Course Syllabus

MBNS 604 Research Methodology and Techniques in Neuroscience

Academic Year 2021

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

Course Coordinator: Asst. Prof. Sujira Mukda
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Instructors:

1. Prof. Duncan Richard Smith
2. Assoc. Prof. Naiphinich Kotchabhakdi
3. Assoc. Prof. Nuanchan Chutabhakdikul
4. Assoc. Prof. Vorasith Siripornpanich
5. Asst. Prof. Sujira Mukda
6. Asst. Prof. Sukonthar Ngampramuan
7. Asst. Prof. Kittikun Viwatpinyo
8. Asst. Prof. Narisorn Kitiyanant
9. Asst. Prof. Alisa Tubsuwan
10. Dr. Chutikorn Nopparat
11. Dr. Jiraporn Panmanee
12. Dr. Narisra Komalawardhana
13. Dr. Lalitta Suriya-Arunroj

Supporting Staff:

1. Ms. Somsong Phengsukdaeng
2. Ms. Sasithorn Prommet
3. Ms. Kanda Putthaphongphuek
4. Ms. Kornkanok Promthep
5. Mr. Umnaj Chanama
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. Acquire new knowledge in research techniques in Neuroscience (PLO1) I, P
2. Integrate and apply comprehensive knowledge in research techniques in Neuroscience to solve scientific research questions (PLO2) P, R
3. Analyze and present lab data by using appropriate information and communication technologies (PLO6) P
4. Demonstrate scientific integrity, responsibility, and safety practice (PLO1, PLO4) I, P, R
5. Demonstrate teamwork, interpersonal skills and responsibilities for the work Assignments (PLO5) P

Alignment of teaching and assessment methods to course learning outcome:

Course learning outcome	Teaching method	Assessment method
1. Acquire new knowledge in research techniques in Neuroscience	(1) Lecture (2) Class discussion	(1) Written examination (2) Reports (3) In-class discussion
2. Integrate and apply comprehensive knowledge in research techniques in Neuroscience to solve scientific research questions	(1) Class discussion (2) Problem-based learning	(1) Direct observation (2) Oral presentation (3) In-class discussion
3. Analyze and present lab data by using appropriate information and communication technologies	(1) Experimental data presentation and discussion	(1) Reports (2) Oral presentation (3) In-class discussion
4. Demonstrate scientific integrity, responsibility, and safety practice	(1) Assignment (2) Lab safety guidelines (3) Hands-on practice	(1) Assessment of assigned work (2) Direct observation (3) Class attendance (4) Lab performance (5) MU Labpass certificate

Course learning outcome	Teaching method	Assessment method
5. Demonstrate teamwork, interpersonal skills and responsibilities for the work assignments	(1) Group/individual assignment	(1) Direct observation (2) Assessment of assigned work (3) Assessment of responsibility for assigned work

Course description:

The principles and methods used in neuroscience research; experimental design, data analysis and interpretation; presentation of the research results; technique to analyse the physiological, anatomical, and chemical changes of the cells, proteins, or genes in the nervous system

Course schedule:

Date: Monday-Friday

Time: 09.00-16.00

Rooms A107(1), B402(2), D401-02(3), and MB Animal Center (4) Institute of Molecular Biosciences

Date/Time	Topic/Details	Number of Hours	Class Activity	Lecturer
21 March 2022				
09.00-11.00	**Orientation to IMB Central Instrument Facility**	2	Lecture	Sujira Umnaj(1)
13.00-15.00	**Lect 1: Neuroimaging techniques** - Neuroimaging or Brain Imaging techniques - Structural, Functional and Chemical imaging techniques - Neuroimaging in Cognitive Neuroscience and Clinical Investigations - From Imaging of microscopic and electron microscopic for various neuronal cells, tissues, to whole brain - Molecular neuroimaging - New advanced techniques, e.g., “Clarity”, Optogenetic, Multiphoton Laser Confocal Scanning microscope of living neurons - Neuroimaging for human brain, Computerized Tomography (CT) or Computerized Axial Tomography (CAT), High-speed 3D Fast CT, Magnetic resonance	2	Lecture/ In-class discussion	Naiphinich/ Vorasith(1)

Date/Time	Topic/Details	Number of Hours	Class Activity	Lecturer
	imaging (MRI), nuclear magnetic resonance imaging (NMRI), or magnetic resonance tomography (MRT), Functional MRI, Tractography with Diffusion Tensor Imaging (DTI) for fiber tracts, MRI-Spectroscopy (MRS) - Brain Connectomes, Glass-fly-through techniques, - Experimental neuroimaging designs and their applications - Single Photon Emission Spectroscopy Tomography (SPECT) - Positron Emission Tomography (PET), Functional PET - Development of techniques for investigation of dementia and Alzheimer's Disease - Optical neuroimaging, Functional Near-Infra-Red Spectroscopy (FNIRS) - Neuro-navigators, surgical operating room multimodal neuroimaging - Neuroimaging with EEG, ERP and Topographic Brain Mapping			
22 March 2022				
09.00-11.00	**Lect 2: How to design the ERP paradigm and ERP recording** - Equipments for EEG and ERP recording - The principle of ERP paradigm - The common ERP paradigms used in cognitive research	2	Lecture/ In-class discussion	Vorasith[(1)]
11.00-12.00	***Lab:*** **ERP Recording I** - EEG acquisition - Using Stim2 program for creating an ERP paradigm - EEG and ERP recording - Analysis of ERP data	1	Lab/ In-class discussion	Vorasith[(2)]

Date/Time	Topic/Details	Number of Hours	Class Activity	Lecturer
13.00-16.00	***Lab:*** **ERP Recording II** - EEG acquisition - Using Stim2 program for creating an ERP paradigm - EEG and ERP recording - Analysis of ERP data	3	Lab/ In-class discussion	Vorasith[(2)]
23 March 2022				
09.00-11.00	**Lect 3: Electrophysiology: extracellular recording** - Basics of extracellular action potentials - Potentials, benefits, and limitations - Signal processing (amplifier, analog-to-digital conversion, data synchronization, data storage, etc.) - Single-unit vs. multi-unit activities - Local field potentials (LFP)	2	Lecture/ In-class discussion	Lalitta[(1)]
13.00-16.00	***Lab:*** **Electrophysiology** - Electrophysiology & neural signal collection - Basics of neural data analyses	3	Lab/ In-class discussion	Lalitta[(1)]
24 March 2022				
09.00-11.00	**Lect 4: Cell culture technique in nervous system** - The concept of cell culture - Describes and classify types of cell culture - Classification the cell culture room - Routine method of cell culture - Apply the cell culture technique in Research	2	Lecture/ In-class discussion	Chutikorn[(1)]
13.00-15.00	**Lect 5:** Genetic Modification, Genome Editing, and CRISPR - DNA/Gene/ Genome - Genome editing - History of genome editing technology - Structure and mechanism of genome editing technologies	2	Lecture/ In-class discussion	Alisa[(2)]

Date/Time	Topic/Details	Number of Hours	Class Activity	Lecturer
	- Application of CRISPR/Cas9 - CRISPR/Cas9 genome editing workflow (guide RNA design and it functional testing, CRISPR-Cas delivery method, detection and identification of genome editing)			
25 March 2022				
09.00-11.00	**Lect 6: 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	2	Lecture/ In-class discussion	Jiraporn/ Sujira[(1)]
13.00-16.00	***Lab:*** **RNA isolation & RT-PCR I** - RNA isolation using Trizol reagents	3	Lab/ In-class discussion	Jiraporn/ Chutikorn[(3)]
28 March 2022				
09.00-11.00	***Lab:*** **RNA isolation & RT-PCR II** - Practicing RT-PCR Gel electrophoresis	3	Lab/ In-class discussion	Jiraporn/ Chutikorn[(3)]
13.00-16.00	***Lab:*** **How to design primers for PCR** - What are primers? - Primer parameters - Tips for designing primers - Primer design using NCBI-Primer BLAST - Checking primer quality by PCR primer Stats and PCR *in silico* UCSC	3	Lab/ In-class discussion	Jiraporn/ Chutikorn[(3)]
29 March 2022				

Date/Time	Topic/Details	Number of Hours	Class Activity	Lecturer
09.00-11.00	**Lect 7: Identifying proteins of interest** - The purpose of protein investigation - Antibody considerations - The concepts behind the methods of the protein investigation: - Western blot - Enzyme-linked immunosorbent assay (ELISA) - Immunohistochemistry (IHC)	2	Lecture/ In-class discussion	Sujira[1]
13.00-16.00	***Lab:* Protein extraction and determination** - Protein extraction - Determine the concentration of protein	3	Lab/ In-class discussion	Sujira/ Kittikun[3]
30 March 2022				
09.00-12.00	***Lab:* Western blotting I** - Practice the SDS-PAGE gel setting - Mix and Load samples in acryamide gel	3	Lab/ In-class discussion	Chutikorn/ Kittikun/ Jiraporn[3]
13.00-16.00	***Lab:* Western blotting II** - Run the SDS-PAGE gel and transfer the protein samples to PVDF membranes - Blocking the non-specific binding of the protein - Hybridization process	3	Lab/ In-class discussion	Chutikorn/ Kittikun/ Jiraporn[3]
31 March 2022				
09.00-12.00	***Lab:* Western blotting III** - Hybridization process (continue) - Western blot detection	3	Lab/ In-class discussion	Chutikorn/ Kittikun/ Jiraporn[3]
13.00-16.00	***Lab:* Western blotting IV** - Calculation of the protein band density and data analysis	3	Lab/ In-class discussion	Chutikorn/ Kittikun/ Jiraporn[3]
1 April 2022				
09.00-11.00	**Lect 8: Flow cytometry analysis** - Principles of flow cytometry - Flow cytometry data analysis and presentation	2	Lecture/ In-class discussion	Narisorn[1]

Date/Time	Topic/Details	Number of Hours	Class Activity	Lecturer
13.00-15.00	**Lect 9: Basic Histological Technique** - Pros and Cons of histological techniques - Routine method of tissue processing - Common errors in tissue processing Advanced methods	2	Lab/ In-class discussion	Kittikun[(2)]
4 April 2022	Examination I (Lecture 1-8)[(5)]			
5 April 2022				
09.00-11.00	**Lect 10: Animal research in neuroscience and behavioral studies** - Animal for researches - Rodents in neuroscience research - Animal models of neurobehavioral disorders - Cognitive function in animal model - Rodent stereotyped behavior - Motor movement test in animal model	2	Lecture/ In-class discussion	Sukonthar[(1)]
13.00-16.00	***Lab:*** **Animal models** - Spatial learning memory test (Morris water maze) - Measurement of rodent stereotyped behavior - Locomotion activity measurement in an open field	3	Lab/ In-class discussion	Sukonthar / Sujira[(4)]
7 April 2022				
09.00-11.00	**Lect 11: Bioinformatics in neuroscience study** - What is bioinformatics? - Introduction to primary databases (GenBank, ArrayExpress and PDB) - Protein analyses using secondary databases (InterPro, Uniprot and Ensembl) - The importance of metadata - Searching homology sequences by BLAST - Identifying protein domains from sequences using protein databases	2	Lecture/ Computer/ In-class discussion	Jiraporn/ Sujira[(1)]

Date/Time	Topic/Details	Number of Hours	Class Activity	Lecturer
	- Tools for protein target prediction of bioactive molecules			
13.00-15.00	**Lect 12: Bio-statistical analysis for research** - Experimental designs: observational and experimental studies - Summarizing data: central tendency and dispersion - Probability distribution and sampling of population - Confidence interval - Hypothesis testings - Statistical errors and significance level - Correlation and regression analysis	2	Lecture/ In-class discussion	Kittikun[(1)]
8 April 2022				
09.00-11.00	**Lect 13: Research ethics** - Ethical issues and guidelines for human and animal research - Ethics in data reporting: falsification and fabrication of data - Plagiarism and copyright infringement	2	Lecture/ In-class discussion	Kittikun[(1)]
13.00-15.00	**Lect 14: 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 - Abstract#1 - The introduction: Why and what and structure (and language pointers) - Objectives	2	Lecture/ In-class discussion	Duncan[(1)]

Date/Time	Topic/Details	Number of Hours	Class Activity	Lecturer
	- Literature review - Materials and methods (including Ethics statements) - Results/preliminary results - Avoiding data presentation problems - Abstract#2 - Time lines - Literature citation and referencing - Final words			
11 April 2022				
09.00-11.00	**Lect 15: Reference management using Endnote software** - What is EndNote, Workflow of EndNote - Defining journal term list for new library - Data inputs: Manual typing, Online search, import filter, Direct export, import pdf - organize references into groups - Maintenance of the library - Cite While You Write (CWYW) - Create separate bibliographies to chapters in a single document	2	Lecture/ Computer/ In-class discussion	Nuanchan[(1)]
13.00-15.00	**Lect 16: Research performance analysis and technique** - What is research performance, journal quality: quartile, top percentile - How to choose journal for publication - How to analyze research quality: scholarly output, citation, field-weighted citation impact - Analysis tool and technique: JournalFinder, SciVal - How to avoid predatory journals, e-books and publishers	2	Lecture/ Computer/ In-class discussion	Narisra[(1)]
12 April 2022	**Examination II (Lecture 9-16)** [(5)]			
18 April 2022				

Date/Time	Topic/Details	Number of Hours	Class Activity	Lecturer
09.00-11.00	**Student Presentation**	3	Problem-based learning/ In-class discussion	RCN Staff[(2)]

Assessment Criteria:

Assessment Criteria	Assessment Method	Scoring Rubric
Assignments/ Examination (50%)	(1) Report (2) Written examination	(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	(1) Ability to apply knowledge to solve research problems (2) Ability to answer questions
Class attendant (10%)	(1) Number of classes signed in (2) Direct observation	(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

Percentage	Grade	Description
45-49	D+	Poor
40-44	D	Very poor
< 40	F	Fall

Lab Performance Evaluation Rubric				
Criteria	**Exemplary (score = 4)**	**Proficient (score = 3)**	**Basic (score = 2)**	**Inadequate (score = 1)**
Active participation	Student enthusiastically involves in participation and discussion with friends and teachers, and shows evident leadership skills.	Student actively involves in participation in class with friends and teachers.	Student is present in class and shows moderate interest during study.	Student shows no interest in participation or fails to present in class.
Group communication		Student communicates well with other students and teachers, both verbally and non-verbally.	Student moderately communicates or discusses with other students, or when being asked.	Student fails to communicate with others and tends to leave discussion.
Theory knowledge		Student shows profound background knowledge on topics being discussed and evaluated.	Students has some degree of knowledge of topics being studied, but could be improved in certain points.	Student has very little or no knowledge about topics being studied and not prepared for this session.

Problem-based learning Presentation Rubric					
Criteria	**Excellent (score = 5)**	**Very good (score = 4)**	**Adequate (score = 3)**	**Limited (score = 2)**	**Poor (score = 1)**
Information quality and organization of topic presented (including answering the questions)	Main points are explicitly presented with impressive detail and organization. Information is directly linked to the topic of presentation.	Main points are presented with good amount of detail. Information is well-organized and linked to the topic given.	Main points are somewhat clear but could add some more detail. Information is organized and linked to the topic given.	Main points are not clear and lack detail. Information is loosely organized and some are off-topic.	Main points are missed and have no detail. Information is disorganized and off-topic.
Verbal communication and English language proficiency	Speaker's voice is very steady, clear and confident. Spoken language is very fluent and grammatically corrected.	Speaker's voice is steady and confident. Spoken language is fluent and mostly grammatically corrected.	Speaker's voice is moderately confident but could be developed. Spoken language is mediocre and has some grammatical errors.	Speaker's voice is unsteady and lacks confident. Use of spoken language needs to be improved, and many errors can be recognized.	Speaker fails to deliver proper presentation orally. Unable to deliver presentation via spoken English language.
Non-verbal communication	Speaker appears to be comfortable and confident. Effective uses of eye contacts and	Speaker appears to be fairly confident. Eye contacts and gestures are generally used.	Speaker appears to be generally at ease. Moderate use of eye contact and gesture but	Speaker appears uneasy, insecure or panicked. Eye contact and gesture are rarely used.	Speaker is obviously uncomfortable for presentation. No eye contact or

Problem-based learning Presentation Rubric					
Criteria	**Excellent (score = 5)**	**Very good (score = 4)**	**Adequate (score = 3)**	**Limited (score = 2)**	**Poor (score = 1)**
	gestures are presented to support the presentation.		not very effective.		gesture is presented.
Visual tools	Visual aids are very creative, easy to read and greatly enhance presentation.	Visual aids are typically clear and easy to follow.	Visual aids are good in terms of quality, but some points can be improved.	Limited visual aids are used or difficult to help audiences follow the topic.	No visual aids are used, and presentation is not interested by audiences.

Date revised: 2 June 2021