BIO335: Neurobiology Laboratory

Course syllabus & information - Fall 2018

Neurobiology in action: Benjamin Pavard of France scores the "Goal of the Tournament" against Argentina in the 2018 World Cup.

Welcome!

This lab course explores the physiology and neurobiology of action: how electrically excitable cells in nerve and muscle cause and control the movements that underlie behavior, in animals ranging from earthworms to humans. You will start by investigating how electrical nerve impulses are conducted along nerve fibers, and the molecular events that underlie this process. You will study, and experience, how neural information is converted to action by muscular excitation and contraction, and how the vertebrate heartbeat is initiated and modulated. You will observe and manipulate neuromuscular development in a vertebrate embryo and compare the neuroanatomy of different vertebrate brains, including the human brain. You will analyse electrical and imaging data that is beginning to show us the complexity of the human brain in action. The course ends with discussion and debate of how this knowledge can be best applied to the problem of drug addiction.

This syllabus has information on course learning objectives, schedule, resources and materials, how to succeed in lab, written work and grading standards. The background and procedures for each week's work will be posted as separate documents on the main course Blackboard site.

COURSE DESCRIPTION (from Undergraduate Bulletin)

A laboratory course in physiology with a focus on neuromuscular function. Topics include acquisition and analysis of electrophysiological data; ion channels, electrical excitability and action potentials; synaptic transmission and muscular contraction; development of physiological functions; central control of movement; sensory function and behavior; cardiac function and regulation; and ethical and political issues of physiological relevance. This course has an associated fee. Please see www.stonybrook.edu/coursefees for more information.
Prerequisite: C or higher in BIO 203 and the following: PHY 122/PHY 124 or PHY 127 or PHY 132; BIO 205 or 207

Stony Brook Curriculum: satisfies **ESI** (Evaluate & Synthesize researched Information)

3 credits.

COURSE AIMS & LEARNING OBJECTIVES

This course aims to train students to design, perform, interpret and report on experiments in neurobiology and physiology. It integrates, applies and extends knowledge from neurobiology and physiology lecture courses. Students who successfully complete this course will be able to:

- explain nerve and muscle function in terms of the molecular activities of ion channels and molecular motors, the electrical properties of cells and axons, and the operation of intercellular synapses.
- outline the neural pathways that initiate and control neuromuscular action in humans, and explain the consequences of damage to these circuits from disease or trauma.
- prepare selected animal material for experimentation, following principles for the ethical use of laboratory animals.
- apply physical principles and quantitative reasoning to set up equipment for stimulation, recording and analog-to-digital conversion.
- plan data collection; acquire and analyse electrophysiological or behavioral data.
- troubleshoot experimental problems and develop reasonable hypotheses to explain both expected and anomalous observations.
- use a simulator program to model neural membranes and axons, predict and test the effects of changing parameters, and relate the results to observations in living material.
- relate experimental results to neural and physiological functions in living, intact organisms.
- independently write and revise experimental reports, in plain language with correct use of technical terms, to interpret experimental results in terms of current knowledge and some original hypotheses.
- work cooperatively in different teams, adopting different roles in planning and performing experiments.
- apply neurobiological and physiological knowledge to a relevant ethical issue, in discussion and debate.

Lecture (all sections): Javits 111 Monday 10:00am - 10:53am (Echo360-recorded but must attend for clicker credit).

Labs + recitations (combined): Biology Learning Laboratories (BLL) 117

Section R02+L02 Tuesdays 1:30 - 5:30pm Section R03+L03 Wednesdays 8:30am - 12:30pm

Section R04+L04 Wednesdays 1:30 - 5:30pm Section R05+L05 Thursdays 1:30 - 5:30pm

Walk-in help session (all sections) Fridays 1-2pm, BLL 117

Week # Monday	**Lecture**	**Lecturer**	**Lab + recitation session** **TA + (faculty instructor)**	• Assignments & *pre-labs* due this week.
1 8/27	Intro to course; extracellular recording of action potentials.	Kernan	Intro to LabChart: pulse recording. Action potentials in earthworm giant fibers (Kernan).	• Introduce yourself
2 9/3	LABOR DAY - no lecture		Earthworm giant fibers continued (Kernan) Intro to Neurons in Action (Park)	• LabChart worksheet
3 9/10	Membrane and cable properties	Park	Modeling axons with Neurons in Action	• Worm AP worksheet • *Online test: NIA*
4 9/17	Membrane potentials & currents	Park	Experimental design: NIA & earthworms (Kernan)	• NIA worksheet • *Experimental plan (1/ group, 48 hrs before lab)*
5 9/24	Myelinated nerves in vertebrates	Sher	** new lab teams ** Compound action potentials in frog sciatic nerve. (Sher)	• Exptl. design report (200 points, revisable)
6 10/1	Muscle	Evinger	Ulnar nerve stimulation & EMG	• Sciatic nerve report
10/8	fall break: no classes 10/8-9		No labs	• Ulnar nerve report
7 10/15	Cardiac cycle: mechanical & electrical properties	Xiong	Frog heart: mechanical responses & ECG. (Xiong)	
8** 10/22	Cardiac cycle: hormonal control	Xiong	Frog heart: neurotransmission & hormonal control. (Xiong)	• *In-class worksheet (one per group)* • *Heart: hypothesis chart*
9 10/29	Sensory transduction	Kernan	** new lab teams ** Mechanosensory transduction in insects; spike sorting. (Kernan)	• Frog heart report (200 points, revisable)
10 11/5	EEG!	Vasudevan	Electroencephalography	• Sensory report
11 11/12	Neuroanatomy	Powers	Comparative vertebrate neuroanatomy.	• EEG worksheet
12 11/19	Debate-related lecture 1	TBA	No labs - Thanksgiving	
13 11/26	Brain imaging	DeLorenzo (recorded)	PET imaging the human brain	• Neuroanatomy report
14 12/3	Debate-related lecture 2	Kritzer	Superquiz. Discussion/ debate (Kernan, others)	• *Pre-debate outline* • PET imaging report
15 12/10	Careers in Neuroscience	TBA	no labs	

***** Last date to withdraw: Friday October 26.***

INSTRUCTORS

The course is taught by faculty in the Department of Neurobiology & Behavior, and lab section instructors (TAs) from the Ph.D. graduate program in Neuroscience.

Faculty: Professors **Maurice Kernan & Erin Vasudevan** (course directors); **Memming Park, Roger Sher, Craig Evinger, Qiaojie Xiong, Alice Powers, Mary Kritzer.** Other guest faculty may also participate.

Section TAs: R02+L02 (Tuesday pm): **Jeffrey Malgady** R04+L04 (Wednesday pm): **Shreevidya Korada**
R03+L03 (Wednesday am): **Liam Lang** R05+L05 (Thursday pm): **Zachary Hobel**

Contact information for all, and office hours for course directors, are posted on Blackboard.

MATERIALS

Downloadable course materials will be provided on the **main course Blackboard site**. These include background material and instructions for each lab module, and Powerpoint files from lectures. Instructors may notify you when new material is posted, but it is your responsibility to check for, and read, background material before each week's lab. Your section instructor will also run a separate Blackboard site for your lab section: this is where you will submit written work (checked by SafeAssign) and see your scores.

There is no required textbook. **Neurons in Action 2** software is provided on lab and SINC site computers; it can be purchased ($34, for a code for download) for your own use from the publisher at http://register.dashboard.oup.com/product?catalog=9781605353913 . You may also want to refer to general physiology and neurobiology texts, as used in BIO203, BIO334 or BIO328. A document listing relevant sections/ chapters from these texts is posted on Blackboard. Some **example problem sets** are also posted there, for quiz preparation.

A **clicker** is needed to answer questions during lectures for credit. Its use gives you and the instructors fast feedback on your background knowledge, and understanding of new material. A QT, NXT, or later Turning Technologies models will work. These are available through your account on the Turning Technologies site at https://account.turningtechnologies.com/account/. If you are setting up a new TT account, use your @stonybrook.edu address. To receive credit, your clicker must be **licensed**, and **registered in this course for this semester**: in the Blackboard "Tools" section, click on "Turning Account Registration (clickers)" and follow instructions, or see: https://www.turningtechnologies.com/info/pdf/Blackboard.pdf . You will need the Device ID (a 6-character code printed below the bar code on the back). Any clicker must be registered to **only one student** in the course. More info at https://it.stonybrook.edu/help/kb/buying-clickers or contact Turning Technologies at: 1.866.746.3015

LECTURES: 10:00am – 10:53am, Javits 111 First lecture: Monday 8/27.

A Monday lecture gives you the background knowledge needed to understand each week's experiments. Questions asked during lecture can be answered for credit using clickers. These may include questions on the prior week's lab sessions, and on the background material for the current week. To allow for occasional absences, you can receive full clicker credit with 90% of the available clicker points, but no points will be made up for individuals for forgotten clickers, low batteries, or absence for any reason. If possible, register your clickers before the start of the semester and bring them to the first lecture. Scoring for credit will start in the second lecture (week 3).

Lectures will be recorded by the SBCapture (Echo360) system and available on Blackboard. These recordings are for your later review. They do not substitute for regular attendance, so do not rely on the recordings alone.

LAB/RECITATION SESSIONS: Biology Learning Labs, room 117, starting Tuesday 8/28

Attendance at labs is mandatory. Each section meets once per week, for a four-hour combined recitation and lab session. **Be prepared to spend the full 4 hours in lab**. You sign in and take a quiz at the start of each session. If you are absent from a lab session for reasons beyond your control, you must provide some valid documentation to the course directors. Unexcused absence from a lab session will result in a zero score for the quiz and report. A maximum of **two excused absences** is allowed. If you are absent for more, you must contact and meet with the course directors as soon as possible. Students absent from the first lab session may be deregistered.

EXTRA HELP

Your TAs may be contacted by email with short queries. The **course directors** will be available during office hours. Other faculty instructors will be available by appointment in the week during and after their lab module. A weekly, **walk-in help session** for all sections (initially on **Fridays, 1-2pm**), will be staffed by a TA &/or instructor, to help clarify any issues arising from that week's lab. Not a proofreading session: draft lab reports will not be reviewed.

WRITTEN WORK

You will describe your work in written reports, usually due within a week after a lab module is complete. The formats range from structured worksheets requiring answers to specific questions, to more extended descriptive reports. A report guideline or blank worksheet for each lab will be posted on Blackboard just after each lab session. General guidelines for scientific writing are also posted on Blackboard. Reports are evaluated for:

- clear, concise writing. See the **general writing guidelines** for more on this.
- evidence that you understand the function and physiological mechanisms of the system being studied.
- completion of the experimental procedures, or good explanations for why they could not be completed. Extra credit is given for good interpretation of unexpected observations; reasonable hypotheses, for example to explain a negative result; actual or suggested additional experiments to test them...
- accurate, legible data summary and presentation, in text, graphs and/or tables.
- logical analysis and interpretation of the data.
- knowledgeable, focused discussion of what the data imply about the system studied.

A general standards rubric on the last page of this syllabus defines the standards expected for preparation, lab performance and written work at different grade levels. Rubrics/answer keys for specific assignments will be posted when grading of each assignment is completed. Up to 3 regrade requests are allowed; they must refer to these rubrics, be submitted within one week of the rubric being posted, and include a completed **Regrade request form** (download at Bb>Course Information>Syllabus, resources, forms).

Two longer (200-point) reports may be revised after grading and resubmitted to recover up to 2/3 (67%) of the points lost. These resubmissions must follow the **Report Resubmission instructions** (also at >Course Information>Syllabus, resources, forms). Late penalty points cannot be recovered.

Independent work and academic integrity.

You can and should discuss lab results and analyses with your teammates during the lab session. But unless explicitly directed, all individual pre- and post-lab work and written submissions must be completed independently. **Plagiarism** (that is, presenting another person's work as your own) **is cheating**.

All written assignments must be submitted as an electronic file in .pdf format to SafeAssign, on Blackboard. This site checks for similarities to other texts, lab manuals, Internet postings, and other student submissions (including previous lab reports from BIO 335 for many years). Detected plagiarism will result in a zero grade for that lab report, and a referral to Academic Judiciary.

Discussing clicker questions with your neighbors is encouraged, but you must use only the clicker registered to you, to submit your answer. **Answering questions with a clicker that is not registered to you, or having some else answer using your clicker, is cheating.** If anyone is found doing this, both the person using the clicker and the person to whom that clicker is registered will lose all clicker points for the course and will be referred to Academic Judiciary.

Any two instances of academic dishonesty, whether plagiarism in a report, copying/cheating on a quiz, or misuse of a clicker, will result in a FAIL grade for the course.

Deadlines; late penalty

Unless otherwise specified, worksheets and reports are due to the appropriate SafeAssign folder on your section Blackboard site, before the start of your lab section, one week after the last session in which the corresponding work was done. A 5 point penalty will be deducted for each day or partial day late, beginning with the due date and time. No reports will be accepted more than 1 week late (-35 points).

Absences and lab reports

You must attend all labs. However, a student with a valid excused absence for a lab for which a short report or worksheet is based will be excused from that report; their lab report grade will be based on all other reports. If you have a valid excuse for one period of a lab exercise that normally involves two lab periods, you will be allowed to get the data from the missed section exercise from your lab partners and write the report. **The deadline for the report is the same as if you had not been absent.**

If you are absent for **more than two lab sessions, whether excused or unexcused,** you must **contact and meet with a course director** as soon as possible, to discuss if withdrawal from the course is advisable.

HOW TO SUCCEED IN LAB…

Prepare in advance.

Practical work is the best way to learn science - but it does require commitment from you, as well as the instructors. To get the benefit from your time and effort, do **read the advance material before coming to lab.** This includes the material presented in lecture, the background and procedural parts of the lab instructions, and any other material posted for that week. Pre-lab lectures, and the courses you have already taken, will give some of the needed background. Online pre-lab assignments will give additional preparation for some labs. If you need more help, **ask** your TA or the professors. Short quizzes given at the start of each lab period will test your understanding of that week's lecture and advance material, as well as the previous week's work. Practice quiz questions will help you prepare for these.

Cooperate in lab (but write lab reports independently)

Students in each section will work in **groups** of three students each. Initial team assignments will be random; we will completely reshuffle all teams twice during the semester. Instructors have discretion to reassign individual students at any time.

Group members must **cooperate** to get the work done efficiently – but not so quickly that it is rushed or sloppy, or that any team member misses an important observation or does not understand what has just happened. One way to manage this is to assign a role to each person - for example, one checks and changes connections and settings on the electronic equipment; one dissects and monitors the biological preparation, and one manages the progress of the experiment, tracks displays and logs data. It is important to **rotate** these roles among group members between sessions, or even during a session, so that everyone becomes competent in all roles.

You are encouraged to discuss your results, and compare them to the results of other groups, while doing the work. But any pre-lab assignments or in-lab quizzes, and all individual post-lab worksheets and reports, must be each student's independent work.

Record your work as you go.

As you work, keep an orderly record of what you are doing. Be sure to note any changes from the procedures in the instruction sheets, and other important information - such as the physiological condition of the material, or the reason why a particular test was done - which might later turn out to be significant in interpreting the results. The more relevant information you write down, the more you will have to work with when writing up your report.

You will need to record data and notations from the lab computers: you can record data files to your mysbfiles account, a shared Dropbox or Google account and/or a USB flash drive. All group members should have access to this data at all times after the lab session. Any data left on the lab computers **is automatically erased** overnight.

Keep calm and....troubleshoot.

You may be expecting a particular result, from your knowledge of physiology or the lab instructions. If what actually happens differs from your expectations, calmly, at that point in the experiment, check if your results come from incorrect interpretation of the raw data (scales!), or incorrect equipment setup (power on? connections? sampling frequency? gain/sensitivity settings? frequency filters?). If everything looks OK, consider what might be physiologically abnormal about the preparation, or if a piece of equipment is malfunctioning. Think about how you can identify the problem. Change one variable or item at a time, to see if you can locate the source of a problem (spares of some equipment units are available for this purpose). Or consider another possibility: *'The most exciting phrase to hear in science, the one that heralds new discoveries, is not "***Eureka!***" but "*That's funny…*"'* (Isaac Asimov).

Innovate. Explore. Do science.

The lab manual sections lay out experimental sequences that you will probably be able to complete within the lab period. If you have time left over, use it to explore further. Are there other questions you can ask with the preparation and equipment on hand? Are there any anomalous observations you want to follow up? Or just ask "what happens if I change X...?" Go ahead and do it! Just be sure to (i) record your hypothesis and results and (ii) check with the TA or professor before making any new connections between electronic equipment, **or before making any change to a protocol with a human subject**.

Be a good lab citizen: keep a neat bench; treat the equipment with care, the animals and animal material with care and respect, and leave the lab in the same state as you found it.

GRADING AND GRADE BASIS

Your final grade in the course will be based on a weighted combination of scores from these sources:

I. Clicker Questions (5% weight): asked in lecture and scored as: 2 points for a correct answer, 1 point for an incorrect answer, 0 points for no answer (or absence). Therefore always try to answer - if in doubt, guess! Scoring for credit begins in the second lecture. To allow for the occasional absence, you will get full clicker credit with 90% of the available clicker points.

II. Prelab assignments (5% weight), to be completed before certain lab sessions. Some assignments are done cooperatively, with one submission from each group: all group members receive the same score for these.

III. Lab Quizzes (25% weight*), given at the beginning of most lab sessions. These will assess your understanding of the previous lab and preparation for the current session. No makeup quizzes are given, so come to lab on time. A cumulative superquiz, worth double quiz points, will be given in the final week. Example question sets, compiled from previous years' in-lab quizzes and posted on Bb, are a useful resource for self-testing, and will give you an idea of what to expect in quizzes.

IV. Your lab performance**:** (10% weight*)**.** Assessed primarily by your section instructor (TA). Based on:
- The extent to which you plan and organize your lab time.
- Your ability to answer, and ask, questions during the lab session.
- Your improving ability to handle the equipment and living material.
- Your contribution to a cooperative, productive lab team and section.

V. Laboratory Reports and worksheets: (55% weight*). In general, worksheets or reports on a single week's lab work can score a maximum of 100 points; those on two weeks' work, 200 points.

* Quiz, lab performance or report scores for each section may be normalized to all-class averages if there is evidence for a consistent between-section difference in the scoring of that item.

The course is not graded on a curve. A **standards rubric** on the last page of this document describes levels of preparation, lab performance and written work expected at each grade level. This rubric will guide the scoring of lab and written work, and the conversion of total weighted scores to letter grades. An approximate conversion of total scores to letter grades is: A, 87.5 - 100; A-, 85.0 - 87.4; B+, 82.5 - 84.9; B, 75.0 - 82.4; B-, 70 – 74.9; C+, 65 – 69.9; C, 50 – 64.9; D, 40 – 49.9; F < 40. Actual grade boundaries may be adjusted in either direction to match larger gaps in the score distribution.

UPPER DIVISION WRITING REQUIREMENT (BIO 459)

Either 200-point report (Experimental Design or Frog Heart), or an optional essay based on the debate topic may fulfil the Upper Division Writing Requirement for graduation. Fill out and sign a UDWR form (posted on the Undergraduate Biology website), have it signed by your section instructor (or a course director for the essay), then bring the signed form and a copy of the graded report to the Undergraduate Biology Office. These reports will be reviewed by staff from the Writing and Rhetoric program and they will work with you, if necessary, to obtain UDWR approval. UWDR submissions should be turned in **as soon as possible after you receive the graded report,** to allow time for any needed revisions.

UNIVERSITY POLICIES

Student Accessibility Support Center:
If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Student Accessibility Support Center, ECC (Educational Communications Center) Building, Room 128, (631) 632-6748. They will determine with you what accommodations, if any, are necessary and appropriate. All information and documentation is confidential. https://www.stonybrook.edu/commcms/studentaffairs/sasc/

Academic Integrity:
Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty is required to report any suspected instances of academic dishonesty to the Academic Judiciary. For more comprehensive information on academic integrity, including categories of academic dishonesty please refer to the academic judiciary website at: http://www.stonybrook.edu/commcms/academic_integrity/

Rubric: general standards for preparation, lab performance & reports in BIO335.

These standards describe the level of work expected at each grade level. They will be used to guide scoring of lab performance and written work, and to translate numerical scores into letter grades; the course is not graded on a curve. Score boundaries are approximate and may be adjusted in either direction to coincide with larger gaps in the score distribution. Each standard should be assumed to include all positive elements of those below it. Students need not necessarily meet a grade standard in all categories or in all lab modules: few if any may meet an A standard at the start of the course, but most should be able to raise their performance over the semester.

GRADE	Preparation	Lab performance	Lab reports/worksheets
A, A- range: **86 - 100%**	Thorough understanding of background concepts. Knows in detail how experimental aims relate to methods and data to be collected. Can explain expected results well, predict alternate outcomes, and identify experimental limitations. Able to think of and compare alternative approaches.	Proactive, fully engaged in all lab activities; takes the initiative in troubleshooting. Records relevant, extended data sets. Anticipates difficulties; prioritizes and plans work to complete all specified experiments; uses extra time to refine or extend datasets, or to think of and attempt new experiments. Can propose soundly-based hypotheses to explain unexpected results. Helpful but not intrusive explainer. Major contributor to group success.	Clear, concise, easy-to-read writing style, with well-explained observations & some original interpretation. Answers specific questions in detail, almost all correctly. Figures are optimally designed and organized to summarize data and display results. If experiments unsuccessful, uses other available data; also includes possible reasons why & suggestions for alternate approaches. Researches and refers to relevant sources/literature as well as provided materials, to compare with results.
B-, B, B+ range: **70 - 85%**	Understands all basic background concepts. Has read materials and is well-prepared for lab session. Knows experimental aims and how they relate to the data to be collected. Can explain expected results without prompting.	Active, engaged participant in lab activities. Plans work so as to complete all specified experiments. Records all specified data. Has mastered recording equipment & computer interfaces; would be able to do experiments if working alone. Consistently compares results to expectations; able to interpret some unexpected results. Cooperative worker; net contributor to group success.	Well written, understandable, concise. Refers to provided papers & materials. Answers most specific questions correctly, with some relevant detail. Figures are complete and correctly labeled. If experiments are unsuccessful, uses other available data, with references. Discusses results in context of materials provided.
C, C+ range: **50 - 69%**	Understands most basic concepts. May have looked at materials before lab, but lacks some needed knowledge. May know experimental aims but be hazy on how these relate to methods and data, or vice versa. With prompting, able to work through explanations of expected results.	May be passive, waiting for others in a group to do the work and provide solutions, or active but tend to persist in mistaken activity. May fail to complete some experiments due to poor planning. Unclear on some operating principles of equipment & data acquisition; would struggle if working alone. Unsure if results compare to expectations. Neutral with respect to group success.	Answers most specific questions adequately, but lacking relevant detail. Reports not easy to read, due to ambiguity and/or poor organization. May be either too long (including irrelevant information) or too short (lacking relevant needed detail). Figures lack some elements or labels. If experiments unsuccessful, includes a note, but no explanation or alternate data. Little contextual discussion of results.
others: **<50%**	Lacks understanding of important background concepts. Probably has not reviewed materials. Clearly unprepared for lab session.	Passive and disengaged much of the time, or an actively disruptive influence. Would not be able to do experiments if working alone. Net detractor from group success.	Many specific questions answered incorrectly or inadequately. Statements are ambiguous or hard to interpret (beyond reasonably allowable language errors if ELL); sentences may not make sense or be ungrammatical. Blanks left with no explanation.