Course description
Third or later semester of research in neuroscience, involving active participation at group meetings 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, presentation at one or more group meetings, and final report required.

Prerequisites
NE 393: NE 372 or NE 392, Program approval of research proposal, and Junior standing.
NE 493: NE 372 or NE 392 or NE 492, Program approval of research proposal, and Senior standing.

Course requirements and assignments (with associated BU Hub learning outcomes)
Prior to registration: Course proposal (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 (CRI 1, 2; OSC 1, 2, 3)
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 propose novel research directions and troubleshoot emerging research setbacks with your research mentor (CRI) and how to organize and deliver a compelling lab meeting presentation (OSC). 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 (CRI 1, 2; OSC 1, 2, 3)
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 (CRI 1; OSC 2, 3)
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 (CRI 1; OSC 1, 2, 3)**
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.

**Second half of semester: Lab meeting presentation (OSC 1, 2, 3)**
You are required to lead at least one lab meeting where you will present an overview of your project, your preliminary results, and your future directions for the remainder of the semester and, if applicable, beyond. You should prepare your presentation in your lab’s “house style” and thus must meet with your research mentor about the presentation at least twice prior to delivering it: at least once to plan the presentation and its content, and at least a second time to go over preliminary slides and practice your presentation. Your research mentor will give you feedback on your presentation’s content/style and on your oral delivery following these meetings. You may also refer to the following resources to help with your slide design and delivery:

- How to give a dynamic scientific presentation. 2015. *Elsevier Connect*.

**End of semester: Final paper (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 (CRI 1, 2; OSC 1, 2, 3)**
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 Creativity/Innovation and Oral and/or Signed Communication, as follows:

**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 first semester of research (NE 391/491), CRI units are reserved for students in NE 392/492 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 392/492 are highly 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.

**Oral and/or Signed Communication (OSC) Learning Outcomes:**

Being able to effectively discuss scientific topics and orally present the results of one’s experiments, both informally (to colleagues and mentors in the lab) and more formally (in presentations at lab meetings), is another critical skill that students practice continually at all stages of their independent research experiences. Students will achieve these learning outcomes informally through their day-to-day interactions with their research mentors in the lab and formally through participation in laboratory meetings in their research group, a standard practice (usually weekly) in STEM lab groups where the research team meets to discuss scientific articles and/or be briefed on the research progress of individual members in the lab.

1. **Students will be able to craft and deliver responsible, considered and well-structured oral and/or signed arguments using media and modes of expression appropriate to the situation.**

Students must attend regular lab meetings of their research group, where they are expected to contribute productively to the group discussion. This means that students must carefully read any assigned articles or manuscripts in advance, integrate the information from each article/manuscript into their growing body of knowledge in the field, and come to lab meetings prepared to argue for the strengths and weaknesses of each paper or project under discussion. When preparing their own lab meeting presentation, students must use discipline-appropriate media (PowerPoint or similar technologies to make their talk slides), and modes of expression, modeling their slides and presentation style on those that would be presented at a professional scientific talk in neuroscience. Students will also gain valuable experience discussing research projects in their lab, including their own, during informal discussions with research mentors and peers in the lab.

2. **Students will demonstrate an understanding that oral/signed communication is generally interactive, and they should be able to attend and respond thoughtfully to others.**

While STEM lab meetings often have an assigned presenter or facilitator who provides an initial presentation, they are not simply passive lectures. Rather, they serve to initiate discussion and debate among members of the
research team and often serve as group brainstorming sessions. After the initial presentation, all members of the research group work together interactively, to dissect the paper or project under discussion, enumerating its strengths, weaknesses, and implications, and integrating its findings and significance in the context of the broader field. All members of the lab, including the student, must take turns to propose ideas, ask and answer each other's questions, support each other's arguments, argue constructively, and respectfully disagree.

3. **Students will be able to speak/sign effectively in situations ranging from the formal to the extemporaneous and interact comfortably with diverse audiences.**

NE 393/493 contains many opportunities for students to speak formally based on defined expectations (through their lab meeting presentation), as well as extemporaneously (via debate and discussion during other lab meetings, or during meetings or research time in the lab with research mentors and peers). The average neuroscience research group contains other undergraduates, graduate students at various stages of training, postdoctoral researchers, the research mentor (PI), and perhaps other staff or scientists/technicians), providing a diverse audience (from peers to mentors) for students to interact with.

**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.