BIOLOGY 360 NEUROBIOLOGY
Autumn 2019 - SYLLABUS

COURSE DESCRIPTION: Understanding the inner workings of the brain is the goal of neuroscience. Neuroscience is a vast, rapidly evolving and exciting area ranging from elucidating neuronal function at the molecular and cellular levels to providing mechanistic explanations of higher level cognitive function. The goals of this course are: 1) to provide an underpinning of basic neuroscience principles, and 2) to prepare students for 400 level neuroscience courses at the University of Oregon. The course is divided into two parts: the first part focuses on the cellular and molecular mechanisms and principles responsible for proper neuronal function at the level of a single nerve cell. The second half of the course surveys a variety of topics at the systems, developmental, cognitive and medical neuroscience levels.

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COURSE WEBSITE: https://canvas.uoregon.edu/

TEXTS and VIDEOS (copies of all texts are on 2 hr reserve in the Science Library)

1) Kandel, Schwartz, Jessell, Siegelbaum and Hudspeth (K), *Principles of Neuroscience*, 5th Edition, Elsevier (2014). Lucidly written, extremely comprehensive, expensive neurobiology text with more clinical coverage than other texts. Recommended for those wanting a first-rate, wide-ranging neuroscience reference text. *N.B*., Other UO Neuro courses use this text.

2) Nicholls, Martin, Fuchs, Brown, Diamond & Weisblat (N), *From Neuron to Brain*, 5th edition, Sinauer (2012). Provides deeper coverage of fewer issues than Kandel and is an easier read. Experimental emphasis plus a more historical approach.

3) Sacks, *The Man Who Mistook His Wife for A Hat*, Harper and Row (1985). **REQUIRED READING.** This inexpensive paperback provides a very different view of neuroscience. The organization of the Sacks book does not correlate with that of the lecture schedule, hence you are responsible for chapters 1-12 for Exam #1 and the rest for Exam #2.

4) Videos: Harvard's Fundamentals of Neuroscience course (MCB) has numerous online videos available to the general public free of charge. These provide an excellent overview of the material covered in Bi 360. These can be accessed at https://www.mcb80x.org/map. It is highly recommended that you view the videos, preferably prior to the assigned lecture. You are also encouraged to view other adjunct MCB course videos not specifically assigned (*e.g.,* the labs and special topics are particularly useful).

LECTURE #, DATE, & SUBJECT (READING/VIDEO ASSIGNMENTS)

1) 01 Oct **COURSE OVERVIEW & INTRODUCTION:** history of neuroscience; structure of neurons; signaling in CNS; recording techniques; stretch reflex (K, Ch. 1 & 2; N Ch. 1; Appendix A in K and N; MCB, Intro).

2) 03 Oct **IONIC BASIS OF RESTING POTENTIAL:** ionic distribution in neurons; Nernst equation (K, Ch.6; N, Ch. 6; MCB, Resting Potential).

3) **08 Oct** **CONTROL OF IONIC PERMEABILITY:** action potentials; voltage clamp; Na-K pump (K, Ch. 7; N, Ch. 7; MCB, Action Potentials & Action Potential Propagation).

4) **10 Oct** **CHANNELS:** calcium action potentials; distribution of excitability (K, Ch. 6; N, Ch. 5; MCB, Action Potentials & Action Potential Propagation).

5) **15 Oct** **PASSIVE PROPERTIES OF NEURONS:** cable theory; time & length constants; action potential propagation (K, Ch. 6; N, Ch. 8; MCB, Passive Membrane Properties).

6) **17 Oct** **SYNAPSES I:** electrical synaptic transmission; intro to chemical synaptic transmission; synaptic potentials (K, Ch. 8 & 9; N, Ch.11 & 12; MCB, The Synapse).
ASSIGNMENT #1 DUE.

7) **22 Oct** **SYNAPSES II:** reversal potentials; transmitter-dependent channels; IPSPs; post-synaptic inhibition (K, Ch. 10; N, Ch. 12 & 13; MCB, Excitation & Inhibition).

8) **24 Oct** **SYNAPSES III:** control of transmitter release; quantal & vesicle hypotheses; MEPPs & role of calcium (K, Ch. 12; N, Ch. 13; MCB, The Synapse & Simple Circuits).

9) **29 Oct** **TRANSMITTERS:** neurotransmitter criteria; acetylcholine, biogenic amines; amino acid transmitters; peptides (K, Ch. 13; N, Ch. 14 & 15; MCB, Neuromodulators).

10) **31 Oct** **EXAM #1** (in class, open or closed book exam determined by a vote of the class)

11) **05 Nov** **SENSORY SYSTEMS I:** General properties of sensory systems; chemical senses overview; olfaction (K, Ch. 21 & 32; N, Ch. 19; MCB, The Other Senses & Brain Anatomy sections on gustation and olfaction).

12) **07 Nov** **SENSORY SYSTEMS II:** central processing of olfactory information; gustation (K, Ch. 32; Ch.13; N, Ch. 19; MCB, The Other Senses & Brain Anatomy sections on gustation and olfaction).

13) **12 Nov** **CONTROL OF MOTOR PATTERNS I:** reflexes; fixed action patterns; central pattern generators; simple neural networks (K, Ch. 33-34 & 36; N, Ch. 18; MCB, The Motor System, Brain Anatomy section on Motor Systems & Simple Circuits section on central pattern generators).

14) **14 Nov** **FILM (TBA)**

15) **19 Nov** **CONTROL OF MOTOR PATTERNS II:** Complex motor patterns; fish swimming; hatching in chicks; human infant behavior (K, Ch. 33-34 & 36; N, Ch. 18; MCB, The Motor System, Brain Anatomy section in Motor Systems & Simple Circuits section on central pattern generators).**ASSIGNMENT #2 DUE.**

16) **21 Nov** **NEURONAL PLASTICITY I:** Memory systems; non-associative learning including mechanisms underlying habituation, sensitization and dishabituation; (K, Ch. 65-67; N, Ch. 16; MCB, Potentiation & Depression).

17) 26 Nov **NEURONAL PLASTICITY II:** Long-term potentiation; mechanisms underlying associative learning; other types of neural plasticity (K, Ch. 65-67; N, Ch. 16; MCB, Potentiation & Depression).

18) 28 Nov **NO LECTURE** (Thanksgiving).

19) 03 Dec **CNS DISORDERS:** Alzheimer's and Parkinson's (K Ch. 14 & 44; N, not available)

20) 05 Dec **COURSE WRAP-UP:** Discussion of Sacks book and movie; Brief overview of other areas of neuroscience; Discussion on the future direction of brain research. Is there a continuing need for animal research? ***N.B.*, The class will decide whether Exam #2 is a 24 hr, open book, take home exam or a closed book exam. If the former, Exam #2 will be handed out in class on 05 December and will be due the following day, Friday 06 December. If the latter, the exam will be given during Exam Week.**

DISCUSSION SCHEDULE

Weeks 1-8: Discussion sections at usual times

Week 9: No discussion (Thanksgiving week)

Week 10: No discussion if Exam #2 is due on Friday 06 December.

ASSIGNMENTS

Grading of each paper will be based on the insightfulness, quality and depth of your discussion and the clarity of your writing (100 pts maximum). Points will be taken off for superficial analyses or poor/imprecise writing. Papers must be typed and stapled. ASSIGNMENTS ARE DUE AT THE BEGINNING OF CLASS. Papers longer than the maximum length or assignments submitted late will have 10 points deducted from your score.

ASSIGNMENT #1: Report on a primary scientific paper (DUE: 17 October at 10:00 am; 3 double spaced pages maximum; 100 points maximum). A prerequisite to being a biologist of any sort, even a physician, is the ability to read and critically evaluate the primary scientific literature. The goal of this assignment is to help develop these essential skills.

Your assignment is to read and write a short report on a primary scientific neuroscience paper published in the past 5 years. The key word here is "primary"; you must read and report on an experimental paper written by those who performed the work rather than a review of that work. A good rule of thumb is that if the paper has a Materials and Methods section, then it almost certainly is a primary scientific paper. Papers can be on any neurobiological topic from any primary journal. You may choose a paper from a recent neuroscience journal such as *Journal of Neuroscience, Journal of Neurobiology, Neuron, Journal of Neurophysiology,* and *Neuron.* Other journals with neuroscience papers may also be used (*e.g.*, *Journal of Experimental Biology*). *Nature* and *Science* are also good sources of interesting neurobiology papers. Review articles are not appropriate. If you are unsure about the paper you have chosen, check with me or your TAs first. You may also find it useful to read other papers related to the one you are reading. The most useful related papers are generally those cited in the references.

You must specifically and fully answer the following questions in order. Please number each answer.

1. What is the title of the paper, who are the author(s), and where was it published (journal, volume, page numbers, year)? Please attach a copy of the title page and abstract. (10 points)

2. What is (are) the major scientific issue(s) addressed by the paper? What is (are) the specific experimental hypothesis (hypotheses) posed in the paper? (15 points)

3. What were the results for each experiment? (25 points)

4. What did the author(s) conclude from the results? Are their conclusions justified? (25 points)

5. Based on these results, what two experiments should the researchers do next? (25 points)

ASSIGNMENT #2: Report on an unsolved neuroscience question (DUE: 19 November at 10:00 am; 3 double spaced pages maximum; 100 points maximum). There are literally hundreds of intriguing neuroscience questions not yet understood. Choose one and write a short paper describing it, its importance and possible approaches to its solution. At least 3 scientific references are required; Wikipedia is not allowed.

Your paper must have the following format (please organize your paper with the following subheadings):

A. Background and Significance (12 points): Be organized – use subheadings when possible. Make sure the significance of the topic is explicitly stated. Clearly state the gaps in knowledge.

B. Main Hypothesis (8 points): Clearly state your hypothesis. Briefly explain the experimental design to test the hypothesis (*N.B.,* experimental design differs from the methods section. The former describes the approach for testing the hypothesis, not the technical procedural details of the experiment).

C. Rationale (10 points): How does the experimental design test your hypothesis? What is your reasoning?

D. Methods (16 points): List general approaches first, explaining why the methods you propose are the best available for your questions. Be as specific as space allows. Include your approaches to statistical analyses.

E. Anticipated Results (30 points): Explain how your data will be analyzed and all potential outcomes of your experiments and their likelihood. Explain your interpretation of the different possible results and how they relate to your hypotheses.

F. Problems and Pitfalls (24 points): This section serves as a reality test of your proposed experiment. Be honest and explain pitfalls and problems with your experiments and how alternative approaches will be used if they occur. All experiments have potential problems so not including these indicates you have not thought carefully about your experiment. If this section feels uncomfortable, it is because you are probably proposing an experiment that is not feasible.

Common Mistakes observed for Assignment #2

Background and Significance: Neither significant nor interesting; Lack of compelling rationale; Incremental and low impact research; Lack of new or original ideas

Main Hypothesis: Too ambitious, too much work proposed; Unfocused aim, unclear goal; Limited aim and uncertain future direction

Experimental Design: Not enough detail; Lack of appropriate controls; Not directly testing hypothesis; Correlative or descriptive data; Experiments not directed towards mechanisms

Methods: Not enough detail but don't include too much to conserve space for the other sections

Anticipated Results: Insufficient discussion of proper data analysis and interpretation of data

Problems and Pitfalls: No discussion of potential pitfalls and alternative models or hypotheses

Formatting Problems: Exceeds 3 pages; Grammatical and/or spelling errors

GRADING POLICY

Your course grade will be based on your performance on four assessments, two exams and two written assignments. Each exam/assignment will count as 25% of your course grade.

The exams will be graded on a modified curve. A numerical score will be assigned and converted to a letter grade. The class will choose whether Exam #1 will be an open or closed book in class exam and whether Exam #2 will be an open book take home or a closed book exam.

The assignments will be graded out of a 100 pts maximum and converted to a letter grade using the following conversion scale:

97-100	A+
94-96	A
90-93	A-
87-89	B+
84-86	B
80-83	B-
77-79	C+
74-76	C
70-73	C-
67-69	D+
64-66	D
60-63	D-
<60	F

Your course grade will be the average of the mean of the exam letter grades and the mean of the assignment letter grades.

ALTERNATIVE GRADING METHOD: If you wish, you may skip Exam #2 and instead write a 5 page paper on any topic in neuroscience. That paper will be due when Exam #2 is due and will be graded pass/fail. If you choose this method and receive a pass on your paper, your first exam will count for 50% of your course grade. You can make your decision about this method as late as the last day of class.

PLEASE NOTE: There are no make-up exams. A missed exam will be graded an "F" unless arrangements are made in advance of the scheduled exam. A late paper or one longer than the 3 page maximum will have 10 pts deduced from its score.

LEARNING OUTCOMES: By the end of the course, students should be able to:
1) Describe the known cellular and molecular mechanisms responsible for neuronal function at the single neuron level;
2) Explain the basic principles of sensory transduction and processing;
3) Articulate the general concepts underlying motor control;
4) Know the basic cellular and molecular mechanisms underpinning associative and non-associative learning;
5) Understand the symptoms, etiology and treatment alternatives of several nervous system disorders;
6) Read and comprehend primary and review papers in neuroscience;
7) Develop an understanding of living with a neurological disorder;
8) Identify an unanswered question in neuroscience, develop a testable scientific hypothesis to explore the question, design an experiment to test the hypothesis, and critically evaluate potential outcomes of the experiment;
9) Improve critical thinking and oral and written expression skills, and,
10) Enroll and perform well in 400 level neuroscience courses at the University of Oregon.