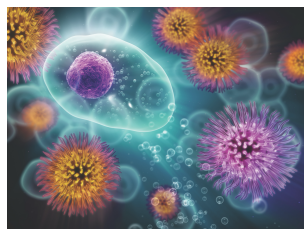




School of Molecular & Cellular Biology

MCB 501 part 1, Fall 2024

Advanced Biochemistry. Four credit hours.



Instructor/Instructional Team

Jim Imlay

B303

jimlay@illinois.edu; 217-333-5812

Class Meeting Schedule

M, W 830-950, B102 CLSL; Fri, 9-1020 or 1030-1150 as assigned, rooms 105/107 Burrill Hall.
Office Hours Friday 2-3 pm, drop by the office at any time, or arrange a meeting by email.

Course Overview and Description

Chemistry and evolution of cellular bioenergetics, enzymology, pathway logic, and substrate networks.

1. What processes must cells conduct in order to be viable?
2. How do thermodynamics determine what processes require energy? Which ones yield it?
3. Why are pathways configured the way they are? Can we predict them?
4. Knowing the reaction that an enzyme catalyzes, can we predict its mechanism and structure?
5. How do new pathways evolve?
6. How do new enzymes evolve?
7. How do cells transform relatively inert substrates?
8. How do cells perfectly balance the fluxes of substrates into competing pathways?
9. Can we re-engineer cells into chemical factories?
10. Why are electron-transfer chains configured the way they are?
11. How can profoundly different types of respiratory processes evolve?
12. How can proteins guide electron movement?
13. How can proteins push protons across membranes?
14. How do the dynamic motions of proteins contribute to their function? How is this motion stimulated?
15. Does accidental chemistry occur inside cells?

Course Prerequisites: Previous course in Biochemistry or equivalent, or permission of instructor. This course is for graduate students only.

Student Learning Outcomes

At the end of the course, through assignments, discussions, activities and assessments, students will be able to:

- Generate pertinent questions pertaining to topics in cellular biochemistry
- Propose hypotheses solidly based upon chemical and evolutionary principles
- Design experiments that will distinguish between multiple hypotheses

Course Text/Materials Information

No course text is assigned, but students are encouraged to have a basic Biochemistry text

Course Website: <https://canvas.illinois.edu/courses/48844>

Grading Information and Breakdown

Two exams for Imlay section of course. Information regarding Sanfilippo section should be obtained from his syllabus. Total points will be equally divided between Imlay and Sanfilippo sections.

Homework will be evaluated by the effort made. Homework scores may determine final grade if the total score sits at the boundary between two grades. Course grades will be assigned on letter scale (A-F).

Policies:

Class attendance is expected each day, and students should arrive on time. The classroom discussion prompts students to consider the material in an active way as we puzzle over questions. The intention is to hone one's ability to apply fundamental concepts to new situations. This outcome is not achieved by merely reviewing PPT slides at a later time, and students who merely do the latter will struggle to answer questions on exams.

Religious Observances and Practices:

- Students are required to submit the Request for Accommodation for Religious Observances Form (which can be found at www.odos.illinois.edu/.../Religious_Observance_Accommodation_Request_Form.docx) to their instructors and the Office of the Dean of Students requesting accommodation 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/>.

Disability Resources and Educational Services (DRES) Accommodations:

- We are committed to providing a learning environment where our students can succeed. If you require special accommodations, please contact us and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak Street, Champaign, call 217.333.4603, or email disability@illinois.edu. We will try to meet all accommodations once the process has started. Please note that accommodations are not retroactive to the beginning of the

semester, but begin the day you contact your professor, instructor or coordinator with a current letter of accommodation from DRES.

- If a student believes that they need DRES accommodations, they should contact DRES at disability@illinois.edu.

Academic Integrity:

- The Code of Policies and Regulations Applying to All Students will be applied in all instances of academic misconduct committed by students. This applies to all exams, presentations, assignments and materials distributed or used in this course. You can review these policies at the following website: <http://admin.illinois.edu/policy/code/index.html> and specifically here: <http://studentcode.illinois.edu/article1/part4/1-401/>
- Science cannot exist without honesty. The faculty and staff in MCB require students, as scientists-in-the-making, to hold the highest standards of scientific and academic conduct. Any form of cheating on any graded work in courses is unacceptable.
- We require that all graded work be entirely your own, and that anything you write using the words of other writers be correctly attributed. Some specific points follow.
- On exams, the answers that your turn in for grading must be your own, formulated during the exam from your own understanding of the material. Copying the work of another student, or allowing another to copy your work, or copying work from any other source, is unacceptable. Since we cannot always monitor you as you complete your work, we must rely upon appearance of your work from which to judge. If the work you submit resembles that of another student or another source too closely, we may conclude that it was not your original work. Always make a conscious effort to complete your work on your own and to protect it from the view of others, in order to ensure that it will be seen as your own. Failure to adhere to these standards for any portion of an exam may result in a grade of zero for the entire exam for all persons involved.
- Texting, or the use of a cell phone or any other device for any purpose, during an exam is prohibited. Doing so may earn you a zero or a more extreme penalty on the exam at the discretion of the instructor.
- Use of any social or electronic media to share information, request information or make confidential information public is 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.
- On written or electronic assignments, the answers that you turn in for grading must be written in your own words, formulated from your own understanding of the material. While you may be working with other students in the course, you must formulate and submit your own answers. Copying or paraphrasing the work of another student, or allowing another to copy or paraphrase your work, is unacceptable. Since we cannot monitor you as you complete your work, we have only the appearance of your work from which to judge. If the work you submit resembles that of another student too closely, we may conclude that it was not your original work. Always make a conscious effort to complete your work on your own and to protect it from the view of others, in order to ensure that it will be seen as your own. You must also make a conscious effort to protect your passwords and accounts. Failure to adhere to these standards may result in a grade of zero for the entire assignment for all persons involved.
- On written or electronic assignments, if you use a statement taken directly from any book or other publication, including the course textbook, you must provide a citation.

That is, you must put the text in quotes and put the author of the publication in parentheses after the quotation. Failure to do so will result in zero credit for that answer. Further, using only the words of another author as your entire answer or as the majority of your answer to any question is never sufficient to earn credit. If the majority of your work has been taken directly from a publication, you are likely to receive no credit for the work, since you would not be demonstrating knowledge beyond the ability to copy. Even if you quote another, your answer must be substantially your own words, drawn from your own understanding of the material.

University Information of Student Safety - Active Threats:

- **General Emergency Response Recommendations** ([Emergency Response Guide](#)):
- **Security Threat.** The Department of Homeland Security and the University of Illinois at Urbana-Champaign Office of Campus Emergency Planning recommend the following three responses to any emergency on campus: **RUN > HIDE > FIGHT**
- **Only follow these actions if safe to do so.** When in doubt, follow your instincts - you are your best advocate!
- **RUN** – Action taken to leave an area for personal safety.
 - Take the time to learn the different ways to leave your building **before** there is an emergency.
 - Evacuations are mandatory for fire alarms and when directed by authorities! No exceptions!
 - Evacuate immediately. Pull manual fire alarm to prompt a response for others to evacuate.
 - Take critical personal items only (keys, purse, and outerwear) and close doors behind you.
 - Assist those who need help, but carefully consider whether you may put yourself at risk.
 - Look for **Exit** signs indicating potential egress/escape routes.
 - If you are not able to evacuate, go to an Area of Rescue Assistance, as indicated on the front page of this plan.
 - Evacuate to Evacuation Assembly Area, as indicated on front page of this plan.
 - Remain at Evacuation Assembly Area until additional instructions are given.
 - Alert authorities to those who may need assistance.
 - Do not re-enter building until informed by emergency response personnel that it is safe to return.
 - **Active Threat:** IF it is safe to do so, run out of the building. Get as far away as possible. Do NOT go to the Evacuation Assembly Area.
- **HIDE** – Action taken to seek immediate shelter indoors when emergency conditions do not warrant or allow evacuation.
 - **Severe Weather:**
 - If you are outside, proceed to the nearest protective building.
 - If sheltering-in-place due to severe weather, proceed to the identified Storm Refuge Area or to the lowest, most interior area of the building away from windows or hazardous equipment or materials.
 - **Active Threat:**

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- Lock or barricade your area.
 - Get to a place where the threat cannot see you.
 - Place cell phones on silent.
 - Do not make any noise.
 - Do not come out until you receive an Illini-Alert advising you it is safe.
 - **FIGHT** – Action taken as a last resort to increase your odds of survival.
 - Active Threat: If you cannot run away safely or hide, be prepared to fight with anything available to increase your odds for survival.

Student Resources/Where to go for Help:

We Care at Illinois

- For sexual misconduct support, response and prevention visit: 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

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, 3rd 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

LGTB 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, 2nd 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
 - Discrimination & Harassment Prevention
 - Title IX
 - Accessibility & Accommodations
 - Inclusive Illinois

For non-academic campus assistance and support:

- See Office of Diversity, Equity and Access (ODEA) information at the end of this document.

Student Advocacy Resources:

- For student-centered advocacy programs and services visit: mcb.illinois.edu/undergrad/advising/resources.

Statement on Policies:

- Unfamiliarity with policies is not a defense for not knowing what they cover.

Contacting MCB Course Personnel:

Imlay welcomes contact by email or by office drop-in.

Class Absences:

- Regular class attendance is expected of all students at the University.
(http://odos.illinois.edu/studentAssistance/absence/revised_code.asp)

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- If you find yourself ill, you must submit confirmation of a visit with a medical practitioner within 24 hours of your absence. The confirmation cannot be provided by a relative, even if the relative is a practitioner.
 - The Office of the Dean of Students will only provide informative letters to instructors for protracted illness of 3 or more days, certain emergencies and to be present during the serious illness of immediate family members (parents, legal guardian, spouse/partner, siblings, children, or grandparents). These letters do not excuse you from class but merely provide information for the instructor to consider with regard to excusing the absence and permitting make-up work. Students must request absence letters from the Office of the Dean of Students after the student has returned to class but not more than 10 business days after the last date of absence.
 - Absences that may be excused without a letter 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 which cause destruction to a primary residence or disrupt air travel. All will require documentation.
 - Absences that may also be excused without a letter include a conference or job, graduate or professional school interviews, though a best effort should be made to schedule these events to minimize class attendance disruption. All will require documentation.
 - Absences planned for the items listed in previous bullet point must be communicated to your instructor or course coordinator at least two weeks in advance of the absence. Failure to do so may result in the loss of opportunity to reschedule the missed class period and the portion of the grade associated with this class period.
 - Absences that will not be excused include family events such as reunions or weddings, or presence during serious illness of extended family members (aunt, uncle, niece, nephew, or cousin).
 - Unplanned absences may result in the loss of opportunity to reschedule the missed class period and, therefore, the portion of the grade associated with this class period.
 - Absences will be handled according to individual course policy.

Exam Absences:

- If you must miss an exam due to unforeseen circumstances, you are required to contact your instructor within 24 hours of the absence. You will then have 48 hours from the absence in which to submit documentation to your instructor or course coordinator. You must also submit an online Absence Form if one is available on your course website. Course personnel will evaluate 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.
- If you find yourself ill, you must submit confirmation of a visit with a medical practitioner within 24 hours of your absence. The confirmation cannot be provided by a relative, even if the relative is a practitioner.
- If you must miss an exam for a conference or job, graduate or professional school interviews, a make-up exam must be arranged with the instructor. Notice must be given at least one week in advance.
- If the absence is a result of a protracted illness of 3 days or more, you should follow the procedure for obtaining a letter from the Office of the Dean of Students. The

request may be made once the student returns to class but not more than 10 business days after the last date of absence.

Exam Conflicts:

- If you have a regularly scheduled University course that conflicts with the exam, you must contact the instructor at least one week in advance. An make-up exam will be arranged.
- Work schedules should be adjusted, if at all possible, in order to eliminate a conflict with scheduled exams. Please plan accordingly at the beginning of the semester. If eliminating a conflict is not possible, the student should contact the instructor at least one week in advance.
- Students with DRES accommodations should also submit the online Conflict Request Form by 5:00 pm no later than 3 business days prior to the exam. Requests made after 5:00 pm and less than 3 business days prior to the exam will not be granted.

Electronic Media/Device Use:

- Use of any social or electronic media to share course information, request course information or make confidential course information public is prohibited. Any use of this type may earn you a zero on an assignment or exam or a more extreme penalty at the discretion of the instructor.
- Any violation of the social media policy **on your account** may result in a zero on an assignment or exam or a more extreme penalty at the discretion of the instructor.
- Any social media sites created in relation to MCB courses 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).
- No electronic devices, including smart watches, are allowed at exams.

Recording and Posting Course Material:

- Students are welcome and encouraged to make audio recordings of course lectures.
- The material recorded is 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.
- Posting or redistributing of course material in any format is strictly prohibited.

MCB 501: Advanced Biochemistry

Professor: Joe Sanfilippo

Lectures: 8:30 – 9:50 AM Mondays and Wednesdays
- B102 CLSL

Discussion: 9:00 – 10:20 AM or 10:30 – 11:50 AM Fridays
- 105 Burrill Hall or 107 Burrill Hall

Course Summary: This course is required of 1st year MCB PhD students. Graduate students from other units may also enroll.

Course content will be focused on **physical** mechanisms underlying biological processes. Content will be organized as a series of major biological **questions** on a diverse set of topics. Each question will be addressed as if the answer is not known, and we will collectively propose the most efficient experimental approaches to answer each question. Along the way, we will learn about core concepts in biochemistry, such as molecular motors, ATPases, protein stability, and biosynthesis. Additionally, we will learn the utility of traditional and modern biochemical approaches, such as protein purification, *in vitro* enzymatic assays, spectroscopy, and optical tweezers.

10/18 (F)	What is biochemistry? What does a scientist look like?
10/21 (M)	How does a cell find its middle?
10/23 (W)	Identification of Fts and Min proteins
10/25 (F)	GFP, ATPases, protein purification, oscillations, geometry
10/28 (M)	How do muscles generate motion?
10/30 (W)	Molecular motors, myosin, actin, overcoming incorrect scientific models
11/1 (F)	Biophysical measurements, “order of magnitude” thinking
11/4 (M)	How do bacteria move?
11/6 (W)	Bacterial flagellum, ATP, proton motive force, ATP synthase
11/8 (F)	Molecular machines, flagella, pili, secretion systems
11/11 (M)	EXAM #1
11/13 (W)	How does heat kill cells?
11/15 (F)	Physical limits of life, heat-shock response, protein stability
11/18 (M)	Stress responses, transcriptional vs post-transcriptional
11/20 (W)	How do cells interact with light?
11/22 (F)	Chlorophyll, chemical synthesis vs. biochemical synthesis
12/2 (M)	Diversity and interconnection of biological molecules, synthetic biology
12/4 (W)	How is cell shape controlled?
12/6 (F)	Cytoskeleton, biological diversity, cell wall
12/9 (M)	Protein filaments, mechanical forces, growth
12/11 (W)	EXAM #2

Major content learning objectives:

1. Understand the **physical** logic of how a cell finds its middle during cell division
2. Understand how molecular motors **physically** move an organism
3. Understand how biological molecules **physically** interact with light
4. Understand how the **physical** environment provides limits to biology

Major practical learning objectives:

1. How to ask a simple, scientific **question**
2. How to propose simple, realistic approaches to answer a scientific **question**
3. How to interpret when there is adequate support for a particular hypothesis
4. How approaches from biochemistry, genetics, and cell biology support one another

Grading: There will be two non-cumulative exams (11/11 and 12/11) and occasional homework assignments. Scores from my section of the class are merged with those from Professor Imlay's section of the class, prior to assignment of a final course grade.

Office hours: Please email for appointment. I am happy to meet via Zoom or In-Person.