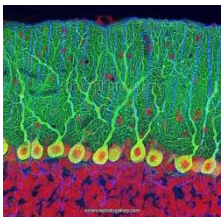
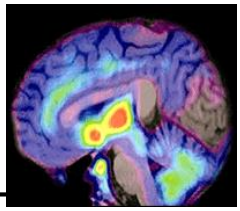


NEUROBIOLOGY 384

GUSTAVUS ADOLPHUS COLLEGE

AUTUMN 2016



COURSE DESCRIPTION

We will study nervous systems by integrating, rather than compartmentalizing, the hierarchical levels of organization: from cellular and molecular, to circuits, to behavior. In this biology course we will discuss how information is carried by nervous tissue by examining the electrochemical properties of resting and action potentials, signal propagation and synaptic transmission. We will also examine the transduction and processing of sensory information, neural control of motor systems, regulation of sleep and eating, neural plasticity (learning and memory), brain disorders and the development and evolution of the nervous system. **We will follow a discovery-based approach to learning each scientific storyline by reading and interpreting results from key experiments. The focus is on how we come to know what we know, rather than just knowing.** Along the way, we will learn about the modern tools used by neurobiologists to explore the wonders of the brain.

This course will be taught at an intermediate to advanced level for students who have successfully completed either PSY 260 or the biology core sequence.

The goals of this course:

- To develop a strong background in the fundamental principles of neurophysiology.
- To apply integrative thinking as a way of understanding the biological basis of nervous system function.
- To demonstrate that higher order processes like behavior and cognition emerges from neural circuits and the activity of an ensemble of neurons.
- To demonstrate how structure and function is plastic in response to environmental and genetic influences.
- To understand the underlying mechanisms of some major neurological diseases and syndromes.
- To learn basic electrophysiological and behavioral techniques as a way to explore the properties of neurons and neural systems.
- To become confident and adept in the critical analysis of novel findings in the broad literature of neuroscience.
- To improve skills in communicating and analyzing empirical results.

It is a great time to be a neuroscientist! — (1) funding for basic and clinical neuroscience research remains strong even within a tight economic climate (see President Obama's recent launch of the BRAIN initiative http://www.whitehouse.gov/infographics/brain-initiative) and the Society for Neuroscience newsletter below (2) the employment prospects for talented, young neuroscientists in the academic, government, and commercial sectors are extremely promising, and (3) above all, we now have the tools and the knowledge base to approach what was previously unapproachable in our quest to understand behavior and to develop treatments for neurological diseases and disorders.

INSTRUCTOR

Mike Ferragamo
office: Beck Hall 247
phone: 933-6369
email: mferrag@gac.edu Responses usually within 24 hours, except during weekends.

Office Hours: Monday and Wednesday 1:30-2:30 pm or by appointment on Google calendar.

CLASS MEETINGS (M, W 2:30-4:20 AM IN BH 211)

Attendance and participation in class is absolutely essential to your success in this course. Each week you will be expected to contribute to discussions of reading material and participate in class activities. If you come to class regularly you will discover that exams will emphasize the material from lecture. On Monday of each week you should check the course Moodle site for an update of the lecture notes, readings, and lab instructions.

Please, absolutely no texting while in class or lab is in session.

Moodle: http://moodle.gac.edu/ after you log in please select 2016 f-bio-384-001
Class email alias: f-bio-384-all (for lab section only, replace the "all" with your section number: Tu 03, Th 04)

LABORATORY MEETINGS (T, TH 1:30-4:20 PM IN BH 214)

There is a separate laboratory syllabus that provides details on laboratory schedule, assignments and expectations. We will discuss the organization of the lab early in the semester. You will be expected to keep the lab clean and the instrumentation well maintained. Some of the labs are prescribed, but there may be some opportunity for you to learn how to do science by designing and conducting novel experiments. The facilities to do these experiments were made possible by an award to the instructor from the National Science Foundation.

GENERAL ORGANIZATION OF COURSE TOPICS

Following an introduction, the course will be divided into general sections:

1. Generation, propagation and communication of neural signals
2. Circuits: Sensory systems and motor control
3. Regulation
4. Synaptic Plasticity
5. Brain Disorders
6. Evolution and development of nervous systems

It will be a challenge to cover each of these areas in adequate detail — but we will try to cover as much as we can in the time allowed. **Please keep in mind that the material in the first section serves as the basis for understanding all later topics.** Our textbook is highly suited to our adopted integrative, discovery–based approach.

READINGS AND SOFTWARE

1. Textbook:

Principles of Neurobiology (2015, Garland)
Liqun Luo

2. Neural Simulation CD-ROM (not for purchase, available in lab and may be used by instructor during lecture):

Neurons In Action V2
John W. Moore, Ann E. Stuart
During lecture session you may perform neurosimulations to replicate some of the 'classic' experiments in neurobiology.

3. Literature comprising primary and review articles will be posted on the course website. Expect exams to draw material from both the textbook and supplemental reading material.

TO FACILITATE CLASS DISCUSSIONS YOU SHOULD READ THE MATERIAL BEFORE CLASS TIME.

COURSE GRADING
Your final grade in this course will be based upon several criteria. Generally, grades will be calculated according to the following:

Exams I, II, III	50%
Laboratory Assignments	35%
Quizzes, Reading Questions	10%
Discussion	5%

Writing in the discipline (WRIT-D)
Neurobiology (BIO384) is a WRIT-D course as approved by the GAC curriculum committee

WRITD courses "*allow students to write in ways that exemplify the structures, genres, and conventions of a specific discipline."* excerpt from the Gustavus curriculum committee (2006)
There will be four laboratories in which you will report results in the form of a partial or whole article similar in style and format to one published in a peer-refereed neuroscience journal (eg, Journal of Neuroscience). All of you have experience writing lab reports in the style standard to most social and natural scientific disciplines**.** To do so, you may refer to *Writing Papers in the Biological Sciences* by Victoria McMillan; Bedford/St Martins: Boston, 1997. There is a copy available in the lab and one will be placed on reserve in the library. Standard practice is to read primary literature as the basis for an introductory section that motivates your study, and is later used in the discussion to interpret your results within a broader context. A methodology section includes a precise description of procedures and analytical techniques and should be written with sufficient clarity for potential replication of the experiment by others. The results section describes the findings by referring to the product of the analyses typically displayed in the form of figures and tables. The paper is preceded by a stand-alone database-ready abstract, and concludes with a reference section. For some assignments a minimum number of references to *primary* sources will be required – please ask if you have questions on the relevance or quality of those resources.

WRITD courses *"should provide students with opportunities to revise their work with an instructor's feedback."* excerpt from the Gustavus curriculum committee (2006)
For two lab assignments you will be provided with an opportunity for revision to address comments and suggestions regarding improvement of both form and content. Since you will only have a few days to address the revisions you should make a sincere effort to treat your original submission as your final one.

LITERATURE QUESTIONS AND DISCUSSION
We will devote a substantial amount of time to the practice of reading and discussing primary and review articles from leading journals to supplemental textbook material. As you progress in your scientific career you will become less dependent upon textbooks and increasingly favor peer-refereed journals to obtain a more comprehensive and critical understanding of scientific results. This facet of

the course will be conducted in the style of a seminar. You will be expected to have read each article with a critical eye, and to come prepared to discuss its contents and to pose questions to clarify your understanding. In order to help prepare you to become an active participant in these discussions, I will post reading questions that will guide you towards the key points in each article. On the date that the article is discussed, you will have prepared and submitted written answers to each question.

Throughout the semester a general record of your participation will be noted.

Poor	Frequently absent and\or are disengaged.
Good	Contributions that reveal that you read or listen carefully.
Excellent	Contributions that reveal that you understand the relevance and interpretation of results and concepts, can explain figures and ask critical questions.

The following are some general guidelines to consider while reading:

- Understand the basics—hypothesis, methods, results, etc. Clarify material prior to class by consulting background sources or meeting with the instructor.
- Focus on figures. Practice explaining them.
- Prepare *specific* questions.

GENERAL ORGANIZATION OF THE LABORATORY

In lab we will get acquainted with some of the equipment necessary to observe and record neuronal activity in animal nervous systems. During the majority of the semester we will attempt to perform some "wet lab" experiments using invertebrate and vertebrate nervous systems as model preparations. **We will follow strict guidelines for the care and ethical treatment of all animals.** The goal of these labs is to acquaint you with the types of reasoning and techniques used to study neural systems. The outcomes of these projects will be written in scientific format (see section **"writing in the discipline section"** above).

Lab equipment will remain set up continuously throughout the semester. It will be your equipment to use and maintain. You are welcome to work on lab assignments in the laboratory throughout the week. Laboratory readings and protocols will be provided on the course website. Please consult the lab syllabus for the schedule and writing requirements.

LABORATORY ACTIVITIES

Anatomy:
Golgi-Cox Staining of Brain Cells in Two Mouse Strains

Cellular Physiology (3 of 4 as chosen by instructor)**:**
Compound Action Potential
Sciatic Nerve-Gastrocnemius Neuromuscular Junction
Effects of Ions on Setting Resting Membrane Potential: Intracellular Recording from Muscle
Chara Action Potential

Sensory Physiology (1 of 3 as chosen by instructor)**:**
Extracellular Recording of Giant Fiber Responses to Mechanical Stimuli in the Ventral Nerve Cord of Insects
Responses to Auditory Stimuli by the Cells of the Torus Semicircularis
Stretch Receptor: A Model for Muscle Spindle Organ

Plasticity:
Modulation of Cholinergic Inputs to Hippocampus in a Spatial Navigation Task

TENTATIVE CLASS SCHEDULE

*Note this is a *tentative* list of topics and literature themes. Updates and reminders will be posted on the course Moodle site each week.

Date	Topic	Reading
	The Basics	Chapter 1,2,3
	Introduction	
	Cell Composition; Membrane Structure;	
	Maintenance of Cell Volume; Membrane	
	Potential: Ionic Equilibrium	
	Membrane Potential: Ionic Steady State	
	Generation of Nerve Action Potential;	
	Voltage Clamp Experiments	
	Synaptic Transmission: NMJ and CNS	
	Iontotropic and Metabotropic Receptors	
	Glia	pdf Ch 10 Neuron to Brain

Potential Literature Themes: Channelopathies; Roles of Glia

10/10/16 **EXAM 1**

	Sensory	Chapter 4,6
	Retinal Organization; Phototransduction	
	Brain Mechanisms of Vision	
	Cochlea; Hair Cell Physiology; Sound Localization	
	Chemical Senses	
	Somatosensation	
	Evolution of Vision	Chapter 12
	Sexual Activity	Chapter 9

Potential Literature Themes: Slow Vision; Pheromone Detection

11/14/16 **EXAM 2**

	Motor and Regulatory Systems	Chapter 8
	Spinal Circuits; Descending Control	
	Central Pattern Generators	
	Upper Motor: Coding Movement in Motor Cortex	
	Eating Behaviors	
	Brain Waves, Sleep and Rhythms	
	Memory, Learning, Synaptic Plasticity	Chapter 10
	Brain Disorders or Wiring of Nervous System	Chapter 11 or 7

Potential Literature Themes: Obesity; Installing, Deleting and Editing Memory; Neurodegenerative Diseases

12/19/16 **EXAM 3** (10:30 pm in BH 211)

Information issued by the Provosts's Office:

Disability Services
At its May 2011 Faculty Meeting, the faculty approved changes to Faculty Handbook Section 2.2.7: "Through information provided in syllabi, faculty members will notify students of the availability of disability services at Gustavus and how to access them." The following statement is recommended for inclusion on all syllabi:

Gustavus Adolphus College is committed to ensuring the full participation of all students in its programs. If you have a documented disability (or you think you may have a disability of any nature) and, as a result, need reasonable academic accommodation to participate in class, take tests or benefit from the College's services, then you should speak with the Disability Services staff, for a confidential discussion of your needs and appropriate plans. Course requirements cannot be waived, but reasonable accommodations may be provided based on disability documentation and course outcomes. Accommodations cannot be made retroactively; therefore, to maximize your academic success at Gustavus, please contact Disability Services as early as possible. Disability Services (https://gustavus.edu/advising/disability/) is located in the Academic Support Center. Disability Services Coordinator, Kelly Karstad, (kkarstad@gustavus.edu or x7138), can provide further information.

Academic Honesty
At its November 2006 Faculty Meeting, the faculty approved changes to *Faculty Handbook* Section 2.2.9: "Through information provided in syllabi and/or other means, faculty members will explain to students how the Honor Code will operate in their respective courses." The following statement is suggested as a pledge for students to sign on all graded assignments and projects:

"On my honor, I pledge that I have not given, received, or tolerated others' use of unauthorized aid in completing this work."

A similar statement may be signed by students at the beginning of a course, indicating that their work for that course will comply with the academic honesty policy and the Honor Code.

Full descriptions of the Academic Honesty Policy and the Honor Code can be found in the *Academic Catalog* (online at https://gustavus.edu/general_catalog/current/acainfo). For more information about the Honor Code, contact Dean Julie Bartley (jbartley@gustavus.edu or x7541).

NIH Seeks $4.5 Billion Over 10 Years for BRAIN Initiative

In early June, NIH embraced a long-term vision for President Barack Obama's BRAIN Initiative by calling for a decade-long $4.5 billion investment in NIH's portion of the project. The Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Initiative, announced by Obama in April 2013, seeks to accelerate the development and application of new technologies that will enable researchers to fill major gaps in our knowledge about the brain and provide unprecedented opportunities for exploring how the brain functions.

Though NIH is working with the Defense Advanced Research Projects Agency (DARPA) and the National Science Foundation (NSF) on the BRAIN Initiative, the estimated price tag for this latest request only includes funding for NIH's portion of the program for fiscal years 2016-2025.

The BRAIN Working Group of NIH's Advisory Committee to the Director, which has been working on a plan for NIH's portion of the initiative for more than a year, developed the cost estimate as part of a rigorous report that maps out the necessary funding commitments and makes recommendations for achieving the goals of the BRAIN Initiative. NIH Director Francis S. Collins enthusiastically accepted the group's recommendations and described the report as bold and game-changing.

"How the brain works and gives rise to our mental and intellectual lives will be the most exciting and challenging area of science in the 21st century," Collins said. "As a result of this concerted effort, new technologies will be invented, new industries spawned, and new treatments and even cures discovered for devastating disorders and diseases of the brain and nervous system."

Working group co-chairs Cornelia Bargmann of the Rockefeller University and Bill Newsome of the Stanford University School of Medicine presented a summary of the group's recommendations to the NIH director, focusing on the revised budget and the changes that were made to the group's interim report from last September. The co-chairs stated that while the deliverables set in the report are meant to be achievable within a 10-year timeframe, the milestones are meant to be aspirational and to push the field to increase the limit of discovery and possibility. Further information is available in a Q&A with Bargmann and Newsome on SfN.org.

Funding

The NIH report outlines an investment ramping up to $400 million a year for fiscal years 2016-2020 to focus on technology development and $500 million a year for fiscal years 2020-2025 to focus on the application of those technologies. The working group emphasized that its cost estimates assume that the funds for the BRAIN Initiative will supplement NIH's existing investment in the broader spectrum of basic, translational, and clinical neuroscience research.

The BRAIN initiative kicked off in fiscal year 2014 with a $100 million investment, with $40 million going to NIH. The president has requested that Congress approve $200 million for the BRAIN Initiative for fiscal year 2015, with $100 million going to NIH.

Recommendations

The NIH working group recommended that over the 10-year period from 2016-2025, the initiative focus the first five years on technology development and the second five years on integrating technologies to make fundamental new discoveries about the brain. With this vision in mind, the group identified the following scientific goals as high priorities in the field:

- Identify and provide experimental access to the different brain cell types to determine their roles in health and disease.
- Generate circuit diagrams that vary in resolution from synapses to the whole brain.
- Produce a dynamic picture of the functioning brain by developing and applying improved methods for large-scale monitoring of neural activity.
- Link brain activity to behavior with precise interventional tools that change neural circuit dynamics.
- Produce conceptual foundations for understanding the biological basis of mental processes through development of new theoretical and data analysis tools.
- Develop innovative technologies to understand the human brain and treat its disorders; create and support integrated brain research networks.
- Integrate new technological and conceptual approaches produced in the other goals to discover how dynamic patterns of neural activity are transformed into cognition, emotion, perception, and action in health and disease.

The NIH report sets out a long-range timeline, but work is already underway. In December 2013, NIH announced six funding opportunities in response to the high-priority areas identified by the working group's interim report, and awards are expected to be announced this September. To read the full version of this article, visit SfN.org. ■