NUTR 245
Scientific Basis of Nutrition: Micronutrients
Fall 2019

Meets: Fridays 9 am - 12 pm in Jaharis 118

Course Instructors
Edward Saltzman, MD
Email: Edward.Saltzman@tufts.edu
Phone: (617) 636-6633
Office: Jaharis 269
Office hours by appointment: Contact Patty Dawson, Patty.Dawson@tufts.edu, (617) 636-2467

Mathieu Lalonde, PhD
Email: lalonde@fas.harvard.edu
Office hours by appointment

Robert Post, PhD, MEd, MSc
Email: robert.post@foodtritionsolutions.com
Office hours by appointment

Teaching Assistant
Emily (EJ) Johnson
Email: E.Johnson@tufts.edu
Office hours by Appointment

Tufts Graduate Credit
3 Semester Hour Units

Prerequisites
Undergraduate chemistry and biology, or by instructor permission.

Course Description
NUTR 245 is one course of a pair of courses designed to provide students with an in-depth understanding of nutrition and its scientific underpinnings. NUTR 245 focuses on micronutrients, including fat- and water-soluble vitamins and minerals. The second course of the sequence, NUTR 246, focuses on macronutrients and energy.

This course will cover micronutrient sources; digestion, absorption and bioavailability; homeostasis; functions throughout the lifecycle including roles in promotion of health and prevention of disease; and deficiency and toxicity states. Additional concepts will include micronutrient fortification and supplementation, gene-diet interactions, and the social and biological determinants of micronutrient status.

Course Goals:
1. Integrate the multiple processes and factors that determine micronutrient status.
2. Explain fundamental micronutrient functions.
3. Identify risks for, and manifestations of, major deficiency and toxicity syndromes.
4. Explain how micronutrient requirements can be assessed.
5. Understand the basis of micronutrient controversies.
6. Appreciate real-world applications of micronutrients in food science, nutrition science, public health, agriculture and food policy.

Course Texts and Materials:

The course will utilize two electronic textbooks, both of which are available online through the Tufts Health Sciences Library website:

- Netter's Essential Physiology (2016), Susan E. Mulroney et al. (eds): this textbook may be useful for optional background reading in basic science topics necessary to understand course material.
- Modern Nutrition in Health and Disease, 11th edition (2014), A. Catherine Ross et al. (eds): several chapters from this textbook will be assigned as required reading.

Readings will be assigned from these books and a variety of other sources. All required and supplemental reading will be posted on Canvas.

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.

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 (https://nutrition.tufts.edu/sites/default/files/documents-forms/2018-2019PolProc.pdf) 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. Written assignments will be assessed by online plagiarism detection tools.

Description of Course Elements:

- **Lectures:** Lectures will be provided most weeks. Lectures will be recorded and posted on Canvas. In-class activities involving small groups will not be recorded.
- **Readings:**
  - All readings will be posted on Canvas or links will be provided.
  - **Required readings:** It is expected that required readings will be completed prior to class. Content from required reading may be reflected in course assignments.
  - **Supplemental readings:** Supplemental readings are not required and are intended to complement lecture material or to provide a scientific background for the course material. Content from supplemental readings will not be reflected in course assignments.
• **Paper discussions:** Scientific publications will be included in required readings for some weeks. The publication will be discussed in detail in class and must be read prior to class. All class members should be prepared to participate in paper discussions.

• **Weekly assignments:** The purpose of weekly assignments is to assess comprehension of that week’s topic and integrate the topic into course concepts. Weekly assignments will reflect topics covered in lecture, discussions, and in required reading. There will 11 weekly assignments, each of which will correspond to a week during the course. Each assignment will reflect the learning objectives from the course, and in some cases may be cumulative and include material from earlier in the course. **Each student must submit a minimum of 8 weekly assignments.** If more than 8 assignments are submitted, the highest scoring 8 assignments will count towards the course grade. Assignments will generally be able to be completed in 3-4 pages. Assignments will be due prior to the beginning of the next week’s class.

• **Team-based learning:** There will be two team-based learning (TBL) sessions that will require prior preparation outside of class. At the beginning of each TBL session students will complete a brief written quiz to assess comprehension of assigned readings. Following the quiz, students will be assigned to small groups and each small group will receive the same questions to discuss as a group. For the second half of the session the entire class will reconvene for discussion of questions.

• **Interviews:** Each will interview an expert in a relevant topic of interest and will submit a written summary of the interview. The interview process will take place in several stages, with each stage associated with a deadline over the semester:
  - Students will initially define a relevant topic of interest and submit a brief (2-3 page) concept note that summarizes background and provides justification for the topic. Concept notes will be submitted and will be subject to peer-review in class.
  - Students will propose interview questions and those questions will be submitted and peer-reviewed in class.
  - Individuals with expertise in topics will be identified and invited.
  - Interviews will be conducted in person or electronically (by phone, WebEx or Skype).
  - A written summary of the interview will be submitted and will be due at the end of the final examination period. The format of the written summary will be explained in class.

• **Extra credit and makeup assignments:** Students in jeopardy of failing the course may be offered assignments, either remediation of previously completed assignments or additional assignments, to achieve a passing grade. No other assignments for additional credit will be offered; i.e. students who are not at risk for passing the course will not be offered the opportunity to improve their course grade.

**Instructions for Submission of Assignments:**

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 time the assignment is due. Students who are unable to complete an assignment on time and wish to request an extension must contact the instructor and TA by email **prior to the submission deadline** and include a specific date and time by which the assignment will be submitted. **Assignments received after deadlines without approved extensions will not be graded or counted towards the final course grade.**

**Assignments and Grading:**

<table>
<thead>
<tr>
<th>Activity (number during course, % contribution each)</th>
<th>Contribution to Final Grade (%)</th>
</tr>
</thead>
</table>

NUTR 245 Syllabus Fall 2018
Page 3 of 12
Class Preparation and Participation: The course instructors may increase or decrease the final course grade on the basis of preparation for class (readings completed prior to the lecture, participation in discussions and TBL). The “average” level of preparation and participation will result in no final course grade adjustment.

± 1 Level of the Final Course Grade (e.g. A- to A or A to A-)

Course Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Topics</th>
<th>Assignments Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9/6/19</td>
<td>Course Introduction&lt;br&gt;Lecture: Mechanisms of Digestion and Absorption; Dietary Assessment; Iron Part 1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>9/13/19</td>
<td>Lecture: Iron Part 2 (Saltzman)&lt;br&gt;Paper Discussion: Collings et al</td>
<td>Weekly Assignment 1</td>
</tr>
<tr>
<td>3</td>
<td>9/20/19</td>
<td>Lecture: Zinc, Copper, and Iodine&lt;br&gt;Discussion: Approaches to Iodine Nutrition in the Era of Dietary Sodium Reduction</td>
<td>Weekly Assignment 2</td>
</tr>
<tr>
<td>4</td>
<td>9/27/19</td>
<td>Lecture: Bone Health&lt;br&gt;Discussion: Is Dairy Necessary for Bone Health?</td>
<td>Weekly Assignment 3</td>
</tr>
<tr>
<td>5</td>
<td>10/4/19</td>
<td>No in-class activities&lt;br&gt;See course schedule for assigned reading and weekly assignment</td>
<td>Weekly Assignment 4</td>
</tr>
<tr>
<td>6</td>
<td>10/11/19</td>
<td>TBL: Micronutrients and Blood Pressure</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>10/18/19</td>
<td>Lecture: Vitamin A, Carotenoids, Vitamin K, and the Microbiota&lt;br&gt;Discussion: Biomarkers of Vitamin A</td>
<td>Weekly Assignment 5</td>
</tr>
<tr>
<td>8</td>
<td>10/25/19</td>
<td>Lecture: Oxidative Stress and Antioxidant Nutrients</td>
<td>Weekly Assignment 6</td>
</tr>
<tr>
<td>9</td>
<td>11/1/19</td>
<td>Lecture: Vitamin B12 and Folate&lt;br&gt;Discussion: Folic Acid Fortification of Food</td>
<td>Weekly Assignment 7</td>
</tr>
<tr>
<td>10</td>
<td>11/8/19</td>
<td>Lecture: Micronutrients in Energy and Macronutrient Metabolism Part 1&lt;br&gt;Activity: Peer Review of Interview Concept Note</td>
<td>Weekly Assignment 8 Interview Concept Note Due</td>
</tr>
<tr>
<td>11</td>
<td>11/15/19</td>
<td>Lecture: Micronutrients in Energy and Macronutrient Metabolism Part 2&lt;br&gt;Activity: Peer Review of Interview Questions</td>
<td>Weekly Assignment 9 Interview Questions Due</td>
</tr>
<tr>
<td>12</td>
<td>11/22/19</td>
<td>Lecture: Nutritional Anemia</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>12/6/19</td>
<td>TBL: Fortification and Supplementation</td>
<td>Weekly Assignment 11</td>
</tr>
<tr>
<td>12</td>
<td>12/19/19</td>
<td>Interview Summary</td>
<td></td>
</tr>
</tbody>
</table>

Course Schedule, Reading and Assignments

Weeks 1 and 2 are displayed together
Week 1  
Lecture: Course Introduction; Mechanisms of Digestion and Absorption; Dietary Assessment; Iron (Part 1)

Week 2  
Lecture: Iron (Part 2)  
Paper Discussion: Collings et al.

Learning Objectives:  
1. Provide examples of mechanisms for transport of micronutrients in and out of cells.
2. Differentiate between heme and non-heme iron in regard to  
   a. Dietary sources  
   b. Factors that influence bioavailability  
3. Describe the major functions of iron in humans.  
4. Summarize iron homeostasis mechanisms, including genetic and physiologic contributors.  
5. Contrast the usefulness and pitfalls of biomarkers of iron status.  
6. Explain why iron deficiency is the most common deficiency worldwide.  
7. Discuss if iron absorption from whole diets followed the predicted pattern as reported in the assigned reading by Collings et al.  
8. Contrast advantages and disadvantages of dietary assessment methods discussed in class and utilized in the Collings paper.

Required Reading:  

Supplemental Reading:  
1. Basic science background  

Assignments Due:  
1. Weekly Assignment #1 due on Friday 9/13/19

Week 3  
Lecture: Zinc, Copper, and Iodine  
Discussion: Approaches to Iodine Nutrition in the Era of Dietary Sodium Reduction

Learning Objectives:  
1. Identify and explain factors that influence zinc and copper bioavailability, including food-related and physiologic factors.  
2. Recognize risk factors for zinc and copper deficiency.  
3. Discuss long-term effects of zinc deficiency in children.  
5. Explain these nutrient-nutrient interactions  
   a. How copper deficiency can cause iron deficiency.
b. How zinc supplementation can cause copper deficiency.
6. Describe the physiologic functions of iodine.
7. Identify appropriate biomarkers of iodine status.
8. Discuss implications of dietary sodium reduction on iodine status in countries that fortify iodine with salt.

Required Reading:

Supplemental Reading:

Assignments Due:
1. Weekly Assignment #2 on Friday 9/20/19 @ 9:00am.

Week 4
Lecture: Micronutrients in Bone Health
Discussion: Is Dairy Necessary for Bone Health?

Learning Objectives:
1. Diagram and explain vitamin D metabolism and homeostasis.
2. Discuss the advantages and disadvantages of biomarkers of vitamin D status.
3. Diagram and explain calcium homeostasis, including roles played by calcium sensing, vitamin D, and organs (liver, kidney, intestine, bone and skin).
4. Discuss the effects of calcium and vitamin D intake at each life stage in promotion of bone health and prevention of age-related bone disease.
5. Defend your opinion regarding vitamin D and calcium supplementation with consideration of age, gender, race/ethnicity, and health history.
6. Explain the basis for the current Dietary Reference Intake recommendations for vitamin D and calcium.
7. Explain how dietary protein could promote or impair bone health.

Required Reading:

Supplemental Reading:

Assignments Due:
1. Weekly Assignment #3 on Friday 9/27/19 @ 9:00am.

---

**Week 5**
Topics: Magnesium, Phosphorus and Fluoride
Even though there is no class, please complete required reading, which is needed to complete the assignment due next week.

**Learning Objectives:**
1. Summarize proposed health effects of magnesium intake.
2. Discuss the implications of phosphorous food additives.
3. Explain the mechanism by which fluoride promotes resistance to dental caries.

**Required Reading:**

Assignments Due:
1. Weekly Assignment #4 on Friday 10/4/19 @ 9:00am.

---

**Week 6**
Team Based Learning: Micronutrients and Blood Pressure

**Learning Objectives:**
1. Describe advantages and disadvantages of methods for dietary assessment of sodium and potassium.
2. Discuss micronutrients proposed to influence blood pressure and identify foods and diet patterns rich in these micronutrients.
3. Explain current controversies regarding sodium intake and propose research to resolve controversies.
4. Discuss the relationship between social determinants of health and prevalence of hypertension as well as morbidity associated with hypertension.
5. Critique approaches to reduce sodium intake.

**Required Reading:**

Assignments Due:
1. There will be a brief written quiz during class to assess comprehension of the assigned readings for the TBL exercise.

Week 7
Lecture: Vitamin A, Carotenoids, Vitamin K, Microbiota
Discussion: Choosing and Using Biomarkers of Vitamin A

Learning Objectives:
1. Differentiate between vitamin A and pro-vitamin A carotenoids and provide examples of their sources.
2. Summarize vitamin A homeostasis, including regulation of pro-vitamin A carotenoid metabolism.
3. Explain the major functions of the active forms of vitamin A and provide examples of each.
4. Explain functions of carotenoids in humans.
5. Contrast biomarkers of vitamin A intake and status and propose appropriate uses in diverse scenarios.
6. Identify risk factors for, and manifestations of, vitamin A deficiency and excess.
7. Discuss the evidence to-date regarding high dose carotenoid supplementation for prevention of disease.
8. Differentiate between the two major forms of vitamin K.
9. Explain the major biochemical function of vitamin K.
10. Propose appropriate use of biomarkers of vitamin K intake and status.
11. Define microbiota, microbiome, probiotic and prebiotic.
12. Provide examples of how microbial production of micronutrients may contribute to micronutrient status.

Required Reading:

Supplemental Reading:
2. Modern Nutrition in Health and Disease. Chapter 17: Vitamin A.

Assignments Due: Weekly Assignment #5 due Friday 10/18/19 @ 9:00am.
**Week 8:**
Lecture: Oxidative Stress and Antioxidant Nutrients

**Learning Objectives:**
1. Define oxidative stress and explain how oxidative stress can result in tissue damage and disease.
2. Describe how vitamins C and E act as antioxidants.
3. Explain the relationship between vitamin C and vitamin E in the antioxidant defense network.
4. Explain implications of vitamin C homeostasis on use of oral vitamin C supplements for disease prevention.
5. Describe the functions of vitamin C and provide examples for each function.
6. Provide examples of how scurvy manifests.
7. Discuss why vitamin C supplementation trials utilizing in vitro and animal models may not predict results in humans.
8. Describe the mechanisms of vitamin E absorption and its distribution in the body.
9. Summarize the biological functions of vitamin E.
10. Explain emerging evidence for the importance of different forms of vitamin E.
11. Describe the role of selenium in antioxidant defense.

**Required Reading:**

**Supplemental Reading:**

**Assignments Due:**
1. Weekly Assignment #6 due Friday 10/26/19 @ 9:00am.

---

**Week 9**
Lecture: Vitamin B12 and Folate
Discussion: Folic Acid Fortification of Food

**Learning Objectives:**
1. Differentiate the major food forms of vitamin B12 and folate.
2. Describe the biochemical functions of vitamin B12.
3. Summarize the major risk factors for vitamin B12 deficiency.
4. Explain the basis for the age-related RDA for vitamin B12.
5. Contrast the methods for assessment of vitamin B12 status.
6. Describe the major functions of folate.
7. Contrast the methods for assessment of folate status.
8. Summarize known effects and gaps in knowledge regarding the health benefits and potential harm from folic acid fortification.
9. Explain how deficiencies of folate and vitamin B\(_{12}\) cause the same type of anemia.
10. Explain how supplemental folic acid may mask the effects of the vitamin B_{12} deficiency.

**Required Reading:**

**Assignments Due:**
1. Weekly Assignment #7 due Friday 11/2/18 @ 9:00am.

### Week 10

Lecture: Micronutrients in Energy and Macronutrient Metabolism Part 1: Thiamine; Niacin; Chromium

**Learning Objectives:**
1. Explain how thiamine and niacin functions relate to macronutrient and energy metabolism.
2. Summarize risk factors for, and manifestations of, thiamine deficiency.
4. Explain the proposed mechanism for chromium’s role in insulin action.
5. Describe the dietary and non-dietary pathways of NAD synthesis.
6. Differentiate between non-consumptive and consumptive NAD functions.
7. Discuss the potential role for niacin in prevention of aging and chronic disease.
8. Summarize risk factors for, and manifestations of niacin, deficiency.

**Required Reading:**

**Supplemental Reading:**

**Assignments Due:**
1. Weekly Assignment #8 due Friday 11/9/19 @ 9:00am.
2. Interview Concept Note due Friday 11/9/19 @ 9:00am.

### Week 11: Micronutrients in Energy and Macronutrient Metabolism Part 2: Vitamin B6; Riboflavin; Biotin; Pantothenic Acid

Class Date: November 16th

**Learning Objectives:**
2. Provide examples for the roles of vitamin B6 in intermediary macronutrient metabolism.
3. Propose an explanation for why vitamin B6 is added to products such as energy drinks.
4. Explain riboflavin functions and provide examples.
5. Explain biotin functions and provide examples.
6. Explain pantothenic acid functions and provide examples.

**Required Reading:**

**Supplemental Reading:**

**Assignments Due:**
1. Weekly Assignment #9 due Friday 11/16/19 @ 9:00am
2. Interview Questions due Friday 11/16/19 @ 9:00am.

---

**Week 12**
Nutritional Anemia

**Learning Objectives:**
1. Summarize the general processes that can lead to anemia.
2. Identify the roles of micronutrients in development of anemia.
3. Explain complications of anemia at different life stages.
4. Recognize risk factors for nutritional anemia in diverse populations and scenarios.
5. Discuss interventions for prevention and treatment of nutritional anemia in diverse populations.

**Required Reading:**

**Assignments Due:**
1. Weekly Assignment #10 due Friday 11/30/18 @ 9:00am.

---

**Week 13**
Team-Based Learning: Dietary Supplements and Fortification

1. Describe how dietary supplements are regulated by the FDA.
2. Provide examples from earlier in the course where dietary supplements were demonstrated to be beneficial, were demonstrated to not be beneficial, or may have caused harm.
3. Explain why folic acid was recently approved for fortification of corn flour.
4. Provide arguments for and against use of multivitamins.
5. Discuss demonstrated and proposed benefits of micronutrient supplementation during pregnancy and during adulthood.
6. Contrast biofortification with genetic modification.

**Required Reading:**

**Supplemental Reading:**
Assignments Due:
1. Weekly Assignment #11 due Friday 12/7/19 @ 9:00am.
2. There will be a brief written quiz during class to assess comprehension of the assigned readings for the TBL exercise.