THE UNIVERSITY OF EDINBURGH

PROGRAMME SPECIFICATION FOR

MSc/Diploma in Synthetic Biology and Biotechnology

1) Awarding Institution: University of Edinburgh
2) Teaching Institution: School of Biological Sciences
3) Programme accredited by: N/A
4) Final Award: MSc/Diploma
5) Programme Title: Synthetic Biology and Biotechnology
6) UCAS Code: N/A
7) Relevant QAA Subject Benchmarking Group(s): N/A
8) Postholder with overall responsibility for QA: Dr Maurice Gallagher
9) Date of production/revision: October 2013
10) External Summary (200-250 words)

The MSc in Synthetic Biology and Biotechnology will seek to attract home, EU and overseas students to Edinburgh to an academically challenging and career-developing MSc programme on research and development using biological and chemical principles and systems to create new products, services and industries. We will teach students to employ elements of the developing field of ‘synthetic’ biology to bring about significant changes and major innovations which address the challenges of rapidly changing human demographics, resource shortages, energy economy transition and the concomitant growth in demand for more and healthier food, sustainable fuel cycles, and a cleaner environment.

This programme will build on the success of the MSc in Biotechnology, which now has 28 students (18 O/S, 10 Home/EU and three of whom did an Edinburgh undergraduate degree). In 2013-14 it brings in £466,400 of fee income in CSE, the great majority of which comes back into SBS. Since its inception two years ago it has generated £824,970 in total fee income.

However this programme now faces capacity constraints and has too many students to be accommodated on some popular MSc courses. We feel that around 20 students is probably optimal for class discussion and learning and teaching interactions. However Biotechnology received a large pool of applications (286, see the latest version of SBS PGT Admissions Statistics which is attached). If we can re-route some of these to another course, we would have a win-win strategy. Therefore we wish to create a new MSc in Synthetic Biology and Biotechnology (thus using the name-recognition factor, and popularity that Biotechnology has in many areas of the world (i.e. India, China, S. America, Europe, N. America - all of which send students to our current MSc Biotech) and offer additional teaching in an area of strategic importance to Edinburgh’s research agenda.

Students will enhance their career prospects by acquiring current, marketable knowledge and developing advanced analytical and presentational skills, within the social and intellectual sphere of a leading European university. The School of Biological Sciences is offering a research rich environment in which to develop as scientists and entrepreneurs.

During the programme students can expect to achieve the following:
• Strong background knowledge in the fields underlying synthetic biology and biotechnology
• Understanding of the limitations and public concerns regarding the nascent field of synthetic biology
• Ability to approach the technology transfer problem equipped with the skills to analyse the problem in scientific and practical terms
• Understanding of how biotechnology relates to real-world biological problems
• Ability to conduct practical experimentation in synthetic biology and biotechnology
• Ability to think about the future development of research, technology and its implementation

10) Educational aims of programme:

The MSc in Synthetic Biology and Biotechnology aims to give students a thorough grounding in biotechnology and the supportive enabling technologies in synthetic biology and produce a trained intellect that is capable of critical thinking.

The programme aims to develop skills in:
• Knowledge and understanding
• Research skills in both laboratory and library
• Awareness of unresolved issues and unanswered questions in the area of Biotechnology
• Confidence in leadership and responsibility in research
• A range of generic transferable skills

The programme aims to teach experimental methods used to investigate biology; how to perform and document experiments in a laboratory; how to draw quantitative conclusions from experimental data and how to present results and theoretical knowledge. In addition, all students will develop the level of understanding that will allow engagement in debates on current topics in a broader context.

11) Programme outcomes:

11a) Knowledge and understanding

• Strong background knowledge in the fields underlying synthetic biology and biotechnology
• Understanding of the limitations and public concerns regarding the nascent field of synthetic biology
• Ability to approach the technology transfer problem equipped with the skills to analyse the problem in scientific and practical terms
• Understanding of how biotechnology relates to real-world biological problems
• Ability to conduct practical experimentation in synthetic biology and biotechnology
• Ability to think about the future development of research, technology, its implementation and its implications

11b) Graduate attributes: Skills and abilities in Research and Enquiry

Through a combination of laboratory practicals, research projects and group work, students will learn new skills and approaches in biological research. An understanding of scientific method, allied to the ability to construct alternative arguments and hypotheses will lead students to develop an ability to evaluate evidence for and against particular points of view. Our students will have developed numerical competence. They will learn to report research data and conclusions through written reports and competent oral presentations.

Through participation in a combination of different teaching and laboratory experiences, graduates acquire the ability to:

• Develop critical thinking
• Discuss and evaluate scientific arguments
• Exchange ideas with scientific colleagues
• Communicate concepts and ideas to the wider public
- Formulate scientific questions and programmes of research
- Ability to design, interpret and critique experiments
- Understand introductory scientific entrepreneurship

11c) Graduate Attributes: Skills and abilities in Personal and Intellectual Autonomy

Critical thinking is a core skill to be developed during the training provided in the Synthetic Biology and Biotechnology MSc programme. Students will develop an increasing competence to deal with intellectual concepts and scientific discussion, and to evaluate contradictory arguments through both essay writing and laboratory research.

Students acquire the ability to:
- Organise complex arguments and draw these together into a coherent conclusion
- Understanding the relative value of different scientific approaches
- Summarise and interpret the work of others in the context of previous work and likely developments.
- Evaluate the strength and weaknesses of scientific evidence, thereby being able to arrive at independent conclusions
- Analyse graphs, figures and tables
- Practise and record accurate observation
- Deliver presentations in a logical and coherent manner
- Acquire knowledge of opportunities and career pathways for professional development
- Learn analytical methods and apply them to problem solving
- Consider and understand scientific theories
- Formulate, investigate and discuss questions
- Build on existing knowledge to suggest new directions for investigation
- Understand the relevance and importance of explaining scientific ideas and the impact of science to the wider community.

11d) Graduate Attributes: Skills and abilities in Communication

The development of communication skills occurs at all stages of the MSc programme. Skills comprise of:

- Oral and written communication (project, poster and paper presentations)
- Computer skills
- Graphical and numerical skills
- Library skills
- Problem solving skills
- Group and teamwork skills (working effectively)
- Analytical skills
- Independent learning
- Time management
- Organisational skills
- Numeracy and statistical analysis skills
- Problem solving
- Online/Internet information retrieval skills
- Communicating with the wider public, policy makers and other practitioners

11e) Graduate Attributes: Skills and abilities in Personal Effectiveness

Student personal development is achieved through a number of interconnected learning processes and interaction with other students and staff. These processes include:
- Group working using a range of techniques (e.g. leadership; interaction with other students, supervisors, research fellows)
• Building confidence from completion of assignments and from successful work experiences within the laboratory, and via projects, presentations and essays.
• Collaborating efficiently and productively with others in the process of learning and presenting conclusions
• Organising their own learning, managing workload and working to a timetable
• Effectively plan, and possess the confidence to undertake and to present scholarly work that demonstrates an understanding of the aims, methods and considerations, and ability to form their own conclusions
• Working independently on the creation of essays and reports.
• Learning study techniques; such as literature reading.
• Learning to analyse individual strengths and weaknesses through the provided written and oral feedback.

11f) Technical/practical skills

Technical/practical skills are acquired mainly through laboratory practicals and the summer research project. Quantitative and statistical skills are included within all course options.
• Ability to approach the technology transfer problem equipped with the skills to analyse the problem in scientific and practical terms
• Ability to conduct experiments and contribute to the development of tools and their application within synthetic biology and biotechnology
• Enhanced scientific and business communication skills
• Ability to think about the future development of research, technology and its implementation

12 Programme structure and features

Entry Requirements:
Students should possess a UK University undergraduate degree or its equivalent outside the UK (usually at least a 2:1 honours degree or its equivalent). Candidates are expected to possess a strong background in one or more of the following areas: biotechnology, biochemistry, molecular biology and the related sciences. Engineering, particularly bio-engineering, physics, mathematics, or other backgrounds will also be considered on a case-by-case basis.

The minimum requirements for non-native speakers of English are:
- IELTS Academic Module 6.5 (with at least 6.0 in each section)
- TOEFL-IBT 92 (with no score lower than 20 in each section)
- Pearson Test of English 61 (with no score lower than 56 in each section)
- Cambridge CPE Grade C (ONLY for applicants who do NOT need Tier 4 visas to enter UK)
- Cambridge CAE Grade B (ONLY for applicants who do NOT need Tier 4 visas to enter UK)

However, because much of these courses involve presentations and the rapid production of research write-ups, students with the minimum language requirements may find the language expectation demanding. We therefore recommend that students should reach:
- IELTS 7.0
- TOEFL 100

Students who do not have this level of English are recommended to take one of the summer English language courses in "English for Academic Purposes" at the University of Edinburgh's Institute of Applied Language Studies (IALS) prior to starting the degree programme in September. Further details can be found at: http://www.ials.ed.ac.uk/.
Modes of Study:
The programme is full time, running from mid September to the end of August, with Graduation taking place end of November/beginning of December.

Progression and Exit Awards:
Students who gain >=50% overall and >=50% in at least 80 of the 120 credits in the final overall assessment of the taught stage at the end of May can proceed to the dissertation stage, and carry out a full-time research project from June – August.
Students who gain >=40% overall and >=40% in at least 80 of the 120 credits in the final overall assessment who do not qualify to proceed will be awarded the Diploma and leave in June.

To be awarded the MSc, students must successfully complete both the taught and dissertation stages. Students may elect to exit at the end of the taught stage with the award of Diploma. Both the MSc and the Diploma may be awarded with Distinction.

Curriculum:
The taught component of the programme will comprise 120 credit points made up of compulsory courses and optional courses. In addition, there will be a full time dissertation project in the second part of the year valued at 60 credits. Courses will be 10 or 20 credit points, and will be split between the first and second semesters.

A full breakdown of the course options available with credit points and levels is given below:

Compulsory Courses

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
<th>Credits</th>
<th>SCQF Level</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>PGBI11065</td>
<td>Research Project or Industrial Placement (MSc)</td>
<td>60</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td>PGBI11092</td>
<td>Tools for Synthetic Biology</td>
<td>10</td>
<td>11</td>
<td>1</td>
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<tr>
<td>PGBI11061</td>
<td>Research &amp; Development: The Laboratory Foundation Part 1</td>
<td>20</td>
<td>11</td>
<td>1</td>
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<tr>
<td>PGBI11089</td>
<td>Practical Systems Biology</td>
<td>20</td>
<td>11</td>
<td>1</td>
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<tr>
<td>PGBI11094</td>
<td>Applications of Synthetic Biology</td>
<td>10</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td>RCSS11001</td>
<td>Social Dimensions of Systems and Synthetic Biology</td>
<td>20</td>
<td>11</td>
<td>2</td>
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</table>

Optional Courses

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
<th>Credits</th>
<th>SCQF Level</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>PGBI11051</td>
<td>Information Processing in Biological Cells</td>
<td>10</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>BITE10001</td>
<td>Enzymology and Biological Production</td>
<td>10</td>
<td>10</td>
<td>1</td>
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<tr>
<td>BITE10010</td>
<td>Gene Expression and Microbial Regulation</td>
<td>10</td>
<td>10</td>
<td>1</td>
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<tr>
<td>PGBI11023</td>
<td>Molecular Modelling and Database Mining</td>
<td>10</td>
<td>11</td>
<td>1</td>
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<tr>
<td>PGBI11059</td>
<td>Economics and Innovation in the Biotechnology Industry</td>
<td>10</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>PGBI11066</td>
<td>Intelligent Agriculture</td>
<td>10</td>
<td>11</td>
<td>1</td>
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<tr>
<td>PGBI11063</td>
<td>Vaccine Development and Clinical Testing</td>
<td>10</td>
<td>11</td>
<td>1</td>
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<tr>
<td>PGBI11088</td>
<td>Drug Discovery</td>
<td>10</td>
<td>11</td>
<td>2</td>
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<tr>
<td>PGBI11062</td>
<td>Research &amp; Development: The Laboratory Foundation Part 2</td>
<td>20</td>
<td>11</td>
<td>2</td>
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<tr>
<td>PGBI11049</td>
<td>Commercial Aspects of Drug Discovery</td>
<td>10</td>
<td>11</td>
<td>2</td>
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<tr>
<td>PGBI11006</td>
<td>Bioinformatics</td>
<td>10</td>
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Assessment:
The programme will be assessed by a combination of in-course assessment (both continuing assessment and a written exam in most cases), and an MSc dissertation prepared from the major research project. Examinations will be held at the end of the semester in which the course is completed. Students reaching a satisfactory standard in course assessment will be allowed to continue to the MSc, and will be required to submit a dissertation on an approved topic by the end of the programme (mid-September). The weighting given to each course will be according to its credit points.
Teaching and Learning Methods and Strategies

Teaching and Learning strategies employed at the University of Edinburgh consist of a variety of different methods appropriate to the programme aims. The graduate attributes listed above are met through a teaching and learning framework (detailed below) which is appropriate to the level and content of the programme.

Teaching and Learning Activities include:

- Lectures
- Workshops
- Presentations
- Laboratories
- Field Work
- Tutorials
- Seminars
- Discussion Groups/Project Groups
- Problem based learning activities

Examples: Students attend problem based tutorial sessions, one to one meetings with personal tutor/programme director, project work in a research laboratory; students carry out their own research at the frontier of knowledge and can make a genuine contribution to the progress of original research. This also involves reviewing relevant papers, analysing data, writing a report and giving a presentation.

Innovative Learning Week

The University of Edinburgh Innovative Learning Week is scheduled in Week 6 of Semester 2. During this week ‘normal’ teaching is suspended which provides space outwith the curriculum for staff and students to explore new learning activities. Some examples of the types of activities held in Biological Sciences were workshops, peer assisted learning activities, public engagement activities, careers events and field trips.

Assessment Methods and Strategies

Courses are assessed by a diverse range of methods and it often takes the form of formative work which provides the student with on-going feedback as well as summative assessment which is submitted for credit.

- Essays; students are provided with written feedback
- Assessed Problems; students are provided with written feedback
- Oral Presentations; feedback is provided by peers and staff
- On-line Tests; on-line feedback with explanations
- Written Degree Examinations; students have the opportunity to meet with course organisers to view their examination scripts.
- Multiple Choice Tests
- Project Reports and Presentations; students are provided with written feedback.

Career Opportunities

Synthetic biology is fast becoming a central, enabling set of technologies ready to be used by industry. The need for trained graduates will be pivotal to the expansion and acceptance of this technology by the already established biotechnology companies in the UK and beyond.

Graduates will have a wide range of career options with possible recruitment by both the more established companies in the biotech industry (specialising in bioenergy, bioremediation, distilling, pharmaceuticals) and by ‘start-ups and spinouts’- young companies seeking to develop novel ideas into innovative products and services.
Equally this qualification is great preparation for further research at PhD level.

16 Other Items

The MSc in Synthetic Biology and Biotechnology will add to the choice of Masters programmes offered by the School of Biological Sciences at the University of Edinburgh. The success of the MSc in Biotechnology illustrates the demand for the MSc qualification in this area and the addition of Synthetic Biology seeks to build on key research strength of the University and indeed the UK. The 8 programmes offered by the University share a common structure, and thus a wide range of educational opportunity is presented through the optional courses.

Students will be encouraged to integrate themselves with the vibrant postgraduate student body (both MSc, MRes and PhD students) based in the King’s Buildings campus, and to make best use of the vibrant research community there.

The Programme Director of the MSc in Synthetic Biology and Biotechnology also adopts the role of Personal Tutor to each student on the programme, providing them with both academic and pastoral guidance. Throughout a students time at the university the Programme Director guides the student in choice of courses and provides general support. Courses are administered and run through Teaching Organisations. These produce detailed course guides for new students. These guides provide details of courses and also advise students on assessment and general university policy and regulations.