Boston University
NE 392: Junior Research in Neuroscience 2
NE 492: Senior Research in Neuroscience 2
NE 401: Honors Research in Neuroscience 1

Course description
NE 392/492
Second semester of research in neuroscience, involving the use of research literature and significant creative contributions by the student. Application through the Undergraduate Program in Neuroscience. Students conduct research under supervision of a faculty mentor. Attendance at group meetings and final report required.

NE 401
First semester of Honors-level mentored research (leading to graduation with Honors in Neuroscience) involving extensive use of the research literature, significant creative contributions by the student, and substantial independence. Application through the Undergraduate Program in Neuroscience. Minimum 16 hours/week involving lab work, meetings, data analysis, and writing.

Prerequisites
NE 392: NE 391 or four credits of NE 191/192/291/292/371 or UROP-funded research, Program approval of research proposal, and Junior standing.
NE 492: NE 371 or NE 391 or NE 491 or UROP-funded research, Program approval of research proposal, and Senior standing.
NE 401: 1+ semester/summer of prior research in the lab sponsoring the student, GPA 3.4 or higher, Program approval of honors research proposal, and Senior standing.

Course requirements and assignments (with associated BU Hub learning outcomes)
Prior to registration: Course proposal (RIL 1, 2; CRI 2)
Prior to registration you must submit a short course proposal for review by the Undergraduate Program in Neuroscience (deadlines for each semester, along with direct links to the Research Application form, are posted on the UPN website here). In the course proposal you must concisely describe the background and context of your proposed project, your research question(s) and hypotheses, and the general methodology you will use to address your research question(s). All text in the course proposal should be your own, but you should plan and write it in close consultation with your prospective research mentor. At least 3 citations of the primary neuroscience literature must be included.

Beginning and end of semester: Student researcher UPN sessions (RIL 1, 2; CRI 1, 2)
You are required to attend two group meetings each semester, led by the Director of the UPN. The first session will provide you with a general overview of the BU Hub learning outcomes and assignments/requirements of your course and provide a refresher on several Hub-related skills you will practice during the semester, such as how to search for peer-reviewed articles (RIL) and how to propose novel research directions and troubleshoot emerging research setbacks with your research mentor (CRI). The second session will be a reflection and roundtable discussion of how these Hub Learning outcomes were reflected in your actual experiences over the semester, and how you can draw on those experiences in future classes and postgraduate experiences.

Throughout semester: Research-mentor-supervised independent research (RIL 2; CRI 1, 2)
You are expected to devote 12-16 hours per week (3-4 hours per credit) to independent research in your lab. The exact nature of the research will vary from lab to lab and must be discussed and agreed to with your research mentor as a part of preparing the Course Proposal. You will conduct your research under the supervision of your research mentor and their lab research team (including graduate students and postdocs).
You are expected to remain in close contact with the research team using appropriate and diverse modes of communication, including in-person discussions, email, and other technologies that are used in your specific lab (phone, Zoom, Slack, MS Teams, etc.), in addition to attending lab meetings (see below).

Throughout semester: Research mentor progress check-ins (RIL 2; CRI 1)
You are required to schedule at least three check-in meetings with your research mentor (with or without other members of the lab research team present) where you will discuss your progress on your research project. At these meetings you will brainstorm creative ways to overcome challenges that you have encountered or to capitalize on new research possibilities that have presented themselves as a result of your ongoing work. Over the course of the semester these meetings will help you to iteratively refine your project (as all academic researchers do) and to balance riskier and more speculative research strategies (with high potential payoff) with safer, more predictable experiments.

Throughout semester: Attendance of lab meetings (RIL 2; CRI 1)
You are required to attend and participate in your lab’s lab meetings throughout the semester. You are expected to read all assigned materials (e.g. journal articles for journal club discussions or manuscripts in preparation for meetings focused on ongoing research in the lab) and contribute to the discussion with your peers and mentors.

End of semester: Final paper (RIL 1, 2; CRI 2)
You must complete a final paper summarizing your research progress over the entire semester. The length, exact format, and specific grading criteria required of this paper will be set by your research mentor, who will also grade the paper (the default format will be a research-article style paper, similar to lab reports you may have written in your STEM classes). Your final paper must include at least 10 citations of the primary neuroscience literature (you may include the 3+ citations you used in your course proposal).

End of semester: Final course survey (RIL 1, 2; CRI 1, 2)
You must complete a survey at the end of the semester (link posted on the UPN website here) where you will reflect on your research experience generally and on the BU Hub-related skills you gained as a part of your research.

General education learning outcomes (BU Hub)
This course will address the BU Hub areas Research and Information Literacy and Creativity/Innovation, as follows:

Research and Information Literacy (RIL) Learning Outcomes:
Students will build on existing RIL skills that they learned in the classroom during the required sophomore-level RIL course NE 203 in a “real-world” context. These include basic STEM RIL skills like how to search for scientific publications from databases such as PubMed or Google Scholar, how to cite the literature, how to incorporate citations into concise, logical, and clear scientific writing, and how to generate new research ideas and hypotheses and propose them in a compelling fashion.

1. Students will be able to search for, select, and use a range of publicly available and discipline-specific information sources ethically and strategically to address research questions.

The ability to search for, read, understand, and synthesize articles from the scientific literature is among the first skills that undergraduate researchers must master. Students will begin working on this learning outcome immediately upon joining their lab as they begin preparing their Course Proposal to register for the course, and hone these skills over time as they remain embedded in their research group, attending lab meetings and journal clubs and discussing the literature and the results of their ongoing experiments with increasing proficiency. Under the direction of their PI and other senior researchers in their lab, students will use discipline-appropriate search engines and databases (Web of Science, PubMed, Google Scholar, etc.) to choose papers to read and cite.
in their course proposal, lab meeting presentation, and final paper. Students will read and cite a minimum of 10 peer-reviewed articles (and likely substantially more) across these three assignments.

2. **Students will demonstrate understanding of the overall research process and its component parts, and be able to formulate good research questions or hypotheses, gather and analyze information, and critique, interpret, and communicate findings.**

Students will begin to address this learning outcome during the course proposal stage: as new members of an established research group, they must find and read publications from their new lab to understand the research questions their lab addresses, and must also find and read important publications from outside their lab, to understand the context of their research within their broad field (students will also read all additional papers assigned for discussion as a part of the lab’s normal lab meetings.). The course proposal serves as the first assignment that asks students to synthesize what they have read (and discussed with their research mentor) into a proposed research project, complete with clear research questions and hypotheses. Students will then address the bulk of this learning outcome through their actual research activities, as they learn (by doing) how to carry out the research process, including how to gather and analyze neuroscience data and how to interpret and communicate their findings (via scientific writing in their final paper and via conversations with their research mentor during creativity check-ins). Throughout the semester, student attendance at regular lab meetings will complement these assignments. Students will engage with other lab members during lab meetings in discussions of the scientific literature and will provide and receive constructive criticism on the research projects being carried out in their lab.

**Creativity/Innovation (CRI)**

The ability to creative contribute to a lab’s research program, while central to the authentic practice of science, is difficult for new lab members who have not yet had the time to learn the scientific techniques used in their lab or develop a deep understanding of their lab’s area of research through reading the literature and attending lab meetings. Thus, even though students will have made significant creative contributions to their research project during their prerequisite prior research experiences, CRI units are reserved for students in NE 392/492/401 and above. As students learn how to perform research in neuroscience it becomes clear that it’s an iterative, if not repetitive, process of experiments and analysis, whereby new possibilities are imagined, and the potential benefits of slight alterations in approach that may yield novel insights or better quality data must be weighed against the risks of failure and having to perform experiments anew. All this done in consultation with mentors providing feedback along the way.

Advanced research-for-credit students are expected to be able to develop more complex and innovative research projects, and will consequently encounter new challenges that must be overcome, often with minimal guidance from the literature, and with greater research independence expected. Additionally, as students develop more unique projects that address research questions with fewer established protocols and findings, they will need to develop novel approaches to their projects. Research is an inherently iterative process, so as students gain experience in the lab, they will become better equipped to discern what processes work well and are appropriate to their research goals and how they can refine their methods to better address their goals.

1. **Students will demonstrate understanding of creativity as a learnable, iterative process of imagining new possibilities that involves risk-taking, use of multiple strategies, and reconceiving in response to feedback, and will be able to identify individual and institutional factors that promote and inhibit creativity.**

Students in NE 391/491/402 are experienced and trained members of their lab research group. Working together with their research mentor and other lab colleagues (especially supervising graduate students and postdocs) as a research team, they will creatively contribute to the experimental design of their own project, helping to troubleshoot the inevitable failures and setback that occur during real experimentation. This process occurs naturally as a part of the authentic research process the student is engaged in; it is also formally supplemented by the 3+ scheduled research check-in meetings that students are required to have with their research mentor throughout the semester, and by the student’s self-reflection while completing the end-of-semester survey.
Additionally, as experienced researchers, they will offer constructive comments, criticisms, and ideas to support the research projects of other lab members at lab meetings and during informal conversations with their research team.

2. Students will be able to exercise their own potential for engaging in creative activity by conceiving and executing original work either alone or as part of a team. This learning outcome is simply fundamental to the entire experience of NE 392/492. Students conceive of an original work (their novel research project, as described in their course proposal) and then execute that work through their research in the lab, sometimes working alone and sometimes working alongside their mentors and other members of the lab’s research team.

Grading
Final grades are based on the research mentor’s assessment of research performance and on their assessment of the course assignments described above. Details of the lab’s expectations for student workers, expectations for the lab meeting presentation and final paper, and the research mentor’s grading criteria must be discussed and documented with the supervising faculty member prior to the start of the course.

Academic conduct
The Undergraduate Program in Neuroscience takes any form of academic misconduct, however minor the action seems, very seriously. If you have any doubts about what actions constitute academic misconduct (e.g., you don’t understand the difference between acceptable collaboration vs. unacceptable plagiarism), consult with your research mentor immediately. You are responsible for knowing and understanding the provisions of the University’s Academic Conduct Code. The UPN will refer any and all referred cases of academic misconduct to the Dean’s office for review and potential discipline, which could result in a course grade of F and/or other academic consequences.