BIOL 640-001: Intro to Neurophysiology

COURSE SCHEDULE:	**M, R: 2:30 -3:50 PM**
INSTRUCTOR:	**Dirk Bucher**
OFFICE HOURS:	**M, R: 11 am -12 pm or by appointment (zoom)**
COURSE WEBSITE:	**NJIT Canvas (https://canvas.njit.edu/)**

COURSE SUMMARY

This course will examine the nervous system from a functional perspective. The goal is to understand how ion channels and other components of nerve cells give rise to electrical excitability and synaptic function, and how those properties are then used for information coding and higher order function in the nervous system.

TEXTBOOK

“From Neuron to Brain", 5th ed, Nicholls et al.; Sinauer 2012; ISBN 9780878936090. Other materials will be provided. Be sure to have access to Canvas, login with UCID.

LEARNING GOALS

At the end of the course students will be able...

- to understand in some detail how electrical and chemical signaling within and between nerve cells works,
- to understand the experimental and theoretical approaches used to study neurophysiology, both for basic research and medical diagnostics,
- to understand fundamental principles of how the nervous system uses electrical activity to encode and decode information about the outside world and internal states,
- to further develop critical thinking and communication skills. This will be measured in the ability to interpret graphs, experimental designs, and problem discussion. Students will be required to participate in instructor-led discussions of the material as they analyze problems and propose possible mechanisms used by neurons to solve them. Weekly quizzes will be used to test some of these goals and reinforce the learning of the material. The midterm exams will require to independently apply the learned concepts to understand novel material.

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COURSE OUTLINE

- Introduction and course overview – What is Neurophysiology?

Section 1: Intrinsic neuronal properties

- Neurons and glia cells: Morphological and molecular diversity
- Membrane potential I: Ions, channels, Nernst Equation
- Membrane potential II: GHK equation and equivalent circuit
- Passive properties: Input resistance, capacitance, length constant, time constant
- Action potential I: Ionic mechanisms
- Action potential II: Hodgkin-Huxley formalism, propagation, myelination
- Diversity of voltage-gated channels: molecular identities and effect on neuronal firing

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Section 2: Synaptic signaling

- Electrical and chemical transmission: Gap junctions, crayfish escape system, frog neuromuscular junction.
- Central synapses, small molecule transmitters and ionotropic receptors.
- Metabotropic transmission, GPCRs, 2nd messenger signaling.
- Transmitter release I: Quantal analysis.
- Transmitter release II: SNARE complex, vesicle pools, postsynaptic receptors.
- Transmitter types: Synthesis, transport, release, re-uptake and degradation.
- Types of communication: Transmitters, neuromodulators, neurohormones.
- Synaptic plasticity I: Short-term synaptic dynamics.
- Synaptic plasticity II: Long-term synaptic dynamics. Aplysia gill withdrawal, LTP, LTD

Section 3: Sensory transduction mechanisms and simple coding principles

- Sensory transduction, modalities, coding principles.
- Somatosensory and auditory coding
- Visual and chemosensory coding
- Motor coding: posture and movement control

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GRADING POLICY AND SCALE

Assignment	%
Participation & Weekly Quizzes	20
Midterm Exam I (take-home problem set)	25
Midterm Exam II (take-home problem set)	25
Final Exam (in-class)	30
TOTAL	**100**

Grading Scale	
A	88.1 - 100
B+	80.1 - 88
B	73.1 - 80
C+	66.1 - 73
C	60.1 - 66
F	0 - 60

IMPORTANT RULES AND POLICIES

- If you miss an exam due to a valid excuse, medical or other, you need to provide valid and verifiable documentation to the Dean of Students Office and ask them to inform the instructor. Make-up assignments will be determined on a case-by-case basis.
- Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy. Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office.

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Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office.

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BIOL 441/640 - Tentative Schedule FALL 2023

	Date	Lecture Topic
	Thu, Sep 7	Introduction and course overview – What is Neurophysiology?
INTRINSIC NEURONAL PROPERTIES AND EXCITABILITY	Mon, Sep 11	Neurons and glia cells
	Thu, Sep 14	Membrane potential
	Mon, Sep 18	Membrane potential
	Thu, Sep 21	Passive properties
	Mon, Sep 25	Passive properties
	Thu, Sep 28	Active Properties: action potentials
	Mon, Oct 2	Active Properties: action potentials
	Thu, Oct 5	Active Properties: diversity of voltage-gated channels
	Mon, Oct 9	*Review, Examples, and Exercises*
	Thu, Oct 12	**MIDTERM I**
SYNAPTIC SIGNALING	Mon, Oct 16	Electrical and chemical transmission
	Thu, Oct 19	Ionotropic receptors.
	Mon, Oct 23	Metabotropic receptors
	Thu, Oct 26	Transmitter release
	Mon, Oct 30	Transmitter release
	Thu, Nov 2	Short-term synaptic plasticity
	Mon, Nov 6	Long-term synaptic plasticity
	Thu, Nov 9	Neurotransmitters
	Mon, Nov 13	Neuromodulation
	Thu, Nov 16	*Review, Examples, and Exercises*
	Mon, Nov 20	*Review, Examples, and Exercises*
	Tue, Nov 21	**MIDTERM II**
SENSORY TRANSDUCTION AND CODING PRINCIPLES	Thu, Nov 23	THANKSGIVING
	Mon, Nov 27	Sensory transduction
	Thu, Nov 30	Somatosensory and auditory coding
	Mon, Dec 4	Visual and chemosensory coding
	Thu, Dec 7	Posture and movement control
	Mon, Dec 11	*Review, Examples, and Exercises*
	TBD	**FINAL**