

COURSE OUTLINE

Course Title	Research Experience		
Course Code	BS9001		
Offered	Study Year 2, Sem 2, after exams Study Year 3, Sem 2, after exams		
Course Coordinator	Curtis Alexander Davey (Assoc Prof)	Davey @ntu.edu.sg	6592 1549
Pre-requisites	None		
No of AUs	3		
Contact hours	Laboratories: 180		
Last revised	1 Mar 2018, 08:53		

Course Aims

This pass/fail course aims to give undergraduate students experience in laboratory-based scientific research. You work full time for 6 weeks under the supervision of a participating School of Biological Sciences / Lee Kong Chian School of Medicine / Duke-NUS faculty member. You will design, plan, prepare and perform experiments before analyzing and interpreting results, thus gaining experience in the scientific research process.

Note the 6 weeks of research takes place anytime between Semester 2 and Semester 1 (May-August). In the first half of March, students are invited to meet with participating faculty to find a potential match for a project. The choice of lab and timing are per mutual agreement between student and supervisor, at which point the student may apply for the module.

Intended Learning Outcomes

Upon successfully completing this course, you should be able to:

1. Identify important biological research issues
2. Develop a research hypothesis which explains or addresses biological problems or issues
3. Formulate a research plan
4. Conduct the planned experiment
5. Demonstrate adaptability and analytical skills based on detailed observation
6. Record observations and experimental outcomes
7. Analyse and interpret experimental results using e.g. Excel, PyMOL
8. Make a presentation of results using visual media
9. Analyze critically and interpret experimental results in discussions with supervisors or peers

Course Content

Background on specific biological concepts, depending on research topic

The process of scientific experimentation

Assessment

Component	Course ILOs tested	SBS Graduate Attributes tested	Weighting	Team / Individual	Assessment Rubrics
Continuous Assessment					
Laboratories					
Presentation	1, 2, 5, 7, 8, 9	1. a 2. a, b, c, e, h 3. b, e 5. a, b, c, d, e 6. c 7. a, b	15	individual	See Appendix for rubric
Essay	1, 2, 5, 6, 7	1. a 2. a, b, c, e, g, h 3. b, e 4. a, c 5. a, b, c, d, e 6. c, d 7. a, b	15	individual	See Appendix for rubric
Research Competency	1, 2, 3, 4, 5, 7, 9	1. a 2. a, b, d, e, g, h 4. a, c 5. a, b, c, d, e 6. d 7. a, b	40	individual	See Appendix for rubric
Log Book	3, 5, 6, 7	2. a, b, c, e, g, h 3. b 4. c 5. a, c, d, e 6. c, d 7. a	30	individual	See Appendix for rubric
Total			100%		

These are the relevant SBS intended learning outcomes.

1. Recognize the relationship and complexity between structure and function of all forms of life, resulting from an academically rigorous in-depth understanding of biological concepts

- a. Possess a conceptual framework that identifies the relationships between the major domains in the field of biology.

2. Critically evaluate and analyze biological information by applying the knowledge, scientific methods and technical skills associated with the discipline

- a. Identify the assumptions behind scientific problems and issues
- b. Create and evaluate hypotheses
- c. Create abstract models of data
- d. Design experiments relevant to authentic problems and their models
- e. Analyze the validity of qualitative and quantitative scientific data
- g. Evaluate the results of their own experiments and decide on the next step
- h. Identify unintended results as opportunities for discovery

3. Develop and communicate biological ideas and concepts relevant in everyday life for the benefit of society

- b. Display and explain scientific results clearly and persuasively to peers both verbally and in writing (includes the ability to graph data appropriately and accurately).
- e. Discuss current critical questions in the field of biology

4. Acquire transferable and entrepreneurial skills for career development

- a. Demonstrate innovative approaches to solving problems in biological science, leading to new approaches or techniques
- c. Demonstrate a flair for conducting research

5. Develop communication, creative and critical thinking skills for life-long learning

- a. Learn independently and then share that knowledge with others
- b. Learn collaboratively and be willing to share expertise with peers
- c. Demonstrate critical thinking skills such as analysis, discrimination, logical reasoning, prediction and transforming knowledge
- d. Question the assumptions, sources, and contexts of scientific investigation
- e. Demonstrate good observation skills and a curiosity about the world

6. Develop codes of social responsibility and scientific ethics, particularly in relation to biological advancement and applications

- c. Respect regulations involving plagiarism and copyright
- d. Respect requirements regarding confidentiality, data protection, conflict of interest, and falsification of data

7. Demonstrate information literacy and technological fluency

- a. Locate and evaluate information needed to make decisions, solve problems, design experiments, and understand scientific data
- b. Work effectively with common technologies in biology

Formative Feedback

You will be part of a research team and will receive feedback on a continual basis from your supervisors (coaching, training, questioning, critique). This aspect of working as part of a team, together with one or more supervisors, impinge upon all 9 of the intended learning outcomes.

Learning and Teaching Approach

Laboratories (180 hours)	<p>Lab research: Learning how to plan, execute and interpret experiments [This helps you to achieve learning outcomes 1-5, 7, 9.]</p> <p>Logbook keeping: Experience with recording and analyzing data [This helps you to achieve learning outcomes 3, 5, 6, 7.]</p> <p>Lab presentation: Experience with preparing and presenting data, together with critical thinking and critique from peers [This helps you to achieve learning outcomes 1, 2, 5, 7, 8, 9.]</p> <p>Lab essay (short research report): Experience with scientific writing [This helps you to achieve learning outcomes 1, 2, 5, 6, 7]</p>
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Reading and References

You must meet with supervisors and discuss in detail the nature of their project prior to initiating lab research. You are expected to familiarize yourselves with scientific literature pertinent to your project, both at the beginning and through the course of your research experience. If anything regarding the nature of the project is unclear, you should ask the supervisor(s) for more information, including suggestions on helpful literature and web-based materials. At all times and in all circumstances, you are to maintain a vigilant attitude and respect towards regulations regarding plagiarism and copyright, for instance, as pertains to presentations and logbook keeping.

Course Policies and Student Responsibilities

(1) General

Your schedules can be flexible, but must be planned in full agreement with supervisors and must meet the minimum 6 week full time requirement for lab research conducted. You are expected to participate actively as part of the research team, including in particular deference towards ongoing research activities and general lab function. You are also expected to conduct any necessary preparations, including literature reading and research, to prepare yourselves appropriately for the research activities.

At all times and in all circumstances, you are to maintain ethical approaches in data collection, analysis and presentation, including strictly following regulations regarding plagiarism and copyright.

(2) Absenteeism

You must complete a minimum of 6 weeks of full time lab research. Any times where the student is absent must be compensated for to complete the minimum requirement.

(3) Compulsory Assignments

During the course of the Research Experience, you will be given tasks/experiments to complete by your supervisors that are specific to the particular research project in question. The diligence, enthusiasm and meticulousness with which these tasks/experiments are carried out will be reflected in your continual assessment marks from the supervisors. You are also required to give a presentation, write a short essay and to submit a daily-maintained logbook at the conclusion of your Research Experience, which coincide with the remaining marks component for the course.

Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the [Academic Integrity website](#) for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor

Office Location Phone

Email

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Planned Weekly Schedule

Week	Topic	Course ILO	Readings/ Activities
1	Background (reading, instruction) on specific biological concepts, depending on research topic. Initiating the process of scientific experimentation and logbook preparation	1, 2, 3, 4, 5, 9	Literature/protocol review (you may need to equip yourself with background knowledge prior to initiating the Research Experience; that is, before week one) Following required format, detailed elsewhere
2	Conducting experiments, logbook entries	6, 7	Including reference to any appropriate articles/citations
3	Conducting experiments, logbook entries	6, 7	Including reference to any appropriate articles/citations
4	Conducting experiments, logbook entries	6, 7	Including reference to any appropriate articles/citations
5	Conducting experiments, logbook entries	6, 7	Including reference to any appropriate articles/citations
6	Conducting experiments, logbook entries Presentation at conclusion of research experience Written lab essay (short research report) submitted at conclusion of research experience	6, 7, 8, 9	Including reference to any appropriate articles/citations Including literature review and appropriate citations in your presentation and written lab essay

Appendix 1: Assessment Rubrics

Rubric for Laboratories: Presentation (15%)

You need to give a 15 minute presentation (including Q&A) at the conclusion of the course.

Marks are awarded based on the following criteria.

1. Concepts, ideas and information presented clearly and appropriately.
2. Able to interpret/explain results.
3. Able to plan/discuss future work and answer questions.

Marking guidelines for each of the 3 presentation criteria are as follows:

0-2 marks, performance is MUCH below expectations

-- most or all key elements lacking

3-4 marks, performance is below expectations

-- major elements lacking, with many points of critique

5-6 Marks, performance meets expectations

-- overall criteria met, but with several minor shortcomings

7-8 Marks, performance exceeds expectations

-- only few, very minor, elements lacking

9-10 Marks, performance FAR exceeds expectations

-- only a single, very minor, point of critique (9)

-- no points of critique and essentially no room for improvement (10)

Total marks will be scaled to 15%.

Rubric for Laboratories: Essay (15%)

A Lab Essay (short report on the research conducted) is to be written at the conclusion of the course.

-- Maximum of four pages of double spaced text

-- 4-page limit does not include references/citations for which there is no limit

- Begins with abstract (summary), with a maximum size of 150 words
- Abstract followed by 1 to 3 paragraphs each for Introduction, Methods, Results, Discussion
- Must include References section (unlimited space) after Discussion section

Marks are awarded based on the following criteria.

1. Correct format and general clarity of scientific writing
2. Informative abstract and introduction, descriptive and logical methods and results
3. Meaningful discussion of results and ample and accurate literature citations

Marking guidelines for each of the 3 lab report criteria:

0-2 marks, performance is much below expectations

- most or all key elements lacking

3-4 Marks, performance is below expectations

- major elements lacking, with many points of critique

5-6 Marks, performance meets expectations

- overall criteria met, but with several minor shortcomings

7-8 Marks, performance exceeds expectations

- only few, very minor, elements lacking

9-10 Marks, performance FAR exceeds expectations

- only a single, very minor, point of critique (9)
- no points of critique and essentially no room for improvement (10)

Total marks will be scaled to 15%.

Rubric for Laboratories: Research Competency (40%)

Marks are awarded based on the following criteria.

1. Able to follow instructions
2. Kept designated workspace, common areas and equipment clean and organized
3. Excellent addition to an existing group (able to function well as part of a research team)
4. Dedicated sufficient time to the project
5. Worked to the best of their ability
6. Excellent work attitude

7. Made appropriate preparations prior to starting experiments (planning, reading literature/protocols)
8. Able to work independently

Marking guidelines for each of the 8 research competence criteria:

0-2 Marks, performance is much below expectations

-- most or all key elements lacking

3-4 Marks, performance is below expectations

-- major elements lacking, with many points of critique

5-6 Marks, performance meets expectations

-- overall criteria met, but with several minor shortcomings

7-8 Marks, performance exceeds expectations

-- only few, very minor, elements lacking

9-10 Marks, performance FAR exceeds expectations

-- only a single, very minor, point of critique (9)

-- no points of critique and essentially no room for improvement (10)

Total marks will be scaled to 40%.

Rubric for Laboratories: Log Book (30%)

Marks are awarded based on the following criteria.

1. Correct format is used in all required sections (a. to f. below)
2. Data (figures and tables) are clear and figure legends well described
3. Aims of the experiments are stated clearly
4. Protocols are clearly written
5. Lab log book is clean and neat

Research activities are to be recorded daily (format as follows):

- a. Date and page number.
- b. Brief description of the aim of each experiment (one can refer back to previous experiment with page number on the log book if it is a repeated experiment).
- c. Protocol (one can refer back to previous experiment with page number on the log book if it is a repeated experiment).
- d. Results.

- e. Remarks (including any references or citations).
- f. Student and Supervisor Signature (Weekly).

The marking guidelines for each of the 5 Log Book criteria are as follows:

0-2 marks, performance is MUCH below expectations

-- most or all key elements lacking

3-4 marks, performance is below expectations

-- major elements lacking, with many points of critique

5-6 Marks, performance meets expectations

-- overall criteria met, but with several minor shortcomings

7-8 Marks, performance exceeds expectations

-- only few, very minor, elements lacking

9-10 Marks, performance FAR exceeds expectations

-- only a single, very minor, point of critique (9)

-- no points of critique and essentially no room for improvement (10)

Total marks will be scaled to 30%.

Appendix 2: Intended Affective Outcomes

As a result of this course, it is expected you will develop the following "big picture" attributes:

Willingness to work in a team and individually

Willingness to work independently

Respect for others' equipment and experimental processes

Ethical approach to data collection, analysis and presentation

Willingness to consider social and global implications of scientific research