NUTR 370

Nutritional Biochemistry and Physiology: Macronutrients

Fall 2017

Time: Tuesdays, Thursdays and Fridays (10:00 AM-12:00 noon)

Room: J155

Course Director: Stefania Lamon-Fava, MD PhD, Cardiovascular Nutrition Laboratory, HNRCA 520 email: stefania.lamon-fava@tufts.edu; tel: 617-556-3105. Office hours by appointment.

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Tufts Graduate Credit: 1.5 credits

Prerequisites: Graduate Biochemistry (BCHM 223)

Course Description: NUTR 370 is an advanced course in the nutrition sciences. Students are expected to be familiar with the material covered in introductory nutrition as well as the biochemistry and physiology courses offered at Tufts. These courses will serve as the foundation for the material we will explore in this course. NUTR 370 will cover topics related to: energy metabolism, carbohydrates and fiber, lipids and lipoproteins, and amino acids and proteins. These topics will be covered in 3 sections, each of approximately 4 weeks duration. Class format will include lectures, student presentations, and class discussion/student participation/team-based learning. There will also be an online learning component, which will allow students to view pre-recorded lectures online with possible follow-up in-class discussions of the covered material. These online segments will allow students some greater flexibility in managing the course materials along with greater pre-class preparation for class discussion.

- Course material will all be available on **Canvas**: https://canvas.tufts.edu

Course objectives:

1) To expand the knowledge of how carbohydrates, lipids, and proteins are digested, absorbed, transported in the blood, and metabolized in the whole organism using principles of physiology, biochemistry, cell biology, and molecular biology.
2) To explain how metabolic pathways are regulated during different dietary and environment conditions.
3) To integrate information of macronutrients in health and disease, with particular emphasis on the most prevalent nutrition-related diseases: cardiovascular disease, obesity, diabetes, cancer, and sarcopenia.
4) To provide the forum for discussing experimental approaches to studying macronutrient metabolism and function.

Grading:

		% of final grade
Exams (one for each 4-wk section)	3 x 20% =	60%
Student presentation (Lipids and Carbohydrates sections)		10%
Abstract (Protein section)		5%
Study Design		5%
Team-based learning		10%
Class participation		10%

For assignments that are turned in late, a one letter grade deduction will be applied for every day that the assignment is late. Students are expected to take exams on the specified dates and times unless otherwise arranged ahead of time with the course instructor. Last-minute absences from exams due to illness will require a note from the doctor in order to re-take the exam at a later date.

Course text and material: There is no required textbook but selected chapters from *Modern Nutrition in Health and Disease* (Editors: A. Catharine Ross, Benjamin Caballero, Robert J. Cousins, Katherine L. Tucker, and Thomas R. Ziegler; 11th Edition, Lippincott Williams and Wilkins, Baltimore, MD, 2012) will be assigned throughout the semester. This book is available online through the Hirsch Health Sciences Library under "e-books".

Academic Conduct: Each student is responsible for upholding the highest standards of academic integrity, as specified in the Friedman School's Policies and Procedures manual (http://nutrition.tufts.edu/documents-and-forms/policies-and-procedures-students) and Tufts University policies (http://students.tufts.edu/student-affairs/student-life-policies/academic-integrity-policy). It is the responsibility of each student to understand and comply with these standards, as violations will be sanctioned by penalties ranging from failure on an assignment and the course to dismissal from the school.

Description of assignments, participation, exams and other required activities:
Readings: Readings will be assigned for all class meetings. The list of readings will be provided at the beginning of each section. **Read assigned material prior to the class**. Selected papers will also be discussed in class. Preparation will maximize your benefit from each lecture and enable you to contribute to class discussions.

Exams: There will a two-hour exam at the end of each section. The format of the exam will be open questions and answers.

Student Presentations (Carbohydrate and Energy Section and Lipid Section): Half of the students will be divided in groups to present selected topics during the Carbohydrates and Energy section. The other half will be divided in groups and present selected topics on Lipids. Students are expected to provide a very short description of the topic and spend most of the presentation on the aspects of the topic controversy and stimulating discussion among the other fellow students. We expect that all students will have reviewed the literature on the chosen topics and will be prepared to contribute their opinion during the discussion. Each presentation will be approximately *30 minutes (20 minutes for student presentations and 10 minutes for*

general discussion). Further details of the assignment will be given in class. Presentation grade will be as described above (Class presentations).

Abstract (Protein Section): During the protein section, all students will be given protein turnover data (excel format). Students will be asked to analyze and then prepare a written abstract similar to that for a conference or journal publication. The abstract should follow standard journal guidelines and include: background/purpose, methods, results and conclusion and be limited to 250-300 words. Students will be graded on clarity, interpretation of the results, and final conclusions. Further details of the assignment will be given in class.

Study Design: During each section one third of the students will be given a question to be developed into a small study proposal that they will present in class for discussion. Proposals will be posted on Canvas in advance of the in-class discussion. Other students are expected to be familiarized with the research question and review the proposals developed by their classmates before the in-class activity.

Team-based learning: Students will work together in class for this activity. Reading will be assigned and must be completed in advance. Students will be divided into small groups and questions for discussion will be assigned. The class will then gather for discussion of the assigned questions with each small group reporting. Specific instructions will be provided in class. *Attendance is required to receive credit.*

Student participation: will be expected during all class periods. For this reason your prior preparation is essential. If a situation arises that prevents you from preparing adequately prior to the class, please inform the instructor prior to the class. Likewise, if you will have to miss a class, common courtesy asks that you tell the instructor in advance.

Grading of student presentation, participation and team-based learning will be evaluated as follows:

- 90-100/100 Outstanding
- 80-90/100 Good
- 50-70/100 Mediocre
- <50/100 Poor
- 0/100 No evident participation

Course Schedule

	NUTR 370 - Biochemistry and Physiology: Macronutrients - Course instructor: Dr. Stefania Lamon-Fava						
2017	**Date**	**Day**	Class	**Time**	**Room**	**Instructor**	**Lecture Topic**
Energy and Carbohydrate Section							
Sept	5	Tue	1	10:00-12:00	J155	Lamon-Fava/*Online*	Introduction/*(Online: Carbohydrates: basic concepts & other)*
	7	Thur	2	10:00-12:00	J155	Rios	Central control of energy
	8	Fri	3	10:00-12:00		Pothos	Non homeostatic control of energy
	12	Tue	4	10:00-12:00	J155	Das	Energy expenditure
	14	Thur	5	10:00-12:00	J155	Roberts	Factors affecting energy metabolism
	15	Fri	6	10:00-12:00	J155	*Online*	*(Online: Fiber)*
	19	Tue	7	10:00-12:00	J155	Das	Under- and over-nutrition
	21	Thur	8	10:00-12:00	J155	Saltzman/Kane	Gut hormones/Microbiota
	22	Fri		10:00-12:00	J155	Student presentations (2)	
	26	Tue	9	10:00-12:00	J155	Kaushik/Study Design	Insulin resistance
	28	Thur	10	10:00-12:00	J155	Obin/Student presentations (1)	Diabetes
	29	Fri		10:00-12:00	J155		
Oct	3	Tue	11	10:00-12:00	J155	Team-based learning	To be determined
	5	Thur		10:00-12:00	J155	***Exam***	**First Midterm Exam: Energy and Carbohydrates**
Lipid Section							
	6	Fri	1	10:00-12:00		*Online*	*(Online: Basic concept)*
	10	Tue	2	10:00-12:00	J155	Lamon-Fava	Exogenous pathway of lipid metabolism
	12	Thur	3	10:00-12:00	J155	Lamon-Fava/Kaushik	Endogenous pathway/LDL metabolism
	13	Fri		10:00-12:00			
	17	Tue	4	10:00-12:00	J155	Lamon-Fava	Reverse cholesterol transport pathway
	19	Thur	5	10:00-12:00	J155	Ordovas	Gene-diet interactions
	20	Fri	6	10:00-12:00		Student presentations (1)/*Online*	*(Online: Diabetic dyslipidemia)*
	24	Tue	7	10:00-12:00	J155	Lamon-Fava	Lipids and gene regulation
	26	Thur	8	10:00-12:00	J155	Team-based learning	To be determined
	27	Fri	9	10:00-12:00	J155	*Online*	*Adipocyte lipid metabolism*
	31	Tue	10	10:00-12:00	J155	Scott/Student presentation (1)	Lipids and cognition
Nov	2	Thur	11	10:00-12:00	J155	Wu/Study Design	Essential FA and eicosanoids
	3	Fri		10:00-12:00			
	7	Tue		10:00-12:00	J155	*Friday's schedule*	**Second Midterm Exam: Lipids**
Protein Section							
	8	Thur	1	10:00-12:00	J155	Fielding/*Online*	Sarcopenia and other health outcomes/*(Online: Protein: Basic Concepts)*
	10	Fri		10:00-12:00		Holiday/Veterans Day	
	14	Tue	2	10:00-12:00	J155	Sacheck	BCAA
	16	Thur	3	10:00-12:00	J155	Rivas	Muscle insulin resistance
	17	Fri	4	10:00-12:00		*Online*	*(Online: Protein requirements and quality; Protein energy malnutrition)*
	21	Tue	5	10:00-12:00	J155	Whitcomb/Sacheck	Protein modification and degradation/Abstract instructions
	23	Thur		10:00-12:00		Holiday	
	24	Fri		10:00-12:00		Holiday	
	28	Tue		10:00-12:00	J155	Study Design	
	30	Thur	6	10:00-12:00	J155	Ausman	Sulfur AA and lysine
Dac	1	Fri	7	10:00-12:00		Team-based learning	To be determined
	5	Tue	8	10:00-12:00	J155	Maher	Neurotransmitters: phenylalanine and tryptophan
	7	Thur	9	10:00-12:00	J155	Maher	NO production
	8	Fri	10	10:00-12:00		Lamon-Fava/Sacheck	Macronutrients: metabolism and fuel utilization regulation/Abstract grad
	12	Tue					
	14	Thur		10:00-12:00	J155	***Exam***	**Third Midterm Exam: Proteins**

Course Schedule and Class Objectives

Required readings and supplemental readings will be posted on TRUNK approximately one week prior to each class.

ENERGY AND CARBOHYDRATES SECTION

Class 1: September 5
Topic: Course description
Instructor: Stefania Lamon-Fava, MD PhD

Topic: *Online Module - Carbohydrate Classification, Digestion, Transport, and Controversies*
Instructor: Edward Saltzman, MD
Learning Objectives
Upon completion of this class, students will:

- know the structure and classification of carbohydrates
- have learned the food sources of different types of carbohydrates
- have learned the digestion and absorption of carbohydrates
- know the different transporters involved in carbohydrate absorption and cellular uptake
- have learned how to assess glucose homeostasis
- have learned about fructose metabolism and health effects
- understand the concept of glycemic index and glycemic load

Class 2: September 7
Topic: Central Control of Energy
Instructor: Maribel Rios, PhD
Learning Objectives
Upon completion of this class, students will:

- learn the central nervous system (CNS) regions involved in the regulation of food intake
- learn the neurotransmitters and cells involved in appetite regulation
- know the anorexigenic and orexigenic input signals in the brain

Class 3: September 8
Topic: Non-Homeostatic Control of Energy Intake
Instructor: Emmanuel Pothos, PhD
Learning Objectives
Upon completion of this class, students will:

- know the difference between homeostatic and non-homeostatic CNS signals
- know the neurotransmitters involved in non-homeostatic control of energy
- understand the biological and psychological implications of non-homeostatic control of energy intake

Class 4 : September 12
Topic: Energy Expenditure
Instructor: Sai Krupa Das, PhD
Learning Objectives:
Upon completion of this class, students will:

- know the different components of total energy expenditure
- know the different laboratory methods to assess energy expenditure

Class 5: September 14
Topic: Factors Affecting Energy Metabolism
Instructor: Susan Roberts, PhD
Learning Objectives
Upon completion of this class, students will:

- understand the effects of age on energy metabolism
- understand the effects of gender on energy metabolism
- know the hormones that influence energy expenditure and why
- know how diet influences energy metabolism

Class 6: September 15
Topic: *Online Module - Fiber*
Instructor: Edward Saltzman, MD
Learning Objectives
Upon completion of this class, students will:

- know the definition and classification of different types of fiber
- know the food sources of fiber
- understand the physiological effects of fiber on energy regulation, cardiovascular disease, insulin resistance, and colon cancer

Class 7: September 19
Topic: Under- and Over-Nutrition
Instructor: Sai Krupa Das, PhD
Learning Objectives
Upon completion of this class, students will:

- know how to define under-nutrition and over-nutrition
- understand the changes in the different components of energy expenditure during under-nutrition and over-nutrition
- understand adaptation to under- and over-feeding
- know carbohydrate, lipid, and protein metabolism in under-nutrition

Class 8A: September 21
Topic: Gut Hormones
Instructor: Edward Saltzman, MD
Learning Objectives
Upon completion of this class, students will:

- understand what is sensed by the gut and how it is sensed
- understand how information is conveyed to the brain
- be able to describe how different types of bariatric surgery could influence these sensing mechanisms

Class 8B : September 21
Topic: Microbiota
Instructor: Anne Kane, MD
Learning Objectives:
Upon completion of this class, students will:

- learn how the field of microbiota has developed
- know what is currently known about composition and function of microbiota
- learn about the role of microbiota in metabolism

Class 9: September 26
Topic: Insulin Resistance
Instructor: Virendar Kaushik, PhD
Learning Objectives:
Upon completion of this class, students will:

- understand the definition of insulin resistance (IR) and type 2 diabetes mellitus
- understand the integrated action of insulin
- know the sensing of energy demands by the cell via AMP-activated protein kinase (AMPK) and Silence Information Regulator 2.1 (SIRT1)

- know how to clinically assess IR and diabetes

Class 10: September 28
Topic: Diabetes
Instructor: Martin Obin, PhD
Learning Objectives
Upon completion of this class, students will:
- understand that the Metabolic Syndrome as a critical stage in development of T2DM
- understand the role of adipocytes in glucose and fatty acid homeostasis
- know the function of adipose tissue as an endocrine organ- adipokines, lipokines
- know the effect of dysregulated adipokines and adipose tissue inflammation on insulin resistance
- have learned about therapeutic effects of TZDs, incretins, and bariatric surgery

Class 11: October 3
Topic: To be determined
Instructor: Stefania Lamon-Fava, MD PhD
Learning Objectives:
- Team-based learning

LIPIDS SECTION

Class 1: October 6
Topic: *Online Module - Basic Concepts*
Learning Objectives
Upon completion of this class, students will:
- know the biochemistry of the different classes of lipids
- have learned the lipid and apolipoprotein composition of different lipoproteins

Class 2: October 10
Topic: Exogenous Pathway of Lipid Metabolism
Instructor: Stefania Lamon-Fava, MD PhD
Learning Objectives
Upon completion of this class, students will:
- know how dietary fat digestion and absorption occurs and how lipids are delivered to target tissues
- have learned the role of the gut in lipid homeostasis

Class 3A: October 12
Topic: Endogenous Pathway of Lipid Metabolism
Instructor: Stefania Lamon-Fava, MD PhD
Learning Objectives
Upon completion of this class, students will:
- know the metabolism of VLDL, IDL, and LDL
- understand the biological functions of LDL and other atherogenic lipoproteins
- have learned about Lipoprotein(a) and its association with cardiovascular disease
- be able to describe the pathogenesis of cardiovascular disease and the role of dietary fat on lipoprotein metabolism and on the pathogenesis of cardiovascular disease

Class 3B October 12
Topic: Regulation of LDL Metabolism
Instructor: Virendar Kaushik, PhD
Learning Objectives
Upon completion of this class, students will:

- understand the membrane cycling of the LDL receptor
- understand the different pathways of LDL regulation (SREBP, PCSK9. IDOL, etc.)

Class 4: October 17
Topic: HDL and Reverse Cholesterol Transport Pathway
Instructor: Stefania Lamon-Fava, MD PhD
Learning Objectives
Upon completion of this class, students will:

- understand the role of HDL in reverse cholesterol transport
- know other anti-atherosclerotic functions of HDL
- be able to describe genetic and secondary causes of low HDL-C and high HDL-C levels
- understand the role of life-style factors on HDL-C levels

Class 5: October 19
Topic: Gene-Diet Interactions
Instructor: Jose Ordovas, PhD
Learning Objectives
Upon completion of this class, students will:

- understand the concept of personalized nutrition
- understand the interaction between genetics and nutrition and its role in lipid metabolism, obesity, and inflammation
- learn about the function of microRNA in gene expression

Class 6: October 20
Topic: *Online Module – Diabetic Dyslipidemia*
Instructor: Henry Ginsburg, MD
Learning Objectives
Upon completion of this class, students will:

- understand the interrelation between insulin resistance and cardiovascular disease
- understand the plasma lipid alterations associated with insulin resistance
- know the mechanism of the insulin resistance-related dyslipidemia

Class 7: October 24
Topic: Lipids and Regulation of Gene Expression
Instructor: Stefania Lamon-Fava, MD PhD
Learning Objectives
Upon completion of this class, students will:

- understand the role of lipid molecules as transcriptional regulators of gene expression
- understand the role of lipid molecules as regulators of gene expression in signal transduction
- understand how these roles affects lipid utilization and storage, and cell function
- be able to describe the molecular mechanisms of regulation of plasma lipids by dietary lipids and carbohydrates

Class 8: October 26
Topic: To be determined
Instructor: Stefania Lamon-Fava, MD PhD
Learning Objectives:

- Team-based learning

Class 9: October 27
Topic: *Online Module - Adipocyte Lipid Metabolism*
Instructor: Susan Fried, PhD
Learning Objectives
Upon completion of this class, students will:

- understand the regulation of adipose cell metabolism in obesity
- know how triglyceride metabolism (synthesis and hydrolysis) is regulated during feeding and fasting
- know the role of adipose tissue as an endocrine organ
- know the modulation of insulin resistance by the adipose tissue

Class 10: October 31
Topic: Brain Lipids and Cognition
Instructor: Tammy Scott, PhD
Learning Objectives
Upon completion of this class, students will:

- know the role of long chain polyunsaturated fatty acids in brain development and cognition
- learn the evidence from animal, epidemiological, and clinical intervention studies on the role of omega 3 fatty acids on cognition

Class 11: November 2
Topic: Essential FA, Eicosanoids, and Immune Function
Instructor: Dayong Wu, MD PhD
Learning Objectives
Upon completion of this class, students will:

- have reviewed the essential fatty acids structure and PUFA biosynthesis
- know the pathways of eicosanoid biosynthesis
- understand the function of prostaglandins, thromboxanes, and leukotrienes
- understand the role of eicosanoids and other PUFA-derived mediators in inflammation and in the resolution of inflammation
- know the different molecular aspects of the anti-inflammatory effects of aspirin

PROTEIN SECTION

Class 1A: November 8
Topic: *Online Module - Protein: Basic Concepts, Digestion, Absorption, etc.*
Instructor: Lynne Ausman, DSc
Learning Objectives
Upon completion of this class, students will:

- able to describe the type of roles that proteins play in the body
- understand protein structure and organization
- understand amino acid classification systems
- be able to describe the nitrogen cycle and its importance to replenishment of nitrogen into foodstuffs.
- be able to describe protein digestion and absorption, and resultant transport of amino acids and peptides across the epithelial membrane.
- know the fate of absorbed amino acids, as well as their synthesis and degradation.

Class 1B: November 8
Topic: Sarcopenia and other Health Outcomes
Instructor: Roger Fielding, PhD
Learning Objectives
Upon completion of this class, students will:

- have learned the definition of sarcopenia
- know the role of protein intake and protein metabolism on sarcopenia

- know the effect of exercise on muscle mass in the elderly

Class 2: November 14
Topic: Branched Chain Amino Acids
Instructor: Jennifer Sacheck, PhD
Learning Objectives
Upon completion of this class, students will:
- learn the metabolism of branched chain amino acids
- learn the biological functions of glutamine and alanine
- know the contribution of different organs to amino acid metabolism

Class 3: November 16
Topic: Muscle Insulin Resistance
Instructor: Donato Rivas, PhD
Learning Objectives
Upon completion of this class, students will:
- understand lipid and glucose uptake, metabolism and storage in muscle cells
- understand the role of intramyocellular lipid in muscle cell metabolism and insulin resistance
- know the concept of metabolic flexibility
- know the role of exercise on insulin sensitivity in muscle cells and its mechanism of action

Class 4: November 17
Topic: *Online Module - Protein Requirements and Quality/Protein Energy Malnutrition*
Instructor: Lynne Ausman, DSc
Learning Objectives
Upon completion of this class, students will:
- be able to describe the protein contents in the major food groups
- know the principles of the DRI and how they were established for protein
- be able to describe in detail the methods used to determine human protein requirements.
- be able to compare the several methods by which protein quality is measured

Class 5: November 21
Topic: Protein Degradation
Instructor: Elizabeth Whitcomb, PhD
Learning Objectives
Upon completion of this class, students will:
- know the different systems that break down proteins inside cells.
- know why and what kind of proteins need to be degraded
- have learned methods to monitor intracellular protein degradation

Class 6: November 30
Topic: Sulfur AA Metabolism and Lysine
Instructor: Lynne Ausman, DSc
Learning Objectives
Upon completion of this class, students will:
- be able to discuss the concept of amino acid pattern and complementation vis-à-vis the importance of methionine and cysteine sufficiency
- be able to describe the transmethylation, transulfuration, and transamination pathways of sulfur amino acid metabolism and how they are regulated
- understand the chemical role that sulfur plays as a component of sulfur amino acids and their metabolites
- know taurine production and its importance in nutrition
- understand the important role of the liver in metabolizing/catabolizing the amino acid influx from the portal vein

- know the structures of lysine and why its structure predicts some of the roles that it plays
- be able to explain the important catabolic steps for lysine

Class 7: December 1
Topic: to be determined
Instructor: Stefania Lamon-Fava, MD PhD
Learning Objectives

- Team-based learning

Class 8: December 5
Topic: Neurotransmitters: Phenylalanine and Tryptophan
Instructor: Timothy Maher, PhD
Learning Objectives
Upon completion of this class, students will:

- have learned the metabolism of AA serving as precursors of neurotransmitters (choline, tryptophan, tyrosine, histidine, threonine)
- know how AA are transported into the brain and their role in cognition and other effects

Class 9: December 7
Topic: NO production
Instructor: Timothy Maher, PhD
Learning Objectives
Upon completion of this class, students will:

- know the metabolism of arginine and the effects of its metabolite ADMA
- know the synthesis of NO from arginine and the effects of NO on the vascular system

Class 10: December 8
Topic: Macronutrients: Metabolism, Storage and Regulation of Fuel Utilization
Instructor: Stefania Lamon-Fava, MD PhD
Learning Objectives
Upon completion of this class, students will:

- learn about macronutrients interconversion and storage
- understand tissue-specific differences in fuel utilization
- know the body's regulation of fuel utilization during fasting and starvation
- know the regulation of fuel utilization in the feeding state by different organs and tissues
- understand the regulation of fuel utilization by muscle tissue during exercise
- understand gender differences in fuel utilization