BI460: Cell and Molecular Neurobiology
Spring 2015

Instructor:
Jennifer R. Kowalski, Ph.D.
Office: Gallahue Hall 271
Phone: 940-8879; E-mail: jrkowals@butler.edu
Office Hours: 10:00 - 11:00 a.m. Mon., Wed., & Fri.

Class Schedule:
Lecture: GH290, TR, 9:35-10:50AM
Laboratory: GH292, R, 2:25-5:15PM

Course Description:
Neuroscience is a broad, integrative sub-discipline of biology that investigates how the nervous systems of diverse animals are organized and how that organization leads to functions that determine behavior. The study of neuroscience can be done at a systems level (think anatomy and circuit physiology), at the behavioral level, at the cellular/molecular/genetic level, or even at a psychological level. From nervous system development, to learning and memory, to the causes and symptoms of neurological diseases, the breadth of neurobiology makes it an exciting and dynamic area of research. However, this breadth as well as the complexity of neuroscience, makes it a challenging field that requires a working knowledge of a number of areas in biology (e.g., cell biology, physiology, genetics), chemistry, and even physics. Since covering all facets of neurobiology, even a basic level, is not feasible for a single semester-long course, in this course we will focus our efforts in both lecture and lab on understanding the molecular and cellular principles and processes that underlie nervous system development and function.

While it is expected that you all have a fundamental understanding of cell structure and function and molecular genetics from your introductory coursework, it is likely that none of you have identical biology backgrounds. Thus, each of you has a unique base of knowledge from which to work. Despite the fact that your diverse backgrounds may mean that you will sit through some review of familiar material in the beginning (which is quite new for other students), the major advantage of having different backgrounds is that, as a group, we have a wide range of information, skills and experiences from which to draw. As we move through the semester, I hope you will see this course as an opportunity to share your own knowledge and perspectives, while learning from those of others as we explore together the intricacies and exciting new discoveries in molecular neurobiology.

Overall, my goal for this course is that you learn something about the cellular basis of nervous system function; however, equally important is that you develop an understanding of how neuroscientists acquire knowledge through experimentation in these areas, as well as strengthen your own experimental design and analysis skills. Finally, I hope to make this YOUR course as much possible. In the lab, you will clearly have control of the direction of your projects, but even in lecture, while I have suggested a list of topics that to discuss, I am open to your ideas and suggestions. I welcome your input throughout the course and look forward to learning with you!

Course Objectives:
By the end of this course, you should be able to

- Explain and demonstrate the fundamental organization and development of nervous systems across phylogeny and the cellular and molecular principles governing nervous system function. (Departmental Student Learning Objective #1)
- Apply knowledge of normal neuronal function to understand the molecular basis of neurological disorders. (Departmental Student Learning Objectives #1 and 5)
- Explain common experimental approaches used to investigate the cellular and molecular basis of nervous system function and describe their benefits and caveats. (Departmental Student Learning Objective #1)
- Design, execute, trouble-shoot, and analyze data from both open-ended and hypothesis-driven scientific experiments aimed at addressing basic questions in cellular and molecular neurobiology. (Departmental Student Learning Objective #3)
- Read, interpret, and critically evaluate scientific literature. (Departmental Student Learning Objective #2)
- Communicate orally and in writing concerning your own and others’ scientific data. (Departmental Student Learning Objective #4)
Course Format: In our Tuesday and Thursday class meetings, we will discuss what is known about the cell biology of neurons and other cells of the nervous system through a combination of lecture and group work, as well as regular discussions of relevant primary scientific literature. We will approach these topics from a comparative viewpoint, drawing on studies done in a variety of organisms. As we do this, it will be important to keep in mind that not all changes at the molecular level impact nervous system function in obvious ways and, due to the complexity of the nervous system, even with clear cellular phenotypes, it is sometimes difficult to predict what will be the ultimate effects on the nervous system as a whole. In addition, the field of molecular and cellular neuroscience has emerged only in recent years with the advancement of imaging and electrophysiological techniques, as well as more sophisticated molecular genetic methodologies. In the laboratory, you will use several of these modern cellular and genetic techniques firsthand in a semester-long independent project investigating the molecular control of nervous system function in the model roundworm, C. elegans.

Text:

Additional readings, lab handouts, and other homework assignments will be posted on Moodle.

Final Grade Determination:
Your final grade will be determined by summing your total points earned divided by the total points possible. The following is a tentative list of the point distribution in the course. Each component is described below.

- 200pts Take-home Exams (2 @ 100 pts each)
- 100pts Final exam
- 80pts In-class quizzes (5 @ 20 pts each, dropping the lowest quiz score)
- 25pts Lecture assignments/activities
- 40pts Paper discussion leader (partner)
- 50pts Class/lab participation
- 70pts Lab notebook (30pts)/assignments (30pt)/peer evaluations (10pt)
- 80pts Research project plan (group: draft, mini-presentation, final version)*
- 80pts Research manuscript (drafts and final version)
- 20pts Research progress reports*
- 80pts Poster presentations (group)*

Total points: 825

The grading scale for this course is:

- A 92-100%
- A- 90-91%
- B 82-87%
- B- 80-81%
- C 72-77%
- C- 70-71%
- D 62-67%
- D- 60-61%
- F < 60%

EXAMS, QUIZZES, & LECTURE ACTIVITIES

Exams: There will be two mid-semester exams and a final exam in the course. Each of the exams will be largely essay question-based and worth 100 points. The focus will be to test your ability to synthesize, analyze, and apply information that we have discussed in the course. The two mid-semester exams will be administered as take-home exams given over the weekends indicated. The final exam will be taken in class on the date set by the university.

Quizzes: There will be five in-class quizzes administered throughout the semester as noted on the course schedule. Each quiz will be worth 20 pts, and your lowest quiz score in the course will be dropped to give a total of 80 quiz points. These quizzes will contain more knowledge-based questions along with one or two critical thinking questions and will include a combination of multiple choice, fill in the blank, and short answer formats. The purpose of these quizzes to ensure that you are keeping up with the course material so that you will be prepared for the paper discussions, lab projects, and exam questions that will follow.

Other assignments/activities: In addition to quizzes, exams, and paper discussions (see below), there will be occasional other small homework or in-class activities for which you will receive points. Points for these assignments may vary, but in total, 25 points in the course will be accounted for by these assignments.
Paper Discussions: While we will use a textbook for much of the basic material in the course, we will regularly go beyond the textbook to read and discuss current primary scientific literature related to the topic at hand. The purpose is to expose you to a range of research questions, techniques and model systems used in modern neurobiological research and to train you in the critical evaluation of the scientific literature. We will have seven paper discussion days, as noted on the course schedule. I will prepare and lead the first of these discussions. For the remainder, you each will take a turn working with partners to help select a paper, write reading questions, present relevant background information, and lead a journal club style discussion of the paper in which the rest of your classmates will participate. You will earn up to 40 points for this activity. Details will be provided in class.

Participation: This course is designed to be an upper level seminar in which student participation is paramount. This is seen most obviously in the paper discussions and lab components of the course; however, even on other days, while there will be some lecturing, I will frequently stop to ask questions, solicit your input, or have small group discussions. In addition, I welcome questions from you. Thus, the attendance and active engagement of each of you is essential for the success of the course. For this reason, there are 50 points in the course designated for participation. To earn full points, you must not only attend class but also actively participate in discussions both in lecture and lab, as well as pulling your weight in your lab group (see below). You will be allowed two unexcused lecture absences without penalty. (NOTE: These absences MAY NOT include Paper Discussion classes, as your attendance and participation on these days is necessary for a productive class discussion. Unexcused absences from paper discussions will result in a reduction of your final course grade by up to 10%). Beyond that, unexcused absences (that is, absences without legitimate documentation) will lead to a reduction in your final participation score. If you do miss a class, please make arrangements with a classmate to review their notes.

LABORATORY

Laboratory attendance each week is mandatory. Because of the ongoing nature of the projects and the live animals being used, you should plan to attend the entire length of the lab sessions. Any unexcused absence from lab will result in a reduction of your final course grade by up to 10%. In addition, the independent projects you will be performing will involve the maintenance of live worm strains and bacterial cultures; thus, you will be required to spend time outside of the normal lab period caring for your worms and/or setting up your experiments (see below). The lab room will be left open for your convenience.

The lab component of this course is unique for several reasons. First, as you will notice on the course schedule, the lab is completely project-based and involves a semester-long investigation into nervous system function using the model roundworm, C. elegans. Second, the work you will be doing is completely novel – that is, you are not doing canned labs that have been pre-tested to ensure your success. Instead, you are doing real research that has not been done before – you are on the forefront of science and have the potential to contribute new knowledge that has not been discovered previously by anyone in the world! In addition, the work we will do in the course this semester will pave the way for even more cutting edge research to be done by students in future semesters who will hopefully be able to link some of the research that you do to some novel research being done in the Biochemistry and Chemical Biology lab courses in the Chemistry department. So, you are doing some pretty important studies that I hope you will find exciting and motivating.

The project itself is focused around identifying and characterizing enzymes that regulate neuronal communication in C. elegans. As many worm genes have human homologs, this means that you may very well be learning more about the enzymes that control human nervous system function, as well. To do this, each group will first select and test a panel of candidate enzyme genes for their ability to affect the structure of synapses using fluorescence microscopy. Based upon the results of that initial screen, each group will then choose one or more genes to test in follow-up functional studies of their choosing (additional imaging experiments, behavioral studies, etc). Along the way, you will learn several important cellular, molecular, and genetic techniques that are frequently used in modern neuroscience studies, and even more importantly, you will gain experience in doing authentic scientific research, which involves experimental design and execution, data collection and analysis, oral and written communication of your findings and lots of trouble-shooting! These are the ultimate goals of the lab experience in this course, as doing science is how scientific information is generated. As you will see, it is not always a linear path, but it often is more exciting that way!
A special note about independent research and this course: A noted above, the lab is a critical part of this course. Here, you will utilize experimental design and data analysis skills, as well as learn to trouble-shoot experiments in real time. While the techniques you will use are routinely used in the field, the experimental questions you are addressing have not been previously tested - you are doing novel research! The downside is that this type of research doesn’t always work the first time, or the second time, or sometimes even the third time... so patience and thoughtful perseverance are essential skills for success here. Because I understand the nature of scientific research, your grade on this project does not necessarily depend on your experimental success. That would be great; however, I am simply looking for your ability to carefully research and design well-controlled experiments, to execute them as precisely as possible, to interpret the results, and to trouble-shoot efficiently. Thus, your care, effort, and ability to explain what you are doing are the goals here. The assignments described below are designed to help you achieve these outcomes.

Lab Notebook/Assignments/Peer Evaluation: An integral component of success and accuracy in the laboratory is the maintenance of a detailed, organized lab notebook. This notebook contains a written, dated record of each experiment you perform, including your experimental questions and hypotheses, the composition of solutions, ages of animals, treatment conditions and timing, and other observations, as well as a detailed log of your results and conclusions. This information is important for ensuring that you( or others) can replicate your experiment, and accuracy is critical for maintaining the integrity of the scientific process. Finally, you will need the experimental information that you keep in your notebook when it comes time to prepare your research manuscript and final poster. Each group will keep one shared notebook of their work. These notebooks will be checked periodically by me, and you will turn in the final notebook at the end of the semester for a total of up to 30 points. There also will be a few other small assignments/quizzes totaling 30 points in the early portion of the lab to help get you acclimated. Details and specific assignment guidelines will be provided in class.

Since the nature of the lab projects throughout the semester requires significant cooperation and teamwork among group members, along with submitting your group’s notebook and other group assignments (*, see above list), each student will be asked to submit confidential evaluations (2 points each) of your group members’ (and your own) contributions to the project. These evaluations will be used to determine if each group member is contributing equally to the work. Any group member not doing his/her fair share on the project may lose some or all lab notebook points earned by the group, as well as receive a reduction of up to 50% of the points for class participation and/or specific group assignments, depending on the nature of the issue. Please do your part to be an engaged group member – the project will be more meaningful and your final reports will be much easier if you do!

Research Project Plan: You will work in groups of three or four students throughout the semester on projects investigating genes controlling nervous system function in C. elegans. These projects will proceed in two parts: first, the groups will work in parallel to test a panel of genes for their effects on the abundance and distributions of a synaptic vesicle protein; second, each group will select one or more candidate genes on which to perform follow-up studies. The nature of these studies will be decided by the group and will depend on the nature of the candidate genes tested. Once an idea for the experimental plan is established, the group will prepare a written proposal to be submitted on the Friday before spring break. The group also will present and discuss their plan in a lab meeting format at which time they will receive feedback from their peers and from me. That feedback will then be incorporated into a final, revised version of the project plan, which will be resubmitted. The group will earn a total of 80 points for these components (initial plan, mini-presentation, and final draft) of the project plan.

Research Manuscript: To gain practice in written scientific communication, upon completion of the screening portion of your research projects, each student will write a scientific manuscript describing your work. However, as good writing of any sort requires revision, you will write drafts of each portion of the manuscript during the first half of the semester while the screen is in progress (see course schedule). You will receive feedback on these drafts which you will be able to use to help you in writing the final completed manuscript. More details and writing guidelines will be provided; you will earn up to 80 points for this assignment.

Research Progress Reports: To monitor progress on your independent projects, twice during the semester you will be asked to submit progress reports on your groups’ activities. These reports may involve discussing problems encountered, analyzing results, or just updating on work that still needs to be completed. Reports generally will be done as a group but parts may be individual. 20 total points are allotted for these reports.
Poster Presentation: For the concluding activity related to your research projects, each group will prepare a scientific poster summarizing both parts of their investigation (screening and follow-up studies). These posters will then be presented in two poster sessions at the end of the semester. The first of these sessions will occur during the final lab period. Students will receive feedback on their posters at this time and will have the opportunity to revise their poster layout prior to presenting it during a cross-departmental Chemistry/Biology poster session during the afternoon of Monday, April 27th (the final day of classes for the semester). Additional assignment details and examples will be provided in class. The poster and presentations will be worth 80 points.

COURSE POLICIES
Attendance in both class and lab is required (see “Participation” and “LABORATORY” sections above). Be advised that assignments given in class may not be announced, and in many cases will require group work or discussions. In class quizzes and assignments cannot be made up. Documented legitimate absences will be worked out case by case. If you expect to be absent during the time period of an exam you must contact me in advance, i.e., BEFORE the exam. If you fail to notify me, you have one week to apply in writing for a make-up exam. Make-up exams will be granted only for a legitimate excuse (such as illness) that can be documented.

Late Policy: All assignments are due at the beginning of the period or by the stated time online. If you do not have them ready to turn in then, they are considered late. For lab assignments and papers, 25% of the point total will be deducted for each day late. Documented legitimate absences will be worked out case by case.

Academic Honesty: Cheating is forbidden, as is plagiarism. The way this course is designed will necessitate working closely with other students. You will be asked to discuss problems in class and in lab, as well as working together on specific assignments. But, items for which you are receiving an INDIVIDUAL grade must be done as an INDIVIDUAL. Plagiarism is a form of cheating and is defined by the Student Handbook as "the fraudulent misrepresentation of any part of another's work as one's own." Plagiarism thus includes but is not limited to copying from past or present students, failure to cite the sources of ideas or information (especially in written work), and the use of quotes without quotation marks. No form of cheating will be tolerated; the formal procedures outlined in the Student Handbook will be instigated if cheating is discovered.

Use of TurnItIn: By taking this course, you are agreeing that all assignments may be subject to submission for textual similarity review to Turnitin.com for the detection of plagiarism. All papers submitted to Turnitin become source documents in the Turnitin.com reference database, which is used solely for the purpose of detecting plagiarism of such papers. Additional notifications are found on the Moodle site used in this and other Butler courses. Additional information is also available on the Usage Policy posted on the Turnitin.com site.

Requests for Academic Accommodations: It is the policy and practice of Butler University to make reasonable accommodations for students with properly documented disabilities. Written notification from Student Disability Services is required. If you are eligible to receive an accommodation and would like to request it for this course, please discuss it with me and allow one week’s notice. Otherwise, it is not guaranteed that the accommodation can be processed in time. If you have questions about Student Disability Services, please contact Michele Atterson, JH 136, ext. 9308.

A FINAL IMPORTANT NOTE ABOUT THIS CLASS
This class will function as a community of learners working in an environment that fosters inquiry and free expression. Such communities work best when all members feel free to express themselves without fear of ridicule or disrespect. Respect for the community also means that individuals do not disrupt the focus of the class with behaviors/actions that may distract others. Examples include tardiness, ringing/vibrating cell phones, texting, leaving/re-entering class once it begins, or packing up prior to the end of class. Please be respectful of your classmates and me by refraining from these activities.

Communications: If you do not do so already, please begin checking both your Butler University email account and Moodle on a daily basis. E-mail is my preferred means of communication, and I will send the class communiqués, information, and reminders via e-mail. If you need to contact me, use e-mail for best results.
BI460 Spring 2015 Course Schedule

The following is a TENTATIVE schedule for the activities and topics we will cover this semester. We will do our best to keep close to this schedule, but the topic, timing, and/or nature of the activities may change depending on the needs of group. I will let you know of any changes with as much advance notice as possible, and I appreciate your flexibility in working to make this a productive and engaging experience for each of you!

<table>
<thead>
<tr>
<th>Day</th>
<th>Topic</th>
<th>Textbook Readings</th>
<th>Assignments (more TBA)</th>
<th>Labs (Thursdays)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 13th</td>
<td>Intro to Course/Neurobiology</td>
<td>Chpt 1, 7</td>
<td>Review assignment; RCR training</td>
<td>Intro to <em>C. elegans</em>; project goals; safety &amp; lab notebook training</td>
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<tr>
<td>Jan 15th</td>
<td>Neuron &amp; Nervous system structure</td>
<td></td>
<td>*Read Worm handbook, IBC protocol</td>
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<tr>
<td>Jan 20th</td>
<td>Membrane Potentials</td>
<td>Chpt 2-4</td>
<td>Mello &amp; Conte, 2004 (lab)</td>
<td>Select RNAi target genes; <em>Worm quiz – Part I</em></td>
</tr>
<tr>
<td>Jan 22nd</td>
<td>Electrical Signaling (GPs, APs)</td>
<td></td>
<td><em>Worm quiz – Part II</em></td>
<td></td>
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<tr>
<td>Jan 27th</td>
<td>Quiz #1; AP propagation; Info coding Synaptic Transmission Intro</td>
<td></td>
<td>Kammath, et al., 2002 (lab)</td>
<td>Design RNAi experimental protocol</td>
</tr>
<tr>
<td>Jan 29th</td>
<td>Paper Discussion #1 (Dr.K) Presynaptic Mechanisms</td>
<td>Chpt 5, 6, 8</td>
<td>Sun, et al., 2013 (NMJ imaging); Outline Hmwk</td>
<td>RNAi &amp; slide training; Start cultures <em>Scientific writing workshop</em></td>
</tr>
<tr>
<td>Feb 3rd</td>
<td>Paper Discussion #2</td>
<td></td>
<td><strong>Tentative</strong> Screen Intro and M&amp;M (Tues)</td>
<td>RNAi screening</td>
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<tr>
<td>Feb 5th</td>
<td>Post-synaptic Mechanisms Quiz #2; Synaptic Integration</td>
<td></td>
<td><strong>Tentative</strong> <em>Lab Notebook Check</em></td>
<td></td>
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<tr>
<td>Feb 10th</td>
<td>Synaptic Plasticity</td>
<td></td>
<td><strong>Tentative</strong> Take-home Exam #1 due</td>
<td></td>
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<tr>
<td>Feb 12th</td>
<td>Paper Discussion #4</td>
<td></td>
<td><strong>Tentative</strong> RNAi screening</td>
<td></td>
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<tr>
<td>Mar 3rd</td>
<td>Paper Discussion #3</td>
<td>Assigned articles</td>
<td><strong>Tentative</strong> Results/Disc (Fri 2/6)</td>
<td>Screen analysis, RNAi clone sequence Plan follow-up studies</td>
</tr>
<tr>
<td>Mar 5th</td>
<td>Paper Discussion #4</td>
<td></td>
<td><strong>Tentative</strong> Screen Intro and M&amp;M (Tues)</td>
<td></td>
</tr>
<tr>
<td>Mar 9-13th</td>
<td>No Classes – Spring Break!</td>
<td></td>
<td><strong>Tentative</strong> RNAi screening</td>
<td></td>
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<tr>
<td>Mar 17th</td>
<td>Quiz #3: Axon Outgrowth and Pathfinding Synapse Formation, Trophic Factors;</td>
<td>Chpt 23</td>
<td>Initial Project Plan (Thurs AM)</td>
<td>Research Mtg: Mini-presentations; Discussion of Project Plans</td>
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<td>Mar 19th</td>
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<td></td>
<td><strong>Tentative</strong> Research Mtg</td>
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<tr>
<td>Mar 24th</td>
<td>Synapse Elimination; Synaptic Circuitry Changes</td>
<td>Chpt 23, 24</td>
<td>Final Project Plan (Mon 3/23)</td>
<td>Independent Projects</td>
</tr>
<tr>
<td>Mar 26th</td>
<td>Quiz #4; Technique Review</td>
<td></td>
<td>Final Manuscript (Fri 3/27)</td>
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<tr>
<td>Mar 31st</td>
<td>Paper Discussion #5</td>
<td>Assigned articles</td>
<td><strong>Tentative</strong> Progress Report I (Fri 4/3)</td>
<td>Independent Projects</td>
</tr>
<tr>
<td>Apr 2nd</td>
<td>Paper Discussion #6</td>
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<td><strong>Tentative</strong></td>
<td></td>
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<tr>
<td>Apr 7th</td>
<td>Injury, regeneration and repair Neurodegeneration</td>
<td>Chpt 25</td>
<td>Take-home Exam #1 due</td>
<td>Independent Projects</td>
</tr>
<tr>
<td>Apr 9th</td>
<td>(Friday) <strong>Butler URC</strong></td>
<td></td>
<td><strong>Tentative</strong> <em>Lab Notebook Check</em></td>
<td></td>
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<tr>
<td>Apr 10th</td>
<td>Stem cells and therapeutics</td>
<td>Chpt 25; Assigned articles</td>
<td><strong>Tentative</strong> Progress Report II (Fri 4/17)</td>
<td>Independent Projects</td>
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<tr>
<td>Apr 14th</td>
<td>Paper Discussion #7</td>
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<td><strong>Tentative</strong></td>
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<tr>
<td>Apr 16th</td>
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<td><strong>Tentative</strong></td>
<td></td>
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<tr>
<td>Apr 21st</td>
<td>Quiz #5; Hot topics in Neuroscience Course Wrap-up</td>
<td>Assigned articles</td>
<td>Final Poster (Sat 4/25, noon)</td>
<td>Class Poster session</td>
</tr>
<tr>
<td>Apr 23rd</td>
<td>(Mon) Bio/Chem Poster Session, TBA (Wed) FINAL EXAM 1-4pm GH158</td>
<td></td>
<td><strong>Tentative</strong></td>
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*Note: We will integrate examples of both normal and pathological nervous system function into these topics.