Course Syllabus

MBNS 604 Research Methodology and Techniques in Neuroscience

Academic Year 2/2025

Course ID and Name: MBNS 604 Research Methodology and Techniques in Neuroscience

Course Coordinator: Assoc. Prof. Sujira Mukda

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Instructors:

1. Prof. Duncan Richard Smith
2. Assoc. Prof. Dr. Vorasith Siripornpanich
3. Assoc. Prof. Dr. Sujira Mukda
4. Asst. Prof. Dr. Sukonthar Ngampramuan
5. Asst. Prof. Dr. Narisorn Kitiyanant
6. Asst. Prof. Dr. Kittikun Viwatpinyo
7. Asst. Prof Dr. Jiraporn Panmanee
8. Lect. Dr. Narisra Komalawardhana
9. Lect. Dr. Lalitta Suriya-Arunroj
10. Lect. Dr. Siraprapa Boobphahom
11. Lect. Dr. Ekkaphot Khongkla
12. Lect. Dr. Sumeth Klomchitcharoen

Supporting Staff:

1. Ms. Somsong Phengsukdaeng
2. Ms. Chonnicha Subkod
3. Ms. Kanda Putthaphongphuek
4. Ms. Kornkanok Promthep
5. Mr. Pannaphan Makarathut
6. Ms. Chanikarn Boonchuay

Credits: 3 (2-2-5)

Curriculum: Master of Science Program in Neuroscience (required course)

Doctor of Philosophy Program in Neuroscience (required course for students from B.Sc.)

Semester offering: Second semester

Pre-requisites: None

Course learning outcomes (CLOs):

Upon completion of this course, students are able to:

1. Demonstrate an understanding of ethical issues in neuroscience research and apply ethical principles in experimental design. (aligned with PLO1(R))
2. Design a comprehensive research project that integrates neuroscientific theories with practical methodologies. (aligned with PLO3(P))

3. Analyze and interpret quantitative data using appropriate statistical methods. (aligned with PLO5(P))
4. Critically assess existing literature in neuroscience, identifying strengths and weaknesses in study designs. (aligned with PLO2(P))
5. Collaborate effectively within a team to achieve common research goals. (aligned with PLO4(P))

Alignment of teaching and assessment methods to course learning outcome:

Course learning outcome	Teaching method	Assessment method
CLO1 Demonstrate an understanding of ethical issues in neuroscience research and apply ethical principles in experimental design.	1. Lecture 2. In-class discussion 3. Hands-on practice	1. Formative assessment using scoring rubric 2. Written examination 3. Assignments/ exercises
CLO2 Design a comprehensive research project that integrates neuroscientific theories with practical methodologies.	1. Lecture 2. In-class discussion 3. Assignments/ Exercises	1. Written examination 2. In-class discussion 3. Assessments/ exercises
CLO3 Analyze and interpret quantitative data using appropriate statistical methods.	1. In-class discussion 2. Assignments/ Exercises	1. Written examination 2. Assessments/ exercises 3. Oral presentation 4. In-class discussion
CLO4 Critically assess existing literature in neuroscience, identifying strengths and weaknesses in study designs	1. In-class discussion 2. Assignments/ Exercises	1. Written examination 2. Assessments/ exercises 3. Oral presentation 4. In-class discussion
CLO5 Collaborate effectively within a team to achieve common research goals.	1. In-class discussion 2. Hands-on practice	1. Formative assessment using scoring rubric 2. In-class discussion 3. Performance in social skills

Course description:

The principles and methods used in the research process in neuroscience; fundamental skills required to assess the data generation and collecting; research ethics; research strategy and design; research practice; writing up research proposals; data analyses and interpretation; and presentations of the research results

Course schedule:

Date: Monday-Friday

Time: 09.30-16.00

Venue: Lecture: Room A207-01(1), A107(2) Institute of Molecular Biosciences

Lab: Rooms B402(3), MB Animal Center (4), D401-02(5), and D413(6) Institute of Molecular Biosciences

Schedule

MBNS 604 Research Methodology and Techniques in Neuroscience

Lecture: 16 March 2026 – 10 April 2026

Course Coordinator: Assoc. Prof. Sujira Mukda

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	Date	Time	Topic	Lecturer
0	16 Mar 2026	09.30-10.00	**L0:** Course orientation	Sujira[(1)]
		10.00-12.00	**L0:** Orientation to IMB Central Instrument Facility - Overview of shared research infrastructure and core services - Laboratory safety regulations and access policies - Instrument booking systems and user responsibilities - Introduction to major neuroscience-relevant platforms (imaging, molecular, electrophysiology)	Pannaphan[(1)]
1		13.30-15.30	**L1:** Methods for studying human brain functions: from observation to neuroimaging. - Historical approaches: lesion studies and behavioral observation - Cognitive and neuropsychological assessments - Structural vs functional neuroimaging principles - Strengths, limitations, and translational relevance of human brain studies	Vorasith[(1)]
2	17 Mar 2026	10.00-12.00	**L2:** How do neuroscientists measure the activities of the brain and the mind? - Neural correlates of cognition and behavior - Temporal vs spatial resolution in brain measurement - Invasive vs non-invasive recording techniques - Interpretation of neural signals in cognitive neuroscience	Vorasith[(1)]
		13.30-16.30	*Lab:* EEG experimental setup - EEG system components and electrode placement - Signal acquisition, noise sources, and artifact reduction - Basic EEG paradigms and data visualization	Vorasith[(3)]
	18 Mar 2026		MB OPEN HOUSE	

	Date	Time	Topic	Lecturer
3	19 Mar 2026	10.00-12.00	**L3:** Animal research in neuroscience and behavioral studies - Principles of animal research and animal models in neuroscience. - Behavioral assessment of cognitive and motor functions in animals. - Interpretation of behavioral data for translational neuroscience research.	Sukonthar(2)
		13.30-16.30	*Lab:* Animal models - Introduction to handling and experimental observation - Behavioral assay demonstrations - Data recording and ethical considerations	Sukonthar(4)
4	20 Mar 2026	10.00-12.00	**L4:** Biosensor technology in neuroscience research - Principles of biological sensing - Electrochemical, optical, and molecular biosensors - Applications in neurotransmitter and biomarker detection - Emerging trends and translational potential	Siraprapa(2)
5		13.30-15.30	**L5:** Cell culture technique in nervous system - Introduction to cell culture - Cell culture laboratory safety - Guidelines for maintaining cultured cells - Contamination in cell culture - Applications of cell culture in neuroscience research	Sujira(2)
6	23 Mar 2026	10.00-12.00	**L6:** Nucleic acid isolations & amplification - What are nucleic acids? - Central dogma - Biological samples - DNA/RNA isolation - Nucleic acid quantification - Introduction to polymerase chain reaction (PCR) • Reverse Transcription PCR (RT-PCR) - Variations of basic PCR-based techniques - PCR applications	Jiraporn(2)
		13.30-16.30	*Lab:* RNA isolation & RT-PCR I - RNA extraction workflow	Jiraporn/ Sujira/ Narisorn(5)

	Date	Time	Topic	Lecturer
			- RNA integrity and contamination control	
7	24 Mar 2026	10.00-12.00	**L7:** Bio-statistical analysis for research - Statistical methodology - Descriptive statistics - The ordered array; The frequency distribution; Measure of central tendency; - Measure of dispersion - Population and Sample - Inferential statistics - Hypothesis testing; Correlation Analysis; Parametric and Non-parametric tests	Sumeth[(1)]
		13.30-16.30	*Lab:* RNA isolation & RT-PCR II - Reverse transcription and PCR amplification- - Interpretation of amplification results	Jiraporn/ Sujira/ Narisorn[(5)]
8	25 Mar 2026	10.00-12.00	**L8:** Identifying proteins of interest - Protein structure and function in neuroscience - Quantitative and qualitative protein analysis - Antibody-based detection principles	Ekkaphot[(2)]
		13.30-16.30	*Lab:* Protein extraction and determination - Protein isolation methods - Concentration measurement and normalization	Ekkaphot/ Siraprapa[(6)]
9	30 Mar 2026	10.00-12.00	**L9:** Electrophysiology: extracellular recording - Why extracellular recordings: what we can measure (single units, multi-unit, LFP) and what questions it answers (circuit coding, decision signals, sensory/behavior alignment). - Experimental setup overview: electrodes/probes + headstage/amplifier + DAQ. - How a recording session works: targeting strategy, unit search, stabilization, running trials, and the key "in-session QC" checks (noise, SNR, waveform drift, timing sanity). - From raw signals to results: preprocessing, spike sorting basics, unit quality criteria, and examples of readouts (PSTHs, tuning curves, population activity, LFP power/coherence).	Lalitta[(1)]
		13.30-16.30	*Lab:* Electrophysiology	Lalitta[(1)]

	Date	Time	Topic	Lecturer
10	31 Mar 2026	10.00-12.00	**L10:** Guidelines on writing a research proposal - What is a research proposal - primary and secondary objectives - How do we do a research proposal - sourcing appropriate literature - How to read a scientific paper - A cautionary word: What is, and how to avoid plagiarism - Common research proposal formats - Selecting a title for your proposal - Writing the core sections: - Introduction and rationale - Objectives and hypotheses - Literature review - Materials and methods (including ethical considerations)	Duncan(2)
11		13.30-15.30	**L11:** Basic Histological Technique - Tissue fixation and processing - Sectioning and staining principles - Microscopic evaluation of neural tissue - Relevance to structure–function relationships	Kittikun(2)
12	1 Apr 2026	10.00-12.00	**L12:** Bioinformatics in neuroscience study - An introduction to bioinformatics - Type of databases - Primary databases - Secondary databases - Database analysis tools - Neuroinformatics resources	Jiraporn(2)
		13.30-16.30	*Lab:* How to design primers for PCR - Primer design principles and parameters-Specificity, efficiency, and common errors	Jiraporn/ Sujira/ Narisorn(5)
13	2 Apr 2026	10.00-12.00	**L13:** Research ethics - What and why - Six Norms of scientific research - General guidelines for authorship contributions - Case studies	Narisorn(2)

	Date	Time	Topic	Lecturer
14		13.30-15.30	**L14:** Reference management and Endnote software - Role of reference management in scientific writing and research integrity - Overview of reference management tools (EndNote, Zotero, Mendeley): scope and use cases - Common citation styles in neuroscience (e.g., APA, Vancouver, Nature) - Introduction to EndNote - Building and Organizing an EndNote Library - Using EndNote with Word (Cite While You Write)	Ekkaphot(2)
15	3 Apr 2026	10.00-12.00	**L15:** Research performance analysis and technique - What is research performance, journal quality: quartile, top percentile - How to choose journal for publication - Analysis tool and technique: SciVal - How to analyze research quality: scholarly output, citation, field-weighted citation impact	Narisra(2)
16		13.30-15.30	**L16:** OMICs applications in neuroscience research - Overview of genomics, transcriptomics, proteomics, metabolomics - OMICs experimental workflows - Data integration and systems neuroscience- - Challenges and future directions in OMICs-based neuroscience	Ekkaphot(2)
Exam II	7 Apr 2026	09.00-16.00	**Exam**	Sujira/Somsong
	8 Apr 2026	09.00-12.00	*Lab:* Western blotting I: Sample preparation and gel electrophoresis	Ekkaphot/ Siraprapa(6)
		13.30-16.30	*Lab:* Western blotting II: Protein transfer and antibody incubation	Ekkaphot/ Siraprapa(6)
	9 Apr 2026	09.00-12.00	*Lab:* Western blotting III: Detection and imaging	Ekkaphot/ Siraprapa(6)
		13.30-16.30	*Lab:* Western blotting IV: Data analysis	Ekkaphot/ Siraprapa(6)
	10 Apr 2026	09.00-12.00	**Student Presentation**	Lecturers

Assessment Criteria:

Assessment Criteria	Assessment Method	Scoring Rubric
Written examination/ Assignments (40%)	1. Written examination 2. Report	1. Comprehension
Laboratory performance (20%)	1. Direct observation 2. Practical examination 3. In-class discussion	1. Ability to follow procedure or to design a procedure for experiment 2. Use of equipment 3. Working area and safety 4. Group work
Problem-based learning presentation (20%)	1. Presentation 2. In-class discussion	1. Ability to apply knowledge to solve research problems 2. Ability to answer questions
Class attendance (10%)	1. Number of classes signed in 1. Direct observation	1. Class attendance
Participation in in-class discussion (10%)	1. In-class discussion	1. Class participation

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

Percentage	Grade	Description
85-100	A	Excellent
80-84	B+	Very good
70-79	B	Good
60-69	C+	Fairly good
50-59	C	Fair
45-49	D+	Poor
40-44	D	Very poor
< 40	F	Fall

Rubric for Evaluating Laboratory Performance

Course: MBNS 604 Research Methodology and Techniques in Neuroscience

Student Name: ..... Date of Evaluation: .....

Criteria	PLOs & CLOs Alignment		Poor (1)	Needs Improvement (2)	Satisfactory (3)	Good (4)	Excellent (5)	Level of Achievement*
	CLOs	PLOs						
1. Ethical Conduct and Laboratory Safety	CLO1	PLO1	☐ Disregards lab safety and ethical conduct.	☐ Frequently fails to follow safety rules or ethical guidelines.	☐ Generally follows ethical and safety guidelines but occasionally needs reminders.	☐ Follows ethical and safety protocols with minor lapses.	☐ Consistently demonstrates ethical behavior and excellent adherence to lab safety protocols without reminders.	☐ I ☐ R ☐ P ☐ M
2. Technical Competency in Laboratory Skills	CLO2	PLO3	☐ Cannot perform techniques reliably.	☐ Struggles to perform basic techniques; needs constant assistance.	☐ Can complete techniques with frequent support.	☐ Performs techniques correctly with occasional guidance.	☐ Performs lab techniques accurately and efficiently with minimal supervision.	☐ I ☐ R ☐ P ☐ M
3. Problem Solving and Adaptability	CLO3	PLO5	☐ Unable to identify or respond to problems.	☐ Rarely identifies issues; depends heavily on supervision.	☐ Needs guidance to identify or solve issues.	☐ Recognizes problems and takes appropriate corrective actions.	☐ Independently identifies and resolves technical issues with innovative solutions.	☐ I ☐ R ☐ P ☐ M
4. Data Recording and Interpretation	CLO3	PLO5	☐ Records are missing or show no attempt at analysis.	☐ Incomplete or unclear records; poor interpretation.	☐ Records are complete but lack clarity or critical interpretation.	☐ Maintains clear records and makes reasonable interpretations.	☐ Maintains accurate, complete lab records and interprets data critically and appropriately.	☐ I ☐ R ☐ P ☐ M
5. Engagement with Literature and Protocol Justification	CLO4	PLO2	☐ No evidence of literature engagement.	☐ Rarely uses literature or struggles to apply it.	☐ Refers to literature with limited integration or understanding.	☐ Uses literature to support methodology with good understanding.	☐ Consistently integrates relevant literature to justify protocol steps and troubleshoot.	☐ I ☐ R ☐ P ☐ M
6. Teamwork and Communication (CLO5)	CLO5	PLO4	☐ Disrupts teamwork; unwilling to engage with team.	☐ Rarely collaborates or communicates effectively.	☐ Participates in team activities with occasional issues.	☐ Collaborates well and contributes to team goals.	☐ Proactively collaborates and communicates effectively within the team; supports others.	☐ I ☐ R ☐ P ☐ M
Total Score (30)								

*** Note:** A score in the "Satisfactory" range indicates that the student has achieved at least a **Practiced (P)** level of competency for this course. Students must achieve at least a **P (Practiced)** level in each of the Course Learning Outcomes (CLOs).

*** Guideline for Scoring:** 1 = I (Introduced); 2 = R (Reinforced); 3 & 4 = P (Practiced); 5 = M (Mastery)

Score Interpretation:

- ☐ Outstanding (26 - 30)
- ☐ Good (21 - 25)
- ☐ Satisfactory (16 - 20)
- ☐ Needs Improvement (11 - 15)
- ☐ Poor (6 - 10)

Comments: .....

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Evaluator: .....

Rubric for Evaluating Problem-Based Learning (PBL) Presentation

Course: MBNS 604 Research Methodology and Techniques in Neuroscience

Student Name: ..... Date of Evaluation: .....

Criteria	PLOs & CLOs Alignment		Poor (1)	Needs Improvement (2)	Satisfactory (3)	Good (4)	Excellent (5)	Level of Achievement*
	CLOs	PLOs						
1. Ethical Considerations	CLO1	PLO1	☐ Missing.	☐ Vague or poorly applied.	☐ Basic mention.	☐ Appropriate and clear.	☐ Insightful and thorough application.	☐ I ☐ R ☐ P ☐ M
2. Research Question and Rationale	CLO2	PLO3	☐ Missing or irrelevant.	☐ Poorly justified or unclear.	☐ Basic question with some rationale.	☐ Clear, reasonably justified.	☐ Highly original, clear, strong theoretical integration.	☐ I ☐ R ☐ P ☐ M
3. Methodology Selection and Appropriateness	CLO2 CLO3	PLO3 PLO5	☐ Missing or unjustified.	☐ Inappropriate or unclear.	☐ Basic, limited justification.	☐ Appropriate methodology, good justification.	☐ Highly appropriate methodology, deeply justified.	☐ I ☐ R ☐ P ☐ M
4. Data Analysis Plan	CLO3	PLO5	☐ No clear plan.	☐ Unclear, inappropriate.	☐ Basic, some inaccuracies.	☐ Clear, correct, minor flaws.	☐ Advanced, correct, and well-explained.	☐ I ☐ R ☐ P ☐ M
5. Critical Analysis of Literature	CLO4	PLO2	☐ Missing or irrelevant review.	☐ Mostly descriptive, little critique.	☐ Basic critique, limited depth.	☐ Good critique, identifies some gaps.	☐ Deep critique, multiple perspectives, well-argued.	☐ I ☐ R ☐ P ☐ M
6. Q&A Response and Critical Thinking	CLO4	PLO3	☐ Inability to answer questions effectively.	☐ Struggles to answer or defend logically.	☐ Answers basic questions, limited critical defense.	☐ Mostly clear answers, minor gaps in defense.	☐ Accurate, thoughtful, critically defends research choices.	☐ I ☐ R ☐ P ☐ M
7. Presentation Skills (Overall Communication)		PLO5	☐ Disorganized, unclear.	☐ Confusing, weak delivery.	☐ Understandable, some disorganization.	☐ Clear, organized, minor lapses.	☐ Highly professional, engaging, excellent structure.	☐ I ☐ R ☐ P ☐ M
Total Score (35)								

*** Note:** A score in the "Satisfactory" range indicates that the student has achieved at least a **Practiced (P)** level of competency for this course. Students must achieve at least a **P (Practiced)** level in each of the Course Learning Outcomes (CLOs).

*** Guideline for Scoring**: 1 = I (Introduced); 2 = R (Reinforced); 3 & 4 = P (Practiced); 5 = M (Mastery)

Score Interpretation (Overall):

☐ Excellent	(32 - 35)
☐ Good	(28 - 31)
☐ Satisfactory	(24 - 27)
☐ Needs Improvement	(20–23)
☐ Poor	(≤19)

Comments: .....

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Evaluator: .....

MBNS 604 - Rubric for Evaluating Problem-Based Learning (PBL) Presentation 1

Date revised: 10 March 2026