Biochem 6600 & 6601 Regulation of Metabolism

2020 Spring B 1.5 credits
Tu/Th 9:30-11:00 AM
Eccles Health Sciences Education Building room 2958

Course Director: Janet Lindsley, PhD, Professor of Biochemistry, Adjunct Professor of Nutrition and Integrative Physiology, Assistant Dean of UUSOM Curriculum
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Course Objectives

1. To review and integrate the basic metabolic pathways involving primarily carbohydrates and fats.
2. To provide the foundation for students to be able to understand the literature in the broad fields of type 2 diabetes and metabolic regulation.
3. To understand the integration of signaling events that are initiated outside of a cell (such as insulin binding to the insulin receptor) with those initiated within a cell (such as increased AMP levels activating AMP-activated protein kinase).
4. To outline the goals and methods of specific cutting-edge topics in metabolic regulation from UHealth experts in the field.
5. To demonstrate curiosity about the metabolic research occurring on campus.
6. To demonstrate metabolism knowledge and skill in creating an achievable learning objective by effectively teaching a 5-minute session on a relevant topic.

Course description

This course will be taught by a mixture of discussion, didactic (lecture), readings, on-line quizzes and student presentation modalities. The focus is on the regulation of sugar and fat metabolism in eukaryotes, with an emphasis on mammals. The course will begin with a review of carbohydrate and lipid metabolic pathways, particularly pathway integration and regulation. The middle portion of the course is an exposure to the breadth of metabolism research occurring here at University of Utah Health Sciences. The course ends with students teaching a metabolism topic of their own choosing to the class.

Course resources

Required textbook: Keith Frayn, Metabolic Regulation: A Human Perspective, 3rd Edition. This is a very readable textbook that covers the basic physiology of how human metabolism is regulated. It does NOT have metabolic pathways, but instead clearly explains the concepts of how we can either feast for days or fast for weeks and still function. It is a very accessible introduction to basic endocrine physiology, with a focus on insulin, glucagon and cortisol. This book is available on-line from the Marriot Library (see: http://site.ebrary.com/lib/utah/docDetail.action?docID=10358863) You will need to either be on campus or use VPN to access this free electronic book. The paperback version is available from Amazon for ~$45; note that a 4th edition of this book (Human Metabolism, a Regulatory Perspective) is due out in May, 2020 so you may want to wait for the new addition and use the library's for now.

Basic Metabolism Overview (BMO): This 66-page pdf divided into 4 chapters reviews the metabolic pathways central to human metabolism. You will be expected to know and

use this information, as well as being able to integrate it with the physiology described in the Frayn textbook.

Pathways of human metabolism map (https://metabolicpathways.stanford.edu/): We will be referring regularly to this searchable metabolic map. Additionally, it will be provided for your in-class quiz. Therefore, this class is NOT about memorizing metabolic pathways, but you will be expected to be able to read and interpret the map.

For the first part of the course, access to an undergraduate or medical biochemistry textbook may also be useful. For example: Stryer (Berg et al) or Lehninger Biochemistry might be useful.
The Medical Biochemistry website may also be helpful:
http://themedicalbiochemistrypage.org/

For class sessions 6-14 we will most likely want to look up relevant literature:
https://www.ncbi.nlm.nih.gov/pubmed?myncbishare=uutahlib&holding=uutahlib_fft

Canvas: A Canvas site will be used during this course to post: 1. Learning objectives, 2. Pre-class homework and Post-TED-like talk curiosities (set up as quizzes), and 3. Reading and lecture materials.

Student assessment

Grades will be based on the following criteria:

Attendance	7%
Classroom participation	11%
Pre-class homework (2/28-3/21)	20%
In-class Quiz (March 21)	30%
Post-TED-like talk curiosities	18%
5-min student teaching	14%
Total	100%

This course is based on active discussion and participation within the classroom. Therefore, attendance and participation are required and graded. You will receive 0.5 pt for each class that you attend. Your classroom participation grade will be based on the following criteria: 1) contributed fully to the class discussion of problems, and 2) behaved in a professional and respectful manner towards classmates and faculty, 3) submitted a thoughtful question as part of the homework posted on Canvas (see below), 4) completed all in-class submitted activities. If you are not in class you will not be able to earn classroom participation or attendance points. However, if you notify Dr. Lindsley in advance of your need to miss a class, it may be possible to make up some missed points by completing an alternative assignment.

On-line homework questions will be posted on Canvas prior classes 2-5. These homework assignments will close at 11:59 PM the night before class. They are designed to help prepare you to fully participate in the learning activities occurring during class time. There will be two parts to each assignment (each part posted as a quiz). The multiple-choice question part will be set up to allow you two chances to choose the correct response. The second part will be a few short answer/essay questions, including a place for you to submit a

question you have relating to the upcoming class discussion. Submission of a question will count towards your class participation grade.

Post-TED-like talk curiosities: During the middle section of the course, 12 of our metabolism faculty researchers will each give a ~20-min talk and lead a discussion about where they think this research story could/should go in the future. After each of these 6 class sessions, students will submit a short description of what they found most curious about one of the two discussions and what they would do next on the project. Each submitted curiosity will count for 3% of the course grade. The grading rubric is shown in Appendix A.

Students as teachers: The course finishing with each student quickly teaching a clear, defined topic of their choice in 5 minutes. Each student will first define a SMART (Specific, Measurable, Attainable, Realistic, Timebound (5 min)) learning objective for their 5-min session; this **objective will be submitted on Canvas by no later than April 2, 2020**. One way to determine if your objective is SMART is to consider the verb used: specific and measurable verbs include: describe, explain, differentiate, compare and contrast, interpret, recognize, draw. Non-specific and unmeasurable verbs include: understand, know.

Students will sign-up, or be assigned if all dates work equally well, to teach on April 9, 14, 16, 18 or 21. This brief teaching activity will contribute 14% of the final course grade; see Appendix B for the grading rubric. Students who are not teaching on a given day will provide written feedback to one of the instructing students; providing this feedback will also count as part of the participation grade. See appendix C for the student feedback form.

EVALUATION SCHEME:

Letter Grade	Percentage	Letter Grade	Percentage
A	94-100	C-	70-72
A-	90-93	D+	67-69
B+	86-89	D	64-66
B	82-85	D-	60-63
B-	79-81	E	Below 60
C+	76-78	Scores will be rounded: Example 94.4=94, 94.5=95	
C	73-75		

Class schedule: All classes will be in the Eccles Health Sciences Education Building (EHSEB) room 2958 from 9:30-11:00 on Tuesdays and Thursdays.

2020 BioC 6600
Regulation of Metabolism
9:30 – 11:00 AM in 2958 EHSEB

Date	Day	Class Title	Reading Assignment	Instructor	
2/27	Th	Introduction to metabolism and its regulation	**Frayn Ch 1; BMO Ch 1**	Lindsley	1
3/3	Tu	Respiration, TCA cycle, carbohydrate catabolism	**Frayn Ch 2; BMO Ch 2**	Lindsley	2
3/5	Th	Glycogen, Gluconeogenesis and blood glucose regulation	**BMO Ch 3; Frayn Ch 11**	Lindsley	3
3/8-3/15 **U Spring Break**					
3/17	Tu	Lipid metabolism	**BMO Ch 4; Frayn Ch 10**	Lindsley	4
3/19	Th	Integration of Carbohydrate & Fat Metabolism/ In-class Quiz	**Frayn Ch 7**	Lindsley	5
3/24	Tu	Metabolism TED-like talks & discussion		Rutter, Playdon	6
3/26	Th	Metabolism TED-like talks & discussion		Chaudhuri, Underhill	7
3/31	Tu	Metabolism TED-like talks & discussion		Rodan, Ayer	8
4/2	Th	Metabolism TED-like talks & discussion		Summers, Funai	9
4/7	Tu	Metabolism TED-like talks & discussion		Ducker, Holland	10
4/9	Th	Student presentations		Students	11
4/14	Tu	Student presentations		Students	12
4/16	Th	Student presentations		Students	13
4/21	Tu	Student presentations		Students	14

The Americans with Disabilities Act

The University of Utah seeks to provide equal access to its programs, services, and activities for people with disabilities. If you will need accommodations in this class, reasonable prior notice needs to be given to the Center for Disability Services, 162 Olpin Union Building, (801) 581-5020. CDS will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in an alternative format with prior notification to the Center for Disability Services.

University Safety Statement

The University of Utah values the safety of all campus community members. To report suspicious activity or to request a courtesy escort, call campus police at 801-585-COPS (801-585-2677). You will receive important emergency alerts and safety messages regarding campus safety via text message. For more information regarding safety and to view available training resources, including helpful videos, visit safeu.utah.edu.

Addressing Sexual Misconduct

Title IX makes it clear that violence and harassment based on sex and gender (which Includes sexual orientation and gender identity/expression) is a civil rights offense 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, color, religion, age, status as a person with a disability, veteran's status or genetic information. If you or someone you know has been harassed or assaulted, you are encouraged to report it to the Title IX Coordinator in the Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801-581-8365, or the Office of the Dean of Students, 270 Union Building, 801-581-7066. For support and confidential consultation, contact the Center for Student Wellness, 426 SSB, 801-581-7776. To report to the police, contact the Department of Public Safety, 801-585-2677(COPS).

Appropriate Use of Technology

Technology is an important part of everyday life and can contribute greatly to the learning environment. Students are expected to use technology in a professional and appropriate way that does not distract other learners. Appropriate uses include, but are not limited to: note taking, searching online for relevant information, answering in-class formative assessment questions, and viewing course materials on Canvas. Inappropriate uses include, but are not limited to: texting, personal email, shopping, social media, and browsing any websites not relevant to the course. Course-specific technology guidelines will be indicated by the Course Directors. Please use your judgment when using technology and be considerate of your faculty and fellow students.

Learning Objectives and readings for class sessions:

Class 1: Introduction to metabolism and its regulation
Readings: Frayn's Metabolic Regulation Ch. 1; Basic Metabolic Overview (BMO) Ch. 1

1. Describe the overall course structure, expectations and modes for assessment/grading.
2. Identify the process of carbon oxidation as the basis of our catabolic metabolism.
3. Sketch an overview of the central metabolic pathways, including connections between them.
4. Explain how indirect calorimetry can be used to determine metabolic rate and estimate the approximate ratios of carbohydrates and fats being oxidized.
5. Diagram the common ways that metabolic pathways are regulated.
6. Predict the overall regulation of metabolism by AMP-activated protein kinase and insulin

Class 2: Respiration, TCA cycle, carbohydrate catabolism
Readings: Frayn's Metabolic Regulation Ch. 2; Basic Metabolic Overview (BMO) Ch. 2

1. Describe the roles played by the B vitamins niacin, riboflavin, pantothenic acid and thiamine (examples of micronutrients) in the process of carbon oxidation.
2. Explain how the majority of oxygen is used in our bodies.
3. Explain the function of dehydrogenase enzymes in metabolism.
4. Identify amino acids as essential sources of TCA cycle intermediates.
5. Utilize understanding of respiratory control to predict the effects of inhibitors of the electron transport chain.
6. Explain why deleterious mutations of the mitochondrial genome invariably affect cellular respiration.
7. Diagram the process by which brown adipose tissue functions to produce heat.
8. Explain the overall purpose of glycolysis in the context of human physiology.
9. Match the glycolytic enzyme names with the reactions on the metabolic map, based on an understanding of the types of reactions catalyzed by the classes of enzymes.
10. Describe the regulation of the committed step of glycolysis.
11. Predict which situations are likely to result in elevated blood lactate levels.
12. Analyze why 2-deoxyglucose is so effective in labeling tumors.
13. Describe when and why glucose-6-phosphate enters the pentose phosphate pathway.
14. Recognize and explain the effects of glucose 6-phosphate dehydrogenase deficiency.
15. Explain how fructose and galactose are catabolized.

Class 3: Glycogen, Gluconeogenesis and blood glucose regulation
Readings: Frayn's Metabolic Regulation Ch. 11; Basic Metabolic Overview (BMO) Ch. 3

1. Summarize the metabolic effects of insulin and glucagon on carbohydrate, lipid and protein metabolism.
2. Describe the processes of glycogen synthesis and breakdown.
3. Explain the differing roles of glycogen in the liver and non-liver tissues.
4. Identify the key substrates and enzymes for gluconeogenesis.
5. Describe how insulin and glucagon regulate glycogen synthesis, glycogenolysis and gluconeogenesis.
6. Recognize that a lack of suppression of gluconeogenesis is one of the major causes of hyperglycemia in untreated diabetics.

Class 4: Lipid metabolism

Readings: Frayn's Metabolic Regulation Ch. 10; Basic Metabolic Overview (BMO) Ch. 4

1. Describe the shared property of all lipids that makes their digestion, absorption and metabolism very different from those of carbohydrates and proteins.
2. Explain when blood levels of chylomicrons are expected to be elevated.
3. Describe the fates of dietary lipids, including conditions that should favor lipid storage or fatty acid oxidation.
4. Describe when, where and how fatty acid oxidation occurs in the body.
5. Explain what ketone bodies are and how their levels are primarily regulated.
6. Identify conditions that promote fatty acid synthesis and outline the process.
7. Explain the transport of lipids through the body.
8. Describe the general features of cholesterol biosynthesis and regulation.
9. Explain the formation, role and fate of chylomicrons, VLDLs, LDL-cholesterol and HDL-cholesterol.
10. Predict how HMG-CoA reductase inhibitors (statins, such as Lipitor), functioning primarily in the liver, lower serum LDL-cholesterol.
11. Hypothesize why people with insulin resistance often have elevated serum triglycerides.

Class 5: Integration of Carbohydrate & Fat Metabolism/ In-class Quiz on material from classes 1-5

Readings: Frayn's Metabolic Regulation Ch. 7; Basic Metabolic Overview (BMO) review all chapters

1. Diagram the major metabolic processes occurring in liver, adipose, muscle, brain during the feed-fasting cycle and exercise.
2. Explain the major forms of regulation for these metabolic processes.
3. Draw curves showing blood levels of glucose, non-esterified fatty acids, triglycerides, insulin, and glucagon with time following a meal.
4. Describe the differences in the regulation and metabolism that occurs during untreated diabetes.
5. Demonstrate your knowledge of metabolic regulation on an in-class quiz (closed book, but metabolic pathway map will be provided).

Classes 6-11:

1. To outline the goals and methods of specific cutting-edge topics in metabolic regulation from UHealth experts in the field.
2. To demonstrate curiosity about the metabolic research occurring on campus.

Classes 12-14:

1. To demonstrate metabolism knowledge and skill in creating an achievable learning objective by effectively teaching a 5-min. session on a relevant topic.
2. To practice giving effective feedback to peers.

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Appendix A: Post-TED-like talk curiosity submission grading rubric:

Curiosity characteristics	Grade (pts)
Not submitted or irrelevant to discussed topics or identical to that of other students.	**0**
Submitted a relevant description of something curious, but does not specifically connect with the classroom discussion or show understanding of the topic discussed.	**1**
Submitted a curiosity description that shows understanding of the classroom discussion, and is distinct from other student submissions.	**2**
Submitted a curiosity description that shows understanding of the classroom discussion, thoughtfully goes beyond the discussion (adds new point(s) not mentioned during the class discussion) and is distinct from other student submissions.	**3**

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Appendix B: Student 5-min teaching session grading rubric

Student as teacher: *student name* Faculty Evaluator: **Janet Lindsley**

Teacher's goal: By the end of this session, students in the course will be able to: *Student-teacher provides a SMART (Specific, Measurable, Attainable, Realistic, Timebound (within 5 min)) learning objective.*

20 total points

Possible points	Grading component	Earned points
5	Achievement of your chosen goal: (could students likely now do what you set out to accomplish as your stated goal?)	

Comments:

5	Knowledge of chosen topic: (understanding everything that you present; answered questions appropriately, critically evaluate what's being presented, synthesized well with other material presented during the course)	

Comments:

5	Presentation organization (including keeping to 5-min limit, referencing primary sources used, appropriate use of technology, correct spelling on slides, etc):	

Comments:

5	Engaging the audience (making the session interesting, making connections with other parts of the course, encouraging questions and answering them appropriately):	

Comments:

0-5 extra-credit	Use of innovative (not strictly PowerPoint presentation) teaching modalities (use of white board instead of PowerPoint, posing questions to the audience, etc.)	

Comments:

Final grade (out of 20 points):

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Appendix C: Student peer feedback form for student-taught sessions

Teacher's Name: _ _____ Evaluator's Name: _____

Teacher's goal: By the end of this session, students in the course will be able to:

	Strongly agree	Somewhat agree	Neutral	Somewhat disagree	Strongly disagree
Achieved his/her goal					
Speaks clearly					
Materials (PowerPoint, etc) helpful and professional					
No distracting mannerisms					
Pertinent & accurate information; intellectually prepared					
Well organized; appropriate amount of info; summarized					

What worked well in this presentation? List at least one *specific* item.

How could the presenter improve? List at least one *specific* way.