Neur 461 / 592 Neurotransmitters and Neuromodulators

Spring 2021

9:00-10:15 am, Tuesday and Thursday

INSTRUCTOR

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COURSE DESCRIPTION

Traditionally, the brain has been seen and treated like a "bag of chemical soup", where changes in the levels of these chemicals were associated with patterns of behavior and mental disorders. However, an emerging view brings attention for the circuit properties driven by those chemicals, including their specific location of release and specific synaptic alteration to change the flow of information in the brain.

The goal of this course is to explore the neural basis underlying the major chemicals that drive some of our natural behaviors. You will be introduced to the functional organization of the nervous system and its synaptic transmitters and modulators as a basis for understanding behavioral patterns. Specific emphasis will be placed on how chemicals such as serotonin, dopamine, norepinephrine, acetylcholine, glutamate, GABA and their neural circuits underlie the behavioral expression of processes such as motivation, reward, and emotions. We will also explore how dysregulation of specific brain networks can lead to addiction, affective disorders and other mental illnesses. General experimental strategies to study the role of these chemicals and their circuits will be also addressed. Methods covered include behavioral measures, histological procedures, tracing techniques, optogenetics, chemogenetics.

Textbooks:

Nicholls et al., From Neuron to Brain, 5th edition, 2012.

Meyer JS & Quenzer LF, Psychopharmacology: Drugs, the Brain, and Behavior, 3rd edition 2018.

Carter and Shieh, Guide to Research Techniques in Neuroscience, 2010.

Goals and Learning Outcomes:

As a result of completing this course, students will be able to:

1) Understand the basic principles of the central nervous system organization.
2) Describe the organization, synthesis, release and cellular mechanisms of action of neurotransmitters and modulators in specific neural circuits.
3) Demonstrate knowledge of different methods and techniques to study the role of neurotransmitters/modulators at the cellular, anatomical and behavioral levels and describe their strengths and limitations.
4) Acquire an ethical foundation of scientific methods and critically thinking about neuroscientific literature.

ASSESSMENT

#1 Pre-class reading: Before each class, you are expected to read the corresponding literature. It will help you to fully prepare for the course content and discussions in class.

#2 Proposals: You are expected to develop a grant proposal to study the role of a specific neurotransmitter or modulator in the brain using different methods and techniques. The proposal could for example study the circuit properties of a neuromodulator in the control of emotions. The proposal should have 3 pages maximum, and a 4th page with references. It should have the following components:

1. Title – Abstract
2. Introduction/background
3. Two aims
4. Methods/design
5. Expected outcome
6. Future directions

Abstract: Max 150 words. This describes the overall goal of the proposal. I should address the broad topic at hand, the specific issue you are after, what is expected to be found and what outcome might imply for mental health.

Introduction/background: This section is the basis for your research idea. Here you will cite prior literature (use APA style). You will provide a broad overview of the topic and focus why everyone should care. You will then introduce your hypothesis and idea, convincing the reader that it should be interesting and meaningful to be studied.

Two aims: You should have two aims maximum for your proposal. Here is where you will introduce the concept of your hypothesis to be tested based on previous literature research. The aims could be connected to each other as well as totally independent of each other.

Methods/design: This part details the specific of the experimental approaches you would take to execute your idea. Include animal model or human to be used, specifying sex, age, condition and duration of experiments.

Expected outcome: Here you will describe the most likely outcomes of your proposed experiments and what each will mean for both your specific research topic and for the broader literature.

Future directions: In this section describe briefly how your proposed idea can lead to additional research.

Detailed structure will be introduced and discussed in class. Throughout the whole project writing, you will conduct a literature search on the research and methods used in animal models and human subjects (lab experiment and clinical trials). It will help you to recognize the similarity and discrepancy between animal research and human study and identify the limitations of the existing techniques. By recognizing the limitations of the existing methods, you will be able to identify the key issues for studying the role of neuromodulators in neural circuits and behavior.

#3 Presentations & Panel Reviews: In line with our exploration of different experimental approaches, you are expected to present your proposed study. Feedback will be provided by the instructor and your peers for you to finalize your proposal. Your peers will comment on each one of the components of your proposal.

#4 Reflections/discussion forums: We will hold round-table discussions for published articles studying different neurotransmitters and modulators and behavior outcomes. Groups will be formed to survey different issues of specific behavioral responses and answer to a questionnaire.

#5 Final exam: The exam will be used to examine your knowledge of basic principles transmission in the CNS development, neural circuits, behaviors and experimental methodologies.

Class policies:

- E-mail communication with students will be via AU addresses as listed in Blackboard. *If you do not check your AU account, please forward your AU account to the e-mail address that you do check!*
- Absences and deadlines
    - Deadlines are deadlines – please meet them. Late assignments will receive a letter-grade reduction for each day late (A to B for one day late; B to C for two days late, etc.).
    - Missed exams require doctor's note / letter from Dean
- Academic (dis)honesty
    - Standards of academic conduct are set forth in the University's Academic Integrity Code. By registering, you have acknowledged your awareness of the Academic Integrity Code, and you are obliged to become familiar with your rights and responsibilities as defined by the Code. Violations of the Academic Integrity Code will not be treated lightly, and disciplinary actions will be taken should such violations occur. Please see me if you have any questions about the academic violations described in the Code in general or as they relate to particular requirements for this course.
    - Cheating will result in a 0% score on the exam or paper.

- Plagiarism will not be tolerated. You will receive a 0% if *any part* (much less all!) of your written work is copied from another source. Webster's dictionary definition of **plagiarize**: *transitive verb***:** to steal and pass off (the ideas or words of another) as one's own**:** use (another's production) without crediting the source *intransitive verb***:** to commit literary theft **:** present as new and original an idea or product derived from an existing source.

GRADING (TOTAL: 100%)

- Homework and class participation (**5%**)
- Midterm (**15%**)
- Round table discussion 1 (**15%**), Round table discussion 2 (**15%**)
- Proposal presentation (**15%**)
- Submitted written proposal (**20%**)
- Final exam (**15%**)

Final grade point scale:

94 and more points = A	80-83 points = B-	67-69 points = D+
90-93 points = A-	77-79 points = C+	64-66 points = D
87-89 points = B+	74-76 points = C	60-63 points = D-
84-86 points = B	70-73 points = C-	59 and fewer points = F

In cases where the number of points falls in between letter grades, points will be rounded to the nearest whole number. Please do NOT compute your final grade based on a running percentage of individual components.

Grading. Evaluation of a student's performance in this course will be guided by the following general criteria:

A: Demonstration of superior work in fulfillment of course requirements

B: Excellent work in fulfillment of course requirements

C: Satisfactory work in fulfillment of course requirements

D: Assigned work is not satisfactory or not completed and/or student fails to meet minimum attendance requirements

F: Failure to meet minimum course goals, including exams, written assignments, class participation, and other course requirements.

COURSE SCHEDULE

The course schedule is subject to change – any changes will be announced in class and communicated via email. Please read the assigned chapters from the textbook in advance of the day that it is to be covered so that you are better prepared to understand the material discussed in class.

Dates	Topics	Book chapters
01/25	Overview – organization of the CNS-Neurotransmission	Nicholls, Chapter 25
01/27	Neuromodulators I: Serotonin	Meyer and Quenzer, Chapter 6
02/01	Experimental techniques to access serotonergic system	Carter and Shieh, Chapter 12-13
02/03	Neuromodulators II: Dopamine	Meyer and Quenzer, Chapter 5
02/08	Experimental techniques to access dopaminergic system	Carter and Shieh, Chapter 6
02/10	Neuromodulators III: Noradrenaline	Meyer and Quenzer, Chapter 6
02/15	Experimental techniques to access noradrenergic system	Carter and Shieh, Chapter 15
02/17	Neuromodulators IV: Acetylcholine	Meyer and Quenzer, Chapter 7
02/22	Experimental techniques to access cholinergic system	Carter and Shieh, Chapter 4
02/24	Neurotransmitters I: Glutamate	Meyer and Quenzer, Chapter 8
03/01	Experimental techniques to access glutamatergic system	Carter and Shieh, Chapter 4
03/03	Neurotransmitters II: GABA	Meyer and Quenzer, Chapter 8
03/08	Experimental techniques to access GABAergic system	Carter and Shieh, Chapter 4
03/10	Test 1	
03/22	Round-table I – Genetically distinct cell types	Literature review
03/24	Round-table I – Genetically distinct cell types	Literature review
03/29	Round-table I – Genetically distinct cell types	Literature review
03/31	Round-table I – Genetically distinct cell types	Literature review
04/05	Round-table II – Neuromodulatory systems	Literature review
04/07	Round-table II – Neuromodulatory systems	Literature review
04/12	Round-table II – Neuromodulatory systems	Literature review
04/14	Round-table II – Neuromodulatory systems	Literature review
04/19	Proposals presentation	
04/21	Proposals presentation	
04/26	Proposals presentation	
04/28	Proposals presentation	
05/03	Proposals due	
05/05	Review class	
05/12	Final exam	