

## MCB 401: Cellular Physiology, Fall 2023

3 undergraduate/graduate credit hours

Course Website on Moodle: <https://learn.illinois.edu/course/view.php?id=74468>

### Instructor:

Dr. Catherine Christian-Hinman

email [cathchri@illinois.edu](mailto:cathchri@illinois.edu); phone 217-244-8230

Office: 523 Medical Sciences Building

TA: Robbie Ingram, [robbiei2@illinois.edu](mailto:robbiei2@illinois.edu)

Class hours and location: MWF 1:00-1:50 PM, 161 Noyes Laboratory

Student drop-in hours (Held on Zoom, link posted in Moodle): Friday 9:30 – 10:30 AM

In addition to class times, students should expect to spend approximately 6 hours per week on instructional activities for this course, including reviewing lecture material, reading Journal Club articles, completing homework assignments, and studying for quizzes and exams.

### Course Overview and Description:

The main objective of this course is to provide you with a substantial introduction to cellular physiology. The content will focus on the cellular and molecular bases of physiological processes including cellular homeostasis, signal transduction, water transport, membrane potentials, cellular excitability, synaptic transmission and plasticity, and neuromuscular function. These effects at the cellular level provide the basis for organs to have the requisite machinery to function properly. Therefore, these biological processes are critical to both normal and pathological function, and are targets for drug development and therapeutics for a wide variety of diseases.

Particular focus in this course is placed on the electrical properties of cells and membranes. Therefore, this course will also provide you with an overview of electrophysiological concepts and methods. You will thus learn the fundamental bases of physiological parameters measured in a wide variety of clinical and biological research assessments in cells and animals. In the second half of the semester, the main emphasis is on muscle cells and neurons as two canonical examples of electrically excitable cells.

This course is appropriate for students interested in pursuing medical, veterinary, dental, or nursing school, or biological or biomedical research.

Prerequisite: MCB 252 (Cells Tissues & Development) or permission of instructor. This course is appropriate for senior undergraduate and graduate students.

Some students may find it helpful to have taken a neurobiology course (e.g., MCB 314 or 461), but it is not required; all neurobiology knowledge necessary to succeed in MCB 401 will be provided.

### Student Learning Outcomes:

After you complete this course, you will be able to:

- Describe how animal cell membranes are structured and how solutes and water are moved across membranes in and out of cells
- Differentiate between different types of ion channels and other membrane proteins that permit movement of ions across cell membranes
- Predict directions of ion flux across membranes
- Define the changes in membrane voltage associated with action potentials in multiple cell types and distinguish between the ionic basis of different types of action potentials
- Diagram the steps in synaptic vesicle release and reception of synaptic signals in target cells
- Compare the roles of neurons and glial cells in brain function and distinguish between different forms of cellular plasticity
- Evaluate works in the scientific research literature

Main Textbook:

**Medical Physiology**, 3<sup>rd</sup> ed., Boron and Boulpaep, Elsevier ISBN 9781455743773

Note: An online version of this book is **freely available** through the UIUC library at <https://ebookcentral.proquest.com/lib/uiuc/detail.action?docID=5553767>. *You are not required to purchase this book to take this class.*

Supplemental reading materials will be provided on the lab Moodle site as needed.

Powerpoint slides (both .pptx and .pdf versions) will be available on the Moodle site before each class.

### **Journal Club:**

Selected papers from the literature will form the basis for our Journal Club. These papers and associated questionnaires will be provided on the course Moodle site at least 2 weeks before the designated class. For each session, you are expected to come to class having read the assigned paper and completed the written questionnaire.

You are encouraged to consult with each other to discuss the papers as part of your preparation of the assignment. However, **you must compose your answers to the questionnaire independently**; any written work that indicates copying or plagiarism will be treated as an academic violation. All written assignments must be uploaded to Moodle prior to the beginning of class on the day of discussion. Each questionnaire will be worth 10 points. No credit will be given for questionnaires that are not submitted by the start of the designated class.

On the days in the schedule designated for Journal Club, we will have a general class discussion of the papers. Through the discussion, you will be provided with the information needed to complete an assignment in Moodle. This assignment can be completed and submitted in class if you bring a device that can access Moodle but must be submitted by the start of the following class session for full credit. Completion of the Moodle assignment will be worth a total of 5 points.

Note: Video recordings of Journal Club discussion days to enable completion of the in-class Moodle assignment will only be made available to students who are absent for an excused reason (see “Missed Exams/Quizzes and Scheduling Conflicts” section below). Otherwise, attendance in class to participate in the discussion is expected.

### **Policies:**

*Academic Integrity:* All students are expected to adhere to the Student Code guidelines on Academic Integrity, found at [http://studentcode.illinois.edu/article1\\_part4\\_1-401.html](http://studentcode.illinois.edu/article1_part4_1-401.html). Cheating and plagiarism of any form will not be tolerated. Examples of infractions, and the procedures for addressing suspected violations, may be found at <http://www.las.illinois.edu/students/integrity/>.

*Social Media and Sharing of Course Information:* All publicly available information about this course is shared at the sole discretion of the instructors. Use of any social or electronic media to share information about the course is prohibited. Any social media or website that refers to this course must grant access to course personnel upon request. Failure to provide access will result in a failing grade in the course for the group/site’s administrator(s). Posting or redistribution of course material, including but not limited to Powerpoint slides, quizzes, and exams, in any format is strictly prohibited. Any use of this type may earn you a zero on the exam or a more extreme penalty at the discretion of the instructor.

*Phones and Laptops/Tablets:* Turn off all cell phones before class begins. If your phone rings, you must silence it immediately without answering. If this happens more than once, you will be asked to leave class for the day.

You may use a laptop or tablet for taking notes with all sounds muted. Any use of computers or devices that is disruptive to the learning of your fellow students will not be tolerated and may be grounds for removal from the class. **Quizzes will be taken in Moodle in class**; therefore, you should bring a laptop, tablet, or phone to use to log in to Moodle and take the quiz. You may also use a laptop, tablet, or phone to log in to Moodle to complete the in-class Journal Club assignments. Calculators are not allowed during quizzes or exams. Use of laptops, tablets, calculators, phones, smart watches, or other electronic devices during exams is strictly prohibited.

*Lecture Recordings:* Closed-captioned recordings of lectures (either from this year or a previous year) will be posted on Moodle for study review at least 4 days before each exam. Therefore, it should not be necessary for you to make your own recordings. However, you may choose to do so provided that ONLY audio recordings are made. Note that all material recorded is the intellectual and copyrighted property of the University of Illinois Board of Trustees and may be made for personal use only. Video recordings of any kind are strictly prohibited. Posting of audio recordings or transcriptions on social or electronic media platforms is strictly prohibited. Any student who violates these policies will receive a failing grade for the course.

Any behaviors disruptive to the class that are not addressed upon request from the instructors will not be tolerated, and you may be asked to leave class for the day.

*Class Cancellation:* If a class time is canceled due to an unforeseen circumstance (e.g., campus closure, illness of instructor), we will attempt to avoid changes to the schedule as much as possible by either posting a recorded lecture online as soon as possible after the canceled class or moving the class session onto Zoom instead of meeting in person. If absolutely necessary, an exam review session may be replaced with a regular class session but this will be considered a last resort.

### **Exams and Grading:**

There will be 4 exams, 4 quizzes, and 4 Journal Clubs. All exams and quizzes will be taken during regular class hours (except for Exam 4, which will be taken during the Final Exam period). Each exam will have 25 multiple choice questions. Quizzes will be taken in the first 15 min of the designated class session, and consist of 10 multiple choice, true-false, or fill-in-the-blank questions. Your scores will be available for review on the MCB 401 Gradebook within the course Moodle website.

Exams 1-4	100 points (25 points each)	50%
Quizzes 1-4 (Moodle)	40 points (10 points each)	20%
Journal Clubs 1-4 written (Moodle)	40 points (10 points each)	20%
Journal Clubs 1-4 in-class (Moodle)	20 points (5 points each)	10%
<b>Total</b>	<b>200 points</b>	<b>100%</b>

Minimum points for each letter grade:

A+ = 196; A = 184; A- = 180; B+ = 176; B = 164; B- = 160; C+ = 156; C = 144; C- = 140; D+ = 136; D = 124; D- = 120; F < 120

Full completion and submission of homework assignments by the designated deadlines, as well as a fifth journal club assignment due by the start of the final exam, are optional but will be incorporated into grade calculations as up to 10 points of extra credit. More details on these assignments will be given during the course of the semester.

Based on the performance of the class as a whole as determined at the end of the semester, the grade scale may be adjusted to lower the cutoff for each grade at the sole discretion of the instructors. Except in cases where there is evidence of mathematical miscalculation on the part of the instructors, no requests for changes to final grades will be granted, and extraneous requests for extra credit opportunities beyond those already offered will not receive a response.

**iClicker** questions will be used during lectures. Participation in iClicker questions is optional and these questions do not enter into grade calculations. However, you will likely find that participating helps you to see how well you are learning and integrating key concepts as the course progresses, which can aid in preparation for quizzes and exams. If you do not have an iClicker remote, you may use the free iClicker phone or web apps (<https://www.iclicker.com/students/apps-and-remotes/apps>).

#### **Attendance Policy:**

Credit is not given in this class for attendance only. Therefore, if you miss a regular class day (i.e., not an exam or quiz day) please do not submit an excused absence request. If a serious matter arises that will require your extended absence (1 week or more of consecutive days) from class, please contact Dr. Christian-Hinman to discuss alternative arrangements.

#### **Missed Exams/Quizzes and Scheduling Conflicts:**

Make-up exams or quizzes will be scheduled only for students who have a documented excuse or written evidence of the conflict. Note that a scheduling conflict consists of an expected inability to be present in class at the scheduled exam/quiz time due to justified travel and/or a required academic or professional activity that is scheduled at the same time. Absences that may be excused include:

- Circumstances beyond the student's control such as medical treatment, surgery related to prolonged illness or injury, pregnancy, legal matters, citizenship or naturalization processes, or acts of nature that cause destruction to a primary residence or disrupt air travel
- The need to be present during the serious illness of an immediate family member (parents, legal guardian, spouse/partner, siblings, children, or grandparents)
- Attendance at a professional conference, or interviews for a job or graduate or professional school, though a best effort should be made to schedule these events to minimize class attendance disruption.

All instances will require documentation.

Alternative times will **not** be arranged only because you have exams in other classes on the same day. Absences will also not be excused for family events such as reunions or weddings, or presence during serious illness of extended family members (e.g., aunt, uncle, niece, nephew, or cousin).

As soon as you are aware of an unavoidable scheduling conflict with an exam or quiz time, you must email Dr. Christian-Hinman to provide the justification for the conflict and your class schedule so that an alternative exam/quiz time can be arranged. Planned absences must be communicated to the instructors at least 2 weeks in advance; note that as time gets closer to the exam/quiz day, it may become impossible to arrange for an alternative exam/quiz time.

In the case of illness or other severe unforeseen circumstance on an exam or quiz day, you must email Dr. Christian-Hinman within 24 hours of the absence to acknowledge that you missed the exam/quiz. You will then have 48 hours from the absence in which to submit documentation (e.g., medical care provider's note) or further description of the nature of the absence to Dr. Christian-Hinman. Course personnel will evaluate the documentation and decide whether or not there will be an option to compensate for the missed exam through either a make-up exam or proration. Failure to follow this procedure will result in a zero for the exam.

#### **Final Exam Conflict:**

Conflict final exams may only be granted for one of the following situations:

- Students with three final exams scheduled within a 24-hour period as defined in Section 82.A.4) Final Examinations of the *Code of Policies and Regulations Applying to All Students*, which can be found at: [www.illinois.edu/admin/manual/code/](http://www.illinois.edu/admin/manual/code/)
- Students who have two final exams scheduled at the same time. Final conflict exam requests should be made to the course with larger enrollment. Course personnel can assist with information to determine which course this would be.

- Students who have a verified personal problem, and who have received written permission to take a conflict final exam from a dean in their college.
- Students who have DRES academic accommodations.

Students that find themselves in any of the above situations should email Dr. Christian-Hinman by 5:00 pm on the last day of class in order for the request to be granted. Any requests made after this time may not be granted. If a conflict final exam is granted, it may be scheduled at any time during the final examination period at the discretion of the course instructors.

#### **Disability Access Statement:**

We are committed to providing a learning environment where all students can succeed. If you require special accommodations, please contact Dr. Christian-Hinman and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign, call 217-333-4603, or email [disability@illinois.edu](mailto:disability@illinois.edu). We will try to meet all accommodations once the process has started. Please note that accommodations begin the day you contact Dr. Christian-Hinman with a current letter of accommodation from DRES and are not retroactive to the beginning of the semester.

#### **Adding the Course after the Semester Starts:**

We understand that the University has an add deadline 10 days into the semester, but the University lets individual courses and/or programs determine their policies for late adds. Students who choose to add a course late do so at their own discretion with knowledge that there may be points lost in the process.

#### **Religious Observances and Practices:**

If you anticipate a potential conflict with a religious observance or practice, you should examine the calendar below for potential conflicts as soon as possible. If an accommodation is needed, you must complete the Request for Accommodation for Religious Observances at [https://cm.maxient.com/reportingform.php?UnivofIllinois&layout\\_id=19](https://cm.maxient.com/reportingform.php?UnivofIllinois&layout_id=19) and notify Dr. Christian-Hinman by the end of the second week of the course. Requests that are not submitted within this time frame may not be granted. Information about accommodations can be found in the Student Code: <http://studentcode.illinois.edu/>.

**Student Resources/Where to go for Help:  
We Care at Illinois**

- For sexual misconduct support, response and prevention visit: [wecare.illinois.edu](http://wecare.illinois.edu)

*Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, etc. If you or someone you know has been harassed or assaulted, you can find the appropriate resources here:*

[http://oiir.illinois.edu/sites/prod/files/SexualMisconduct\\_ResourceGuide.pdf](http://oiir.illinois.edu/sites/prod/files/SexualMisconduct_ResourceGuide.pdf)

**Safety and Emergency**

University Police Department, Emergency, 9-911; Non-emergency, 217-333-8911

University Fire Department Emergency, 9-911

Crisis Line, 217-359-4141

Emergency Dean, 300 Turner Student Services Bldg., 610 E. John St., 217-333-0050

Counseling Center, 110 Student Services Bldg., 610 E. John St., 217-333-3704

McKinley Health Center, General Information, 217-333-2701

McKinley Mental Health Center, 1109 S. Lincoln, 217-333-2705

Dean of Students, 300 Turner Students Services Bldg, 610 E. John St., 217-333-0050

Local Sexual Assault Center, RACES, 217-384-4444

Women's Resources Center, 703 South Wright Street, 2nd Floor, 217-333-3137

Rape Crisis 24-hour Hotline, 217-384-4444

Suicide & Psychological Emergency, Suicide Prevention Team, 217-333-3704

SafeRides (free nighttime campus ride program), 217-265-RIDE (265-7433)

SafeWalks (free walking escort service by Student Patrol), 217-333-1216

**Student Services and Advocacy**

Office of the Dean of Students, 300 Student Services Bldg., 610 E. John St., 217-333-0050

**Classroom Support, Teaching Skills, and Instructional Strategies**

Center for Innovation in Teaching & Learning, 249 Armory Building, 217-333-1462

**Counseling Services**

Counseling Center, 110 Student Services Bldg., 610 E. John St., 217-333-3704

McKinley Mental Health Center, 1109 S. Lincoln Ave., 217-333-2701

Psychological Services Center, 3<sup>rd</sup> Floor, 505 E. Green St., 217-333-0041

**Disability Services**

Disability Resources and Educational Services (DRES), 1207 S. Oak St., 217-333-1970

**Lesbian, Gay, Bisexual, Transgender Resource Center**

LGBT Resource Center, 323 Illini Union, 1401 W. Green St., 217-244-8863

**Veterans Services**

Veteran Student Support Services, Office of the Dean of Students, 610 E. John St., 217-333-0050

Center for Wounded Veterans in Higher Education, 908 W. Nevada St., 217-300-3515

**General Study Skills Assistance**

Office of Minority Student Affairs, 130 Student Services Bldg., 610 E. John St, 217-333-0054

Office of Minority Student Affairs Tutoring Services, 701 S. Gregory Dr., Suite 1, 217-333-7547

Writer's Workshop, 251 Undergraduate Library, 1402 W. Gregory Dr., 217-333-8796

\*\*Additional academic assistance may be available through individual departments

**Health Resources**

Health Education, McKinley Health Center, 1109 S. Lincoln Ave., 217-333-2701

Alcohol & Other Drug Office, 2<sup>nd</sup> Floor Counseling Center, 610 E. John St., 217-333-7557  
Sexual Health Educator, McKinley Health Center, 1109 S. Lincoln Ave., 217-333-2714  
Dial-A-Nurse, McKinley Health Center (24-hour), 1109 S. Lincoln Ave., 217-333-2700  
Health Resource Center, McKinley Health Center, 1109 S. Lincoln Ave., 217-333-6000  
Health Resource Center, Room 40 Illini Union, 1401 W. Green St., 217-244-5994  
McKinley Health Center, General Information, 1109 S. Lincoln Ave., 217-333-2701

**Sexual Harassment/Assault & Acts of Intolerance/Hate Crimes**

Office of the Dean of Students, 300 Students Services Bldg., 610 E. John St., 217-333-0050

**The Office of Diversity, Equity and Access (ODEA):**

- For non-academic support visit: [diversity.illinois.edu](https://diversity.illinois.edu)
  - Discrimination & Harassment Prevention
  - Title IX
  - Accessibility & Accommodations
  - Inclusive Illinois

## Schedule – MCB 401 Cellular Physiology, Fall 2023

(Designated pages from Boron and Boulpaep, "Medical Physiology" 3<sup>rd</sup> ed.)

M Aug 21 Course/Syllabus Overview

### Membrane Structure, Signal Transduction, and Solute/Water Transport

W Aug 23 Structure of Biological Membranes, Function of Membrane Proteins (Ch. 2, pp. 8-19)

F Aug 25 Cellular Communication & Signal Transduction: Part 1 (Ch. 3, pp. 47-56)

M Aug 28 Cellular Communication & Signal Transduction: Part 2 (Ch. 3, pp. 56-62, 66-68, 70-72)

W Aug 30 Solute Transport Across Cell Membranes: Part 1 (Ch. 5, pp. 105-108)

F Sep 1 Solute Transport Across Cell Membranes: Part 2 (Ch. 5, pp. 108-117, 120-125)

M Sep 4 NO CLASS (Labor Day)

W Sep 6 **Quiz 1** Regulation of Intracellular Ion Concentrations (Ch. 5, pp. 125-127)

*Quiz 1 covers Aug 23-Sep 1*

F Sep 8 Water Transport and Regulation of Cell Volume (Ch. 5, pp. 127-132)

M Sep 11 Transport of Solutes and Water Across Epithelia (Ch. 2, pp. 43-46; Ch. 5, pp. 136-140)

W Sep 13 **Journal Club 1**

F Sep 15 review

M Sep 18 **Exam 1**

### Membrane Electrophysiology, Action Potentials, and Ion Channel Physiology

W Sep 20 Ionic Basis of Membrane Potentials: Part 1 (Ch. 6, pp. 141-146)

F Sep 22 Ionic Basis of Membrane Potentials: Part 2 (Ch. 6, pp. 146-149)

M Sep 25 Electrical Properties of Cell Membranes (Ch. 6, pp. 149-152)

W Sep 27 Patch Clamp Electrophysiology and Single Channel Recordings (Ch. 6, pp. 152-157)

F Sep 29 **Quiz 2** Action Potentials: Part 1 (Ch. 7, pp. 173-177)

*Quiz 2 covers Sep 20-27*

M Oct 2 Action Potentials: Part 2 (Ch. 7, pp. 177-182, 199-203)

W Oct 4 Classification of Voltage-Gated Ion Channels (Ch. 6, pp. 157-165; Ch. 7, pp. 182-186)

*("Channelopathies" activity to be completed in Moodle before Oct 4 class for extra credit)*

F Oct 6 Voltage-Gated Ion Channel Physiology and Pharmacology (Ch. 7, pp. 186-199)

M Oct 9 **Journal Club 2**

W Oct 11 NO CLASS (**Exam 2 review will be held on Zoom on Monday Oct 9 at 10 AM, with recording posted on Moodle**)

F Oct 13 **Exam 2**

### Neuromuscular Transmission and Muscle Physiology

M Oct 16 Synaptic Transmission; Neuromuscular Junction: Part 1 (Ch. 8, pp. 204-212)

W Oct 18 Neuromuscular Junction: Part 2 (Ch. 8, pp. 212-217)

F Oct 20 Synaptic Vesicle Release and NMJ Pharmacology (Ch. 8, pp. 217-227)

M Oct 23 **Quiz 3** Cellular Physiology of Muscle: Skeletal (Ch. 9, pp. 228-234)

*Quiz 3 covers Oct 16-20*

W Oct 25 Cellular Physiology of Muscle: Skeletal + Cardiac (Ch. 9, pp. 234-238, 241-242)

F Oct 27 Cellular Physiology of Muscle: Smooth (Ch. 9, pp. 242-249)

M Oct 30 **Journal Club 3**

W Nov 1 review

F Nov 3 **Exam 3**



Cellular Physiology and Plasticity of Neurons

M Nov 6 Neuronal Physiology: Part 1 (Ch. 10, pp. 254-256, 258-260; Ch. 12, pp. 295-300)

W Nov 8 Neuronal Physiology: Part 2 (Ch. 12, pp. 300-306)

(“Firing Diversity” activity to be completed in Moodle before Nov 8 class for extra credit)

F Nov 10 Mechanisms of Bursting and Tonic Firing in Thalamocortical Neurons (readings on Moodle)

M Nov 13 **Quiz 4** Glial Cells (Ch. 11, pp. 287-294)

*Quiz 4 covers Nov 6-10*

W Nov 15 Central Synaptic Transmission: Part 1 (Ch. 13, pp. 307-311, 314, 318-320)

F Nov 17 Central Synaptic Transmission: Part 2 (Ch. 13, pp. 323-328)

----*Thanksgiving Break*----

M Nov 27 Plasticity of Central Synapses (Ch. 13, pp. 328-333)

W Nov 29 **Journal Club 4**

F Dec 1 Emerging Techniques for Manipulating Neuronal Physiology (readings on Moodle) (*pre-recorded*)

M Dec 4 NO CLASS

W Dec 6 review

**Exam 4** – given during Final Exams: date and time TBD

(Optional Journal Club 5 written questionnaire due by start of final exam for extra credit)