LF306-15 Engineering Biology

26/27

Department
Life Sciences
Level
Undergraduate Level 3
Module leader
Munehiro Asally
Credit value
15
Module duration
10 weeks
Assessment
Multiple
Study location
University of Warwick main campus, Coventry

Description

Introductory description

Much of bioscience is about discovery, i.e. learning about the naturally evolved properties of living systems. Synthetic and Engineering Biology adds a new dimension to our approach to the living world by identifying and characterising cellular components (e.g. transcriptional elements such as promoters and transcription activators; mRNA elements such as untranslated regions or ribosome binding sites; protein domains that act as binding sites or conformational switches), and trying to assemble (engineer) these into new versions of (synthetic) biological systems. There are two major benefits to this approach. First, in the process of trying to engineer new biological systems, we improve our understanding of the naturally evolved biosphere (build-to-understand). Second, synthetic biology is in the process of radically enhancing our ability to create products and processes that are of value to human society (build-to-apply).
Synthetic biology is having a major impact on the development of applications in biotechnology, medicine, agriculture and energy, and accordingly brings academic and industrial interests together. We have therefore decided to incorporate contributions from representatives of some of our industrial partners into this module so that you can hear about commercially oriented research ‘first-hand’. Overall, this course will suit students who are interested in cutting-edge science and who are keen to understand what the alternative (but related) paths of research in academia and industry might offer them in the future.

Module aims

This module will introduce the core methods and principles of synthetic biology, including the design- construct-test-optimization cycle and the paradigms of build-to-understand and build-to-apply. We will then illustrate how these principles can be applied in diverse prokaryotic and eukaryotic organisms. Ideally, synthetic biologists want to be able to integrate defined biological components into functional circuits, pathways and other cellular systems that behave in predictable ways. However, biological systems are not as simple to construct as electrical circuits, and part of the fascination of synthetic biology is learning what the real rules for predictable bio-assembly are. We will also consider the rapidly developing enabling technologies of synthetic biology, including DNA synthesis and large-scale (genome) assembly methods and system modelling.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

Core Principles of Synthetic Biology: An Overview. • enabling technologies (DNA synthesis; rapid, large-scale assembly methods; modeling) • build to understand and build to apply; the design-construct-test-optimization cycle • the limits of the engineering paradigm in biology

Microbial cells as hosts for circuitry and pathways • circuitry designs in bacteria and yeasts; components extending from DNA through RNA to protein • predicted and actual behaviour of engineered systems • experimental and computational tools available to characterise natural and engineered systems • cell-cell interactions, quorum sensing, microbial communities • applications of microbial engineered circuits, pathways and genomes in medicine, the environment, biotechnology

Computation modelling and tools. • The Design-Construct-Test-Optimise cycle (1 afternoon sessions) • in silico cloning • ODE modelling

Synthetic Biology of eukaryotic systems

- mammalian cell engineering – e.g. T cell engineering and medical applications • interspecies communication (molecular signalling between microbial and mammalian cells) • plant synthetic biology: synthetic sensors, metabolic pathways, genomes, with key examples related to food, biomass, biofuels, polymers, drugs.

Learning outcomes

By the end of the module, students should be able to:

- Understand the relationship between design, construction, testing and optimization in a biological context.
- Understand fundamental concepts of engineering biological systems
- Develop an understanding of the potential of synthetic biology to revolutionize the discovery process in biology and to enable step-change advances in biotechnology, medicine, food security and the environment
- Understand how to apply computational techniques and tools for designing synthetic biology systems

Subject specific skills

a. Demonstrate a clear understanding of the scientific topic
b. Contain evidence of extended reading and lateral integration of material not covered in the lectures
c. Demonstrate independent thought and deep understanding
d. Specifically answer the set question using information from multiple lectures and sources
e. Be structured and formatted in a way that demonstrates understanding and logical flow
f. Use multiple sources to construct complex scientific arguments and integrate these to build and develop the student's own scientific conclusions.

Transferable skills

1. Critical appraisal of source material
2. Self-directed learning
3. Adult learning

Study

Study time

Type	Required
Lectures	20 sessions of 1 hour (13%)
Private study	126 hours 30 minutes (84%)
Assessment	3 hours 30 minutes (2%)
Total	150 hours

Private study description

126.5 hrs of self-study and directed reading to prepare for the closed-book examination

Costs

No further costs have been identified for this module.

Assessment

You do not need to pass all assessment components to pass the module.

Students can register for this module without taking any assessment.

Assessment group B

	Weighting	Study time	Eligible for self-certification
Closed-book end-of-year examination	50%	2 hours	No
In-person locally-timetabled computer-based end-of-year examination. This will be a written assessment that may take the form of essays or data analysis			
In-class computer-based examination	50%	1 hour 30 minutes	No
MCQ In-class computer-based examination			

Assessment group R3

	Weighting	Study time	Eligible for self-certification
Closed-book examination	100%		No
In-person locally-timetabled closed-book examination			

Feedback on assessment

Pastoral meeting with academic tutor

Past exam papers for LF306

Availability

Courses

This module is Core optional for:

- Year 3 of UIPA-C1L8 Undergraduate Life Sciences and Global Sustainable Development
- Year 4 of UIPA-C1L9 Undergraduate Life Sciences and Global Sustainable Development (with Intercalated Year)

This module is Optional for:

- Year 3 of UBSA-C700 Undergraduate Biochemistry
- ULFA-C1A2 Undergraduate Biochemistry (MBio)
    - Year 3 of C1A2 Biochemistry
    - Year 3 of C700 Biochemistry
- Year 4 of ULFA-C702 Undergraduate Biochemistry (with Placement Year)

- Year 3 of ULFA-C1A6 Undergraduate Biochemistry with Industrial Placement (MBio)
- Year 3 of UBSA-3 Undergraduate Biological Sciences
- Year 3 of ULFA-C1A1 Undergraduate Biological Sciences (MBio)
- Year 4 of ULFA-C113 Undergraduate Biological Sciences (with Placement Year)
- Year 3 of ULFA-C1A5 Undergraduate Biological Sciences with Industrial Placement (MBio)
- Year 3 of UBSA-C1B9 Undergraduate Biomedical Science
- ULFA-C1A3 Undergraduate Biomedical Science (MBio)
    - Year 3 of C1A3 Biomedical Science
    - Year 3 of C1B9 Biomedical Science
- Year 3 of ULFA-C1A7 Undergraduate Biomedical Science with Industrial Placement (MBio)
- Year 4 of ULFA-CB18 Undergraduate Biomedical Science with Placement Year
- Year 3 of UMDA-CF10 Undergraduate Integrated Natural Sciences (MSci)
- Year 3 of ULFA-B140 Undergraduate Neuroscience (BSc)
- Year 3 of ULFA-B142 Undergraduate Neuroscience (MBio)
- Year 3 of ULFA-B143 Undergraduate Neuroscience (with Industrial Placement) (MBio)
- Year 4 of ULFA-B141 Undergraduate Neuroscience (with Placement Year) (BSc)

This module is Option list B for:

- Year 3 of UMDA-CF10 Undergraduate Integrated Natural Sciences (MSci)