e.g., reactive intermediates, reaction mechanism, catalysis, design of experiments (DoE) approaches, reactor design, reactions in flow) to plan and execute your own experiments.
2. Employ research techniques (e.g., collection and analysis of experimental data, design and refinement of experiment, synthetic techniques, application of suitable analytical methods and characterisation, technical report writing and effective oral presentation) to analyse and evaluate the outcome of experiments.
3. Use management skills (e.g. decision-making, establishing objective criteria, problem definition, project / experiment design and evaluation, organisation of resources and time) to plan and execute work effectively.
4. Apply your knowledge of synthesis and relevant tools to new processes and new research projects.
5. Effectively plan and execute scientific research (particularly synthetic chemistry) in a safe and productive manner.
6. Critically analyse and evaluate scientific studies, publications and existing chemical processes including the novelty and impact.
7. Propose and appraise your hypotheses using appropriate experimental design and statistical analysis of data to inform synthesis considerations.
8. Critically analyse the strength and validity of results, data and conclusions, compose recommendations for future studies.
9. Prepare scientific documents that present the findings of a lengthy programme of original research with an awareness of the relevant scientific literature.
10. Communicate effectively with your peers and the research community through oral presentations (technical and more general), an oral exam (viva), presentations (short talks, workshops) and written reports, whether in concise form (research proposal) or extended format (dissertation).

The Imperial Graduate Attributes are a set of core competencies which we expect students to achieve through completion of any Imperial College degree programme. The Graduate Attributes are available at: www.imperial.ac.uk/students/academic-support/graduate-attributes

Entry Requirements	
Academic Requirement	The minimum requirement is normally a First Class UK Bachelor's Degree with Honours in Chemistry or Chemical Engineering (or a comparable qualification recognised by the College). For further information on entry requirements, please go to www.imperial.ac.uk/study/apply/postgraduate-taught/entry-requirements/accepted-qualifications/
Non-academic Requirements	None
English Language Requirement	Higher requirement (PG) Please check for other Accepted English Qualifications
Admissions Test/Interview	Online interviews for shortlisted candidates

The programme's competency standards documents can be found at: www.imperial.ac.uk/chemistry/postgraduate/mres/

Learning & Teaching Approach

Learning and Teaching Delivery Methods
The course aims to teach the practice of science with the learning and teaching strategy being aligned with the knowledge, skills and abilities required by professional scientists in academia and industry.
Most of the weighting of the course is focussed on the research component, writing a research proposal, and the extended research project. The research project will normally be conducted in academic laboratories in the Department of Chemistry or Chemical Engineering. The taught content is likely to expose you to fields outside of your undergraduate training, which may be different to your immediate project area. Teaching and learning on the programme will be delivered by the academic staff from the Department of Chemistry and Chemical Engineering and external experts through a range of methods including lectures, workshops, seminars, practical work and online material.

Overall Workload
Your overall workload consists of face-to-face sessions and independent learning. While your actual contact hours may vary according to the optional modules you choose to study, the following gives an indication of how much time you will need to allocate to different activities at each level of the programme. At Imperial, each ECTS credit taken equates to an expected total study time of 25 hours. Therefore, the expected total study time is 2250 hours per year, comprising approximately 125 hours for each of the Fundamental Reactive Intermediates, Chemical Kinetics, Data Analytics and Journal Club modules, 250 hours of planning and designing the research project guided by your supervisors, and 1500 hours of individual research project work.

Assessment Strategy

Assessment Methods

Each assessment is designed to test the acquisition of skills required to achieve the Intended Learning Outcomes and to further a career in synthetic chemistry and associated professional paths. All of the assessments promote effective independent learning and critical enquiry.

The fundamental reactive intermediates presentation will assess your understanding of the core concepts through use to analyse published scientific literature and to develop a presentation as a group (Learning outcomes 4, 6, 8, 10). Chemical Kinetics will evaluate your ability to evaluate chemical kinetics and consider alternative reactor design as a group project, in addition to an individual analysis exercise (2-4, 7, 10). The data analytics workshops will assess your ability to carry out a data science analysis using a variety of tools and interpretation in terms of chemical synthesis. This is assessed through group project-based work and group presentation. (Learning outcomes 3, 7, 8, 10). The AMS Journal Clubs will assess your ability to understand, interpret and explain, in a concise manner, synthesis topics from the published scientific literature. You will

work as a group to present on the chosen work, and to ask questions of other groups (Learning outcomes 4, 6, 10).
The Project proposal will assess your aptitude to critically analyse published scientific literature, plan the work packages necessary to complete the research project and reflect on the safety and commercial/societal considerations (Learning outcomes 1, 5-7, 10).

The Research Project will be judged through a manuscript, a presentation, and an oral examination. The manuscript will take the form of a dissertation in which you will describe the context and background of the research, and present and critically discuss/analyse your own experimental results and data. At the presentation, you will be assessed on your ability to present your research to your examiners with the help of visual tools in a clear, concise fashion, summarising your findings and their relevance. You will also be tested on your ability to answer questions directly relevant to your project. Your oral examination will probe your knowledge and understanding of the relevant literature, methodology and research outcomes including theoretical and practical knowledge of the subject area, of the experimental techniques used and their limitations as well as the proposed follow-on work (Learning outcomes 1-10).

Academic Feedback Policy
With the exception of the major research project module you will receive feedback within 2 week of submission and where this is not possible students will be advised. This feedback should inform learning and performance in subsequent modules. The College's Policy on Academic Feedback and guidance on issuing provisional marks to students is available at: www.imperial.ac.uk/about/governance/academic-governance/academic-policy/exams-and-assessment/
Re-sit Policy
The College's Policy on Re-sits is available at: www.imperial.ac.uk/about/governance/academic-governance/academic-policy/exams-and-assessment/
Mitigating Circumstances Policy
The College's Policy on Mitigating Circumstances is available at: www.imperial.ac.uk/about/governance/academic-governance/academic-policy/exams-and-assessment/

Additional Programme Costs		
This section should outline any additional costs relevant to this programme which are not included in students' tuition fees.		
Description	Mandatory/Optional	Approximate cost
Laptop with camera and microphone	Mandatory	£400-600

Important notice: The Programme Specifications are the result of a large curriculum and pedagogy reform implemented by the Department and supported by the Learning and Teaching Strategy of Imperial College London. The modules, structure and assessments presented in this Programme Specification are correct at time of publication but might change as a result of student and staff feedback and the introduction of new or innovative approaches to teaching and learning. You will be consulted and notified in a timely manner of any changes to this document.

Programme Structure[1]					
Year 1 - FHEQ Level 7 **You will study all core and compulsory modules.**					
Code	Module Title	Core/ Compulsory	Group	Term	Credits
CHEM70022	Fundamental Reactive Intermediates	Compulsory	N/A	Autumn	5
CHEM70023	Chemical Kinetics	Compulsory	N/A	Autumn	5
CHEM70024	Data Analytics in Chemistry	Compulsory	N/A	Autumn	5
CHEM70025	AMS Journal Clubs	Compulsory	N/A	Spring-Summer	5
CHEM70026	Research Proposal for AMS Research Project	Core	N/A	Autumn	10
CHEM70027	Research Project in Advanced Molecular Synthesis	Core	N/A	Spring-Summer	60
				Credit Total	90

[1] **Core** modules are those which serve a fundamental role within the curriculum, and for which achievement of the credits for that module is essential for the achievement of the target award. Core modules must therefore be taken and passed in order to achieve that named award. **Compulsory** modules are those which are designated as necessary to be taken as part of the programme syllabus. Compulsory modules can be compensated. **Elective** modules are those which are in the same subject area as the field of study and are offered to students in order to offer an element of choice in the curriculum and from which students are able to select. Elective modules can be compensated.

Progression and Classification

Award and Classification for Postgraduate Students

Award of a Masters Degree (including MRes)
To qualify for the award of a postgraduate degree you must have:

1. accumulated credit to the value of no fewer than 90 credits at Level 7
2. and no more than 15 credits as a Compensated Pass

Classification of Postgraduate Taught Awards

The College sets the class of Degree that may be awarded as follows:

1. Distinction: 70.00% or above.
2. Merit: 60.00% or above but less than 70.00%.
3. Pass: 50.00% or above but less than 60.00%.

Your classification will be determined through the Programme Overall Weighted Average meeting the threshold for the relevant classification band.

Your degree algorithm provides an appropriate and reliable summary of your performance against the programme learning outcomes. It reflects the design, delivery, and structure of your programme without unduly over-emphasising particular aspects.

a.

Programme Specific Regulations

N/A

Supporting Information
The Programme Handbook is available upon enrolment.
The Module Handbook is available at upon enrolment.
The College's entry requirements for postgraduate programmes can be found at: www.imperial.ac.uk/study/pg/apply/requirements
The College's Quality & Enhancement Framework is available at: www.imperial.ac.uk/registry/proceduresandregulations/qualityassurance
The College's Academic and Examination Regulations can be found at: www.imperial.ac.uk/about/governance/academic-governance/regulations
Imperial College is an independent corporation whose legal status derives from a Royal Charter granted under Letters Patent in 1907. In 2007 a Supplemental Charter and Statutes was granted by HM Queen Elizabeth II. This Supplemental Charter, which came into force on the date of the College's Centenary, 8th July 2007, established the College as a University with the name and style of "The Imperial College of Science, Technology and Medicine". www.imperial.ac.uk/admin-services/secretariat/college-governance/charters/
Imperial College London is regulated by the Office for Students (OfS) www.officeforstudents.org.uk/advice-and-guidance/the-register/
This document provides a definitive record of the main features of the programme and the learning outcomes that you may reasonably be expected to achieve and demonstrate if you take full advantage of the learning opportunities provided. This programme specification is primarily intended as a reference point for prospective and current students, academic and support staff involved in delivering the programme and enabling student development and achievement, for its assessment by internal and external examiners, and in subsequent monitoring and review.