Fall 2020

BIOL 640-001: Cellular Neurophysiology

Dirk Bucher

NJIT BIOLOGY

Course Syllabus

Fall 2020

BIOLOGY 640: Cellular Neurophysiology

INSTRUCTOR:	Dirk Bucher (bucher@njit.edu)	
VIRTUAL OFFICE HOURS:	M: 4-5 pm, R: 4-5 pm, or by appointment	
COURSE SCHEDULE:	M, R: 2:30 -3:50 pm, synchronous online	**COURSE WEBSITE:** Canvas

This course is online, but please follow the requirements below for all on-campus activities:

COVID-19 SAFETY REQUIREMENTS

All persons physically present in any department facility or classroom shall comply fully with the NJIT COVID-19 safety policy at all times. Masks must be worn before entry to all department facilities, and social distancing guidelines must be followed. Individuals who are unable to wear a face mask due to medical reasons should contact the Office of Disability Services or Human Resources. Students who enter a classroom without wearing a mask properly, or remove their mask, will be cautioned by the instructor. The same is true for students who disregard the seating order or guidelines for social distancing. Students with obvious symptoms of respiratory illness should not come to campus and will be asked to leave. Students who do not comply with a request by a department instructor to adjust their behavior, in accordance with the University Policy, will be subject to disciplinary actions. Instructors have the right to expel the student or terminate the class session at which any student fails to comply with the University Policy.

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 coding information and higher order function in the nervous system.

TEXTBOOK:

"From Neuron to Brain", 5th ed, Nicholls et al.; Sinauer 2012; ISBN 9780878936090. 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.

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GRADING POLICY & SCALE:

Assignment	Percentage
Participation in discussions and ungraded quizzes	10%
2 Midterm Exams	60%
Final Exam	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

☒ Academic Integrity Code is strictly enforced.

☒ If you miss an exam due to a valid medical excuse you need to provide a doctor's note or other valid and verifiable documentation. The grade of exams missed for a valid reason will be determined on a case-by-case basis

SCHEDULE AND COURSE OUTLINE: Class will meet twice every week, unless otherwise noted.

- 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

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