Course Syllabus

MBMB 631 CRISPR/Cas9 Genome Editing

Academic Year 2026

Course ID and Title:	MBMB 631 CRISPR/Cas9 Genome Editing
Course Coordinator:	Asst. Prof. Alisa Tubsuwan, Ph.D. Institute of Molecular Biosciences, Mahidol University Tel: 0-2441-9003 Ext. 1366 Email: alisa.tub@mahidol.ac.th
Instructors:	Asst. Prof. Alisa Tubsuwan, Ph.D.
Support Staff:	Miss Pirut Tong-Ngam Mr. Theptharin Charuraksa
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. Describe the molecular mechanisms underlying CRISPR/Cas9 genome editing
2. Demonstrate proficiency in the CRISPR/Cas9 genome editing tool to design and implement gene modifications for addressing scientific research questions
3. Demonstrate scientific integrity, responsibility, and safety practices
4. Communicate scientific concepts effectively through discussions and presentations

Alignment of Teaching and Assessment Methods to Course Learning Outcomes:

Course Learning Outcomes	Teaching Method	Assessment Method
1. Describe the molecular mechanisms underlying CRISPR/Cas9 genome editing and workflows (**Knowledge -** aligned with **PLO1**)	1. Lecture: 2. Case studies	1. Quiz
2. Design an experiment using CRISPR/Cas9 genome editing tool to address a scientific research question. (**Skills-** aligned with **PLO2**)	1. Lecture 2. Interactive discussion 3. Group activity 4. Hands-on lab practice	1. Lab performance 2. Data analysis 3. Written report 4. Presentation 5. Class discussion
Demonstrate scientific integrity, responsibility, and safety practices (**Ethics-** aligned with **PLO3**)	1. Laboratory and practical work 2. Writing lab report	1. Regular attendance tracking 2. Direct observation and evaluation of students during lab sessions. 3. Submission lab report and tasks as per specified deadlines. 4. Evaluation of lab reports for plagiarism and quality of content.
Communicate scientific concepts effectively through discussions and presentations (**Characters** – Aligned with **PLO4**).	1. Presentation 2. Group discussion and peer feedback sessions	1. Presentation 2. Lab performance 3. Written report

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 เข้าสู่เซลล์ การตรวจสอบการแก้ไขจีโนมด้วยการทดสอบด้วยเอ็นไซม์ ที7 เอ็นโดนิวคลิเอส I และเทคนิคการวิเคราะห์หาลำดับนิวคลีโอไทด์ตามด้วยเครื่องมือทางคอมพิวเตอร์

Course Schedule:

Location: Classroom (Room C405) and Laboratory Classroom (Room D408), Institute of Molecular Biosciences.

Unit	Time	Topic	Instructors and Assistants
Day1 November 23, 2025			
	09:00-11:00	Lecture: Overview and workflow for CRISPR/Cas9 genome engineering	AT
	11:00-12:00	Hand-on: Guide RNA design	AT
	13:00-14:00	Hand-on: Donor template design	AT
	14:00-16:00	Hand-on Genome editing validation method TIDE - rapid, powerful and easy analysis of CRISPR experiments	AT
Day2 November 24, 2025			
	09:00-12:00	Hand on: Preparation of sgRNA expression construct I Activity: Preparation of the sgRNA oligos inserts)	AT
	13:00-15:00	Hand on: Preparation of sgRNA expression construct II Activity: cloning the sgRNA into spCas9 vector	AT
	15:00-16:00	Hand on: Preparation of sgRNA expression construct III	AT

Unit	Time	Topic	Instructors and Assistants
		Activity: Transform E. coli with the sgRNA expression plasmid, plate onto selective agar, and incubate for colony growth.	
Day3 November 25, 2025			
	09:00-12:00	Hand on: Cell seeding Activity: Prepare and seed mammalian cells for genome editing	AT
	13:00-16:0	Hand on: Preparation of sgRNA expression construct IV Activity: Screening for recombinant clone, bacterial colony picking and culture for plasmid amplification	AT
Day4 November 26, 2025			
	09:00-12:00	Hand on: Construction of plasmid expressing guide RNA and Cas9 IV Activity: sgRNA Plasmid isolation from cultured *E. coli*	AT
	13:00-16:00	Transfection Activity: Introduce CRISPR/Cas9 plasmid into mammalian cells	AT
Day5 November 27, 2025			
	09:00-12:00	Hand on: Knockout validation by T7 endonuclease I assay I Activity: Cell harvesting, Genomic DNA extraction and PCR amplification of target regions.	AT
	13:00-15:00	Hand on: Knockout validation by T7 endo nuclease assay II Activity: Digestion of PCR products using T7 Endonuclease I, followed by electrophoresis to analyze cleavage	AT

Unit	Time	Topic	Instructors and Assistants
Day 6			
	15:00-16:00	Lab discussion and presentation	AT

Assessment Criteria

Assessment criteria	Rubric	Scoring rubric
Class attendance (10%)	Attendance	4: points full attendance or received approval for all necessary absences 3: points-1 unexecused absence 2: points-2 unexecused absences 1: points-more than 2 unexecused absences
	Punctuality	4: Punctual 3: Less than 5 min late 2: Less than 15 min late 1: more than 15 min late
Quiz or assignment (15%)	Correctness and completion	Raw scores will be adjusted to be in a range of 0-10%
Laboratory performance (30%)	Safety practice	4: Strict adherence to safety protocols, exemplary safety practices 3: Few safety violations, generally adheres to safety protocols

Assessment criteria	Rubric	Scoring rubric
		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. 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,

Assessment criteria	Rubric	Scoring rubric
		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 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.

Assessment criteria	Rubric		Scoring rubric
			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 (30%)	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.

Assessment criteria	Rubric		Scoring rubric
		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. 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.

Assessment criteria	Rubric	Scoring rubric
	Responsible Use of Artificial Intelligence (AI)	4: AI tools are used appropriately to support writing, literature search, or data analysis. AI assistance is transparently acknowledged where appropriate. The report demonstrates critical evaluation and independent scientific interpretation. 3: AI tools are used appropriately with minor omissions in disclosure or critical evaluation. 2: AI-generated content is included with limited modification or insufficient critical evaluation. 1: Inappropriate use of AI, including submission of AI-generated content as original work, fabrication of data, or failure to acknowledge AI assistance.
Presentation (15%)	Clarity of Scientific Background & Objective	4. Background and objectives are communicated clearly and logically for a scientific audience 3. Mostly clear; minor gaps in logic or clarity 2. Background or objectives partially unclear

Assessment criteria	Rubric	Scoring rubric
		3. Background and objectives unclear or missing
	Content	
	Data Presentation & Visual Communication	4: Figures/tables are clear, well-labeled, and effectively support the message 3. Data mostly clear; minor issues in labeling or layout 2. Figures present but confusing or poorly labelled 1. Data presentation unclear or misleading
	Interpretation & Scientific Discussion	4: Results are interpreted clearly, logically, and linked to objectives; limitations discussed 3: Interpretation mostly correct but limited depth 2: Interpretation superficial or partially incorrect. 1: Little or no interpretation
	Use of Scientific Language & Accuracy	4. Terminology accurate and appropriate; no conceptual errors
	Presentation skills	4. Clear speech, confident delivery, logical flow, appropriate timing 3. Mostly clear delivery; minor issues with flow or timing

Assessment criteria	Rubric	Scoring rubric
		2. Hesitant delivery; difficult to follow 1. Poor delivery; unclear communication
	Response to Questions & Discussion	4. Answers demonstrate clear understanding and effective scientific discussion 3. Answers mostly correct with minor gaps 2. Answers partially correct or unclear 1. Unable to answer or discuss

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