

Programme Specification for the MRes in Systems and Synthetic Biology

PLEASE NOTE. This specification provides a **concise** summary of the main features of the programme and the learning outcomes that a typical student might reasonably be expected to achieve and demonstrate if he/she takes full advantage of the learning opportunities that are provided. This specification provides a source of information for students and prospective students seeking an understanding of the nature of the programme and may be used by the College for review purposes and sent to external examiners. More detailed information on the learning outcomes, content and teaching, learning and assessment methods of each module can be found in the course handbook or on-line at <http://www/imperial.ac.uk/systemsbiology>. The accuracy of the information contained in this document is reviewed by the College and may be checked by the Quality Assurance Agency.

- 1. Awarding Institution:** Imperial College London
- 2. Teaching Institution:** Imperial College London
- 3. External Accreditation by Professional / Statutory Body:** Not Applicable
- 4. Name of Final Award (BEng / BSc / MEng etc):** MRes
- 5. Programme Title (e.g. Biochemistry with Management):** Systems and Synthetic Biology
- 6. Name of Department / Division:** Division of Molecular BioSciences
- 7. Name of Faculty:** Natural Sciences
- 8. JACS Code:** C100
- 9. Relevant QAA Subject Benchmarking Group(s) and/or other external/internal reference points:**

The relevant benchmark group is **Biosciences**, detailed on <http://www.qaa.ac.uk/academicinfrastructure/benchmark/statements/Biosciences07.asp>

10. Level(s) of programme within the Framework for Higher Education Qualifications (FHEQ):

Bachelor's (BSc, BEng, MBBS)	Level 6
Integrated Master's (MSci, MEng)	Levels 6 and 7
Master's (MSc, MRes)	Level 7

11. Mode of Study:

1 year full time

12. Language of Study: English

13. Date of production / revision of this programme specification (month/year):

July 2011

14. Educational aims/objectives of the programme:

The programme aims/objectives are to:

- produce physical, bioengineering, life, and biomedical sciences postgraduates equipped to pursue careers at the interface between the physical and life sciences in academia, industry, the public sector and non-governmental organisations;
- develop the ability to undertake research in multidisciplinary teams at this interface;
- develop a knowledge of a range of basic and advanced concepts in systems and synthetic biology;
- develop research and analytical skills related to systems and synthetic biology;
- develop oral and written scientific presentation skills;
- attract the most motivated physical sciences graduates, both from within the UK and from overseas;
- develop new areas of teaching in response to the advance of scholarship and the needs of vocational training;
- provide an experience that is intellectually stimulating, enjoyable, and meets students' needs;
- provide a solid foundation for those who intend to go on to study for a PhD.

15. Programme Learning Outcomes

1. Knowledge and Understanding

Knowledge and understanding of:

1. core and specialised concepts in theoretical and experimental systems and synthetic biology – molecular biology and functional genetics, biophysics, biological networks, advanced technology, data analysis, and bioengineering.
2. research techniques, including information retrieval, experimental design and statistics, computer modelling, sampling, experimental techniques, engineering design, molecular characterisation, problem solving, and laboratory safety;
3. detailed knowledge and understanding of the essential facts, concepts, principles and theories relevant to the student's project;
4. management and communication skills, including problem definition, project design, decision processes, teamwork, written and oral reports, scientific proposals and publications.

Teaching/learning methods and strategies

Acquisition of 1 to 4 is through a combination of lectures, practicals, case studies, course work, seminars, workshops, and research project.

Throughout the students are encouraged to undertake independent reading both to supplement and consolidate what is being taught/learnt and to broaden their individual knowledge and understanding of the subject.

Assessment of the knowledge base is through a combination of written reports, oral presentations and exams, and assessed project/research conduct (1-4).

2. Skills and other Attributes

Intellectual Skills:

Intellectual (thinking) skills:

1. analyse and solve problems in systems and synthetic biology using an integrated multidisciplinary approach;
2. integrate and evaluate information;

3. formulate and test hypotheses using appropriate design of models or experiments, as well as statistical analysis of data;
4. plan, conduct and write-up a programme of original research.

Teaching/learning methods and strategies

Intellectual skills are developed through the teaching and learning methods outlined above. Additionally, students have to participate in at least two transferable-skills courses, which are offered by the Graduate School.

Design of models/experiments and statistical skills are developed in lectures, case studies, proposal writing, and the individual research project. Individual, formative and summative feedback is given to students by the case study supervisor(s) and the project team. The feedback from students on the research proposal before submission in January constitutes an additional learning method.

Assessment is through case studies, group work in practicals, research proposal, lab meetings, journal clubs, mini-conferences, and the individual research project.

Practical Skills:

1. plan and execute safely a series of experiments or computations;
2. use laboratory methods or computer-based tools to generate data;
3. analyse results, determine their strength and validity, and make recommendations;
4. prepare technical reports;
5. give technical presentations;
6. use the scientific literature effectively.

Teaching/learning methods and strategies

Practical skills are developed through the teaching and learning programme outlined above. Practical experimental or computational skills (1 to 3) are developed through case studies, practicals, course work, project work, and through interaction with other research students and the research supervisors.

Skills 4 and 5 are taught by supervisors and fellow students, and are further developed through presentations, feedback on written reports and presentations, and workshops.

Skill 6 is developed through lectures and the individually supervised case studies and research project.

Practical skills are assessed where appropriate through the written reports and oral presentation.

Transferable Skills:

1. communicate effectively across different scientific disciplines through oral presentations, computer processing and presentations, and written reports;
2. apply knowledge, experimental, and modelling skills;
3. management skills: decision processes, objective criteria, problem definition, project design and evaluation needs;
4. integrate and evaluate information from a variety of sources;
5. transfer techniques and solutions from one discipline to another;
6. use Information and Communications Technology;
7. manage resources and time;
8. learn independently with open-mindedness and critical enquiry;
9. learn effectively for the purpose of continuing professional development.

Teaching/learning methods and strategies

Transferable skills are developed through the teaching and learning programme outlined above.

Skill 1 is taught through coursework and developed through feedback on assessed reports and oral presentations.

Skill 2 is taught through lectures and practical work and developed, as appropriate, during individual case studies and research project.

Skill 3 is developed in the research team meetings.

Skill 4 is developed through feedback on a research proposal, case studies, and research project.

Skill 5 is a core activity of the case studies and research projects and is additionally taught in lectures and exemplar case studies.

Skill 6 is taught in lectures developed through project work and individual learning.

Skill 7 is developed throughout the course within a framework of staged coursework deadlines.

Although not explicitly taught, skills 8 and 9 are encouraged and developed throughout the course, e.g. through individual case studies and research project. The overall course is structured and delivered in such a way as to promote these skills.

16. The following reference points were used in creating this programme specification:

- Student Handbook for Course approved by Senate of Imperial College
- Previously approved programme specifications for nanomaterials and biomolecular sciences

17. Programme structure and features, curriculum units (modules), ECTS assignment and award requirements:

Year One:

The programme is only offered as a full-time, one-year course and leads to the MRes degree. Students begin their lecture programme with compulsory core courses and practicals (modules 1-5) in the first term (October-December). In January students choose a topic for the 8-month long multidisciplinary, theoretical or experimental research project, supervised by at least two supervisors with different expertise. One supervisor may also come from industry. During the month of January students write a research proposal (6 pages) on their chosen research project, evaluated by a student mock panel for early feedback prior submission to supervisors. During terms 2 (January-March) and 3 (April-June), a mini-conference will be offered.

Term one:

All students attend modules 1-5, comprised of a combination of lectures, tutorials, practicals (computer or wetlab), problems sessions and case studies. The first module will contain introductory material tailored towards students from different backgrounds. The topics of the other modules 2-5 are as follows: Experimental Systems Biology, Theoretical Systems Biology, Synthetic Biology and Advanced Technology. Students undertake a piece of coursework during each module that will contribute to assessment of the MRes and provide opportunity for feedback.

By end of the term, students will choose their project research topic.

Term Two:

In January students will write a 6-page research proposal on their research project in BBSRC proposal style. Prior to submission to supervisors at the end of January, a student mock panel will evaluate the proposals and give early feedback on the proposed work.

During this and the next term there will also be additional lectures/workshops and a mini-conference.

Term Three:

The research projects will continue. There will be a mini conference near the beginning of the term to provide feedback to the students on the progress of their projects. Projects will be finished and a

written report submitted early in September. Project assessment is based on this written project report, research conduct, and oral exam (viva), conducted prior to the MRes Examination Board meeting in late September.

18. Support provided to students to assist learning (including collaborative students, where appropriate).

- MRes Student Handbook, which includes course and project descriptions.
- Staff:student ratios for research training of 2:1 or greater.
- A large community of postgraduate research students and postdoctoral research workers working in systems and synthetic biology at Imperial College.
- Library and other learning resources and facilities at South Kensington campus.
- Dedicated student computing facilities in the Department of Life Sciences
- Extensive research facilities and centres for interdisciplinary research.
- A postgraduate staff - student committee, which meets three times per year.
- Several seminar series and journal clubs on topics in systems and synthetic biology in various departments and divisions at Imperial College.
- In addition to the oversight person (mentor) the Course Directors will assist students with personal problems and advise on pastoral and academic issues.
- Student email and open personal access to staff including the Course Directors.
- Feedback from students on oral presentations and research proposal.
- Access to student counsellors on the South Kensington site.
- Access to Teaching and Learning Support Services, which provide assistance and guidance, e.g. on careers.

19. Criteria for admission:

The minimum qualification for admission is normally at least an Upper Second Class Honours degree in a Physical, Engineering, Mathematical, or Life/Biomedical Sciences-based subject from an UK academic institution or an equivalent overseas qualification. A-level mathematics will generally be required for entry.

20. Processes used to select students:

The MRes in Systems and Synthetic Biology is advertised in the scientific press, via and College postgraduate website, the website of the Institute of Systems and Synthetic Biology, the websites of its constituent Centres (the Centre for Synthetic Biology and Innovation (CSynBI) and the Centre for Integrative Systems Biology (CISBIC)) and on FindAMasters.com. Short listing and subsequent interviewing is carried out by a panel comprising the Course Directors (Dr Robert Endres and Dr Geoff Baldwin) and one or two other academics who teach on the Course from complementary disciplines. Following the interviews, places are offered to those ranked most highly. The selection process is overseen by the MRes Committee which includes Professor Paul Freemont (Head of the Division of Molecular Biosciences and Co-Director of CSynBI) and Professor Richard Kitney (Director of the Graduate School of Engineering and Physical Science at Imperial College, Co-Director of CSynBI and Chairman of the Institute of Systems and Synthetic Biology (IoSSB).]

21. Methods for evaluating and improving the quality and standards of teaching and learning

a) Methods for review and evaluation of teaching, learning, assessment, the curriculum and outcome standards:

1. Mechanisms for review and evaluation of teaching, learning, assessment, the curriculum and outcome standards

- Annual course review prepared by the Course Directors and considered by the Board of

- Examiners.
 - Postgraduate Staff – Student Committee, held each term, with report to Departmental Teaching Committee.
 - Biennial staff appraisal.
 - Peer review of lectures (at random intervals).
 - External Examiners reports.
 - Periodic Review by Faculty of Science Postgraduate Studies Committee.
 - Periodic review of departmental teaching by an external panel (approximately 6 year interval).
2. *Committees with responsibility for monitoring and evaluating quality and standards*
- Postgraduate Staff – Student Committee (three meetings annually).
 - Departmental Teaching Committee (Life Sciences).
 - Board of Examiners. Will consist of the course directors, the MRes committee and may invite other academic staff that teach on the course, as necessary.
 - Imperial College, Faculty of Science Graduate Studies Committee.
 - Imperial College, Senate.
3. *Staff development priorities include:*
- Development of multidisciplinary research programmes between Physical and Life/Biomedical sciences and Engineering researchers.
 - Staff appraisal scheme and institutional staff development courses.

The external examiner system and Boards of Examiners are central to the process by which the College monitors the reliability and validity of its assessment procedures and academic standards. Boards of Examiners comment on the assessment procedures within the College and may suggest improvements for action by relevant departmental teaching Committees.

The Faculty Studies Committees and the Graduate Schools' Postgraduate Quality Committees review and consider the reports of external examiners and accrediting bodies and conduct periodic (normally quinquennial) and internal reviews of teaching provision. Regular reviews ensure that there is opportunity to highlight examples of good practice and ensure that recommendations for improvement can be made.

At programme level, the Head of Department/Division has overall responsibility for academic standards and the quality of the educational experience delivered within the department or division.

Most of the College's undergraduate programmes are accredited by professional engineering and science bodies or by the General Medical Council. Accreditation provides the College with additional assurance that its programmes are of an appropriate standard and relevant to the requirement of industry and the professions. Some postgraduate taught courses are also accredited.

b) Committees with responsibility for monitoring and evaluating quality and standards:

The **Senate** oversees the quality assurance and regulation of degrees offered by the College. It is charged with promoting the academic work of the College, both in teaching and research, and with regulating and supervising the education and discipline of the students of the College. It has responsibility for approval of changes to the Academic Regulations, major changes to degree programmes and approval of new programmes.

The **Quality Assurance Advisory Committee (QAAC)** is the main forum for discussion of QA policy and the regulation of degree programmes at College level. QAAC develops and advises the Senate on the implementation of codes of practice and procedures relating to quality assurance and audit of quality and arrangements necessary to ensure compliance with national and international standards. QAAC also considers amendments to the Academic Regulations before making recommendations for change to the Senate. It also maintains an overview of the statistics on completion rates,

withdrawals, examination irregularities (including cases of plagiarism), student appeals and disciplinarys.

The **Faculty Studies Committees** and **Graduate School Postgraduate Quality Committees** are the major vehicle for the quality assurance of undergraduate / postgraduate courses respectively. Their remit includes: setting the standards and framework, and overseeing the processes of quality assurance, for the areas within their remit; monitoring the provision and quality of e-learning; undertaking reviews of new and existing courses; noting minor changes in existing programme curricula approved by Departments; approving new modules, changes in module titles, major changes in examination structure and programme specifications for existing programmes; and reviewing proposals for new programmes, and the discontinuation of existing programmes, and making recommendations to Senate as appropriate.

The **Faculty Teaching Committees** maintain and develop teaching strategies and promote inter-departmental and inter-faculty teaching activities to enhance the efficiency of teaching within Faculties. They also identify and disseminate examples of good practice in teaching.

Departmental Teaching Committees have responsibility for the approval of minor changes to course curricula and examination structures and approve arrangements for course work. They also consider the details of entrance requirements and determine departmental postgraduate student numbers. The Faculty Studies Committees and the Graduate School Postgraduate Quality Committees receive regular reports from the Departmental Teaching Committees.

c) Mechanisms for providing prompt feedback to students on their performance in course work and examinations and processes for monitoring that these named processes are effective:

Students obtain the results of their work and feedback within two weeks after submitting their work. To provide this feedback, markers are required to fill out a form for comments using the assessment criteria provided to them. Further feedback is provided to students by two quizzes in term 1, through the question-and-answer session after their oral presentations of the first case study, and through the student mock panel. During the student mock panel, students evaluate each other research proposals using provided assessment criteria. This session is supervised by the course administrators.

d) Mechanisms for gaining student feedback on the quality of teaching and their learning experience and how students are provided with feedback as to actions taken as a result of their comments:

- Postgraduate Staff – Student Committee.
- Meetings with project supervisors and oversight person (mentor).
- Meetings with Course Directors.
- Viva with External Examiners.
- End-of-course anonymous questionnaire for student feedback on MRes course.

e) Mechanisms for monitoring the effectiveness of the personal tutoring system:

Students are not assigned personal tutors but instead have at least two supervisors. These are the first instances of tutoring. If problems occur, which cannot be resolved by the supervisors and student, the course directors are involved for mediating a resolution. The last instance is the course committee. For additional tutoring, students are required to take at least two transferable skills courses, e.g. on presentation and writing skills, or effective working. Furthermore, the two short projects during term one, as well as two quizzes are designed to monitor the students' progress for early intervention by the course directors.

f) Mechanisms for recognising and rewarding excellence in teaching and in pastoral care:

Staff are encouraged to reflect on their teaching, in order to introduce enhancements and develop innovative teaching methods. Each year College awards are presented to academic staff for outstanding contributions to teaching, pastoral care or research supervision. A special award for

Teaching Innovation, available each year, is presented to a member of staff who has demonstrated an original and innovative approach to teaching. Nominations for these awards come from across the College and students are invited both to nominate staff and to sit on the deciding panels.

g) Staff development priorities for this programme include:

Staff at Imperial College are generally advised to participate in development courses and workshops such as improving student supervision, teaching and communication skills. These are provided by the Imperial College Learning Centre. Specifically for this programme, staff are advised to provide lecture notes, uploaded on Blackboard, and clear learning outcomes. Only staff with excellent teaching and multidisciplinary research track records is selected for this course.

22. Regulation of Assessment:

a) Assessment Rules and Degree Classification:

1. **Minimum standards** (i.e. 50%) in each of the three assessed elements (two case studies, research proposal, and research project) will be required with an overall pass mark of 50%. To achieve *pass with distinction* a minimum of 69.9% is required in each of the two elements. To achieve *pass with merit* a minimum of 60%, i.e. no fail, is required in each of the two elements.
2. To **qualify for the award of MRes**, students must complete all the course requirements, including the participation in mandatory extra curriculum events, and must achieve an overall pass mark in the combined examinations including case studies (written reports and oral presentations), research proposal, research report, conduct, and viva.
3. Students will be given two marks, one for each element. There will also be an overall mark used to decide whether a student obtains a Merit or Distinction. For this overall mark, the **weighting of the individual marks** is as below.

The assessment for the MRes will comprise two marks: the first is based on the assessment of coursework from taught modules and the submitted research proposal (40% of degree); the second is based on the project (60 % of degree).

The breakdown of each component is as follows:

Coursework assessment (40% of course), to consist of the following components:

- Module 1a: essentials for life scientists: assessed coursework (2.5%)
- Module 1b: essentials for physical scientists: assessed coursework (2.5%)
- Module 2: Experimental systems biology: assessed coursework (5%)
- Module 3: Theoretical systems biology: assessed coursework (5%)
- Module 4: Synthetic biology: assessed coursework (5%)
- Module 5: Advanced technology: assessed presentation (5%)
- Research proposal: assessed coursework (15%)

Research project: assessed project work (60% of course)

Supervisors assessment: written report (20 %); lab performance (10%)

Internal examiner assessment: written report (20%); oral examination (10%)

The project will be examined by the supervisors who will provide a mark both for the written report as well as the conduct and performance of the student during the project. In addition, two independent internal examiners will evaluate both the report as well as conduct an oral examination that will test the students on their project as well as aspects of the taught material.

Marks will be reviewed by the internal board of examiners and may be moderated. The external examiners will conduct a viva with all students and marks may be moderated further before the award of the final mark.

Summary of grades, marks and their interpretation for MRes degree classification

<u>GRADE</u>	<u>MARKS</u>	<u>INTERPRETATION</u>
A	69.9% - 100%	Marks represent a distinction (truly exceptional or excellent) performance
B	60% - 69%	Marks represent a Merit pass
C	50% - 59%	Marks represent an adequate pass
D	40% - 49%	Marks represent barely acceptable performance at MRes level
E	0% - 39%	Marks represent a fail performance

The Pass Mark for postgraduate taught courses is 50% in overall mark and both components. In order to be awarded a result of merit, a candidate must obtain 60% or greater in both components; a result of distinction requires 70% or greater in both components. Borderline cases may be moderated at the discretion of the Board of Examiners.

b) Marking Schemes for postgraduate taught programmes:

The Pass Mark for all **postgraduate** taught course modules is 50%. Students must pass all elements in order to be awarded a degree.

c) Processes for dealing with mitigating circumstances:

A candidate for a Master's degree who is prevented owing to illness or the death of a near relative or other cause judged sufficient by the Graduate Schools from completing at the normal time the examination or Part of the examination for which he/she has entered may, at the discretion of the Examiners,

(a) Enter the examination in those elements in which he/she was not able to be examined on the next occasion when the examination is held in order to complete the examination,

or

(b) be set a special examination in those elements of the examination missed as soon as possible and/or be permitted to submit any work prescribed (e.g. report) at a date specified by the Board of Examiners concerned. The special examination shall be in the same format as specified in the course regulations for the element(s) missed.

Applications, which must be accompanied by a medical certificate or other statement of the grounds on which the application is made, shall be submitted to the Academic Registrar who will submit them to the Board of Examiners.

d) Processes for determining degree classification for borderline candidates:

Candidates should only be considered for promotion to pass, merit or distinction if their aggregate mark is within 2.5% of the relevant borderline. Nevertheless, candidates whom the Board deems to have exceptional circumstances may be considered for promotion even if their aggregate mark is more than 2.5% from the borderline. In such cases the necessary extra marks should be credited to bring the candidate's aggregate mark into the higher range.

e) Role of external examiners:

The visiting examiners (from other universities and research institutes) are nominated by the MRes Course Committee and approved by the Graduate School of Life Sciences and Medicine (or Executive) Committee. Due to the interdisciplinary nature of the course, two examiners with different backgrounds and expertise were appointed,

Prof. Tom Duke from University College London with expertise in modelling and systems biology

Prof. Gos Micklem from Cambridge University with expertise in genomics, bioinformatics, and synthetic biology.

The role of these visiting examiners is not only to review the core taught modules but also act as exam moderators. In order to do the latter they:

- review written coursework including case studies and research proposal
- see all research project dissertations
- viva all students
- attend the Board of Examiners
- complete a report to the College
- provide informal feedback regarding the nature and direction of the Course
- moderate marks

The primary duty of external examiners is to ensure that the degrees awarded by the College are consistent with that of the national university system. External examiners are also responsible for approval of draft question papers, assessment of examination scripts, projects and coursework (where appropriate) and in some cases will attend *viva voce* and clinical examinations. Although external examiners do not have power of veto their views carry considerable weight and will be treated accordingly. External examiners are required to attend each meeting of the Board of Examiners where recommendations on the results of individual examinations are considered. External examiners are required to write an annual report to the Rector of Imperial College which may include observations on teaching, course structure and course content as well as the examination process as a whole. The College provides feedback to external examiners in response to recommendations made within their reports.

23. Indicators of Quality and Standards:

The programme is administered by the Course Directors (CDs), the Director of Postgraduate Studies (DPS), Examinations officer (EO), Admissions Tutor (AT) together with the Postgraduate Tutor (PT). These, together with the Head of Division (HoD) form the Masters Course Committee, which meets regularly to manage and monitor course admissions, training, and examination.

Overall control of research postgraduate training is through the GSLSM and GSEPS management committees, which report directly to Imperial College Senate. These management committees meet every second month and each Division has two staff. Divisional records of student progress including dates of transfer and thesis submission are complemented through formal record keeping by Imperial College Student Registry. Masters programmes examiners' reports are reviewed by the HoD and the Masters Course Committee. All cases where special circumstances are reviewed in detail by the HoD and the Director of the Graduate School and appropriate action is taken. In addition, the College has established a structure for the review of individual Master Courses and reviewed every 2 years. Best practice emerging from each review is shared throughout the College Graduate Schools.

Students are encouraged to provide feedback to the Faculty committee or Divisional DPS and PT through regular meetings with their Personal Tutor and the CDs and through their student representatives on the GSLSM and GSEPS management committees. Furthermore, a source of anonymous student evaluation of their training is through the Student On Line Evaluation process (SOLE) and a course questionnaire. Students and lecturers provide feedback on the quality of the lectures in personal conversations with the course directors, during informal meetings, as well as by email.

The course organisers are consulting with potential accreditation bodies regarding formal external accreditation but the course is only in its second year so it is too early for this to take place.

24. Key sources of information about the programme can be found in:

www.imperial.ac.uk/systemsbiology - which has links to the prospectus, the course booklet and the course structure