

Metabolic Biochemistry

BIBC 102

Fall Quarter 2023

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Office Hours: Fridays, 10 – 11 am on Zoom

Course Objectives:

This course will examine how energy is harnessed and utilized for metabolism at the cellular and molecular level. We will learn the various biochemical reaction pathways by which carbohydrates, fats, and proteins are oxidized to provide energy for the cell, and by which new biological molecules are synthesized. We will identify the important energy-containing intermediates that form the intersection points of metabolic pathways, and study how metabolism is regulated to direct these intermediates into either energy-yielding (catabolic) fates that produce ATP or biosynthetic (anabolic) fates to construct new biological molecules.

Course Structure:

This class will follow a “flipped-class” format, where the content delivery will be from lecture recordings that you will watch on your own, followed by using the scheduled lecture time for interactive discussions and small-group problem solving. We will use the following weekly schedule.

- Watch lecture recordings There will be 1 – 2 ½ hours of lecture recordings to watch on your own time each week. These will be available on Canvas.
- Quizzes on lecture recordings After watching the lectures, you will take a Canvas quiz at the end of that week. Most weeks, there will be a window from Friday morning (9 am) to Sunday afternoon (5 pm) to take the quiz, and you will have 30 minutes to complete it once you begin. See the class schedule for the quiz dates; note that the last quiz has a different window. There will be 7 quizzes worth 20 points each, and your best 5 quizzes will be taken for your quiz point total of 100 points. Important: You are required to take all 7 quizzes. If you are ill or have internet connectivity issues that prevent you from completing a quiz, this counts as one of the 7 and is compensated for by using one of the other quizzes for your grade.
- Friday review The Friday lectures will be used to review, answer questions, and tackle any difficult points from that week’s lecture recordings. Attendance on Fridays is optional.
- Monday and Wednesday active learning sessions These are held during the scheduled lecture time, 4 – 5 pm. They will help you master the concepts from the previous week’s lecture recordings, and will consist of interactive discussions with

iClickers and small-group problem-solving exercises. You will be assigned to a group of 3 students that you will work with all quarter. Attendance at the Monday/Wednesday active learning sessions is mandatory and will be confirmed by iClicker participation. There are 15 active learning sessions (excluding the exam weeks and the day before Thanksgiving) that begin on Monday of week 1 (Oct 2). Each is worth 8 points for attendance and participation, for a possible 120 points. Only 100 points of this are factored in to your grade. Additionally, there will be some worksheets that you will complete and turn in at the active learning sessions that are worth 50 points. This makes the active learning sessions worth a total of 150 points, or 15% of your grade. Note that you are required to attend each active learning session. If you miss a day due to illness or personal reasons, this is compensated by the additional 20 points for attendance and participation. Notify the instructor if you have a medical situation that will result in you missing more than one week of class.

- **Exams** There will be two midterm exams and a final exam, and each is worth 250 points. Each midterm will be broken up into two sessions on Monday and Wednesday of the exam weeks (see the class schedule below). The first midterm covers roughly the first half of the class, the second midterm covers roughly the second half of the class, and the final is cumulative. Use the problem sets on Canvas to help you prepare for the exams. For the midterm exams (not the final exam), each has a base point value of 250 points, but the exam on which you receive the higher score will be weighed 50% more heavily from this base value (out of 375 points), and the exam on which you receive a lower score will weighed 50% less from the base (out of 125 points).

Course structure	Points weighed toward your grade
Lecture quizzes; 20 points each, best 5 of 7 quizzes	100
Attendance and participation at Mon/Weds active learning sessions; 15 sessions at 8 points each	100
Worksheets from Mon/Weds active learning sessions	50
Midterm exam 1	375 or 125
Midterm exam 2	375 or 125
Final exam	250
Total points for class	1000

Grade cutoffs:

Grades will be based on the following un-curved scale. The grade cutoffs may be adjusted downward at the instructor's discretion.

905-1000	A	780-789	C+
895-904	A-	695-779	C
885-894	B+	675-694	C-
800-884	B	590-674	D
790-799	B-	0-589	F

iClickers:

You are required to bring an iClicker remote to each Mon/Weds active learning session. New and used iClicker remotes are available at the Bookstore. The iClicker mobile app cannot be used for this class.

Important: You must register your iClicker on Canvas before the first active learning session on Monday, Oct 2nd. To do this, login to Canvas and open the iClicker tool in the left-hand menu. Enter you iClicker's remote ID located on the back of the remote, and click Register. Make sure your remote is registered with the correct ID number; if it is not, click Remove to start over.

Attendance and academic integrity:

Attendance and participation in the Mon/Weds active learning sessions is an essential part of the class and counts toward your grade. Because you are earning points for the work you are doing during these sessions, falsely representing yourself as present in the class by having another student respond with your iClicker is a form of cheating. Attendance will be periodically spot checked by taking roll by student workgroup. For any instances of attendance cheating, all students involved will be reported to the Academic Integrity Office.

Recommended Supplementary Textbook:

D.L. Nelson and M.M. Cox, Lehninger-Principles of Biochemistry, 6th or 7th Edition (Freeman). You may wish to purchase this for a secondary form of content delivery and as an additional learning resource. Reading assignments that are tailored to the lecture recordings are provided at the end of the syllabus.

Schedule of topics and activities

W	Lecture Video Topics	Mon/Weds Active learning sessions (on material from previous week)	Lecture Quiz Window
1	Lecture 1: Amino acids and α -keto acids; review protein structure	Organize groups; icebreakers	Quiz 1 Friday (10/6) 9am – Sunday (10/8) 5pm
	Lecture 2: Thermodynamics of biochemical reactions and enzymes	Metabolism game	
2	Lecture 3: Enzymes: catalytic activity, nomenclature, and regulation	Thermodynamics and enzymes	Quiz 2 Friday (10/13) 9am – Sunday (10/15) 5pm
	Lecture 4: Introduction to metabolism: coupling endergonic and exergonic reactions Lecture 5: Biological oxidation-reduction reactions	Thermodynamics and enzymes cont.	
3	Lecture 6: Glycolysis	Enzymes and phosphoryl transfers	Quiz 3 Friday (10/20) 9am – Sunday (10/22) 5pm
		Biological redox reactions	
4	Lecture 7: Different fates of pyruvate: fermentation ethanol metabolism	Glycolysis reactions	Quiz 4 Friday (10/27) 9am – Sunday (10/29) 5pm
	Lecture 8: Cellular respiration 1: the pyruvate dehydrogenase complex	Glycolysis thermodynamics	
5	Lecture 9: Cellular respiration 2: the citric acid cycle	Exam 1 part A (Mon, Oct 30)	no quiz
		Exam 1 part B (Weds, Nov 1)	
6	Lectures 10 and 11: Cellular respiration 3: the mitochondrial electron transport chain	Fermentation and ethanol metabolism	Quiz 5 Friday (11/10) 9am – Sunday (11/12) 5pm
	Lecture 12: Cellular respiration 4: oxidative phosphorylation and ATP synthase	α -ketoacid dehydrogenases	
7	Lecture 13: Gluconeogenesis: glucose synthesis	ETC inhibitors; bioenergetics of oxidative phosphorylation	Quiz 6 Friday (11/17) 9am – Sunday (11/18) 5pm
	Lecture 14: Glycogen metabolism and the pentose phosphate pathway	Ox-Phos experiments	
8	Lecture 15: Oxidation of fatty acids and ketone bodies	Anabolic pathways for carbohydrates	no quiz
		No meeting on Weds – Day before Thanksgiving	
9	Lecture 16: Synthesis of fatty acids and cholesterol synthesis	Exam 2 part A (Mon, Nov 27)	no quiz
		Exam 2 part B (Weds, Nov 29)	
10	Lecture 17: Amino acid metabolism and the urea cycle	Fatty acid metabolism	Quiz 7 Monday (12/4) 9am – Weds (12/6) 5pm
		Metabolism game	
F	Final Exam Tuesday, Dec 12, 3 – 6 pm		

Supplemental reading in Lehninger textbook

Week	Reading: chapter (pages)		Topic
	Lehninger 7 th edition	Lehninger 6 th edition	
1	1(21-29) 13(495-501) 3(75-81;85-88)	1(20-29) 13(505-511) 3(75-81;85-89)	Thermodynamics of biochemical reactions Review protein structure if necessary
2	6(187-198; 225-231) 13(491-494; 507-524)	6(189-200; 226-232) 13(501-504; 510-511; 517-534)	Introduction to metabolism: coupling endergonic and exergonic reactions; Biological oxidation-reduction reactions
3	14(533-545)	14(543-555)	Glycolysis
4	14(553-557)	14(563-568)	Different fates of pyruvate: fermentation ethanol metabolism
5	16 (all)	16 (skip 655-659)	The pyruvate dehydrogenase complex and the citric acid cycle
6	19(711-741)	19(731-762)	The electron transport chain and oxidative phosphorylation
7	14(558-569) 15(601-608)	14(568-580) 15(612-620)	Gluconeogenesis, glycogen, and the pentose phosphate pathway
8	10(361-366) 17(649-657; 668-670)	10(357-361) 17(667-675; 686-688)	Oxidation of fatty acids and ketone bodies
9	21(811-819)	21(833-841)	Synthesis of fatty acids and cholesterol synthesis
10	18(675-691)	18(695-711)	Amino acid metabolism and the urea cycle