**Nutritional Science 619 – 2023**
**Intermediary Metabolism of Macronutrients (3 credits)**
MW 8:30-9:45

**Course Description:** The purpose of this course is to provide students with an understanding of advanced aspects of metabolic control and the control of metabolism of protein, fat and carbohydrate. The course will focus on describing principles underlying the control of metabolism as it applies to macronutrients.

**Course Learning Outcomes:**

- Understanding of common regulatory mechanisms at the organ, cellular and biochemical level controlling intermediary metabolism of carbohydrates, lipids and proteins
- Understanding of how to determine regulatory points in metabolic pathways and an appreciation for how they may change with metabolic state
- Detailed understanding of the changes and mechanisms underlying such changes in protein, carbohydrate and fat metabolism in changing physiological state and also in health vs disease state
- General understanding of modern experimental approaches for studying metabolism.

The instructors are:

**Alan Attie, Prof. of Biochemistry.** Dr. Attie will present a lecture on genetic approaches for studying metabolism. He can be reached at 2-1372 or emailed (attie@biochem.wisc.edu). Office hours by appointment.

**Rick Eisenstein, Prof. of Nutritional Sciences.** Dr. Eisenstein will present lectures in Units on metabolic control, carbohydrate metabolism and protein metabolism. He can be reached at 262-5830 or emailed (eisenste@nutrisci.wisc.edu). Office hours by appointment.

**Jing Fan, Asst. Prof. of Nutritional Sciences.** Dr. Fan will lectures on lipid metabolism, fuel sensing and metabolism in disease. She can be reached at 316-4492 and (jfan@morgridge.org). Office hours by appointment. Dr. Fan is the course director.

**Assumed Knowledge:** Students taking this course will be assumed to have an understanding of general metabolic pathways of macronutrient metabolism as well as a similar degree of understanding of cell structure and physiology. Knowledge of the basic aspects of carbohydrate, lipid and protein structure will be assumed. Students who have taken Nutritional Sciences 510 or Biochemistry 501 or Biochemistry 507/508, or equivalent classes, should have appropriate background for this class.

**Reading:** This is a literature-based course. Lectures will usually contain a list of assigned reading material from the "metabolism literature" as well as optional reading. Copies of assigned reading will be provided. Copies of the optional reading can be obtained by looking up the appropriate reference at Steenbock library. Assigned readings are considered fair game for exams even if some of the material in the reading was not covered in class. Readings for this course will occasionally come from specific books. There is no single book that covers the material presented in class. Several books that contain useful material are listed below.

Devlin, T.M. **Textbook of Biochemistry with Clinical Correlations.** Wiley Liss (2010). New or used copies of this textbook may be available at the UW bookstore.

Fell, D.A. (1997) **Understanding the Control of Metabolism.** Portland Press, London.

Frayn, K.N. (2013) **Metabolic Regulation – A Human Perspective.** Portland Press, London.

Newsholme, E.A. and C. Start (1973) **Regulation in Metabolism.** John Wiley and Sons, London. A used copy of this out of print book can be borrowed, for short periods of time, from Dr. Eisenstein.

Stipanuk, M.H. **Biochemical and Physiological Aspects of Human Nutrition.** W.B. Saunders (2012). A copy of this book can be borrowed, for short periods of time, from Dr. Eisenstein.

Storey, K.B. (2004) **Functional Metabolism: Regulation and Adaptation.** Wiley-Liss.

**Grading:** Your grade will be based on your performance on 4 exams and one in class learning exercises. Two of these exams will contain questions that primarily deal with the facts presented in lectures. Two other exams will be referred to as thought-based exams. The questions on these exams will focus on issues that require you to demonstrate an ability to integrate the fundamental principles illustrated in the lectures or assigned readings. In most years an average grade on the exams is viewed as being a "B". Generally, a score or sum of scores that is more than: 1 standard deviation below the class mean is a BC, 2 standard deviations is a C and 3 is a D.

**Academic Integrity**: Please note that the highest standards of academic integrity are upheld in this course. Academic misconduct in any form, including cheating, will not be tolerated. In cases of academic misconduct, the University of Wisconsin-Madison's guidelines will be implemented.

We adhere to this statement from UW Madison. "By enrolling in this course, each student assumes the responsibilities of an active participant in UW-Madison's community of scholars in which everyone's academic work and behavior are held to the highest academic integrity standards. Academic misconduct compromises the integrity of the university. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these acts are examples of academic misconduct, which can result in disciplinary action. This includes but is not limited to failure on the assignment/course, disciplinary probation, or suspension. Substantial or repeated cases of misconduct will be forwarded to the Office of Student Conduct & Community Standards for additional review. For more information, refer to studentconduct.wiscweb.wisc.edu/academic-integrity/."

**Plagiarism**

"Plagiarism is a serious offense. All sources and assistance used in preparing your assignments must be precisely and explicitly acknowledged. If you have any questions about what constitutes plagiarism, please read the following information at: http://students.wisc.edu/doso/acadintegrity.html Ignorance of what constitutes plagiarism is not a defense. It is your responsibility to be sure. The web creates special risks. Cutting and pasting even a few words from a web page or paraphrasing material without a reference constitutes plagiarism. If you are not sure how to refer to something you find on the internet, you can always give the URL. For more information on writing and source citation, the following website may be helpful:http://writing.wisc.edu/Handbook/Acknowledging_Sources.pdf"

For more information regarding plagiarism please see: http://www.plagiarism.org/

**Plagiarism and NS 619:** For the take home exams each student is allowed to use any electronic or paper source (journals, books etc) as the source of material for synthesizing their own answer for these exams. No communication in any form is allowed with any other person regarding the take home exam until after the exams have been returned to all members of the class. Synthesizing an answer means the student takes information from the sources mentioned above and constructs a written answer in their **own** writing.

**Statement Against Racism and Hate**

The College of Agricultural and Life Sciences (CALS) at the University of Wisconsin–Madison is committed to providing inclusive, equitable and accessible opportunities and environments to students, stakeholders, partners, staff and faculty from all backgrounds. We aim to build a college free from exclusion, discrimination, hate and racism in our academics, research, outreach, administration and the life of the college.
Racism, hate, colonialism and discrimination show themselves in many forms, sometimes with malicious intent and often as unconscious bias. We acknowledge that their wide-ranging effects can come from actions or inactions of individuals, as well as from the policies and practices of institutions. In any form, these are harmful to individuals, our college, the university and society. Our goal is to establish systems and structures in CALS that protect against discrimination and build a welcoming community where everyone feels they belong.

**Hate and Bias Reporting**

Hate and Bias is not acceptable at UW-Madison. We stand with all students who have experienced these, including students who have dealt with hate and bias due to the COVID-19 pandemic. COVID-19 is not specific

to an ethnicity or race—disease does not discriminate. If you experience harassment or discrimination, you are encouraged to file a bias incident report.
(https://cm.maxient.com/reportingform.php?UnivofWisconsinMadison&layout_id=1)

**Accommodations during COVID-19 pandemics**

We work according to university and CDC guidelines to promote a healthy environment on campus. We ask everyone in the class respect the health of others. If you need to miss a class due to health concerns or quarantine needs, the class materials will be available online. This absence will not affect your grade.

Grading is based on performance on the following exams:

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| 2 Fact (Memorization) Exams | **300 points total** |
| Fact Exam 1 - March 3th | (Covers everything through lecture 9) |
| Fact Exam 2 - April 14th | (Everything from lecture 11- lecture 21) |
| 2 Thought (Integrate information; Design experiments) | **400 points total** |
| Thought Exam 1 - Handed Out March 17th and due March 31st | |
| Thought Exam 2 - Handed Out April 26th and due May 10th. | |
| **Total points** | **700 points** |

# Nutritional Sciences 619 -- Intermediary Metabolism of Macronutrients - 2023

(tentative list of lectures – each period is 75 min or 1.5 lectures)

| Date | Topic Number | Topic | |
|---|---|---|---|
| **Unit 1:** | | **Principles of Metabolic Control** | |
| 1/25 | 1 | Principles of Metabolic Control I<br>Organ Anatomy and Microanatomy in Relation to Metabolic Control | Eisenstein |
| 1/30 | 2 | Principles of Metabolic Control II<br>Properties of Enzymes that Control Metabolic Pathways – part I | Eisenstein |
| 2/1 | 3 | Principles of Metabolic Control III<br>Properties of Enzymes that Control Metabolic Pathways – part II | Eisenstein |
| 2/6 | 4 | Principles of Metabolic Control IV<br>Branch Point Control as an Example of Metabolic Control | Eisenstein |
| **Unit 2:** | | **Carbohydrate Metabolism** | |
| 2/8 | 5 | Physiological regulation of carbohydrate metabolism | Eisenstein |
| 2/13 | 6 | How glucose transporters influence glucose metabolism | Eisenstein |
| 2/15 | 7 | Glucokinase and glucose metabolism: Role of tissue specific isoforms and function in glucose sensing. | Eisenstein |
| 2/20 | 8 | Role of pyruvate in energy metabolism – Control of Pyruvate Oxidation | Eisenstein |
| 2/22 | 9 | Control of Gluconeogenesis: What are the roles of PEPCK and other enzymes? | Eisenstein |
| **Unit 3:** | | **Lipid Metabolism** | |
| 2/27 | 10 | Introduction to mouse and human genetics | Attie |
| 3/1 | 11 | Introduction to lipid diversity, function and homeostasis | Fan |
| 3/6 | 12 | Regulation of genes and enzymes of lipid metabolism | Fan |
| 3/8 | 13 | Lipid transport and distribution | Fan |
| **Unit 4:** | | **Fuel Sensing** | |
| 3/20 | 14 | Fuel Sensing I – Role of the AMP activated protein kinase in carbohydrate and lipid metabolism | Fan |
| 3/22 | 15 | Fuel Sensing II – Roles of ACC2 and Malonyl CoA<br>Module on ACC2 and its Role in Metabolism | Fan |
| 3/27 | 16 | Fuel sensing III – Insulin secreatogues, insulin secretion and how the pancreatic beta cell senses glucose | Eisenstein |
| **Unit 5:** | | **Protein and Amino Acid Metabolism** | |
| 3/29 | 17 | Protein Synthesis Mechanism and Control by Hormones and Nutrients – I | Eisenstein |
| 4/3 | 18 | Protein Synthesis Mechanism and Control by Hormones and Nutrients – II | Eisenstein |
| 4/5 | 19 | Mechanism and Control of Protein Turnover – I | Eisenstein |
| 4/10 | 20 | Mechanism and Control of Protein Turnover – II | Eisenstein |
| 4/12 | 21 | Metabolism of amino acids | Fan |
| **Unit 6:** | | **Metabolism in Disease** | |
| 4/17 | 22 | Introduction to metabolism in disease and aging | Fan |
| 4/19 | 23 | Inborn error of metabolism | Fan |

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|---|---|---|---|
| 4/24 | 24 | Redox metabolism and hypoxia | Fan |
| 4/26 | 25 | Immunometabolism | Fan |
| 5/1 | 26 | Cancer metabolism | Fan |
| 5/3 | 27 | Metabolic Interventions for diseases | Fan |