Fall 2021

BIOL 640-001: Cellular Neurophysiology

Dirk Bucher

Course Syllabus

BIOL 640-001: Cellular Neurophysiology

COURSE SCHEDULE:	**M, R: 2:30 -3:50 PM**
INSTRUCTOR:	**Dirk Bucher**
OFFICE HOURS:	**M, R: 11 am -12 pm or by appointment (Webex)**
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. 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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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	25
Midterm Exam II	25
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

- University Code of Student Conduct is strictly enforced.
- If you miss an exam due to a valid excuse, medical or other, you need to provide valid and verifiable documentation to the Office of The Dean of Students and ask them to inform the instructor. Make-up assignments will be determined on a case by case basis.

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