

Course Syllabus
MBMB 642 mRNA Vaccine Development
Academic Year 2025

Course ID and title:	MBMB 642 mRNA Vaccine Development ชมชม ๖๔๒ การพัฒนาวัคซีนชนิด mRNA
Course coordinator:	Associate Professor Sarin Chimnarok, Ph.D. Institute of Molecular Biosciences, Mahidol University Tel: 0-2441-9003 ext. 1383 Email: sarin.chi@mahidol.ac.th
Instructors:	Assoc. Prof. Sarin Chimnarok, Ph.D.
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:	The 2 nd semester
Pre-requisites:	None
Course Learning Outcomes (CLOs):	

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

1. Describe the mRNA vaccine's principle and the entire mRNA production process.
2. Synthesize, purify, and transfect mRNA to express the protein antigen in human cells.
3. Demonstrate responsibility and scientific integrity.
4. Communicate scientific concepts precisely through result discussion and presentation.

Alignment of teaching and assessment methods to Course Learning Outcomes:

Course Learning Outcomes	Teaching method	Assessment method
1. Describe the mRNA vaccine's principle and the entire mRNA production process. (Knowledge - aligned with PL01).	1. Lecture 2. Discussion	1. Q&A during lecture 2. Discussion performance 3. Quiz/short exercise 4. Assignment
2. Synthesize, purify, and transfect mRNA to express the protein antigen in	1. Hands-on lab practice 2. Discussion	1. Lab performance 2. Discussion performance

Course Learning Outcomes	Teaching method	Assessment method
human cells. (Skills - aligned with PL02).		
3. Demonstrate responsibility and scientific integrity. (Ethics - aligned with PL03).	<ol style="list-style-type: none"> 1. Hands-on lab safety practice 2. Discussion (about scientific integrity, responsibility, and safety practice) 3. Writing the lab note 4. Assignment 	<ol style="list-style-type: none"> 1. Lab performance (particularly, safety practice) 2. Lab note writing (accuracy, integrity, and plagiarism) 3. Discussion performance 4. Assignment
4. Communicate scientific concepts precisely through result discussion and presentation. (Characteristics - aligned with PL04).	<ol style="list-style-type: none"> 1. Discussion 2. Lab report 3. Individual or group presentation 	<ol style="list-style-type: none"> 1. Discussion performance 2. Lab report/presentation performance 3. On-time submission of the report and assignments.

Course description

Introduction of mRNA therapeutics; mechanism of mRNA vaccine; components and design of mRNA vaccine; RNA synthesis by *in vitro* transcription; mRNA delivery; evaluation of mRNA efficiency; Prospective mRNA vaccine.

(In Thai) อะไรคือการบำบัดโรคด้วย mRNA, วัคซีนชนิด mRNA ทำงานอย่างไร, รู้จักองค์ประกอบของวัคซีนชนิด mRNA, การสังเคราะห์ RNA ในหลอดทดลอง, จะนำส่ง mRNA เข้าสู่เซลล์อย่างไร, มาประเมินประสิทธิภาพของ mRNA กัน, จินตนาการอนาคตของวัคซีนชนิด mRNA

Course schedule:

(Classroom xxx and lab classroom xxx)

	Activities	Description	Time	Instructors and assistants
Day 1				
1	Lecture: Deep introduction to mRNA. Q&A	<ul style="list-style-type: none"> • History of mRNA • Central dogma and the standard genetic code table • Eukaryotic mRNA structure 	9:00 AM - 10:30 AM	SC
2	Lecture: The actions of the mRNA vaccine. Q&A	<ul style="list-style-type: none"> • What is mRNA therapeutics • Mechanism of the mRNA vaccine • Immune response to RNA 	10:30 AM - 12:00 PM	

	Activities	Description	Time	Instructors and assistants
3	Lab: <i>In vitro</i> transcription (IVT)	Practice RNA manipulation and synthesis of RNA using the <i>in vitro</i> transcription technique	1:00 - 4:00 PM	
4	Lab: Preparation of denaturing gel	The gel is for the analysis of RNA' s sizes and amounts	4:00 - 4:30 PM	
Day 2				
1	Lecture: Design of the mRNA vaccine Q&A	<ul style="list-style-type: none"> The types and components of mRNA vaccines (unmodified and modified bases; non- and self-amplifying mRNA; linear and circular mRNA) 	9:00 AM - 10:30 AM	SC
2	Lecture: Improvement of the mRNA vaccine Q&A	<ul style="list-style-type: none"> RNA polymerase and dsRNA Antigen design 	10:30 AM - 12:00 PM	
3	Lab: RNA purification	Purification of IVT RNAs via RNA precipitation and affinity column	1:00 - 2:00 PM	
4	Lab: RNA visualization	Gel electrophoresis, staining, and visualization	2:00 - 4:00 PM	
Day 3				
1	Lab: mRNA transfection	Cell culture practice and mRNA transfection using liposome	9:00 AM - 12:00 PM	SC
2	Lecture: Delivery systems	<ul style="list-style-type: none"> LNP and mRNA delivery Safety and side-effect 	1:00 - 2:30 PM	
3	Lecture: Future of the mRNA vaccine	<ul style="list-style-type: none"> mRNA vaccine research at CAT Literature review 	2:30 - 4:00 PM	
Day 4				
1	Lab: Quantification of immune response	ELISA of type I IFN	9:00 AM - 12:00 PM	SC
2	Lab: Luciferase assay	To detect the protein antigen expression in transfected cells	1:00 - 4:00 PM	
Day 5				
1	Lab: Discussion of lab results	Gene expression analysis	9:00 AM - 10:30 AM	SC

	Activities	Description	Time	Instructors and assistants
2	Lab: Wrap-up	Discussion/presentation of the future of treating and preventing diseases; mRNA vaccine idea	10:30 AM - 12:00 PM	
3	Student's reflection	To provide students opportunities to describe their learning experiences from this course and how they can be applied to their future learning.	1:00 - 4:00 PM	
4	After-Action Review	To collect comments and suggestions from students for further improvements of the course.		

Assessment criteria:

	Assessment methods	Performance criteria	Scoring rubric
1	Class attendance (10%)	Showing up to the class in time	<ul style="list-style-type: none"> • Full attendance (4) • ~ 80% attendance (3) • ~ 60% attendance (2) • < 50% attendance (1)
2	Quiz/exercise (10%)	Correctness and creativity levels	Raw scores will be adjusted to be in a range of 0-10%
3	Lab note and report (25%)	The lab note is intelligible to others and includes sufficient information (10%)	<ul style="list-style-type: none"> • Excellent (4) • Good (3) • Fair (2) • Need to be improved (1)
		The lab report includes intro, methods, results, discussion, and conclusion with no plagiarism (10%)	<ul style="list-style-type: none"> • Complete (4) • ~ 80% complete (3) • ~ 60% complete (2) • < 50% complete (1)
		Data presentation, analysis, and interpretation (5%)	<ul style="list-style-type: none"> • Excellent (4) • Good (3) • Fair (2) • Need to be improved (1)
4	Lab performance (30%)	Safety practice (5%)	<ul style="list-style-type: none"> • Excellent (4) • Good (3) • Fair (2) • Need to be improved (1)

Assessment methods		Performance criteria	Scoring rubric
		Lab skills (10%)	<ul style="list-style-type: none"> • Excellent (4) • Good (3) • Fair (2) • Need to be improved (1)
		Organization (10%)	<ul style="list-style-type: none"> • Excellent (4) • Good (3) • Fair (2) • Need to be improved (1)
		Troubleshooting skills (5%)	<ul style="list-style-type: none"> • Excellent (4) • Good (3) • Fair (2) • Need to be improved (1)
5	Discussion/presentation performance (15%)	Participation (5%)	<ul style="list-style-type: none"> • Active (4) • Fairly active (2-3) • Inactive (1)
		Creativity and high-order thinking skills (5%)	<ul style="list-style-type: none"> • Excellent (4) • Good (3) • Fair (2) • Need to be improved (1)
		Professional and interpersonal skills (communication level, critical thinking, and active listening) (5%)	<ul style="list-style-type: none"> • Excellent (4) • Good (3) • Fair (2) • Need to be improved (1)
6	Assignment (10%)	Accurate description of the idea with supporting evidence (8%)	<ul style="list-style-type: none"> • Excellent (4) • Good (3) • Fair (2) • Need to be improved (1)
		English writing and punctual submission (2%)	<ul style="list-style-type: none"> • Excellent (4) • Good (3) • Fair (2) • Need to be improved (1)

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

Percentage range	Grade	Description
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

Date of revision: April 2024