May 27, 2010

RE: Changing credit hours for G743/G744/G745

To the IUPUI Curriculum Committee:

The Medical Neuroscience program requests changing the number of credit hours for the following courses from 1 to 2 credit hours.

G743: Electrical Signaling and Ion Channels
G744: Neuropharmacology of Synaptic Transmission
G745: Intracellular Signal Transduction in Neurons

These courses existed previously as three sequential 5 week modules that were listed as N613, N615, and N617 and were taught to first year students in the Medical Neuroscience program. These courses were offered prior to the creation of the Indiana BioMedical Gateway (IBMG) program for open admission to the Graduate School. N613, N615, and N617 were offered originally as 2 credit hour courses scheduled for Mon/Wed/Fri (10 AM-noon). These courses went to 1 credit hour and scheduled for Mon/Fri (10:30 AM-noon) to accommodate the new format of the IBMG program. However, in the ensuing years, we have found that this reduction in class contact time is inadequate to provide a fundamental understanding of the neurosciences that we feel is necessary for our students to successfully compete in today’s academic/professional environment. Therefore, the Medical Neuroscience program wishes to return to this course format to provide more contact time with our students. We have provided the course outlines for N613, N615, and N617 as they existed in 2006 so that the committee can assess the content of these Mon/Wed/Fri, 2 credit hour courses and compare them to the current course outlines for the Mon/Fri 1 credit hour G743/G744/G745. The important point to consider here is that the content is not different between the 2 credit hour courses compared to the 1 credit hour courses, but rather the extent of discussion for each topic is greater. In addition, the change from 1 to 2 credit hours for G743/G744/G745 would now put these courses more in line with the second series of required Medical Neuroscience modular courses N612/N614/N616, which are offered in the Fall semester of the student’s second year. This change to the 2 credit hour, Mon/Wed/Fri (10 AM-noon) format will provide additional continuity to the curriculum of the Medical Neuroscience program. If you have additional questions, please do not hesitate to contact me via email at gnicol@iupui.edu.

Sincerely,

[Signature]

Grant Nicol, Ph.D.
Showalter Professor Pharmacology & Toxicology
Director of Graduate Studies, Medical Neuroscience
Course Change Request

Check Appropriate Boxes: Undergraduate credit [ ] Graduate credit [X] Professional credit [ ]

1. School/Division: GRADUATE/MEDICAL NEUROSCIENCE
2. Academic Subject Code: GRAD
3. Current Course Number: 6743
4. Current Credit Hours: 1
5. Current Title: ELECTRICAL SIGNALING AND ION CHANNELS
6. Effective Semester/Year for changes listed below: SPRING 2011
7. Instructor: CUMMINS

Type of Change Requested (Check appropriate boxes and indicate changes)

☐ 8. Change course number to: ____________________________ (must be cleared with University Enrollment Services)
☐ 9. Current course title: ____________________________

Change to:
Recommended abbreviation (optional) ____________________________ (Limited to 32 Characters including spaces)

☐ 10. Current credit hours fixed at: ______ or variable from: ______ to ______
Change to credit hours fixed at: ______ or variable from: ______ to ______

☐ 11. Current lecture contact hours fixed at: ______/wk or variable from: ______ to ______
Change to lecture contact hours fixed at: ______/wk or variable from: ______ to ______

☐ 12. Current non-lecture contact hours fixed at: ______ or variable from: ______ to ______
Change to non-lecture contact hours fixed at: ______ or variable from: ______ to ______

☐ 13. Is this course currently graded with S-F (only) grades? Yes _____ No _____
Change to S-F (only) grading? Yes _____ No _____

☐ 14. Does this course presently have variable title approval? Yes _____ No _____
Is variable title approval being requested? Yes _____ No _____

☐ 15. Is this course being discontinued? For all campuses ______ or for this campus only ______

☐ 16. Current course description: SEE ATTACHED

Change course description to (not to exceed 50 words)

17. Justification for change: SEE ATTACHED

(Use additional paper if necessary)

18. Are the necessary reading materials currently available in the appropriate library? YES

19. A copy of every new course proposal must be submitted to departments, schools, or divisions in which there may be overlap of this course with existing courses or areas of strong concern, with instructions that they send comments directly to the originating Curriculum Committee. Please append a list of departments, schools, or divisions thus consulted.

Submitted by: ____________________________ Date 6/10/2010
Department Chairman/Division Director

Approved by: ____________________________ Date 6/19/10
Dean

Dean of Graduate School (when required) Date __________

Chancellor/Vice-President Date __________

University Enrollment Services Date __________

After School/Division approval, forward the last copy (without attachments) to University Enrollment Services for initial processing, and the remaining four copies and attachments to the Campus Chancellor or Vice-President.
G743: Electrical Signaling and Ion Channels  
(SPRING 2010)

Overview: In this course we are going to cover some fundamental material that will be essential to your understanding of the cellular and molecular basis of bioelectricity and its functional role in the nervous system as well as in skeletal, smooth, and cardiac muscle and endocrine cells. For those of you interested in the study of neuroscience, exposure to this material will advantage you for the remainder of the associated modular series (G744, G745) in three ways. First, you will be provided with a nervous system context in which to place discussions of research into molecular mechanisms of signaling, development, and form that often may derive from non-neuronal systems. Second, you will begin to develop concepts and a vocabulary related to the cell biology, molecular biology, and anatomy that will be recurring themes in the research literature you will wrestle with in the other modules of this series. Finally, you will evolve an understanding of the methods of modern cell biology, molecular biology, and biophysics which will be absolutely essential for getting through the “Methods” sections of original research papers and understanding data presented in figures in these papers. For some in this class, this material may be familiar, for others completely new and overwhelming. We ask that you both challenge yourselves to understand this material and assist those less familiar with the material to understand it as well.

Emphasis on the basics and their general applicability in all cells. It is our assumption that most of the class will have been exposed to the basics of electrical signaling (i.e. generation of resting and action membrane potentials, voltage-dependent ion channels, membrane properties) through the G715 and G717 courses of the IIBM curriculum in the fall. Thus, we will not repeat much of that material and encourage you to review your notes from those classes. Nonetheless, we will spend a brief period of time at the beginning to make sure that basic electrophysiological principles are appreciated, even at the expense of some specific ion channel biology of perhaps more contemporary interest. Membrane potentials, current and voltage responses, and the role of ion channel behaviors in modulating electrical signaling take precedence over the molecular biology of ion channels. In other words, you may understand how a channel opens or closes, but if you have no idea what the consequences of those events are for the cell, it’s like knowing the alphabet, but you can’t spell.

Association between ion channels and cellular behaviors. We will attempt to associate specific electrical behaviors with ion channel classes, rather than separating the issues of basic signaling vs. ion channel types. In this regard, we will refer to the biology of particular channel types within the context of their function and will discuss original research articles on the channels within this context. The general associations will be as follows:

- Resting membrane potentials: inward rectifier and 2-pore domain K channels
- Neuronal action potentials: voltage gated Na channels and delayed rectifier K channels
- Regulation of action potential frequency: A-type K channels
- Regulation of action potential burst duration: calcium-activated K channels
- Neurotransmitter release: voltage-gated Ca channels
- Modulation of excitability: role of ion channels in disease mechanisms

Structure and Procedures of G743: The first session of each week will consist primarily of basic lectures and class discussion lead by faculty members. Background reading material from textbooks and review articles are indicated. The second session will focus on class discussion of two assigned original research articles (bold type) that build on and extend the
knowledge obtained in the first session. A student leader will be assigned for each paper, but it is expected that all students will participate in the discussion. Students must come prepared for this.

Reading Assignments: Students are expected to read assigned material before coming to class. On the module schedule, required reading will be indicated by an asterisk (*). This will usually include original articles for discussion and textbook chapters or review articles. Supplemental optional articles (e.g. reviews) which may help your understanding of the material are indicated in *italics*. Textbook assignments will come from one or more of 4 on-line texts available through the NCBI website. You can access these texts using a URL link document file that we have provided on a CD-ROM with explanations as to how to use. The texts are:

- Purves et al. *Neuroscience (2nd Edition)*, 2001 (NS)

Paper presentation and Discussion participation: During the first session, each student will be assigned an original research paper that they will lead the discussion of. Every member of the class is expected to have carefully read the paper and participate in the discussion of the paper. A major part of the class is the discussion of original papers. These papers were selected because they illustrate one or more key concepts. The instructors will introduce the background material in the prior lecture, but a significant part of understanding the concepts is for the students to read, question, discuss, and understand the data that support the concepts. Discussion papers are in **bold** on the block schedule.

Discussions should include the following elements:

- Background information. What key experiments and/or developments led up to the present paper?
- General overview. What's the big picture?
- Experimental details. What techniques were used? What are some of the strengths and weaknesses of the techniques employed?
- Results from individual figures. What data are shown? Are there any additional techniques that need to be described to understand the figure? What conclusions are drawn from the data? Do the data fully support the conclusions drawn? Are there any weaknesses in the data that lead you to question the validity of the conclusions? What additional experiments do the data suggest?

**ALL** students (NOT just the discussion leaders) are responsible for reading the paper before class and participating in the discussions. The faculty can easily tell when a student has not read the paper. To help to focus your effort on the key figures and avoid getting unproductively bogged down in occasional minutia, the instructors have written study questions about the reading material. Please use them to guide your comprehension.

**Written questions:** For each Discussion paper, every student is required to write up and turn in one “discussion question”. Each student should come up with their discussion questions independently (see Code of Student Conduct at end of the course syllabus). The discussion questions must be turned in at the beginning of class each Friday and are worth 10% of your total grade. It is hoped that students will use their discussion questions during the actual discussion of the paper.
Computer Familiarity and Access: Personal computers are an integral tool in the endeavor of science. It is not required that you own a computer for this course, but some reasonable access to a computer (preferably operating Windows XP or Vista) is necessary. All materials for use in this course as well as G744 and G745 will be distributed to you on CD-ROM and in some instances, you will be required to use a computer to solve a problem set or in a formal examination for a module. If you have any concerns or questions regarding computer access or appropriateness, please contact Dr. Cummins as soon as possible.

Problem set: A problem set will be assigned in the second week to help you assess your understanding of the material. The problem set will have 4 questions, at least one of which involves the use of a computer neuronal simulation program (see below).

Supplemental materials: We will be using two supplemental materials in this block worthy of special mention. (1) Two neuronal simulation programs (CCWin and VCCWin) will be demonstrated in class and distributed for your use in the block. You will have exam questions requiring you to use this program. Please make sure you have ready access to a computer running Windows 95 or above with a CD-ROM drive. (2) A very good technical reference, the Axon Guide, is available on the web in Adobe PDF format. We will be pointing you to certain chapters in this guide and have provided these files on the CD ROM which accompanies this block. The remainder of the guide is available for you to download at

http://www.moleculardevices.com/pages/instruments/axon_guide.html

Grading: Grades will be based on performance in 6 different areas that add up to a total of 100 points for the final grade:

Attendance: 10 points (1 point per class)
Participation: 10 points determined by subjective evaluation of class participation.
Written questions: 10 points (1 point per question/paper)
Paper presentation: 10 points
Problem set: 20 points (4 questions, 5 points each)
Take-home exam: 40 points (4 questions, 10 points each)

CHEATING AND PLAGIARISM

Students are instructed to make themselves aware of University regulations concerning plagiarism, the maintenance of academic honesty, and the definitions of unacceptable behavior and cheating. Academic misconduct of any sort will not be tolerated and will be dealt with as outlined in the Code of Student Conduct, which can be viewed at:

http://www.iupui.edu/code/

Examples of misconduct include but are not limited to:
1. Cheating
   A student must not use or attempt to use unauthorized assistance, materials, information, or study aids in any academic exercise
2. Fabrication
A student must not falsify or invent any information or data in an academic exercise including, but not limited to, records or reports, laboratory results, and citations to the sources of information.

3. Plagiarism
A student must not adopt or reproduce ideas, words, or statements of another person without appropriate acknowledgment. A student must give credit to the originality of others and acknowledge an indebtedness whenever he or she does any of the following:
   a. Quotes another person’s actual words, either oral or written
   b. Paraphrases another person’s words, either oral or written
   c. Uses another person’s idea, opinion, or theory; or
   d. Borrows facts, statistics, or other illustrative material, unless the information is common knowledge.

4. Interference
   a. A student must not steal, change, destroy, or impede another student's work.
   b. A student must not give or offer a bribe, promise favors, or make threats with the intention of affecting a grade or the evaluation of academic performance.

If a student has a question concerning any of these policies, he/she should direct them to their course instructor or to the IUSM Graduate Division.
### Schedule of Sessions - 2010

Instructors: Ted Cummins (TC) and Alexander Obukhov (AO)

<table>
<thead>
<tr>
<th>Session</th>
<th>Day</th>
<th>Date</th>
<th>Instructor</th>
<th>Lecture / Discussion Topic</th>
<th>Reading (* = Required)</th>
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<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>1/11</td>
<td>TC</td>
<td>Course introduction.</td>
<td>*BN 1-2; NS 1-8; MCB 1</td>
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<td></td>
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<td>Action potential generation, propagation, myelination, segregation of Na and K channels.</td>
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<td>The Axon Guide, Chapter 1</td>
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<td>3</td>
<td>W</td>
<td>1/20</td>
<td>TC</td>
<td>Action potential generation II: gating properties of sodium and potassium channels, Hodgkin Huxley model.</td>
<td>*NS 9-13; MCB 2; BN 3</td>
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<td>Voltage-dependent activation, Single channel currents, gating currents</td>
<td>*Simulation program instructions</td>
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<td>*Hille book, pp. 603-612</td>
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<td>5</td>
<td>M</td>
<td>1/25</td>
<td>AO</td>
<td>Ion channel structure and function: Mechanisms of permeation, activation, and inactivation.</td>
<td>*NS 16; BN 4; MCB 1; MBoC 1</td>
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<td>F</td>
<td>1/29</td>
<td>AO</td>
<td>Diversity of ion channels. Calcium channels: channel subtypes, their roles in cell function and</td>
<td>*BN 5-8; NS 14,15</td>
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<td>7</td>
<td>M</td>
<td>2/1</td>
<td>AO</td>
<td>Discussion of assigned papers</td>
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<td>8</td>
<td>F</td>
<td>2/5</td>
<td>AO</td>
<td>Discussion of assigned papers</td>
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<td>9</td>
<td>M</td>
<td>2/8</td>
<td>TC</td>
<td>Ion channel diseases</td>
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<td>NS 16 (Box D)</td>
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<td>*Ashcroft book Introduction</td>
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<td>10</td>
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<td>TC</td>
<td>Discussion of assigned papers</td>
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<td>F</td>
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<td>2/19</td>
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<td>Take-home exam due, 5 pm</td>
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N613: Introduction to Neuroscience and Electrical Signaling in the Nervous System (FALL 2006)

Overview: Students enter neuroscience training from a variety of backgrounds ranging from experimental psychology and cognitive science to chemistry and engineering. The first few sessions of this module are designed to ease the transition of those without backgrounds in anatomy or cell/molecular biology into some of the jargon and nomenclature of neuroscience required to grapple with the material in later in the course. It is important to understand that the purpose of these early sessions is to help bring everyone to as close to the same level of fundamental understanding of some basic cellular and molecular concepts as possible.

In this module we are going to cover some fundamental material that will be essential to your understanding the cellular and molecular basis of nervous system function. Having exposure to this material will advantage you for the remainder of the course series in three ways. First, you will be provided with a nervous system context in which to place discussions of research into molecular mechanisms of signaling, development, and form that often may derive from non-neuronal systems. Second, you will begin to develop concepts and a vocabulary related to the cell biology, molecular biology, and anatomy that will be recurring themes in the research literature you will wrestle with in the other modules of this series. Finally, you will evolve an understanding of the methods of modern cell and molecular biology which will be absolutely essential for getting through the "Methods" sections of original research papers and understanding data presented in figures in these papers. For some in this class, this material may be familiar, for others completely new and overwhelming. We ask that you both challenge yourselves to understand this material and assist those less familiar with the material to understand it as well.

Emphasis on the basics. We will attempt to make sure that basic electrophysiological principles are covered, even at the expense of some specific ion channel biology of perhaps more contemporary interest. Membrane potentials, current and voltage responses, and the role of ion channel behaviors in modulating electrical signaling take precedence over the molecular biology of ion channels.

Association between ion channels and neural behaviors. We will attempt to associate specific electrical behaviors with ion channel classes, rather than separating the issues of basic signaling vs. ion channel types. In this regard, we will refer to the biology of particular channel types within the context of their function and will discuss original research articles on the channels within this context. The general associations will be as follows:

- Resting membrane potentials: IRK channels
- Neuronal action potentials: voltage gated Na channels and DRK channels
- Regulation of action potential frequency: A-type K channels
- Regulation of action potential burst duration: BK and SK channels
- Neurotransmitter release: Ca channels
- Modulation of signaling: GIRK, KATP, and Ca channels

Structure and Procedures of N613: During the first couple of weeks, this module will consist primarily of basic lectures and class discussion lead by faculty members and reading material from textbooks and review articles. For the remainder of the course, the focus will switch to class discussion of an assigned original research article (bold type) with lectures to fill in gaps in knowledge revealed by the discussion. Also problem sets will be assigned to help you assess your understanding of both.
**Reading Assignments:** Students should always read assigned material **before** coming to class. On the block schedule, required reading will be indicated by an asterisk (*). This includes original articles for discussion and textbook chapters. Supplemental optional articles (e.g. reviews) which may help your understanding of the material are indicated in *italics*. Textbook readings are mostly from *Fundamental Neuroscience* (FunNeuro). Additional optional readings in *Molecular Biology of the Cell* (3rd edition) (MBC) and other sources are also included.

**Computer Familiarity and Access:** Personal computers are no longer an optional accessory in the endeavor of science. It is not required that you own a computer for this course, but some reasonable access to a computer (preferably operating Windows 200 or XP) is necessary. All materials for use in this course (all blocks) will be distributed to you on CD-ROM and in some instances, you will be required to use a computer to solve a problem set or in a formal examination for a block. If you have any concerns or questions regarding computer access or appropriateness, please contact Dr. Simon as soon as possible.

**Small Group Work:** During the first week of class, the instructors will divide the class into small groups. Each small group will be required to lead the discussion of assigned original research papers. In addition, the groups can provide an interactive environment for going over problem sets. Your small group partners are to serve as additional resources to help learn the material.

**Discussion participation:** A major part of the class is the discussion of original papers. These papers were selected because they illustrate one or more key concepts. The instructors will introduce the key concepts in a lecture format, but a significant part of understanding the concepts is for the students to read, question, discuss, and understand the data that support the concepts. Discussion papers are in **bold** on the block schedule.

Each of the small groups will be required to lead the discussion of assigned discussion papers. Discussions should include the following elements:

- Background information. What key experiments and/or developments led up to the present paper?
- General overview. What's the big picture?
- Experimental details. What techniques were used? What are some of the strengths and weaknesses of the techniques employed?
- Results from individual figures. What data are shown? Are there any additional techniques that need to be described to understand the figure? What conclusions are drawn from the data? Do the data fully support the conclusions drawn? Are there any weaknesses in the data that lead you to question the validity of the conclusions? What additional experiments do the data suggest?

**Small groups should meet before their class to decide:**

1. How to cover the main points, and
2. Who will be responsible for leading the discussion of each figure.

ALL students (NOT just the small group presenting a paper) are responsible for reading the paper before class and participating in the discussions. To help to focus your effort on the key figures, the instructors have written study questions about the reading material.

**Supplemental materials:** We will be using three supplemental materials in this block worthy of special mention: (1) Two neuronal simulation programs (CCWin and VCCWin) will be
demonstrated in class and distributed for your use in the block. You will have exam questions requiring you to use this program. Please make sure you have ready access to a computer running Windows 95 or above with a CD-ROM drive. 2) A second neuronal simulation program (NeuroLab) will be demonstrated in class to illustrate certain key points about action potential conduction. It will be made available for your own use, but will not be required for the exam. 3) A very good technical reference, the Axon Guide, is available on the web in Adobe PDF format. We will be pointing you to certain chapters in this guide and have provided these files on the CD-ROM which accompanies this block. The remainder of the guide is available for you to download at

http://www.moleculardevices.com/pages/instruments/axon_guide.html

Examinations: Evaluation of student performance in this course will be accomplished by a single take-home exam composed of 3-5 questions requiring approximately 6 hours to complete in an open book environment. The score on this exam will constitute 85% of the final grade. The remaining 15% will be determined by subjective evaluation of class participation and presentation.

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3. Plagiarism
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   a. Quotes another person's actual words, either oral or written
   b. Paraphrases another person's words, either oral or written
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<tr>
<td>1</td>
<td>W</td>
<td>8/23</td>
<td>GO</td>
<td>Cell Biology of the Nervous System, Basics of Neuroanatomy</td>
<td>FunNeuro pp. 49-69, 79-102</td>
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<td>FunNeuro pp. 32-45, 580-588; 758-765</td>
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<td>The Digital Anatomist (Interactive Brain Atlas)</td>
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<td>2</td>
<td>F</td>
<td>8/25</td>
<td>TC/GO</td>
<td>Action Potentials and Electrical Signaling, Chemical Synaptic Transmission</td>
<td>FunNeuro, Chap. 5, pp. 115-126; Chap. 6, pp. 140-160</td>
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<td>4</td>
<td>W</td>
<td>8/30</td>
<td>TC</td>
<td>Action potential generation, gating properties of sodium channels, Hodgkin Huxley model, elementary propagation of the action potential.</td>
<td>*FunNeuro pp. 140-156</td>
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<td>*Simulation program instructions</td>
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<td>5</td>
<td>F</td>
<td>9/1</td>
<td>TC &amp; GO</td>
<td>Electrical recording modes: voltage clamp vs. current clamp, consequences for synaptic potentials, patch clamp. Introduction to CCWin &amp; VCWin software.</td>
<td>*FunNeuro pp. 140-145, 115-126, 301-304</td>
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<td>LABOR DAY - NO CLASS</td>
<td>Work on assigned problem set</td>
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<td>7</td>
<td>F</td>
<td>9/8</td>
<td>GO</td>
<td>Voltage-dependent activation, gating currents, molecular structure.</td>
<td>*FunNeuro pp. 140-156</td>
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<td>*Hille book, pp. 603-612</td>
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<td>Methods section from Smith-Maxwell et al. 1998(first paper)</td>
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|    |    |     |                          | *Miller. Genome Biology 1:1-5,2000  
| 8  | M  | 9/11 | TC & GO Sodium channel diversity and pharmacology |  
| 9  | W  | 9/13 | GO Propagation of the action potential (Advanced issues): cable properties, myelination, segregation of Na and K channels  
|    |    |     | *Discuss Problem Set #2 | FunNeuro pp. 115-136, 319-329  
| 10 | F  | 9/15 | JH & GO Calcium channels: channel subtypes and their roles in cell function.  
|    |    |     |                           | Dunlap, Luebke, and Turner. TINS 18:89-98, 1995  
| 11 | M  | 9/18 | GN K channel diversity and modulation of K channels (K_{Ca} channels, GIRK, and K_{ATP}) | *FunNeuro pp. 259-274  
|    |    |     |                           | *MBC pp. 543-544, 731-734  
| 12 | W  | 9/20 | GN Regulation of action potential frequency: A-type K channels | *Hille book pp. 115-127  
|    |    |     |                           | *Tierney & Harris-Warrick, J. Neurophysiol. 67:599-609, 1992  
| 13 | F  | 9/22 | TC & GN Ion channel diseases | *Ashcroft book Introduction  
|    | F  | 9/22 | Take-home exam handed out |  
|    | M  | 9/25 | Take-home exam due, 5 pm |