

Course Syllabus
MBMB 631 CRISPR/Cas9 Genome Editing
Academic Year 2025

Course ID and Title: MBMB 631 CRISPR/Cas9 Gene Editing

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Instructors: 1. Asst. Prof Alisa Tubsuwan, Ph.D.
2. Asst. Prof Natee Jearawiriyapaisarn, Ph.D.

Support Staff: xxx

Credits: 1(0-2-1)

Curriculum: Master of Science Program in Molecular and Integrative Biosciences
(Elective course)
Doctor of Philosophy Program in Molecular and Integrative Biosciences
(Elective course)

Semester offering: First and second semesters

Pre-Requisites: None

Course Learning Outcome (CLOs):

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

1. Demonstrate scientific integrity, responsibility, and safety practices
2. Describe the molecular mechanisms underlying CRISPR/Cas9 genome editing
3. Efficiently design and select guide RNA (gRNA) and appropriate donor templates for gene knockout and gene knockin applications.
4. Employ techniques for delivering CRISPR components into human cells
5. Validate genome editing outcomes in engineered cells
6. Communicate scientific concepts effectively through discussions and presentations
7. Demonstrate professional and interpersonal skill

Alignment of Teaching and Assessment Methods to Course Learning Outcomes:

| Course Learning Outcomes | Teaching Method | Assessment Method |
|--|--|--|
| Demonstrate scientific integrity, responsibility, and safety practices | <ol style="list-style-type: none"> Laboratory and practical work Writing lab report | <ol style="list-style-type: none"> Regular attendance tracking Direct observation and evaluation of students during lab sessions. Submission lab report and tasks as per specified deadlines. Evaluation of lab reports for plagiarism and quality of content. |
| Describe the molecular mechanisms underlying CRISPR/Cas9 genome editing and workflow | <ol style="list-style-type: none"> Lecture: Case studies | <ol style="list-style-type: none"> Quiz |
| Efficiently design and select guide RNA (gRNA) and appropriate donor templates for gene knockout and gene knockin applications." | <ol style="list-style-type: none"> Lecture Interactive discussion Hands-on lab practice Group activity | <ol style="list-style-type: none"> Presentation 1 |
| Employ techniques for delivering CRISPR components into human cells | <ol style="list-style-type: none"> Lecture Laboratory demonstration Hand-on lab practice Case studies | <ol style="list-style-type: none"> Lab performance Written report |
| Validate genome editing in engineered cells | <ol style="list-style-type: none"> Lecture Laboratory demonstrations Hand-on lab practice | <ol style="list-style-type: none"> Lab performance Data analysis Written report Presentation 2 |
| Communicate scientific concepts effectively through discussions and presentations | <ol style="list-style-type: none"> Presentation Group discussion and peer feedback sessions | <ol style="list-style-type: none"> Presentation Lab performance Written report |
| Demonstrate professional and interpersonal skill | <ol style="list-style-type: none"> Hand on lab practice | <ol style="list-style-type: none"> Lab performance Written report Presentation 2 |

Course Description:

CRISPR/Cas9 Genome Editing; Guide RNA Design; Construction of Plasmid Expressing Guide RNA and Cas9; Delivery of CRISPR/Cas9 Components into Human Cells; Analysis of Gene Editing Outcomes by T7 Endonuclease I Assay; Sanger Sequencing and Computational Analysis

เทคโนโลยีตัดต่อยีนคริสเปอร์/คาส 9 การออกแบบไกด์อาร์เอ็นเอ การสร้างพลาสมิดสำหรับการแสดงออกของไกด์อาร์เอ็นเอ และโปรตีนคาส 9 การนำส่งส่วนประกอบของคริสเปอร์/คาส 9 เข้าสู่เซลล์การตรวจสอบการแก้ไขจีโนมด้วยการทดสอบด้วยเอ็นไซม์ T7 เอ็นโดนิวคลีเอส I และเทคนิคการวิเคราะห์หาลำดับนิวคลีโอไทด์ตามด้วยเครื่องมือทางคอมพิวเตอร์

Course Schedule:

(Classroom XXX and Lab Classroom XXX)

| Unit | Time | Topic | Instructors and Assistants |
|-------|-------------|--|----------------------------|
| Day1 | | | |
| | 13.00-14.00 | Lecture: Overview CRISPR/Cas9 genome engineering | AT, NJ |
| | 14.00-16.00 | Hand-on: Guide RNA and donor template design | AT, NJ |
| Day2 | | | |
| | 09.00-12.00 | Hand on: Construction of plasmid expressing guide RNA and Cas9 | AT, NJ |
| | 13.00-16.00 | Hand on: Construction of plasmid expressing guide RNA and Cas9 II | AT, NJ |
| Day3 | | | |
| | 09.00-12.00 | Hand on: Cell seeding | AT, NJ, CT |
| | 13.00-16.00 | Hand on: Construction of plasmid expressing guide RNA and Cas9 II | AT, NJ |
| Day4 | | | |
| | 09.00-12.00 | Hand on: Construction of plasmid expressing guide RNA and Cas9 IV | AT, NJ |
| | 13.00-16.00 | Transfection | AT, NJ |
| Day5 | | | |
| | 09.00-12.00 | Hand on: Knockout validation Genomic DNA Preparation, Genomic PCR gel analysis of insertions and deletion. | AT, NJ |
| | 13.00-16.00 | Hand on: Knockout validation Genomic DNA Preparation, Genomic PCR gel analysis of insertions and deletion. | AT, NJ |
| Day 6 | | | |

| Unit | Time | Topic | Instructors and Assistants |
|------|-------------|---|----------------------------|
| | 09.00-12.00 | Hand-on Genome editing validation method TIDE - rapid, powerful and easy analysis of CRISPR experiments | AT< NJ |
| | 13.00-16.00 | Lab discussion and presentation | All staff |

Assessment Criteria

| Assessment criteria | Rubric | Scoring rubric |
|------------------------------|---------------------------------|---|
| Class attendance (5%) | Attendance | 4: points full attendance or received approval for all necessary absences 3: points-1 unexcused absence 2: points-2 unexcused absences 1: points-more than 2 unexcused absences |
| | Punctuality | 4: Punctual 3: Less than 5 min late 2: Less than 15 min late 1: more than 15 min late |
| Quiz (10%) | Correctness and completion | Raw scores will be adjusted to be in a range of 0-10% |
| Laboratory performance (40%) | Safety practice | 4: Strict adherence to safety protocols, exemplary safety practices 3: Few safety violations, generally adheres to safety protocols 2: Some safety violations, limited adherence to safety protocols. 1: Frequent safety violations, disregard for safety protocols. |
| | Experimental protocol adherence | 4: Strict adherence to experimental protocols. 3: Generally follows experimental protocols, moderate adherence. |

| Assessment criteria | Rubric | Scoring rubric |
|---------------------|--------------------------------|---|
| | | 2: Occasionally deviates from protocols, limited adherence 1: Frequently deviates from experimental protocols, lacks adherence. |
| | Experimental technic adherence | 4: Executes laboratory techniques and procedures with precision and skill. 3: Demonstrates good proficiency in laboratory techniques and procedures 2: Shows basic proficiency but may lack precision. 1: Struggles with basic techniques, leading to inconsistent results. |
| | Laboratory equipment handling | 4: Handles laboratory equipment and instruments with expertise and care, preventing damage or accidents. 3: Handles equipment competently but may occasionally mishandle or damage equipment. 2: Shows a lack of proficiency in equipment handling, leading to frequent issues 1: Frequently mishandles equipment, causing damage or delays. |
| | Team work and collaboration | 4: Exceptional collaboration, seamless teamwork, excellent communication 3: Effective collaboration, good teamwork, adequate communication |

| Assessment criteria | Rubric | | Scoring rubric |
|-------------------------|-----------------|--------------|---|
| | | | 2: Limited effectiveness in collaboration, some teamwork issues, minimal communication, 1: Ineffective collaboration, poor teamwork, lab of communication |
| | Time management | | 4: Follows the experiment schedule closely, completing tasks within established timeframes. 3: Mostly adheres to the schedule but may occasionally fall slightly behind or ahead of the timeline. 2: Often deviates from the schedule, leading to notable delays or rushed work. 1: Consistently disregards the schedule, causing substantial delays or incomplete work. |
| Laboratory report (25%) | Plagiarism | | 4: No evidence of plagiarism; all sources properly cited. 3: Proper citation of sources, minimal plagiarism detected. 2: Some minor issues with plagiarism or citation. 1: Evidence of significant plagiarism or improper citation. |
| | Contents | Introduction | 4: Excellent introduction that effectively sets up the study with clear objectives and hypotheses. 3: Clear introduction with well-defined objectives and hypotheses. 2: Basic introduction but lacks detail or clarity in objectives and hypotheses. |

| Assessment criteria | Rubric | | Scoring rubric |
|---------------------|--------|----------------------|---|
| | | | 1: Inadequate introduction with unclear objectives and hypotheses. |
| | | Material and methods | 4: Methods section is detailed, concise, and replicable. 3: Methods section is present but may lack some details. 2: Methods section lacks detail. 1: Methods section is incomplete or confusing. |
| | | Results | 4: Results are accurately presented, with appropriate tables and figures. 3: Results are accurately presented. 2: Results are presented with limited clarity. 1: Results are poorly presented. |
| | | Discussion | 4: Discussion addresses significance and implications effectively 3: Discussion addresses some aspects of significance and implication 2: Discussion lacks depth and significance. 1: Discussion is minimal or absent. |
| Presentation (15%) | | Conclusion | 4: Implications and relevance to the research question are discussed. 3: Conclusions are drawn but may lack depth. 2: Discussion lacks depth and significance. |

| Assessment criteria | Rubric | Scoring rubric |
|---------------------|---------------------|--|
| | | 1: Conclusions are missing or entirely unsupported. |
| | Writing Quality | 4: Good writing quality with minor grammatical or spelling errors 3: Writing quality is fair with noticeable grammatical or spelling errors. 2: Writing quality is poor with frequent grammatical or spelling errors. 1: Writing quality is extremely poor with numerous grammatical or spelling errors. |
| | On-Time Submission: | 4: Submitted on time or well before the deadline. 3: Submitted close to the deadline but within an acceptable timeframe 2: Submitted late but within a reasonable timeframe. 1: Submitted significantly late or not submitted at all. |
| Presentation (15%) | Organization | 4: The presentation is exceptionally well-organized with a clear and logical structure 3: The presentation is well-organized with a clear structure. 2: The presentation is somewhat organized but may lack clarity or logical flow. 1: The presentation lacks clear organization, making it difficult to follow. |
| | Content | 4: The content is exceptionally clear, relevant, comprehensive, |

| Assessment criteria | Rubric | Scoring rubric |
|---------------------|-------------------------------|--|
| | | <p>and effectively conveys key points.</p> <p>3: The content is clear, relevant, and covers necessary information.</p> <p>2: The content is somewhat clear and relevant but may lack depth.</p> <p>1: The content is unclear, irrelevant, or incomplete.</p> |
| | Knowledge/answering questions | <p>4: The presenter exhibits a deep understanding of the subject matter and answers questions with expertise.</p> <p>3: The presentation style is engaging and confident, maintaining the audience's attention.</p> <p>2: The presenter shows some understanding of the subject matter but may struggle to answer questions comprehensively.</p> <p>1: The presenter demonstrates a lack of understanding of the subject matter and is unable to answer questions effectively.</p> |
| | Presentation style | <p>4: The presentation style is highly engaging, confident, and dynamic, captivating the audience.</p> <p>3: The presentation style is engaging and confident, maintaining the audience's attention.</p> |

| Assessment criteria | Rubric | Scoring rubric |
|---------------------|--------|--|
| | | <p>2: The presentation style is passable but lacks strong engagement or confidence.</p> <p>1: The presentation style is ineffective, lacking engagement, and confidence.</p> |

Student's achievement will be graded using symbols: A, B+, B, C+, C, D+, D and F, based on the criteria as follows:

| Percentage range | Grade | Description |
|------------------|-------|-------------|
| 80-100 | A | Excellent |
| 75-79 | B+ | Very Good |
| 70-74 | B | Good |
| 65-69 | C+ | Fairly Good |
| 60-64 | C | Fair |
| 55-59 | D+ | Poor |
| 50-54 | D | Very Poor |
| 0-49 | F | Fail |