

...the "content" of a medium is like the juicy piece of meat carried by the burglar to distract the watchdog of the mind. - Marshall McLuhan (1964)

NSC 248  
Spring, 2007

**Class:** Taylor 6, TR, 11:00am – 12:15pm  
**Lab:** New Science 124, W, 8:00 – 10:50 (01) or 1:30 – 4:20 (02)

# NEUROBIOLOGY

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Office Hours: W, 11:00 – 1:00, and by appointment

## COURSE DESCRIPTION

An exploration of the molecular, cellular, and physiological, and developmental foundations of nervous system function. Topics discussed will include the ionic and electrical properties of neurons; the biochemistry of synaptic signaling; neuronal and synaptic plasticity; basic neuronal circuits; the development and target specification of neurons; and neuroendocrine regulation. Relevant primary literature will be introduced through class discussions and independent critical analyses. A laboratory will introduce the research methods of anatomy and neurophysiology and will culminate in a student-driven independent project. Three class hours and three laboratory hours per week. *Prerequisite: BIO 152*

## MAJOR COURSE QUESTIONS

- How is information neurally coded in the central nervous system?
- How do the electrical properties of ion channels allow neurons to communicate?
- How is neurotransmission regulated at the molecular level?
- How are multiple signals integrated within the nervous system?
- How do neurons “wire up” to underlie complex processes of the brain, including sensation and learning?

## COURSE TEXTS

### Required text

- Tutorial Reader (Available electronically on **Blackboard**)

### Recommended text

- Nicholls JG, Martin AR, Wallace BG, Fuchs PA (2001) *From Neuron to Brain*, 4<sup>th</sup> edition. Sinauer, Sunderland, MA. ISBN # 0-87893-439-1

This text is recommended rather than required – all class examinations will be based on my lectures, your tutorials, and our ensemble class discussions. I abhor textbooks as a rule. That being said, I believe that this text is arguably one of the most concise and clearheaded in neurobiology – it will be a great resource to you as you learn to unpack complex data in this field.

## ACADEMIC BEHAVIOR CODE

All assignments are to be completed in line with the Academic Behavior Code of Muhlenberg College. *I have zero tolerance for academic dishonesty.* By submitting work in this class, you are pledging that your work is not plagiarized and is representative of only your ideas. Please be sure to read the Code carefully (the complete version is in your Student Handbook).

## ASSIGNMENT SUMMARY

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### Literature Tutorial

**75 points**

As a group of 4-5, you will present and lead a discussion on an assigned reading from the literature. The goal of this assignment is to get you thinking about how to interpret the data of a current research approach in cellular and molecular neuroscience.

- I Feb 8 Jordt and Julius (2002) :: Molecular basis for species-specific sensitivity to "hot" chili peppers
- II Feb 22 Hosie et al (2006) :: Endogenous neurosteroids regulate GABA(A) receptors through two discrete transmembrane sites
- III Mar 22 Hlavackovat et al (2005) :: Evidence for a single heptahelical domain being turned on upon activation of a dimeric GPCR
- IV Mar 27 Han et al (2004) :: Transmembrane segments of syntaxin line the fusion pore of Ca<sup>++</sup>-triggered exocytosis
- V April 19 Liberles and Buck (2006) :: A second class of chemosensory receptors in the olfactory epithelium
- VI May 3 Gray et al (2005) :: A circuit for navigation in *C. elegans*

### Examinations

**100 points each**

Written examinations will assess writing skills, basic neurobiology knowledge, research methods, problem-solving skills, and theory-making abilities. The final examination will **not** be cumulative but will be counted as a third examination.

Exam I	Monday, Feb 26	7:00pm	Trumbower 140	Jan 16 – Feb 20, Tutorial I
Exam II	Monday, April 2	7:00pm	Trumbower 140	Feb 22 – March 27, Tutorials II, III
Exam III	TBA, Finals Week	TBA	TBA	March 29 – May 3, Tutorials IV-VI

### Laboratory

**100 points**

Your laboratory grade will be based on active participation in all laboratory endeavors; professionalism in your personal laboratory projects; and effective, concise laboratory reports (see below).

### Class participation

**50 points**

This course depends on regular and engaged participation. Please come to class ready to critically approach the work. Your facility in discussing assigned readings, your commitment to class material, and your professionalism will be used to assign participation grades; therefore, a missed class can significantly affect your final grade. Should you miss class, you are responsible for obtaining any material you may have missed from your class colleagues.

### TOTAL

**525 points**

## EVALUATION

Grades will be assigned based on the sum of the total points you obtain by the end of the semester. Your score will be divided by 525 points and will be translated into a letter grade as follows: A+ = 100-97%, A = 96-93%, A- = 92-90%, B+ = 89-87%, B = 86-83%, B- = 82-80%, C+ = 79-77%, C = 76-73%, C- = 72-70%, D = 69-60%, F = 59% and below.

## **MISCELLANY**

- All assignments are due on the date indicated. **I do not** grant extensions on papers or exams except in case of a medical emergency (documentation required). I will accept late assignments but please bear in mind that they will be penalized for each day that they are past due.
- If you will be unable to make an evening examination due to a scheduling conflict, you must let me know **at least one week** in advance so that we may find a mutually suitable time for you to take the exam.
- Please turn in written work with a single staple in the upper left hand corner. Make sure that your paper is typed, bears your name and the date, is paginated, uses 10, 11, or 12 point font, and has been proofread for grammar and spelling errors.
- Please let me know if you have a documented learning disability that will require special accommodation. I will be glad to assist you.

## **LABORATORY PREPARATION**

- Please maintain a laboratory notebook. Notebooks should contain information about (a) the research method used, including any hook-up diagrams or protocols followed; (b) the research question under study; and (c) the dates of the work and any personnel with whom you worked. I may request to examine your notebook at any time.
- The laboratory sequence is intended to more fully flesh out concepts we'll encounter in class. However, there is not a neat 1:1 correspondence between class concepts and lab concepts. You may need to do some background reading on your own if you are having trouble following a laboratory exercise.
- Laboratory studies are not designed to work perfectly again and again. Science does not guarantee beautiful, easy acquisition of data. The absence of "perfect" data is an opportunity to take a critical look at the conditions of your experiment.
- I purposefully run the laboratory in a friendly, un-canned manner. However, please do not mistake this as "informality" or as a space without rules. Any experimentation takes patience, sharpness of wit, and more patience – but most importantly, experiments require formality and dedication. Please enjoy the collegial atmosphere of the lab while remaining professional and dedicated to the research at hand.
- Laboratory exercises – like life – are an opportunity to minimize fear and maximize self-knowledge.

# COURSE CALENDAR

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Tuesday, January 16

Introductions

Foundational motifs

- Nicholls, Chapter 1

Thursday, January 18

Biophysics of the resting potential

- Nicholls, Chapters 2, 5 & 6

Tuesday, January 23

Biophysics of the action potential

- Nicholls, Chapters 5 & 6

Thursday, January 25

The voltage clamp

- Nicholls, Chapter 6

Tuesday, January 30

Cable properties of neurons I: Passive electrical properties

- Nicholls, Chapter 7

Thursday, February 1

Cable properties of neurons II: Saltatory conduction

- Nicholls, Chapter 7

Tuesday, February 6

Voltage-gated ion channel structure

- Nicholls, Chapters 2, 3, & 6

Thursday, February 8

**Literature Tutorial I**

Some comments on the inactive state of voltage-gated ion channels

- Nicholls, Chapters 2, 3, & 6

Tuesday, February 13

Endplate and synaptic potentials

- Nicholls, Chapter 9

Thursday, February 15

Ionotropic receptor structure

- Nicholls, Chapters 2 & 3

Tuesday, February 20

Ionotropic receptor gating and the patch clamp

- Nicholls, Chapters 2 & 3

Thursday, February 22

**Literature Tutorial II**

Metabotropic receptor structure and function I

- Nicholls, Chapter 10

**Monday, February 26 :: Exam I :: 7:00pm**

Tuesday, February 27

Metabotropic receptor structure and function II

- Nicholls, Chapter 10

Thursday, March 1

G protein signal transduction

- Nicholls, Chapter 10

**Tuesday, March 6 and Thursday, March 8 :: NO CLASS – Spring Recess**

Tuesday, March 13

Neurotransmitter release: Role of Ca<sup>++</sup>

- Nicholls, Chapters 11 & 13

Thursday, March 15

Neurotransmitter release: Fusion pore biophysics

- Nicholls, Chapters 11 & 13

Tuesday, March 20

Quantal release of neurotransmitter I

- Nicholls, Chapter 11

Thursday, March 22

**Literature Tutorial III**

Quantal release of neurotransmitter II

- Nicholls, Chapter 11

Tuesday, March 27

**Literature Tutorial IV**

Neurotransmitter reuptake

- Nicholls, Chapters 11 & 13

Thursday, March 29

Some comments on neurotransmitter localization in the CNS

- Nicholls, Chapters 13 & 14

**Monday, April 2 :: Exam II :: 7:00pm**

Tuesday, April 3

Synaptic plasticity in the short-term

- Nicholls, Chapter 12

Thursday, April 5

Synaptic plasticity in the long-term

- Nicholls, Chapter 12

Tuesday, April 10

Physiological roles of glial cells

- Nicholls, Chapter 8

Thursday, April 12

Olfactory and gustatory receptors I

- Nicholls, Chapter 17

Tuesday, April 17

Olfactory and gustatory receptors I

- Nicholls, Chapter 17

Thursday, April 19

**Literature Tutorial V**

Brain circuits of olfaction

- Nicholls, Chapter 17

Tuesday, April 24

Circuit properties and motor behavior of the leech

- Nicholls, Chapter 15

Thursday, April 26

Motor circuits I

- Nicholls, Chapter 22

Tuesday, May 1

Motor circuits II

- Nicholls, Chapter 22

Thursday, May 3

**Literature Tutorial VI**

Course trajectory, concluding comments, and synthesis

**TBA, Finals Week :: Exam III :: TBA**