PROGRAMME SPECIFICATION	

1	**Awarding Institution**	Newcastle University
2	**Teaching Institution**	Newcastle University
3	**Final Award**	MSc
4	**Programme Title**	Synthetic Biology
5	**Programme Code**	5200F
6	**Programme Accreditation**	
7	**QAA Subject Benchmark(s)**	
8	**FHEQ Level**	Level 7
9	**Last updated**	May 2023

10 Programme Aims

1. To develop the multidisciplinary skills essential to produce the trained synthetic biologists required by academia and by the biotechnology and pharmaceutical industries.
2. To provide the fundamental knowledge required to apply engineering approaches to the specification and design of biological systems with an emphasis on computational approaches.
3. To provide fundamental knowledge of the ethical, social and legal implications of designing, building and using synthetic biological systems.
4. To provide an understanding of the most commonly used, and most important, in-silico analytical, quantitative and experimental methods in synthetic biology.
5. To provide an understanding and practical experience of the most important genetic engineering and molecular experimental methods in synthetic biology.
6. To develop practical skills in molecular biology research.
7. To develop research skills.
8. To develop and improve skills in the use of literary resources and information technology.
9. To develop skills in critical assessment, analysis and storage of information and/or data.
10. To provide a qualification enhancing employment prospects in synthetic biology.
11. To enable a choice between a computational/numerical theme or a biological theme for more advanced studies in synthetic biology.
12. To enhance synthetic biology research by:
    - Requiring research students to undertake substantial synthetic biology research projects
    - Generating a source of qualified research students interested in pursuing PhD research in synthetic biology
13. To provide a programme which meets the FHEQ at Masters level and which takes appropriate account of the draft subject benchmark statements in Computing.

11 Learning Outcomes

The programme provides opportunities for students to develop and demonstrate knowledge and understanding, qualities, skills and other attributes in the following areas. The programme outcomes have references to the benchmark statements for Computing.

Knowledge and Understanding

On completing the programme students should be able to demonstrate:

A1. A detailed understanding of the synthetic biology lifecycle; system specification, design, modelling, implementation, characterisation, testing and refinement.

A2. An understanding of the application of engineering principles, computing, systems biology and statistics to the synthetic biology lifecycle.
A3. An understanding of biological data management, integration and handling and their role in biological systems specification, modelling, design, implementation and characterisation.
A4. A demonstrable, broad, knowledge of the computing, statistical and biological methods and their role in, and relevance to, the synthetic biology life-cycle.
A5. Knowledge of genetic manipulation and genomic engineering.
A6. Knowledge of the ethical, legal and social issues (ELSI) relating to synthetic biological and a knowledge of how these issues are inherent in the whole synthetic biology lifecycle.
A7. An understanding of the technology for studies in modern post-genomic biology, the role of automation and the data that is generated by such studies.
A8. Advanced knowledge and understanding of chosen specialist areas in synthetic biology.
A9. An understanding of the theory and principles which underlie computing and software engineering, so that students can appreciate the current state of these subjects and can apply these principles to problems in synthetic biology.
A10. Knowledge of an up-to-date programming language.

Teaching and Learning Methods

Fundamental and specialist knowledge (A1-A10) are imparted largely through direct student contact (lectures and tutorials), supplemented by practical sessions that may take the form of laboratory sessions, computing sessions (A7-10), problem solving and assessed coursework, and project proposals. Student understanding and learning is enhanced by the use of laboratory work, problem solving, modelling and numerical exercises, literature reviews, teamwork and practical work (in the research thesis in particular) and production of a project proposal. Independent learning is encouraged through the provision of reading lists, literature reviews and critical analysis of research papers, and ready access to online information resources. Adequate time is provided in all modules for private study for independent learning.

Assessment Strategy

Formative strategies are used to assess problem solving, design, modelling and programming skills, group work and literature review exercises. Extra formative assessment is included to provide student feedback throughout the course, without contributing to module marks. Formal feedback is provided for each piece of assessed coursework in the form of an individual proforma and a review session in subsequent lectures (A1-A10). Summative strategies, in the form of examinations, are used assess a students learning achievements, for key modules.

Intellectual Skills

On completing the programme students should be able to:

B1. Propose, carry out and write up an extended synthetic biology project involving, where appropriate, a literature review, problem specifications, design, implementation, analysis and refinement.
B2. Design, and specify appropriate engineering, genetic manipulation and ELSI strategies for synthetic biological systems.
B3. Apply their knowledge of specific biological, computational, mathematical and statistical techniques to the analysis of data from synthetic biology.
B4. Have expertise in the use and applicability of up-to-date modelling and software tools.
B5. Construct and analyse appropriate predictive models of biological systems

Teaching and Learning Methods

Intellectual skills (B1-B5) are imparted by a combination of lectures, practicals, case studies, group working and an in-depth research project tailored to individual interests. Optional modules also permit a student to tailor their degree content. Optional modules are delivered in the form of 'short fat' modules that reduce the emphasis on formally taught material and instead adopt a more directed self-learning approach, including the use of interactive tutorials (both tutor and student led), self-directed study, team-based exercises, laboratory practicals, problem-based learning and investigative work. The use of short fat modules in the second semester has several advantages: (i) key skills development and deep learning is enhanced due to increased student participation and interest; (ii) learning is concentrated, allowing the student to focus in depth on one subject at a time; (iii) modules can be made available to other courses aimed at continuing professional development (for industry or academia); and (iv) enables future extension of module choices. Practical sessions and problem-solving exercises are used to develop both computational, genetic manipulation and analytical skills (B2, B3, B4, B5). Tutorials are used to focus on specific research topics in detail, to carry out problem solving exercises (B1) and critical analysis of the current biological systems design and simulation tools (B4), analytical techniques (B3) and research literature, to ensure up-to-date knowledge of subject-specific research fields.

Assessment Strategy

Intellectual skills (B1-B5) are assessed by written examinations and continuously-assessed material that includes written reports, practical write-ups, literature reviews, group projects, oral presentations, a website and a research thesis. The assessment methods aim to evaluate the students' understanding and ability to apply the laboratory, engineering, computational and statistical techniques that form the basis for the interdisciplinary field of synthetic biology.

Practical Skills

On completing the programme students should be able to:

C1. Utilise the resources necessary to critically evaluate research and literature relating to synthetic biology.
C2. Demonstrate appropriate specifications for constructing synthetic systems that address biological problems.
C3. Design and model synthetic biological systems using an engineering based strategy.
C4. Build, characterise and refine synthetic biological systems.
C5. Present, store, model and handle quantitative information.

Teaching and Learning Methods

Critical evaluation of current research will be developed through literature searching, through coursework exercises and in the research project in particular (C1). The ability to demonstrate appropriate specifications for constructing synthetic systems that address biological problems and to build, characterise and refine synthetic biological systems (C2, C3, C4) will be acquired through practical sessions, the research project and self-directed learning. Tutorials and group discussion will be used to reinforce specific engineering based, computational and numeric methodology (C3). Problem solving exercises and case studies will be used to improve student skills in the application of appropriate solutions to biology data handling and analysis (C4,C5).

Assessment Strategy

Practical skills (C3-C5) are primarily assessed continuously in the form of individual reports from practical studies, literature reviews, tutorial exercises, group project reports and the project dissertation. System design and modelling are a strong component of many modules and are also assessed through the use of examinations and continuously assessed problem solving exercises.

Transferable/Key Skills
On completing the programme students should have: D1. The ability to communicate orally D2. Written communication skills D3. The ability to use computer based literacy resources D4. The ability to work as part of a team D5. Creativity skills D6. Laboratory skills
Teaching and Learning Methods
Oral presentation skills are exercised by group discussions in tutorial sessions, by communication during group exercises, and by the preparation of oral presentations on specific research topics (D1). Written communication skills are developed during independent study, the preparation of coursework, web page design, poster presentation and through the completion of the research project proposal and the project thesis (D2). Formal lectures and practicals address the development of laboratory skills, use of online literacy resources and research techniques, reinforced through the use of practice exercises (D3, D6). Group project and student-led tutorials are used to develop team skills (D4). The preparation of web pages and poster presentations are used to enhance writing and creativity skills (whilst also improving computing skills) (D5).
Assessment Strategy
Written communication and laboratory skills are assessed by report preparation, the research thesis and literature reviews. Oral communication skills are assessed in oral presentations. The ability to use computer-based literacy resources is assessed through the preparation of literature reviews and through self-assessment. Team work is formally evaluated using small group-based problem solving and data analysis exercises. Independent work is assessed in literature reviews and research projects. Creativity is assessed through problem-solving exercises and poster preparation. The production of web pages is included in some modules to assess students' abilities to provide synopses of information in a scientific but creative fashion.

12 Programme Curriculum, Structure and Features
Basic structure of the programme
This is a one year, full time, intensive modular programme. The programme consists of two parts: a ***taught component*** that runs for 6 months and a ***research project*** of 6 months duration, for which a thesis is submitted. The programme is centred in the School of Computing Science, where the students will be based. Due to the interdisciplinary nature of the course, some modules are delivered by members of other Schools. The programme consists of mandatory modules, optional modules, and the major individual project and dissertation. The programme provides a comprehensive training in interdisciplinary aspects of Biology, Engineering, Computing Science and Statistics. The taught component of the course accounts for 90 credits and the Research Project 90 credits. The ***taught component*** of the course is split across semester 1 and semester 2. ***Semester 1*** modules build the basic grounding in, and understanding of, synthetic biology, genetic manipulation, ELSI, computation, and numeric skills to undertake more specialist modules. Four mandatory modules (50 credits total) run from week 1 to week 12. An additional 10-credit module is selected from one of two options to provide students with the opportunity to begin to tailor their degree content depending on their previous scientific background. These modules are examined in January at the end of semester 1. The

numerical skills mandatory module starts in semester 1 and runs through until week 9 of semester 2.

Semester 2 introduces modules that build key research skills (generic and specialist) and impart deep learning by building on, and applying, the fundamental knowledge gained in semester 1.

Semester 2 modules occupy weeks 1 to 6 (with the research project starting in week 7) and taught in intensive three-week periods sequentially. The first 10-credit module is mandatory.

The second 10-credit module is selected from a set of four options. The availability of these options is subject to sufficient demand as determined by student registration at the end reading week in semester 1. The use of optional modules supports two distinct themes to allow tailoring of the specialist learning. This second semester optional module set provides a choice between a computational/numerical theme or a more biologically-oriented theme. Students studying multidisciplinary subjects often fall into two classes based on preference for numerical/computational or biological modules (see 'A Review of Bioinformatics Education in the United Kingdom', http://www.hgmp.mrc.ac.uk/~dcounsel/education.html) and this mechanism allows their degree’s content to be tailored accordingly. However, the choice of one theme or the other is not mandatory.

The remaining 5-credit component of the numeric skills module and a compulsory 5-credit module devoted to building generic key skills, including literature searching and presentation exercises are also delivered in week 1 to 6 of semester 2.

Preparation for the research project (see below) begins in week 7 of semester 2.

Research project. The 90-credit research project is of six months duration. The research project may be based in a research group from one of the Schools that offer synthetic biology-related research training, including the Schools of Computing Science, Mathematics and Statistics, Biology and Cell and Molecular Biosciences. Each student will begin preparatory work on their selected research project (literature search, background reading) during semester 2 as part of their transferable skills module, and will produce a research proposal with a workplan in the style of a standard research council grant application and give a presentation on their research plans, again as part of the research skills module. A website will also form a requirement of the research project, together with the completion of the finished research thesis.

Key features of the programme (including what makes the programme distinctive)

This programme is distinctive for a number of reasons. Firstly, synthetic biology is an emerging field and this course is one only a few in the country. Secondly, the programme is very research focussed. The use of short fat modules in semester 2 allows hands-on, real-world research training scenarios to be delivered. Thirdly, the programme offers a high degree of training in the area of computation, automation and modelling; students with these kinds of skills are currently in high demand by both academia and industry. Thirdly, the programme caters for students from a range of backgrounds and offers a high degree of choice, allowing students to tailor their degree programme to suit their match their training needs with their career aspirations. Finally, the programme is managed and delivered by a team of genuinely multidisciplinary researchers, with an excellent track record in synthetic biology research and training.

Programme regulations (link to on-line version)

5200F: -R5200F

13	Support for Student Learning

Generic information regarding University provision is available at the following link.
Generic Information

14	Methods for evaluating and improving the quality and standards of teaching and learning

Generic information regarding University provision is available at the following link.
Generic Information

Accreditation reports
This programme is not accredited by any professional body.

Additional mechanisms
Turnitin is routinely used by the school to detect plagiarism when appropriate.

15	Regulation of assessment

Generic information regarding University provision is available at the following link.
Generic Information

In addition, information relating to the programme is provided in:

The University Prospectus: http://www.ncl.ac.uk/postgraduate/

Degree Programme and University Regulations: http://www.ncl.ac.uk/regulations/docs/

Please note. This specification provides a concise summary of the main features of the programme and of the learning outcomes that a typical student might reasonably be expected to achieve if she/he takes full advantage of the learning opportunities provided.