Microbial Biochemistry (16:682:502) – Fall 2023

Tuesdays and Thursdays, 3:50-5:10PM
Lipman Hall 202

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Course Objectives

Students will:

1. Gain working knowledge of the biochemistry of microorganisms.
    a. Draw and describe the chemical logic of microbial metabolism.
    b. Compare and contrast how microbes conserve energy in oxic and anoxic environments.
    c. Rationalize how microbial metabolism influences adaptation to specific environments.
    d. Apply knowledge of metabolism and biochemistry to predict new metabolic pathways.
2. Employ cutting-edge approaches in sample acquisition, preparation, and analysis, as well as in data processing and management.
3. Train in scientific rigor and reproducibility, and practice implementing these guidelines when developing their research proposals.
4. Identify potential thesis mentors. Students are exposed to research endeavors of Rutgers faculty, and guided in designing novel experiments related to their research.
5. Apply the scientific process, from identifying gaps in knowledge, to defining evidence-based hypotheses, to preparing NIH-style research proposals.
6. Approach primary literature critically, not only in interpretation of experimental data, but in evaluating experimental design and in delineating logical follow-up experiments.
7. Build their networks by communicating and collaborating with one other and the faculty members, to embrace the interdisciplinary nature of science.
8. Practice public speaking in the context of presenting and defending their research proposals. They will be exposed to scenarios mimicking journal clubs, qualifying exams, and thesis defenses. In doing so, students will build confidence in themselves as scientists and stewards of the community.

Prerequisite Knowledge & Skills

- Familiarity with atomic and molecular structures; bonding; acid/base reactions; structure and function of cells, biomolecules, and proteins, and DNA/RNA; enzyme kinetics; and bioenergetics.
- Ability to design experiments and understand the limitations of each experimental approach.
- Experience with problem-solving by dissecting a problem into its key features.
- Mastery of critical thinking and approaching problems from different perspectives.
- Awareness of available resources for primary literature.
- Working knowledge of computers as information, research, and presentation tools.

Resources

Guides for the following resources will be available via Canvas:

- PubMed, Google Scholar, and/or Rutgers Libraries
- Zotero and/or EndNote
- Google Docs
- Canvas
- Padlet
- Protein Data Bank
- PyMol

Rutgers University Land Acknowledgment

We acknowledge that the land on which we stand is the ancestral territory of the Lenape People. We pay respect to Indigenous people throughout the Lenape diaspora – past, present, and future – and honor those who have been historically and systemically disenfranchised. We also acknowledge that Rutgers University, like New Jersey and the United States as a nation, was founded upon the exclusions and erasures of Indigenous peoples.

SEBS DEI Statement

It is our intention that students of all backgrounds will be well served by this course. We will work to create an environment of inclusion which respects and affirms the inherent dignity, value, and uniqueness of all individuals, communities and perspectives. We are lucky to have a diverse university. Diverse voices and life experiences enhance the learning process and we welcome students to share their personal experiences. We will not tolerate disrespectful language or behavior against any individual or group. If you feel as though you have been disrespected or treated unfairly by the instructors or any other individual please let us know. You may speak with the instructors in person, over email or report anonymously via the Office of Academic Programs. In addition, you may also report bias to the Rutgers Diversity and Inclusion initiative using this link: http://inclusion.rutgers.edu/report-bias-incident/.

Special Accommodations

Rutgers University is committed to the creation of an inclusive and safe learning environment for all students and welcomes students with disabilities into all the University's educational programs. The Office of Disability Services (ODS) is responsible for the determination of appropriate accommodations for students who encounter barriers due to disability. Once a student has completed the ODS process (registration, initial appointment, and submitted documentation) and reasonable accommodations are determined to be necessary and appropriate, a Letter of Accommodation (LOA) can be requested and will be sent to the student and instructor. This should be done as early in the semester as possible as accommodations are not retroactive, and a discussion should occur about how the accommodations will be implemented. More information can be found at www.ods.rutgers.edu. You can contact ODS at (848)445-6800 or via email at dsoffice@echo.rutgers.edu.

Academic Ownership

This course is structured to foster communication amongst the cohort of Biochemistry and Microbiology graduate students and faculty. As the curriculum heavily relies on teamwork and peer-to-peer discussions, students are urged to be present, curious, open-minded, and supportive. If an absence and/or extension is necessary, please discuss this need with Dr. Sun as soon as possible.

Academic Honesty

All work must be the effort of the individual student. When information (data, text, figures, tables) is borrowed from primary literature, it must be referenced appropriately. If it is directly quoted as text, it needs to be identified with quotation marks as well. Assignments may be checked for plagiarism using Turnitin or similar software. Any form of academic dishonesty will result in failing the course. Additional penalties up to and including dismissal from the University may occur.

Grading

- 30% *Project proposal* (peer reviews, outlines, drafts, final written proposal, and culminating oral presentation)
- 30% *In-class exams* (two non-cumulative open-ended exams)
- 20% *Peer-led journal clubs* (groups of 3 students provide additional background and justification for the assigned article; all students post a reflection piece before class; all students engage in critiquing the hypothesis, approaches, and conclusions presented in the assigned article)
- 10% *Class participation* (pre- or post-work to guide guest lectures)
- 5% *Pre-lecture Padlet question submissions* (post 3 “muddiest points” to guide that day’s lesson)
- 5% *After-class quizzes* (3 questions which review material from that day’s lesson)

Your final letter grade will be determined from your numerical grade by the following grading scale:

A = 93 – 100%	C = 74 – 76%
A- = 90 – 92%	C- = 70 – 73%
B+ = 87 – 89%	D+ = 67 – 69%
B = 84 – 86%	D = 64 – 66%
B- = 80 – 83%	D- = 60 – 63%
C+ = 77 – 79%	F = <60%

Curriculum

Date	Topic(s)	Instructor(s)	Assignment(s) due before class
September 5	Course expectations Research techniques and experimental design	Dr. Sun	
September 7	Protein structure and function	Dr. Sun	
September 12	Chemical kinetics	Dr. Sun	Journal club reading Research proposal topics
September 14	Bioenergetics and biochemical reaction types	Dr. Dismukes	
September 19	Scaling of metabolic capacity and fluxes with size	Dr. Dismukes	
September 21	Photosynthesis system level structure and function, part 1	Dr. Dismukes	Outlines for: Research questions (2-3 Specific Aims and Hypotheses) Introduction (Background, Significance, and Innovation)
September 26	Photosynthesis system level structure and function, part 2	Dr. Dismukes	
September 28	Enzymatic conversion of CO2	Dr. Dismukes	
October 3	Oxygenic photosynthesis	Dr. Dismukes	
October 5	Glycolysis	Dr. Sun	Journal club reading
October 10	Pyruvate metabolism	Dr. Chase	
October 12	**Exam 1**	Dr. Sun	
October 17 (asynchronous)	Fatty acid and lipid metabolism	Dr. Toledo (asynchronous)	Rough drafts of: 2-3 Specific Aims (1 page) Background, Significance, and Innovation (1-2 pages)
October 19	Nitrogen and sulfur metabolism Amino acid metabolism	Dr. Sun	Journal club reading
October 24	Microbial aromatic hydrocarbon degradation	Dr. Sun	
October 26	Metabolic pathways utilized on early Earth	Dr. Vetriani	Outlines for: Rationale Approaches Potential Pitfalls / Alternative Approaches
October 31	Cell structure and function	Dr. Sun	Journal club reading
November 2	Cell signaling and its implications for cellular function	Dr. White (asynchronous)	
November 7	Regulation of cell growth and proliferation	Dr. Boyd	
November 9	Biochemical adaptations and microbial diversity	Dr. Häggblom	
November 14	Leveraging microbes to synthesize biomaterials	Dr. Sun	Journal club reading
November 16	Modern approaches in protein structure and folding	Dr. Sun	
November 21	Microbiomes and adaptation	Dr. Zhao (asynchronous)	Rough drafts of: Rationale Approaches Potential Pitfalls / Alternative Approaches (~1 page per Aim) Slides for oral presentations
November 23	**THANKSGIVING RECESS**		
November 28	Research proposal manuscript peer reviews	Dr. Sun	Final drafts of: Research proposal manuscripts
November 30	**Research proposal presentations**	Dr. Sun & Dr. Dismukes	Final drafts of: Research proposal slides
December 5	**Research proposal presentations**	Dr. Sun & Dr. Dismukes	
December 7	**Exam 2**	Dr. Sun	