

Tufts University, Friedman School of Nutrition Science and Policy

NUTR 246-- Scientific Basis of Nutrition: Macronutrients  
Spring 2018

<b>Class Meetings:</b>	Mondays, 3:15-6:15pm
<b>Location:</b>	Sackler 507
<b>Instructor(s):</b>	Erin Hennessy <a href="mailto:erin.hennessy@tufts.edu">erin.hennessy@tufts.edu</a> 617-636-3636
<b>Office hours:</b>	By appointment
<b>Teaching Asst.:</b>	Delphine Van Roosebeke <a href="mailto:Delphine.van_roosebeke@tufts.edu">Delphine.van_roosebeke@tufts.edu</a>
<b>Office hours:</b>	By appointment
<b>Graduate Credits:</b>	1 credit
<b>Prerequisites:</b>	Undergraduate-level biology and chemistry, or by instructor

**Course Description:** NUTR 246 is one course of a pair of courses (with NUTR 245) designed to provide students with an in-depth understanding of nutrition and its scientific underpinnings. NUTR 246 focuses on macronutrients and energy, and will cover topics related to energy metabolism, carbohydrates and fiber, lipids and lipoproteins, and amino acids and proteins while NUTR 245 focuses on micronutrients including fat- and water-soluble vitamins and minerals.

The course has been designed to review and build upon students' existing knowledge of biology and chemistry, and will provide instruction in biochemical and physiologic principles necessary to understand the aspects of macronutrients described above. The focus of the course will be on the scientific basis for and real-world application of macronutrients and energy.

The course is divided into 4 sections in 3-week cycles: energy/energy metabolism, carbohydrates and fiber, lipids and lipoproteins, amino acids and proteins. Each section will address five major questions: what, where, why, when, and how. For example,

- What is a carbohydrate? What is its function?
- Where do I obtain carbohydrates (food sources)?
- Why does my body need carbohydrates?
- When do my needs change (across the lifecourse)?
- How does my body digest/absorb/metabolize carbohydrates?

**Course Objectives:**

- Describe each macronutrient including the recommend dietary intake, major functions and biochemical role, and food sources
- Summarize how macronutrients are digested, absorbed, transported in the blood, and metabolized using principles in physiology, biochemistry, cell biology and molecular biology.
- Explain the health effects associated with each macronutrient

## **Texts and Materials:**

### **Texts:**

Required:

1. Wardlaw's Perspectives in Nutrition, 2016 (Editors: Byrd-Bredbenner, Moe, Berning and Kelley)
2. Modern Nutrition in Health and Disease, 2014 (Editors: Catherine Ross, Benjamin Caballero, Robert Cousins, Katherine Tucker and Thomas Ziegler; 12<sup>th</sup> Edition).

The Byrd-Bredbenner et al text (on reserve at the Health Sciences library) provides an easy-to-read overview of the nutrition concepts presented in class while the Ross et al (free e-book from the Health Sciences library) provides additional detail.

Chapters from required texts and other readings will be assigned throughout the course.

Recommended:

3. Biochemical, Physiological, and Molecular Aspects of Human Nutrition, 3<sup>rd</sup> Edition by Stipanuk and Caudill

The Stipanuk and Caudill (on reserve at the Health Sciences library) is not required, but recommended for those who want to go deeper into specific scientific concepts related to structure/function, digestion/absorption, and metabolism

\*Additional reading and other course materials will be posted on Canvas.

### **Materials:**

Course materials will be available on CANVAS: <http://Canvas.tufts.edu>.

For the Diet Analysis Projects, we will utilize the National Cancer Institute's Automated Self-Administered Recall System (ASA24). The program is available online at no cost to students. See: <https://epi.grants.cancer.gov/asa24/>

Students may wish to familiarize themselves with the basics of nutritional assessment methods. See: <https://dietassessmentprimer.cancer.gov/>

**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/student/documents>) 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.

**Classroom Conduct:** The goal is for everyone to attend each class and arrive on time. If for any reason you must miss class, arrive late, or leave early, please let the Instructor or TA know as soon as possible (via email is fine!). This is a 3-hour course so we will have a 10-minute break during each class. Food and beverages are allowed.

### Description of Course Elements:

- **Lectures:** Lectures will be provided in the classroom and to the extent possible will be recorded. Links to online lecture slides and recordings will be posted on Canvas.
- **Readings:** Required and recommended readings will be posted on Canvas. Required readings that accompany a lecture or activity should be completed in advance of class so that content can be discussed during the class. Recommended readings have been chosen to improve understanding of course material or to allow students to go ‘deeper’ into a topic. These readings are optional and content from the recommended reading list will not be assessed in course assignments.
- **Written Quizzes:** Students will complete 4 take-home quizzes at the end of each Section. Each quiz will be based on the materials presented in lectures and the required readings. The quiz will require you to write comprehensive answers demonstrating knowledge of and ability to apply the materials presented in the course. Your written responses must be in your own words. Please review the Tufts policies on plagiarism prior to completing each quiz (links to these policies are provided under the Academic Conduct section above). Quizzes will be posted on Canvas and students will have one week to complete each assignment.
- **Debate-style presentations:** To help students synthesize and extend their knowledge of course materials, as well as become familiar with the nutrition science literature and communication of that literature in the mass media, students will be required to do an in-class debate-style presentation summarizing their viewpoint (for or against) a current controversy in nutrition science. This will be a Team assignment. You will have the opportunity to rank order your topic choice; teams will be randomly assigned and posted on Canvas. The debate will start with a 20-minute presentation by each team (team 1: ‘pro’ talk for 10 minutes; team 2: ‘con’ talk for 10 minutes), followed by 15-20-minutes of debate. The Instructor or TA will act as Moderator. The Grading Rubric will be available on Canvas.
- **Diet Analysis Project:** Additional details on this assignment and grading rubric are available on Canvas. For this assignment, students will be asked to:
  - a) interview an adult (e.g. a friend, partner, family member, etc) using the multiple-pass, 24-hour dietary recall method. Two recalls must be completed representing 1 weekday and 1 weekend day. Interviews can be conducted in person and/or by phone. It is ideal that you interview another person as this a unique learning experience; however, if you cannot find another person to interview then you may complete self-assessments.
  - b) enter the data (either during or after data collection). You can use the ASA24 web platform to conduct the interview and enter data in ‘real time’ if you are comfortable with the format OR you can familiarize yourself with the procedures and level of detail required by the program and conduct the interviews using pen/paper (recommended).
  - c) provide a two-part written assessment of your participant’s diet based on the information obtained during the recall. The focus of this report will be on energy and energy-yielding nutrients.
- **Final Project.** The final project will be individual assignment. Each student will have the opportunity to apply the knowledge gained over the entire course in a written report. Students may choose their topic based upon discussion and approval with the Instructor and/or TA. Projects will focus on “Diets”. For example, the Mediterranean Diet, Paleo Diet, Vegan-diet, Vegetarian-diet, Western Diet, Weight Watchers Diet, etc. Students are expected to critique the healthfulness of their chosen diet by applying the concepts learned in class – focusing on energy and energy-yielding nutrients. Grading rubric are available on Canvas. It is recommend that students work on this assignment throughout the semester.

**Instructions for Submission of Assignments and Exams:** Assignments should be submitted via Canvas. If Canvas is not operational, the assignment should be emailed to the course Instructor and TA prior to the assignment deadline.

Students who are unable to complete an assignment or exam on time and need to request an extension, please notify the Instructor by email prior to the deadline. You will need to provide a brief explanation for why the extension is needed. Assignments received after the deadlines without approved extensions are subject to an automatic 10% reduction in credit per day.

**Assessment and Grading:** The contribution of course activities to the course grade is found in the table below:

Activity (number during the course, % contribution per each)	Contribution to final grade (%)
Take-home unit exams (4, 10% each)	40%
Debate-style presentations (1, 15% each)	15%
Diet Analysis Project (2 parts, 10% each)	20%
Final Project (25%)	25%

**Accommodation of Disabilities:**

*Tufts University is committed to providing equal access and support to all students through the provision of reasonable accommodations so that each student may access their curricula and achieve their personal and academic potential. If you have a disability that requires reasonable accommodations please contact the Friedman School Assistant Dean of Student Affairs at 617-636-6719 to make arrangements for determination of appropriate accommodations. Please be aware that accommodations cannot be enacted retroactively, making timeliness a critical aspect for their provision.*

**Course Schedule:**

*All classes are on Mondays unless otherwise indicated. All classes take place from 3:15-6:15pm.*

Wk	Date	Location	Topic	Lecturer	Assignment
1	Jan 22	Sackler 216A	Foundations, Concept Review and Course Introduction	Hennessy	None
<b>Energy</b>					
2	Jan 29	Sackler 507	Energy Foundations: Factors Influencing Energy Metabolism	Guest Expert: Roberts	None
3	Feb 5	Sackler 507	Energy Expenditure; Under- and Over-nutrition	Guest Expert: Das	None
4	Feb 12	Sackler 507	Controls Systems of Energy	Guest Expert: Pothos	None
--	Feb 20				Quiz 1 due
<b>Carbohydrates</b>					
5	Feb 22* (Thurs)	Sackler 507	Carbohydrate Foundations: Structure, Function, Digestion, Absorption and Metabolism	Hennessy	Debate (Group A)
6	Feb 26	Sackler 507	Fiber	Guest Expert: Saltzman	Diet Analysis Project (Part I)
			Introduction to the Microbiota	Van Roosebeke	
7	Mar 5	Sackler 507	Carbohydrate Needs and Disorders	Hennessy	Debate (Group B)
			Glycemic Index	Guest Expert: Matthan	
<b>Lipids</b>					
8	Mar 12	Sackler 507	Lipid Foundations: Structure, Function, Digestion, Absorption	Hennessy & Van Roosebeke	Debate (Group C)
--	Mar 13				Quiz 2 due
9	Mar 26	Sackler 507	Health Effects of Fat Intake: The Good, The Bad, and The Ugly	Guest Expert: Lichtenstein	Debate (Group D)
10	Apr 2	Sackler 507	Lipid Metabolism	Guest Expert: Lamon-Fava	Debate (Group E)
<b>Protein</b>					
11	Apr 9	Sackler 507	Protein and Amino Acids Foundations: Structure, Function, Digestion, Absorption	Guest Expert: Ausman	Diet Analysis Project (Part II)
--	Apr 10				Quiz 3 due
12	Apr 23	Sackler 507	Protein Requirements, Protein-related Health Conditions and Outcomes	Guest Expert: Ausman	Debate (Group F)
13	Apr 30	Sackler 507	Alcohol & Semester Wrap-Up (last class of the semester)	Hennessy	Debate (Group G)
--	May 8				Quiz 4 due
--	May 11				Final paper due

\*Note class held on Thursday

## Course Topics, Learning Objectives and Assignments

### Week 1: Foundations, Concept Review and Course Introduction

#### Learning objectives:

Upon completion of this week, students will be able to:

- Describe the characteristics of a healthy diet
- Summarize and know the principles of the Dietary Reference Intakes (DRIs) for Macronutrients, how they are determined
- Discuss the macronutrient information provided on the Nutrition Facts Panel
- Explain the purpose of the Dietary Guidelines for Americans
- Describe the physiological processes of digestion and absorption
- Identify the enzymes and hormones that act in digestion

#### Required reading:

- Wardlaw, Chapter 2 – Tools of a Healthy Diet
- Wardlaw, Chapter 4 – Digestion and Absorption
- 2015-2020 Dietary Guidelines for Americans – Executive Summary
- US Evidence-based Dietary Guidelines: The History and the Process
- The new Nutrition Facts Label

Assignments for this week: None

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## ENERGY SECTION

### Week 2: Factors Influencing Energy Metabolism

#### Learning objectives:

Upon completion of this week, students will be able to:

- Understand the effect of age and gender on energy metabolism
- Describe how diet influences energy metabolism
- Identify hormones that influence energy expenditure

#### Required reading:

- Khan Academy, Basics of Metabolism
- Energy & Food Lecture, Dr. Paul Leavis
- Bogardus C, Lillioja S, Ravussin E et al. Familial Dependence of the Resting Metabolic Rate. *N Engl J Med* 1986;315:96-100
- Ravussin E, Redman LM, Rochon J et al. A 2-Year Randomized Controlled Trial of Human Caloric Restriction: Feasibility and Effects on Predictors of Health Span and Longevity. *J Gerontol A Biol Sci Med Sci.* 2015;70:1097-104.

Assignments for this week: None

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### Week 3: Energy Expenditure; Under- and Over-nutrition

#### Learning objectives:

Upon completion of this week, students will be able to:

- Define key concepts such as under-nutrition, over-nutrition, energy balance; discuss changes in energy balance affect body weight
- Discuss the different components of total energy expenditure; describe the major components of 'energy in' and 'energy out'
- Understand issues and controversies related to under-nutrition, over-nutrition, energy balance such as obesity and caloric restriction

#### Required reading:

- Wardlaw, Chapter 10 – Energy Balance and Weight Management (except Eating Disorders)
- Ross, Energy Needs: Assessment and Requirements
- Das SK, Roberts SB. Energy Metabolism in Fasting, Fed, Exercise and Refeeding States. (Pg 45-55) Present Knowledge In Nutrition, 10<sup>th</sup> Edition Bowman, Russell, Eds. 2012, ILSI Press, Washington DC.

Assignments for this week: None

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### Week 4: Controls Systems of Energy

#### Learning objectives:

Upon completion of this week, students will be able to:

- Describe how the Central Nervous System influences the regulation of food intake
- Understand the difference between homeostatic and non-homeostatic control of energy
- Identify the neurotransmitters involved in appetite regulation and in non-homeostatic control of energy
- Describe the communication between the gut and the brain in control of appetite

#### Required reading:

- Wardlaw, Chapter 9 – Energy Metabolism
- Rui L. Brain regulation of energy balance and body weight. *Rev Endocr Metab Disord* 2013;14:387-407.
- Hussain SS and Bloom SR. The regulation of food intake by the gut-brain axis: implications for obesity. *International Journal of Obesity* 2013;37:625–633.
- Allen PJ, Batra P, Geiger BM, Wommac T, Gilhooly C, Pothos EN. Rationale and consequences of reclassifying obesity as an addictive disorder. Neurobiology, food environment and social policy perspectives *Physiology & Behavior* 2012;107:126–137.

Assignments for this week: None

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**Take Home Quiz: Energy (due February 20)**

## CARBOHYDRATE SECTION

### Week 5: Carbohydrate Foundations: Structure, Function, Digestion, Absorption and Metabolism

#### Learning objectives:

Upon completion of this week, students will be able to:

- Describe the structure, classification, function, digestion, absorption of carbohydrates
- Summarize carbohydrate metabolism
- Recognize the different transporters involved in carbohydrate absorption and cellular uptake
- Identify food sources of different types of carbohydrates

#### Required reading:

- Wardlaw, Chapter 5 – Carbohydrates
- Ross– Carbohydrates

Assignments for this week: [Debate \(Group A\)](#)

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### Week 6: Fiber & Introduction to the Microbiota

#### Learning objectives:

Upon completion of this week, students will be able to:

- Describe the definition and classification of different types of fiber
- Identify food sources of fiber
- Summarize the physiological effects of fiber on energy regulation, CVD, insulin resistance and colon cancer
- Summarize what is known about the composition and function of microbiota and its role in metabolism

#### Required reading:

- Wardlaw, Chapter 5
- Ross – Fiber
- Subramanian S, Blanton L, Frese SA et al. Cultivating Healthy Growth and Nutrition through the Gut Microbiota. *Cell*. 2015;161:36–48
- Komaroff AL. 2016. The Microbiome and Risk for Obesity and Diabetes. *JAMA*.

Assignments for this week: [Diet Analysis Project \(Part I\)](#)

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### Week 7: Carbohydrate Needs and Disorders

#### Learning objectives:

Upon completion of this week, students will be able to:

- Summarize recommended intakes of carbohydrates
- Describe life stages or situations in which needs change
- Understand the concept of glycemic index and glycemic load

**Required reading:**

- Wardlaw, Chapter 5
- Matthan NR, Ausman LM, Meng H, Tighiouart H, Lichtenstein AH. Estimating the reliability of glycemic index values and potential sources of methodological and biological variability. *Am J Clin Nutr.* 2016 Oct;104(4):1004-1013.
- Zeevi D, Korem T, Zmora N, Israeli D, et al. Personalized Nutrition by Prediction of Glycemic Responses. *Cell* 2015;163:1079-94

**Assignments for this week:** Debate (Group B)

**Take Home Quiz 2: Carbohydrate (due March 13)**

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## LIPIDS SECTION

**Week 8: Lipid Foundations: Structure, Function, Digestion, Absorption****Learning objectives:**

Upon completion of this week, students will be able to:

- Describe the structure of saturated, monounsaturated, polyunsaturated fatty acids and identify the fatty acids that are considered essential
- Identify the lipid and apolipoprotein composition of different lipoproteins
- Describe how dietary fat digestion and absorption occurs and how lipids are delivered to target tissues
- Describe the structure of triglycerides and phospholipids and explain their biological significance
- Explain the digestion and absorption of dietary fat, including bile

**Required reading:**

- Wardlaw, Chapter 6 – Lipids
- Ross – Lipids, Sterols, and Their Metabolites

**Assignments for this week:** Debate (Group C)

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**Week 9: Health Effects of Fat Intake: The Good, The Bad, and The Ugly****Learning objectives:**

Upon completion of this week, students will be able to:

- Identify the essential fatty acid structure, pathways of eicosanoid biosynthesis, and role in inflammation
- Describe the role of long chain PUFAs in brain development and cognition
- Summarize the relationship between fat and cardiovascular disease
- Identify food sources and recommend intakes of all lipid classes, including trans fatty acids

**Required reading:**

- Wardlaw, Chapter 6 – Lipids

- Ross – Lipids, Sterols, and Their Metabolites
- Sacks et al. 2017, Dietary Fats and Cardiovascular Disease: A Presidential Advisory from the American Heart Association.
- Mozaffarian et al. 2010, Effects on coronary heart disease of increasing polyunsaturated fat in place of saturated fat. PLoS Med.
- Jakobsen et al. 2009, Major types of dietary fat and risk of coronary heart disease. Am J Clin Nutr.

**Assignments for this week:** Debate (Group D)

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## Week 10: Lipid Metabolism

### Learning objectives:

Upon completion of this week, students will be able to:

- Identify exogenous, endogenous pathways of lipid metabolism
- Describe the regulation of LDL metabolism
- Summarize the role of cholesterol in human nutrition
- Describe how triglyceride metabolism is regulated during feeding and fasting

### Required reading:

- Wardlaw, Chapter 6 – Lipids
- Ross – Lipids, Sterols, and Their Metabolites

**Assignments for this week:** Debate (Group E)

**Take Home Quiz 3: Lipids (due April 10)**

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## PROTEINS/AMINO ACIDS (...and alcohol) SECTION

### Week 11: Protein and Amino Acids Foundations: Structure, Function, Digestion, Absorption, etc.

#### Learning objectives:

Upon completion of this week, students will be able to:

- Describe the chemical structure of amino acids and understand protein structure and organization
- Describe the function of protein in the body
- Identify the AA that are essential in the diet
- Summarize protein digestion and absorption, and transport of AA
- Learn how the metabolism of AA serving as precursors of neurotransmitters; how AA are transported into the brain and their role in cognition

#### Required reading:

- Wardlaw, Chapter 7 – Proteins
- Ross, Chapter 1 – Proteins and Amino Acids

**Assignments for this week:** [Diet Analysis Project \(Part II\)](#)

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## Week 12: Protein Requirements and Protein-related Health Conditions and Outcomes

### Learning objectives:

Upon completion of this week, students will be able to:

- Describe the protein contents in the major food groups
- Explain the difference between high-quality and lower-quality proteins and the concept of limiting amino acid
- Broadly discuss protein requirements across life stages
- Identify and compare methods used to determine human protein requirements
- Describe the types of Protein-Energy Malnutrition (PEM)
- Identify the different types of common food protein allergies (e.g. Wheat/Celiac Disease), their symptoms and treatment options

### Required reading:

- Wardlaw, Chapter 7 – Proteins
- Ross – Proteins and Amino Acids
- Sathe et al. 2016. Food Allergy. *Annu Rev Food Sci Technol*

**Assignments for this week:** [Debate \(Group F\)](#)

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## Week 13: Alcohol & Semester Wrap-Up

### Learning objectives:

Upon completion of this week, students will be able to:

- Define moderate alcohol consumption and ‘one drink’ when referring to an alcoholic beverage
- Describe the process of alcohol absorption and metabolism
- Identify the health implications of alcohol consumption (e.g. potential health benefits of moderate consumption and negative health effects associated with alcohol abuse, alcohol consumption during pregnancy)

### Required reading:

- Wardlaw, Chapter 8 – Alcohol
- Ross – Nutrition in Liver Disorders and the Role of Alcohol

**Assignments for this week:** [Debate \(Group G\)](#)

**Take Home Quiz 4: Protein & Alcohol (due May 8)**