LIFS 3110 Biotechnological Applications of Recombinant DNA Techniques

Course Outline for Fall 2023

Teaching Team

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Course Description

Credit Points: 3
Pre-requisite: LIFS 2040 and LIFS 2210

The course LIFS 3110 Biotechnological Applications of Recombinant DNA Techniques comprises six laboratory exercises. The goals of these exercises are three-fold: (1) to enhance students' comprehension of what they have learnt in lectures; (2) to demonstrate practical skills in the fields of Biotechnology and Molecular Biology; and (3) to prepare students for advanced laboratory studies.

Students will be given exposure to the following areas of molecular biology and recombinant DNA technology:

- Microbial culture and aseptic techniques
- Amplification of DNA by polymerase chain reaction
- DNA recovery from agarose gel
- Plasmid construction by Gibson Assembly
- Transformation of *E. coli*
- Plasmid DNA isolation
- Restriction endonuclease digestion
- Analysis of plasmid DNA by agarose gel electrophoresis
- Site-directed mutagenesis
- Quantitative analysis of recombinant proteins

Intended Learning Outcomes (ILOs)

Upon successful completion of this course, students should be able to:

1. Acquire a sound knowledge of recombinant DNA techniques, gene structure and expression.
2. Perform practical skills relating to Molecular Biology and bacterial culturing to yield recombinant DNA / protein.
3. Plan and execute recombinant DNA techniques in order to create desirable genetic modifications.
4. Work and coordinate effectively in a group to accomplish laboratory-based tasks.
5. Exhibit accuracy and independence in recording and reporting results.
6. Demonstrate analytical awareness via interpretation of experimental results.

Learning Activities

1. **Tutorial:** Theoretical concepts related to the experiments will be reviewed in detail. Analysis and interpretation of experimental results will also be explained.
2. **Laboratory briefing:** Basic theoretical and practical issues pertaining to each laboratory exercise will be emphasized before students start to perform the experiments.
3. **Practical demonstration:** Specific techniques in each laboratory exercise will be demonstrated in real-time or pre-recorded close-up videos. Students are expected to learn a core set of techniques that will be used repeatedly throughout the semester.
4. **Laboratory exercise:** Groups of three students will collaborate to perform the experiments. Workbench, routinely used labware and instruments will be assigned to and managed by each group.
5. **Bench supervision:** A teaching assistant (TA) will be assigned to each bench of students to provide assistance or instructions and ensure smooth experimental progress. The instructor and technicians will also provide support for the class.
6. **In-class discussion:** In certain exercises, students will have to discuss the results among their group before presenting their results to the instructor or TA. Additional discussion on data analysis may also be conducted among the whole class.

Course Schedule

Session	**Venue**	**Time**
Tutorial (T1)	LT-C	Monday, 14:00 – 14:50
Laboratory (LA1 or LA2)	Room 4160	Tuesday, 14:00 – 17:50, unless otherwise stated

Exercise 1. Amplification of DNA by polymerase chain reaction

Week 1: T1 – 4 Sep (Mon) LA1 – 5 Sep (Tue)

Week 2: T1 – 11 Sep (Mon) LA2 – 12 Sep (Tue)

Exercise 2. Plasmid construction by Gibson Assembly

Week 3: T1 – 18 Sep (Mon) LA1 – 19 Sep (Tue)

Week 4: T1 – 25 Sep (Mon) LA2 – 26 Sep (Tue)

Exercise 3. Transformation of *Escherichia coli* by plasmid DNA

Week 6: T1 – 9 Oct (Mon) LA1 – 10 Oct (Tue)

Week 7: T1 – 16 Oct (Mon) LA2 – 17 Oct (Tue)

Exercise 4. Plasmid miniprep and restriction analysis

Week 9: T1 – 30 Oct (Mon) LA1 – 31 Oct (Tue)

Week 10: T1 – 6 Nov (Mon) LA2 – 7 Nov (Tue)

Exercise 5. QuikChange site-directed mutagenesis

Week 11: T1 – 13 Nov (Mon) LA1 – 14 Nov (Tue) & 15 Nov (Wed) 10:30 – 11:20 *

Week 12: T1 – 20 Nov (Mon) LA2 – 21 Nov (Tue) & 22 Nov (Wed) 10:30 – 11:20 *

* Only 1 student per group will need to attend the follow-up session.

Exercise 6. Quantitative analysis of fluorescence emission by green fluorescent protein

Week 13: T1 – 27 Nov (Mon) LA1 – 28 Nov (Tue) 14:00 – 15:50

LA2 – 28 Nov (Tue) 16:00 – 17:50

Final Examination TBC

Assessment Scheme

Method of assessment	Percentage	ILOs* to be assessed
Pop quizzes	18%	(1) and (2)
Laboratory performance	12% (2% per exercise)	(1), (2), (3) and (4)
Worksheets	30% (5% per worksheet)	(1), (5) and (6)
Final examination	40%	(1), (3), (5) and (6)

*** Listed on Page ii**

Pop Quizzes:

Reading the laboratory manual beforehand and paying attention to lab briefing are good practices that are strongly encouraged. Pop quizzes will be conducted online during some of the exercises. These open-book quizzes will contain multiple-choice and short-answer questions, mainly assessing your understanding on experimental background and practical skills. To take the quiz, students should sit apart from each other, use your own device to enter Canvas Quizzes, then complete the quiz independently without communicating with others.

Laboratory Performance:

In each exercise, laboratory performance of students, including efficiency, discipline and safety awareness, will be evaluated individually and on a group basis. Full marks will be awarded if all the criteria below are satisfied:

- Motivation to accomplish the experimental tasks
- Proper execution of the experimental procedures
- Communication with groupmates and instructors
- Completion of experiments in a timely manner
- Tidiness of the bench after experiments

Marks will be DEDUCTED FROM THE OVERALL SCORE each time when you violated the following guidelines:

- Attend the laboratory sessions as scheduled. 3%
- Arrive on time and participate till the end of any sessions. 1%
- Come with proper clothing (i.e. long pants and fully enclosed shoes) and your lab coat to minimize potential injuries against spills. 1%
- Follow lab instructions and safety precautions carefully. 1%

Safety Precautions

Working in a laboratory may expose one to potentially dangerous tools and hazardous reagents. Therefore, students need to exercise discipline and caution to ensure the experiments are conducted under the best and safest conditions.

1. Wear lab coat at all times in the laboratory and wear gloves when handling bacterial cultures, hazardous chemicals/reagents, nucleic acids or proteins.
2. Tie up long loose hair securely to avoid contacting with chemicals, open flame and etc.
3. Read and understand the laboratory manual BEFORE coming to the laboratory. Do not perform any unauthorized experiments or improvise any procedures.
4. Do not operate any equipment until properly instructed. Seek advice if you are unsure about any procedures or the operation/handling of any equipment/apparatus.
5. Report to the instructor IMMEDIATELY for any accidents, such as cuts, burns, and spillage of culture or toxic reagents.
6. Clean the laboratory bench with 70% ethanol BEFORE and AFTER the experiment. Do not put any unnecessary personal items on the bench.
7. Do not eat, drink or put anything in your mouth when you are in the laboratory.
8. Handle Bunsen burners carefully, turn off the gas when not in use and NEVER leave the flame unattended.
9. Clearly label all tubes/samples with your group number and sample name BEFORE incubation/submission.
10. Wash your own apparatus and discard the wastes in designated locations (e.g. discard bacterial culture in container for biohazardous waste).
11. Do not take any equipment, consumables and reagents away from the laboratory.
12. Wash your hands thoroughly before leaving the laboratory.

Worksheets:

Each student is required to complete a worksheet after EACH of the SIX laboratory sessions. Questions in the worksheets cover underlying principles of experiments, data reporting, data interpretation and statistical analysis. Note that all submissions must be your own work written in YOUR OWN WORDS. Academic integrity and honesty are key values at HKUST, therefore, any CHEATING (e.g. making up data) or PLAGIARISM (e.g. copying from others/ course notes/ books/ internet) may be subjected to ZERO MARKS, FAIL in the course and other disciplinary actions. (Refer to http://ugadmin.ust.hk/ug-guide/integrity/dishonesty.html, https://libguides.ust.hk/referencing/plagiarism)

Each worksheet should include your Name, Student Number, Group Number, Date, Course Code and Number of Exercise. Students should indicate the question number (e.g. 1a, 2c) clearly right next to that your answers, and remove the sentence of questions to avoid getting a high percentage of similarity in Turnitin check. Completed worksheets should be submitted as PDF to the corresponding Canvas Assignment within 1 week, which means the submission will be due on the NEXT TUESDAY, unless otherwise specified.

Final Examination:

Students will be assessed individually in the final examination. Knowledge on concepts and principles of recombinant DNA technology, as well as the ability to analyze laboratory data will be evaluated.