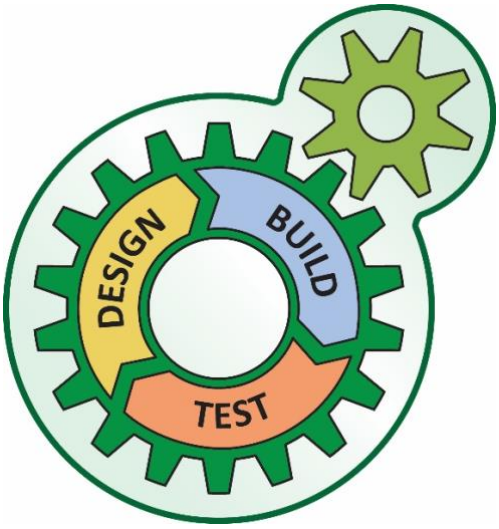
UNSW AUSTRALIA
Science

SCHOOL OF BIOTECHNOLOGY AND BIOMOLECULAR SCIENCES

BABS3200: SYNTHETIC BIOLOGY



COURSE NOTES

TERM 2, 2019

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Course Identity	
Course Code	BABS3200
Course Name	Synthetic Biology
Academic Unit	School of Biotechnology and Biomolecular Sciences
Level of Course	Third-year undergraduate
Units of Credit	6
Term Offered	Term 2
Assumed Knowledge or Prerequisites	Stage 2 molecular biology, biochemistry, or genetics
Hours per week	6 hours per week
Number of Weeks	10 weeks
Commencement Date	Week 1, Term 2, 2019

Staff		
Role	Staff Contact	Contact Details
Course Coordinators	Dr Dominic Glover Dr Matthew Baker	d.glover@unsw.edu.au Tel: 9385 3382 matthew.baker@unsw.edu.au Tel: 9385 1255
Course Administration	Biosciences Student Office Room G06, Biosciences Building North (D26)	BABStudent@unsw.edu.au Tel: 9385 8047
Lecturer	Prof. Paul Curmi	p.curmi@unsw.edu.au
Lecturer	Prof. Peter White	p.white@unsw.edu.au
Lecturer	A/Prof. Chris Marquis	c.marquis@unsw.edu.au
Lecturer	A/Prof. Matthew Kearnes	m.kearnes@unsw.edu.au
Teaching lab technical support	Dr Elessa Marendy	e.marendy@unsw.edu.au

Course Outline	
Course Description	Synthetic biology is the design and construction of novel biological systems or the redesign of existing biological systems. A fundamental aim of synthetic biology is to make biology easier to engineer through the application of engineering principles and standardisation of biological components. Central to this engineering is the deconstruction of biological systems into components (e.g. DNA, enzymes, genetic circuits, metabolic pathways, etc.) that can be uncoupled from each other, abstracted into predictable forms, characterised, and reassembled into novel functional systems to solve specific problems. This course will give students insight into the assembly and design of interchangeable biological parts that form the basis of synthetic biology. Students will learn the methods for standardised assembly of DNA and genes into functioning devices, including biological circuits, DNA/RNA/protein nanostructures, and engineered organisms. An emphasis is placed on using tutorial and computer labs to apply engineering principles for the design of a biological system, followed by wet labs to build and evaluate the biological function of the assemblages. This design - build - test paradigm reinforces an understanding of how biological systems are not static processes to be memorised, but rather, dynamic systems which can be manipulated and built from the ground-up.
Course Aims	The course aims to introduce students to the concept of building biological systems from standardised biological building blocks. Building on second year molecular biology concepts, the course aims to teach students that biological systems can be deconstructed into individual components that can be characterised and assembled into functional devices. The course also aims to introduce students to contemporary research in synthetic biology, including the generation of biofuels, bionanotechnology, microbial synthesis of pharmaceuticals, and the design of biosensors for biomedical or environmental applications.
Learning Outcomes	Upon completion of the course you should: 1. Gain an understanding of how engineering principles and standardisation can be applied for the fabrication of biological systems. 2. Understand the DNA/RNA/protein hierarchy of synthetic biology and the Design - Build - Test paradigm employed in synthetic biology. 3. Display knowledge of how DNA components can be edited and assembled to create novel biological functions, including gene circuits, nucleic acid and protein nanostructures, and enzymatic capabilities of whole organisms. 4. Gain an appreciation of the ethical and social impact of contemporary synthetic biology, including applications in genome construction and human genome editing.

Teaching Strategies	Lectures aim to develop a cohesive understanding of the underlying molecular biology principles in synthetic biology with students subsequently using computer-based learning to directly design biological systems. Wet laboratory classes will further build upon this knowledge by students constructing and evaluating biological assemblies. For example, to gain an understanding and appreciation of gene regulation, students would engineer DNA circuits for sensing of cellular stimuli.
Rationale for Teaching Strategies	The rationale for the teaching methods used in this course is to integrate theoretical background, design principles, and practical application in the context of synthetic biology. Emphasis is placed on using computer labs to apply engineering principles for the design of a biological system, followed by wet labs to build and test the design. This *design - build - test* paradigm reinforces an understanding of how biological systems are dynamic systems that can be manipulated and built from the ground-up.

Additional Resources and Support	
Text Books	There is no set text book for this course. Lecturers will instead refer you to relevant online resources where necessary. These will be made available on the course Moodle site. In addition, the UNSW Library has book and journal resources that cover the field of synthetic biology.
Laboratory Manual	The course laboratory manual will be made available online in week 1. The manual will also be available in Moodle.
Internet Site	Students enrolled in the course have access to the BABS3200 Moodle website and are required to access this regularly. Announcements will be made through Moodle email system. Assessments, practical notes and links to online tutorial material will be provided on Moodle.
Equipment Required	A lab coat or gown, safety glasses and closed shoes must be worn in the laboratory.
Self-management resources	There are study areas where students can study or relax on the ground floor and first floor of the Biological Sciences Building, E26.

BABS3200 Lecture Program				
Week	**Day**	**Date**	**Theme**	**Lecturer**
1	Mon	3rd June	1. Introduction	Dr Dominic Glover
	Tue	4th June	2. DNA and gene assembly	Dr Dominic Glover
	Wed	5th June	3. Building synthetic genomes	Dr Dominic Glover
2	Mon	10th June	*Queen's Birthday holiday*	
	Tue	11th June	4. Genome editing and engineering	Dr Dominic Glover
	Wed	12th June	5. Synthetic bio-circuitry: Transcriptional	Dr Dominic Glover
3	Mon	17th June	6. Synthetic bio-circuitry: Translational	Dr Dominic Glover
	Tue	18th June	7. Synthetic bio-circuitry: Post-translational	Dr Dominic Glover
	Wed	19th June	8. Building synthetic metabolic pathways	Dr Dominic Glover
4	Mon	24th June	9. Cellular engineering of yeast	A/Prof. Chris Marquis
	Tue	25th June	10. Automation in synthetic biology	Dr Dominic Glover
	Wed	26th June	11. *No lecture (mid-term exam revision)*	Dr Dominic Glover
5	Mon	1st July	*MID-SESSION EXAM*	Dr Dominic Glover
	Tue	2nd July	12. DNA nanostructures	Dr Matt Baker
	Wed	3rd July	13. DNA nanotechnology	Dr Matt Baker
6	Mon	8th July	14. Conjugation chemistry: connecting DNA and proteins	Dr Matt Baker
	Tue	9th July	15. Evolutionary methods in synthetic biology	Dr Matt Baker
	Wed	10th July	16. Protein nanotechnology I	Dr Dominic Glover
7	Mon	15th July	17. Protein nanotechnology II	Dr Dominic Glover
	Tue	16th July	18. Modular approaches to synthetic proteins	Prof. Paul Curmi
	Wed	17th July	19. Construction of a synthetic protein motor	Prof. Paul Curmi
8	Mon	22nd July	20. Engineering of antibody therapeutics	Dr Tara Christie
	Tue	23rd July	21. Synthetic and resurrected viruses for biocontrol of cane toads and other pests	Prof. Peter White
	Wed	24th July	22. Cryo-electron microscopy imaging of bio-nanostructures	Dr Juanfang Ruan
9	Mon	29th July	23. Enhancing plants through synthetic design	Dr Briardo Llorente
	Tue	30th July	24. Synthetic biology and society	A/Prof. Matt Kearns
	Wed	31st July	25. *No lecture (final exam revision)*	Dr Dominic Glover

Location and times:

Mon 09:00 - 10:00 Pioneer International Theatre (K-G27-G04)
Tue 10:00 - 11:00 Pioneer International Theatre (K-G27-G04)
Wed 11:00 - 12:00 Pioneer International Theatre (K-G27-G04)

BABS3200 Laboratory and Tutorial Program			
Week	**Date**	**Theme**	**Lecturer**
1	6th June	Cellular biosensors and gene circuits	Dr Dominic Glover
2	13th June	Cellular biosensors and gene circuits	Dr Dominic Glover
3	20th June	Cellular biosensors and gene circuits	Dr Dominic Glover
4	28th June	Biosensor evaluation / Tutorial for group exercise	Dr Dominic Glover
5	4th July	DNA nanotechnology	Dr Matt Baker
6	11th July	DNA nanotechnology	Dr Matt Baker
7	18th July	DNA nanotechnology	Dr Matt Baker
8	25th July	Tutorial for group exercise	Dr Dominic Glover
9	1st Aug	Tutorial for group exercise	Dr Dominic Glover
10	8th Aug	Group design project presentations	Dr Dominic Glover

Lab coat, safety glasses, and covered shoes must be worn in all laboratory classes.

Labs / Tutorials are held on Thursday 10 am – 1 pm
Laboratory classes in week 1-7 are in E26, Lab 11 (K-E26-1101)
Tutorials in week 8-10 are in Electrical Engineering G10 (K-G17-G10)

Assessment Tasks and Feedback			
Assessment type	**Description**	**Mark**	**Due date**
Mid-term exam	50-minute written exam on material covered in lectures and practicals.	25%	Week 5
Lab reports	Two lab reports detailing the design, building, and testing of cellular biosensors and DNA nanostructures.	30%	Week 6/9
Design project	Students will work in small groups to design a synthetic biology innovation or invention. Assessment will involve preparing a short report detailing the device and how it functions. Students will describe their invention in a 10-15 min group presentation, including questions from the audience.	20%	Week 10
Final theory exam	Examines material covered in all lectures and lab practicals for entire session.	25%	TBA

Administration Matters	
Expectations of Students	A pass in BABS3200 is conditional upon a satisfactory performance in the practical program. A satisfactory performance means that you have: • Attended the practical classes (an attendance record is kept). • Satisfactorily submitted all assigned work. • Ability to work independently and in a team environment.
Assignment Submissions	Requirements vary with each assigned task. Your lecturer will advise accordingly.
Occupational Health and Safety	Information on relevant Occupational Health and Safety policies and expectations at UNSW: http://www.hr.unsw.edu.au/ohswc/ohswc_home
Assessment Procedures	SPECIAL CONSIDERATION Students who believe that their performance, either during the session or in the end of session exams, may have been affected by illness or other circumstances may apply for special consideration. Applications can be made for compulsory class absences such as (laboratories and tutorials), in-session assessments tasks, and final examinations. You must submit the application prior to the start of the relevant exam, or before a piece of assessment is due, except where illness or misadventure prevent you from doing so. If you become unwell on the day of the exam or fall sick during an exam, you must provide evidence dated within 24 hours of the exam, with your application. You must obtain and attach Third Party documentation before submitting the application. Failure to do so may result in the application being rejected. UNSW has a fit to sit/submit rule which means that if you sit an exam or submit a piece of assessment, you are declaring yourself fit to do so. Further information on special consideration can be found at https://student.unsw.edu.au/specialconsideration. **HOW TO APPLY FOR SPECIAL CONSIDERATION** **The application must be made through Online Services in myUNSW (My Student Profile tab > My Student Services > Online Services > Special Consideration).** **Students will be contacted via *their official university email* as to the outcome of their application. It is the responsibility of all students to regularly consult their official student email accounts and myUNSW in order to ascertain whether or not they have been granted further assessment.** **Students will be contacted via the online special consideration system as to the outcome of their application. Students will be notified via their official university email once an outcome has been recorded**.

	SUPPLEMENTARY EXAMINATIONS The University does not give deferred examinations. However, further assessment exams may be given to those students who were absent from the final exams through illness or misadventure. Special Consideration applications for final examinations and in-session tests will only be considered after the final examination period when lists of students sitting supplementary exams/tests for each course are determined at School Assessment Review Group Meetings. Students will be notified via the online special consideration system as to the outcome of their application. It is the responsibility of all students to regularly consult their official student email accounts and myUNSW in order to ascertain whether or not they have been granted further assessment.
Equity and Diversity	Those students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course Convenor prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equity and Diversity Unit (9385 4734) or http://www.studentequity.unsw.edu.au/ http://www.equity.unsw.edu.au/disabil.html). Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made. Information on designing courses and course outlines that take into account the needs of students with disabilities can be found at: www.secretariat.unsw.edu.au/acboardcom/minutes/coe/disabilityguidelines.pdf

Grievance Policy	School Contact	Faculty Contact	University Contact
	Biosciences Student Office, Room G06, Biosciences Building (D26) babstudent@unsw.edu.au	Dr Gavin Edwards g.edwards@unsw.edu.au Tel: 9385 4652	University Counselling Tel: 9385 5418

Academic honesty and plagiarism

Plagiarism is the presentation of the thoughts or work of another as one's own.
Examples include:

- Direct duplication of the thoughts or work of another, including by copying work, or knowingly permitting it to be copied. This includes copying material, ideas or concepts from

a book, article, report or other written document (whether published or unpublished), composition, artwork, design, drawing, circuitry, computer program or software, web site, Internet, other electronic resource, or another person's assignment without appropriate acknowledgement.

- Paraphrasing another person's work with very minor changes keeping the meaning, form and/or progression of ideas of the original.
- Piecing together sections of the work of others into a new whole.
- Presenting an assessment item as independent work when it has been produced in whole or part in collusion with other people, for example, another student or a tutor.
- Claiming credit for a proportion a work contributed to a group assessment item that is greater than that actually contributed.
- Submitting an assessment item that has already been submitted for academic credit elsewhere may also be considered plagiarism.
- The inclusion of the thoughts or work of another with attribution appropriate to the academic discipline does not amount to plagiarism.

Students are reminded of their Rights and Responsibilities in respect of plagiarism, as set out in the University Undergraduate and Postgraduate Handbooks, and are encouraged to seek advice from academic staff whenever necessary to ensure they avoid plagiarism in all its forms. The Learning Centre website is the central University online resource for staff and student information on plagiarism and academic honesty. It can be located at: www.lc.unsw.edu.au/plagiarism

The Learning Centre also provides substantial educational written materials, workshops, and tutorials to aid students, for example, in:

- Correct referencing practices.
- Paraphrasing, summarising, essay writing, and time management.
- Appropriate use of, and attribution for, a range of materials including text, images, formulae and concepts.

Students are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting, and the proper referencing of sources in preparing all assessment items.

Group Project

Design of a synthetic biology device or innovation

iGEM is a worldwide synthetic biology competition to build genetically engineered systems using standard biological parts.

In this group project, we will run a "mini-iGEM" to design unique genetically engineered systems that aim to address and solve a real-world problem.

Your team will design a synthetic biology device or innovation and describe:

- What it does
- The problem it solves or applications of the innovation
- How it works
- How it would be built

The final submission will be in the form of a written report and a group presentation.

For inspiration, explore previous iGEM team entries (http://igem.org/Main_Page). One initial approach is to think about significant challenges in the world (e.g. environmental plastic pollution) and brainstorm how synthetic biology could potentially solve the problem (e.g. engineering of microbes to digest plastic).