THE UNIVERSITY OF WESTERN AUSTRALIA

School of Molecular Sciences

Synthetic Biology:
Solving Global Challenges
SCIE5508

6 credit points

Semester 2

Crawley

Dr. Georg Fritz - Unit Coordinator

www.lms.uwa.edu.au

Contents

UNIT DESCRIPTION

Unit description and content

Synthetic biology aims to apply engineering principles to a broad range of biological disciplines, including biochemistry and molecular biology, genetics, genomics, evolutionary biology and computational biology. Through standardisation and modularisation, synthetic biology enables the rational (re-)design of biological systems with novel functionalities. Examples include the construction of synthetic biosensors and regulatory circuits enabling smart cellular decisions in bioremediation and biotechnology; the implementation of novel biosynthetic pathways and enzymes enabling the production of innovative materials, pharmaceuticals, biofuels, renewable chemicals, flavours and fragrances; and the re-programming of cells for advanced immunotherapies. This unit will focus on the presentation and discussion of the building blocks of synthetic biology, including current and future organisms, methods, platforms, and target uses.

Learning outcomes

Students (1) gain advanced knowledge of the concepts, state-of-the-art technologies and latest applications in the field of synthetic biology; (2) are able to critically evaluate the tools, techniques and targets currently used in synthetic biology applications; (3) and are able to apply current synthetic biology concepts and technologies to design and create a novel technology or application.

Unit rules

Prerequisites: Enrolment in the Master of Biotechnology 71580 (specialisations in Synthetic Biology, Genetics and Genomics, Biochemistry and Molecular Biology), or Enrolment in the Master of Biomedical Science 71520 (specialisations in Biochemistry and Molecular Biology, Food Biochemistry) or Enrolment in the Master of Bioinformatics 70550

Incompatibility: Nil

http://handbooks.uwa.edu.au/units/unitdetails?code=SCIE5508

CONTACT DETAILS

Unit coordinator

name: Dr. Georg Fritz (GF)

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phone: 6488 3329

consultation hours: By appointment.

office location: Bayliss Building 3.69

Academic teaching staff

name: A/Prof. Yit-Heng Chooi

email: yitheng.chooi@uwa.edu.au

phone: 6488 3041

consultation hours: By appointment.

office location: Bayliss Building, 2.58

name: Dr. Farley Kwok van der Giezen

email: farley.kwokvandergiezen@uwa.edu.au

phone: via MS Teams

consultation hours: By appointment.

office location: Bayliss Building, 4.56

name: Prof. Ryan Lister

email: ryan.lister@uwa.edu.au

phone: 6488 4407

consultation hours: By appointment.

office location: Bayliss Building, 4.74

Contacting academic and professional staff by email

Writing a professional email is a generic skill that you should acquire while at UWA. All email messages should be polite, considerate, and contain correct grammar and spelling. All should begin with an appropriate salutation, e.g. “Dear…”, and end with a suitable closing, e.g. “Regards…”.

Do not expect an answer to an email outside of business hours (Monday – Friday, 9.00 – 17.00). Please check the “Announcement” section in the unit’s LMS page before sending an email. Your question may have already been addressed.

Unit contact hours

10 lectures, each 45 min; 5 Q&A sessions, each 1 h; 5 seminar/tutorial sessions (depending on student numbers), each 2 h; 4 practical workshops, each 3 h; 6 project meetings, each 1 h; 15 h mentoring; 2 mid-content quizzes, each 90 min

ASSESSMENT MECHANISM

Assessment mechanism summary

Item	Weight	Description and due date
Oral presentation of case studies	25%	A seminar talk (10-12 min + 3-5 min discussion) presenting a recent synthetic biology paper (Journal Club). Marks will be allocated based on the quality of the talk (20%). The seminars are to be presented as a FREE SPEACH with Powerpoint slides as support – no notes on paper or in Powerpoint are allowed. The use of notes or the reading of full sentences from Powerpoint slides will incur a 50% penalty on the seminar mark obtained. An additional 5% will be assigned for active participation in the Q&A sessions, as measured through discussion board contributions. Seminars will be held on a weekly basis with ~4 talks during one session. Dates will be assigned in the first week of the semester, with seminars commencing in week **3**.
Mid-Content quizzes	25%	Two multiple-choice questions and/or extended multiple-choice questions and/or short-answer questions. The contents of lectures in weeks **1-5** are examinable. Dates: **12 Aug 18:00 & 26 Aug 18:00**.
Oral presentation of project pitch Written funding proposal	10% 40%	In groups of ~3 students you will develop an independent idea for a funding proposal in the area of synthetic biology (max. 3000 words). The proposal will describe the

		background of a topical problem and identify a current gap in knowledge and/or a new practical application. An oral group presentation (10%) of the project idea (pitch) is due 4 weeks after the beginning of the project work (**27 Sep**). The funding proposal (40%) will formulate the background and 2-3 research aims to address the problem, lay out the design of a multi-gene construct to solve the problem and experimental plans to test the construct(s) in the laboratory. In a last part the proposal will describe the expected outcomes and the impact these outcomes will have for the wider public. Due date: **28 Oct**

Assessment details

A signed and dated Faculty of Science Assignment Coversheet must accompany all submitted assignments. Assignments without a coversheet will not be accepted or marked. Read and note the definitions of academic misconduct on the Coversheet. See the notes on ethical scholarship, academic literacy and academic misconduct below.

Copies of the coversheet can be downloaded from the SCIE5508 LMS site.

Satisfactory performance in both the practical and theory components of the unit is required to pass the unit. Completion of the practical requirements (attendance and all assessment tasks) is compulsory. Attendance and participation in all debate sessions are compulsory.

Penalty for late assignments and absences

If you have a clash for any assessment task, including a practical session, let the unit coordinator know before the due date, and alternative arrangements will be considered. In the event that a request is not made before the due date or that an extension to the due date is not granted, a penalty of a reduction of 5 percentage points each day the assignment is late will apply. For the purposes of calculating penalties, Saturdays and Sundays will be counted as one day each.

To avoid a mark penalty, if an assessment task is missed due to illness or another unforeseeable cause, special consideration will need to be granted by the Science Student Office (SSO). Applications for special consideration are submitted through askUWA or in person at the SSO, located in the Agriculture Central Building. For details go to: http://www.student.uwa.edu.au/course/exams/consideration

In the event that special consideration is not granted, the UWA policy on late assignments will be followed. Please see: http://www.governance.uwa.edu.au/procedures/policies/policies-and-procedures?method=document&id=UP15/5

Test requirements

No special requirements

Ethical scholarship, academic literacy and academic misconduct

Ethical scholarship is the pursuit of scholarly enquiry marked by honesty and integrity.
Academic literacy is the capacity to undertake study and research, and to communicate findings and knowledge, in a manner appropriate to the particular disciplinary conventions and scholarly standards expected at university level.
Academic misconduct is any activity or practice engaged in by a student that breaches explicit guidelines relating to the production of work for assessment, in a manner that compromises or defeats the purpose of that assessment. **Students must not engage in academic misconduct**. Any such activity undermines an ethos of ethical scholarship. Academic misconduct includes, but is not limited to cheating, or attempting to cheat, through:

- Collusion
- Inappropriate collaboration
- Plagiarism
- Misrepresenting or fabricating data or results or other assessable work
- Inappropriate electronic data sourcing/collection
- Breaching rules specified for the conduct of examinations in a way that may compromise or defeat the purposes of assessment.

Penalties for academic misconduct vary according to seriousness of the case, and may include the requirement to do further work or repeat work; deduction of marks; the award of zero marks for the assessment; failure of one or more units; suspension from a course of study; exclusion from the University, non-conferral of a degree, diploma or other award to which the student would otherwise have been entitled.
Refer to the Ethical Scholarship, Academic Literacy and Academic Misconduct policy.

STUDENT RESPONSIBILITIES AND SERVICES

Appeals against academic assessment

If students feel they have been unfairly assessed, they have the right to appeal their mark by submitting an Appeal Against Academic Assessment form to the Head of School and Faculty Office. It is recommended that students contact the Guild Education Officers to aid them in the appeals process. They can be contacted on +61 8 6488 2295 or mailto:assist@guild.uwa.edu.au. Full regulations governing appeals procedures are available from Academic Policy Services, available online at http://www.aps.uwa.edu.au/home/policies/appeals

Charter of student rights and responsibilities

This Charter of Student Rights and Responsibilities upholds the fundamental rights of students who undertake their education at the University of Western Australia.

It recognises that excellence in teaching and learning requires students to be active participants in their educational experience. It upholds the ethos that in addition to the University's role of awarding formal academic qualifications to students, the University must strive to instil in all students independent scholarly learning, critical judgement, academic integrity and ethical sensitivity.

Please refer to the website the full charter of student rights and responsibilities, located at UWA Charter of Student Rights and Responsibilities (UP07/132)

Student Guild and Service contact details

The University of Western Australia Student Guild
35 Stirling Highway
Crawley WA 6009
Phone: (+61 8) 6488 2295
Facsimile: (+61 8) 6488 1041
E-mail: hello@guild.uwa.edu.au
Website: Student Guild

The University of Western Australia Student Services
Student Services

Student study services and support

STUDYSmarter

UniAccess

UWA Library

Student feedback

In the course of the unit you will be asked to complete Students' Unit Reflective Feedback (SURF) and possibly also Student Perceptions of Teaching (SPOT) questionnaires. The feedback you provide in the SURF is used by the unit coordinator to modify future delivery and content of the unit, ensuring high quality teaching and learning practices at UWA. Your responses on SPOT questionnaires are used by the lecturing and demonstrating staff to develop their individual teaching approaches, unit content and student engagement methods. It may also be used to support excellence in teaching and promotion applications.

We value your feedback!

UNIT RESOURCES

Learning Management System (LMS)

- www.lms.uwa.edu.au
- Lecture capture system – accessed through the unit's LMS site

For assistance with the LMS, do not contact the unit coordinator. On the LMS site, select the "LMS Help: STUDENTS" link at www.lms.uwa.edu.au or contact SISO at support@student.uwa.edu.au or 6488 3814 or in person at the Reid Library and the Science Library

Or, browse answers online anytime or ask a question through askUWA available at: http://ipoint.uwa.edu.au

We strongly recommend that you attend all lectures in the unit and use the lecture capture system as a backup and revision resource. We cannot guarantee that all lectures will be captured as the system does fail from time to time.

Textbooks and resources

Recommended/Required text(s)

No one text covers the topics addressed in this unit. Lecturers will suggest reading lists for each of their lecture topics.

Referencing style

Follow the referencing style of the journal *Genetics*. For examples of how to make in-text citations and cited literature lists, go to : https://www.genetics.org/content/prep-manuscript - references

UNIT SCHEDULE

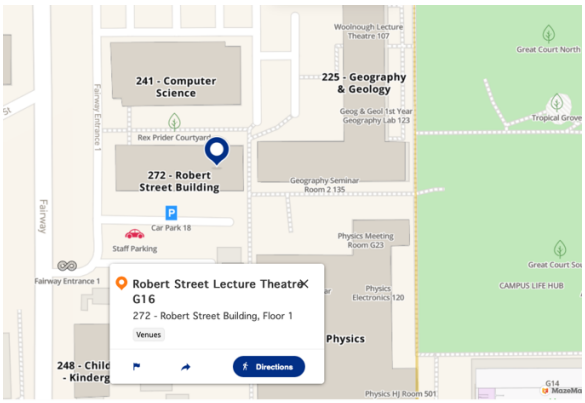
Lectures: Pre-recorded lectures will be available via the LMS Site each Monday before 9:00 in the scheduled week

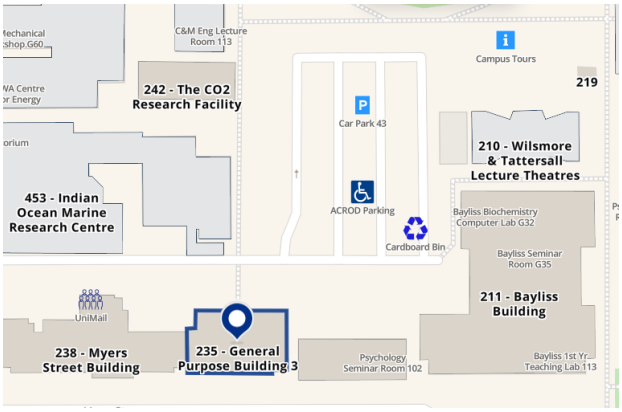
Q & A sessions: Wednesdays, 17:00-18:00, MS Teams (online), weeks **1 - 4**

Workshops: Thursday, 15:00–18:00, RBST: [G16] Robert Street LT, weeks **2 – 5**

Seminar: Friday, 16:00–18:00, GPB3: [G01] Simmonds Lecture Theatre, weeks **2–6**

Project meetings: Flexible times (3h), flexible venue, weeks **6 - 11**





Semester week number	Lecture (pre-recorded) Q&A sessions on demand	Lecturer	Workshop	Seminar / Tutorial	Reading
1	1) Introduction to the unit 2) Foundational concepts of Synthetic Biology	GF		**(selection of seminar topics)**	See Lecture Notes / LMS Site
2	3) Designing genetic circuits I 4) Designing genetic circuits II	GF	Workshop: *In silico* cloning of synthetic timer circuits using Golden-Gate assembly (GF)	Tutorial: Developing a SynBio project (GF)	See Lecture Notes / LMS Site
3	5) Rewiring microbial metabolism I 6) Rewiring microbial metabolism II	Y-HC	Workshop: Building and analysing synthetic metabolic pathways (Y-HC)	Seminar: Recent advances in microbial synthetic circuit design (GF)	See Lecture Notes / LMS Site
4	7) Designer plants I 8) Designer plants II **Quiz #1 (online, covering lectures 1-6)**	FKG	Workshop: Designing synthetic PPR proteins (FKG)	Seminar: Recent advances in metabolic engineering (Y-HC)	See Lecture Notes / LMS Site

5	9) Engineering of mammalian cells I 10) Engineering of mammalian cells II	RL	Workshop: Epigenome editing with a CRISPR/dCas9 system (RL)	Seminar: Recent advances in plant synthetic biology (FKG)	See Lecture Notes / LMS Site
6	**Quiz #2 (online, content: lectures 7-10)**		Project meeting with lecturers (Design phase: discuss project ideas)	Seminar: Recent advances in mammalian synthetic biology (RL)	See Lecture Notes / LMS Site
	TEACHING BREAK				
7			Project meeting with lecturers (Design phase: select project)		See Lecture Notes / LMS Site
8			Project meeting with lecturers (Build phase)		See Lecture Notes / LMS Site
9			Project meeting with lecturers (Test & Learn phase)	**Oral project pitch (group presentation)**	See Lecture Notes / LMS Site
10			Writing		See Lecture Notes / LMS Site
11			Project meeting with lecturers (Review)		See Lecture Notes / LMS Site
12			Writing	**Submission deadline for funding proposal**	See Lecture Notes / LMS Site
	TEACHING BREAK				

GF = Georg Fritz; Y-HC = Yit-Heng Chooi; FKG = Farley Kwok van der Giezen; RL = Ryan Lister

Funding proposal guidelines

- Pre-assigned groups of ~3-4 students
- Supervision (lecturers/postdocs):
    - Face-to-face meeting (1h/week) of student groups with supervisor
    - On-demand feedback via online mentoring (e.g. MS Teams)
    - Student group meetings (~1h/week) to develop project & prepare discussion with supervisor
    - Self-study time (3h/week) to develop project & prepare discussion with supervisor
- Challenge: Propose a Synthetic Biology project in which you use a *multi-gene construct* (e.g. sensory & regulatory circuit, metabolic pathway, etc.) to address a topical problem (e.g. environmental, agricultural, biotechnological, medical, etc.)
    - **Design phase** (weeks 7): Brainstorm on potential projects problems & identify a current gap in knowledge and/or a new practical application; Formulate how this project will (positively) impact the broader society
    - **Build phase** (week 8): Develop a detailed plan to build the genetic construct using existing and/or new genetic parts
    - **Test & Learn phase** (week 9): Develop a plan to test the function of your genetic constructs experimentally, including the measurement techniques and controls needed; Predict the expected experimental outcomes
    - **Oral pitch** (week 9): Give a 5 min project pitch (group presentation) & gain feedback from your peers
    - **Writing** (weeks 10-12): Write project proposal draft
    - **Review** (week 11): Get feedback on your draft from your supervisor
    - **Wrap up** (week 12): Finalise your project proposal (max. 3000 words)

How to prepare the proposal

Independent of the number of team members in your project group, you should divide the workload evenly between students, ending up with an average of 800 - 1,000 words (min/max) to be written by each student. For each student this contribution will make up **40% of the total mark** in the unit. In your written presentation you should use illustrations/figures to display your concepts and ideas. As a rule of thumb, consider approximately 1 figure per section. In addition to graphical illustrations of your designs, please submit your plasmid sequences in GenBank (*.gb) or Geneious (*.geneious) file format. All sequences need to be annotated with meaningful descriptors (promoters, RBS, gene names, terminators and all other relevant features, such as e.g. the plasmid origin of replication, the methylation site or any kind of mutations introduced). If you have questions regarding your specific design, please consult your supervisor whether your sequences + annotations are appropriate. **Please start preparation of your proposal and your sequence designs as soon as possible, and please understand that it is your responsibility to ask for feedback from your supervisors with reasonable lead time (1-2 business days).**

Project teams composed of 4 students (default team size):

- **Background & aims** (800-1,000 words min/max; written by student 1; 30% of total mark for student 1) – Explain the problem you want to solve, give a brief background on how you want to do this and formulate 1-2 aims that you will address in your proposal

- **Design** (800-1,000 words min/max; written by student 2; 30% of total mark for student 2) – Provide a detailed description of your genetic design, using e.g. SBOL visual for a graphical representation; explain the anticipated function of this design and how it will address your aims
- **Build** (800-1,000 words min/max; written by student 3; 30% of total mark for student 3) – Provide a detailed description of the experimental (genetic) implementation, including the biological parts you will use and how you will build up your genetic constructs; Provide plasmid maps (or alike) for your final genetic constructs
- **Test & Learn** (800-1,000 words min/max; written by student 4; 30% of total mark for student 4) – Describe your plan to test the function of your genetic constructs experimentally, including the measurement techniques and controls needed; Predict the expected experimental outcomes; Prepare schematic illustrations on how the expected data will look like; Conclude by discussing how these results will show that you can solve the overall problem
- **Genetic construct** (prepared by all students; 10% of total mark for each student) – Submit your fully annotated plasmid sequences in Geneious format to your project supervisor, together with a brief statement explaining the contribution of each team member to the assembled plasmid (who researched & obtained the sequences for the individual parts, who designed the primers, who did the assembly, etc).

Project teams composed of 3 students:

- **Background & aims** (written by all students; 600-800 words min/max; group-mark; 5% of total mark for each student) – Explain the problem you want to solve, give a brief background on how you want to do this and formulate 1-2 aims that you will address in your proposal
- **Design** (600-800 words min/max; written by student 1; 25% of total mark for student 1) – Provide a detailed description of your genetic design, using e.g. SBOL visual for a graphical representation; explain the anticipated function of this design and how it will address your aims
- **Build** (600-800 words min/max; written by student 2; 25% of total mark for student 2) – Provide a detailed description of the experimental (genetic) implementation, including the biological parts you will use and how you will build up your genetic constructs; Provide plasmid maps (or alike) for your final genetic constructs
- **Test & Learn** (600-800 words min/max; written by student 3; 25% of total mark for student 3) – Describe your plan to test the function of your genetic constructs experimentally, including the measurement techniques and controls needed; Predict the expected experimental outcomes; Prepare schematic illustrations on how the expected data will look like; Conclude by discussing how these results will show that you can solve the overall problem
- **Genetic construct** (prepared by all students; 10% of total mark for each student) – Submit your fully annotated plasmid sequences in Geneious format to your project supervisor, together with a brief statement explaining the contribution of each team member to the assembled plasmid (who researched & obtained the sequences for the individual parts, who designed the primers, who did the assembly, etc).

Seminar

Select one paper from a pre-defined list of Synthetic Biology papers (available on LMS) and give a seminar talk on the topic (10-12min talk + 10 min discussion).