

# **The Neurobiology of Food Intake and Overeating (PSY 333)**

**Disclaimer:** Please note that elements of this syllabus are subject to change at the discretion of the professors. Any changes will be provided to students via email or on the course D2L website.

**Overview:** It is clear that as a species we are experiencing tremendous difficulty in our relationship with food. Food intake can be regulated by precise feeding mechanisms that have evolved allowing for the survival of the human race. However, the environmental conditions our ancestors dealt with differ drastically than those presented in today's society, where obesity and its physical comorbidities (e.g., diabetes, heart disease) continue to place a burden on society in general, and the individual in particular.

**Instructional Objectives:** This undergraduate course will examine the underlying basis of energy (food) intake, its expenditure; learned and unlearned physiological and neurological mechanisms that drive food intake and overeating, and vulnerabilities to obesity. Information will be presented from a range of disciplines including psychology, neuroscience and medicine. The overall goal of the course is to consolidate our understanding of what drives us to eat and why what we eat, and where we eat it is so important. Please be aware that this course deals with a lot of the **biology** underlying how the brain and body influence eating behaviors. If you don't like biology very much, this may not be the course for you.

## **Time and Location:**

10:20-11:40 AM on Tuesday and Thursday throughout Spring Semester 2024 in Natural Sciences Bldg 116.

**\*\*Office hours on Fridays 9:00-10:00 AM\*\*:** <https://msu.zoom.us/j/97759330531>  
Meeting ID: 977 5933 0531. **Passcode:** officehour

## **Instructor and Office Hours**

Dr. Alex Johnson

**Office hours:** Fridays 9-10AM (or by appointment)

**E-mail:** awj@msu.edu

**Graduate TA:** Bing Mo

**Office hours:** Wednesdays 9:00-10:00AM <https://msu.zoom.us/j/94424919406>

**E-mail:** mobingxi@msu.edu

## Top Hat:

We will be using Top Hat Pro ([www.tophat.com](http://www.tophat.com)) for class participation and discussion. You will be able to submit answers to in-class questions using Apple or Android smartphones and tablets, laptops, or through text message. For instructions on how to create a Top Hat account and enrol in our Top Hat Pro course, please refer to the invitation sent to your MSU email address or consult Top Hat's Getting Started Guide (<https://bit.ly/31TGMIw>).

To connect to Top Hat complete the following:

- Go to <https://app.tophat.com/register/student>
- Click "Search by school" and input the name of our school
- Search for our course with the following join code: **256046**

If a paid subscription is required, it will be listed at checkout when you enrol in Top Hat Pro course. Should you require assistance with Top Hat at any time please contact their Support Team directly by way of email ([support@tophat.com](mailto:support@tophat.com)), the in-app support button, or by calling 1-888-663-5491. Specific user information may be required by their technical support team when troubleshooting issues

**Grading:** Grades will be determined from **five** sources:

(i) **Module quizzes** (40%): Three Midterm Exams: These exams will cover material dealt with during lecture periods (lectures, movies, discussion, etc) or contained in the readings. They will be multiple-choice tests delivered via D2L.

(ii) **Class participation** (15%): During each class, students will receive on average four questions based on the material being discussed. Each correct response will be credited and contribute to the grade for class participation.

(iii) **In class symposium** (20%): Towards the end of the semester, there will be an in-class symposium which will include video presentations and topical contemporary questions on the study of obesity and its impact on our society. Discussion points will be based on material being presented and information that will have been previously discussed in class. Grading will be derived from attendance, engagement and contribution to the symposium.

(iv) **Final exam** (20%): There will be a final exam that covers material dealt throughout the semester. It will be the same format as the midterms.

(v) **Class attendance** (5%): Attendance will be monitored throughout the semester; many classes will have overlapping themes, which are designed to help with conceptualizing the topics discussed. Students who attend less than 90% (without genuine mitigating circumstances) of the classes will receive a 5% reduction in their overall grade.

### **Grades will be assigned on the following scale:**

90-100% = 4.0 75-79% = 2.5 60-64% = 1.0

85-89% = 3.5 70-74% = 2.0 < 60% = 0

80-84% = 3.0 65-69% = 1.5

## **Questions, exams and make-up exams**

If you are having difficulty with the material, have questions or other concerns, you may come to office hours or make an appointment. Please reach out with any questions to the TA, Bing Mo: [mobingxi@msu.edu](mailto:mobingxi@msu.edu). Please note that the TA and instructor will endeavor to return e-mails with a 48 hr window.

Make-up exams will **only be given in extreme cases such as**: 1) a documented serious medical or family emergency, or 2) a documented scheduled conflict, such as a religious holiday or required participation in a university-sanctioned event. No makeup exams will be given unless you have a valid, documented excuse (e.g., a note from the dean, a note from your doctor recommending that you not attend class). If you cannot get a note or if your excuse involves something that is personal and that you want to keep private, you must get a note from the Dean. If you cannot take the exam because of a university-scheduled event (e.g., a commitment for a sports team), a religious holiday, or some other acceptable event that you could have been foreseen, you must notify the instructor at least one week before the exam. If you cannot take the exam because of a sudden illness or because of a family emergency, you must notify the instructor **by the end of the day of the exam**. Absence from an exam for any other reason will result in a grade of 0 for that exam.

Given the ongoing pandemic, MSU encourages students who need to quarantine themselves, have been sick with COVID-19 symptoms, tested positive for COVID-19, or have been potentially exposed to someone with COVID-19 to follow CDC guidance to self-isolate or stay home. We will make accommodations for those who must miss an exam due to COVID-19.

There are no make-up exams without a written valid excuse AND permission from the instructor. **Permission must be obtained immediately before or after the missed exam (within 1 day).**

## **Academic Honesty**

Article 2.3.3 of the Academic Freedom Report states that "The student shares with the faculty the responsibility for maintaining the integrity of scholarship, grades, and professional standards." In addition, the Department of Psychology adheres to the policies on academic honesty as specified in General Student Regulations 1.0, *Protection of Scholarship and Grades*; the all-University Policy on *Integrity of Scholarship and Grades*; and Ordinance 17.00, Examinations. (See *Spartan Life: Student Handbook and Resource Guide* (<http://www.vps.msu.edu/SpLife/index.htm>) and/or the MSU Web site: <http://www.msu.edu>). At MSU, General Student Regulation 1.00 states in part that "no student shall claim or submit the academic work of another as one's own." (For the complete regulation, see *Protection of Scholarship and Grades*.) You are expected to

complete all course assignments, including homework, lab work, quizzes, tests and exams, without assistance from any source. You may not assist anyone or be assisted by anyone on an exam, and you may not use the text or any notes during an exam. Your written work must be your own and you are not authorized to use the [www.allmsu.com](http://www.allmsu.com) web site to complete any course work in this course. Any student caught cheating, plagiarizing or otherwise violating the MSU academic integrity policy may receive the maximum punishment, including a grade of 0.0 in the course. This includes using social-media applications or links (e.g., class group chat) to share information that contributes to a student's class grades (including attendance links, exam questions or Tophat questions).

## **Classroom Behavior**

Classes begin on time. Students are expected to put away all distractions before class begins, and turn off cell phones etc. It is not appropriate to answer phone calls or text message during lecture. If you arrive late or leave early, plan to sit near the back and by an aisle to minimize the disruption to others. **Please stop talking to your neighbor during the lecture.** Please respect your instructors and fellow students by turning off electronic communication devices during class. Laptop use is permitted. However, distracting activities such as instant messaging, writing e-mail, social networking, or playing games is **strictly prohibited during class time.** These behaviors are disruptive and are not conducive to the learning process.

## **Accommodations for Disabilities**

Students with disabilities should contact the Resource Center for Persons with Disabilities (RCPD) to establish clear and reasonable accommodations. For an appointment with a counselor, call 353-9642 (voice) or 355-1293 (TTY). If you require testing accommodations as specified from RCPD, contact the instructor with the appropriate paperwork at least one week prior to the exam date.

## **Additional information**

Reading and other material: Relevant manuscripts, commentaries, opinion articles and reviews will be made available electronically (suggested material can be found below). These readings have been purposely chosen due to their relevance to the material discussed in class. During class you will also be shown carefully selected videos on topics relevant to the study of food intake and overeating.

## **Suggested reading material**

### **Module 1 Reading: Taste, flavor and experience**

Scott, K. K. (2005). Taste recognition: food for thought. *Neuron*, 48(3), 455–464.

Brunstrom, J. M., & Mitchell, G. L. (2007). Flavor-nutrient learning in restrained and

unrestrained eaters. *Physiology & Behavior*, 90(1), 133–141.

Berridge, K. C., & Kringelbach, M. L. (2015). Pleasure Systems in the Brain. *Neuron*, 86(3), 646–664.

Teff, K. L., Mattes, R. D., Engelman, K., & Mattern, J. (1993). Cephalic-phase insulin in obese and normal-weight men: relation to postprandial insulin. *Metabolism-Clinical and Experimental*, 42(12), 1600–1608.

### **Module 2 Reading: Traditional Feeding centers**

Balagura & Davenport (1970). Feeding patterns of normal and ventromedial hypothalamic lesioned male and female rats. *Journal of Comparative and Physiological Psychology*. 71(3), 357-364.

Mogenson, G. J., & Stevenson, J. A. F. (1966). Drinking and self-stimulation with electrical stimulation of the lateral hypothalamus. *Physiology & Behavior*, 1(3), 251–IN9.

### **Module 3 Reading: Orexigenic gut peptide—ghrelin**

Ariyasu, H. (2001). Stomach Is a Major Source of Circulating Ghrelin, and Feeding State Determines Plasma Ghrelin-Like Immunoreactivity Levels in Humans. *Diabetes*, 86(10), 4753–4758.

Cummings, D. E., Purnell, J. Q., Frayo, R. S., Schmidova, K., Wisse, B. E., & Weigle, D. S. (2001). A preprandial rise in plasma ghrelin levels suggests a role in meal initiation in humans. *Diabetes*, 50(8), 1714-1719.

### **Module 4 Reading: Anorexigenic gut peptides—insulin and leptin**

Le Roux, C. W., Batterham, R. L., Aylwin, S. J. B., Patterson, M., Borg, C. M., Wynne, K. J. & Bloom, S. R. (2006). Attenuated peptide YY release in obese subjects is associated with reduced satiety. *Endocrinology*, 147(1), 3-8.

Lieverse, R. J., Jansen, J. B., Masclee, A. A., & Lamers, C. B. (1995). Satiety effects of a physiological dose of cholecystokinin in humans. *Gut*, 36(2), 176-179.

Kahn, S. E., Hull, R. L., & Utzschneider, K. M. (2006). Mechanisms linking obesity to insulin resistance and type 2 diabetes. *Nature*, 444(7121), 840–846.

Ruhl et al., (2007). Body mass index and serum leptin concentration independently estimate percentage body fat in older adults. *The American journal of clinical nutrition*, 85(4), 1121-1126.

### **Module 5: Contemporary feeding mechanisms**

Arora, S., Anubhuti. (2006). Role of neuropeptides in appetite regulation and obesity – A review. *Neuropeptides*, 40(6), 375–401.

## **Module 6: Brain reward and stress centers**

Harbuz, M. S., & Lightman, S. L. (1992). Stress and the hypothalamo-pituitary-adrenal axis: acute, chronic and immunological activation. *Journal of Endocrinology*, 134(3), 327-339.

Wyvell, C. L., & Berridge, K. C. (2000). Intra-accumbens amphetamine increases the conditioned incentive salience of sucrose reward: enhancement of reward “wanting” without enhanced “liking” or response reinforcement. *Journal of Neuroscience*, 20(21), 8122-8130.

## **Module 7: Neuropeptide reward and stress feeding**

Malik, S., McGlone, F., Bedrossian, D., & Dagher, A. (2008). Ghrelin Modulates Brain Activity in Areas that Control Appetitive Behavior. *Cell Metabolism*, 7(5), 400–409.

Abizaid, A., Liu, Z.-W., Andrews, Z. B., Shanabrough, M., Borok, E., Elsworth, J. D., et al. (2006). Ghrelin modulates the activity and synaptic input organization of midbrain dopamine neurons while promoting appetite. *Journal of Clinical Investigation*, 116(12), 3229–3239.

Johnson, A. W. (2013). Eating beyond metabolic need: how environmental cues influence feeding behavior. *Trends in Neurosciences*, 36(2), 101-109.

## **Module 8 Reading: Learning, cognition and obesity**

Watson, P., Wiers, R. W., Hommel, B., & De Wit, S. (2014). Working for food you don't desire. Cues interfere with goal-directed food-seeking. *Appetite*, 79, 139-148.

Siegel, S. (1975). Conditioning insulin effects. *Journal of Comparative and Physiological Psychology*, 89(3), 189.

## **Module 9 Reading: Genetics of obesity**

Bouchard, C., Tremblay, A., Després, J.-P., Nadeau, A., Lupien, P. J., Thériault, G., et al. (1990). The Response to Long-Term Overfeeding in Identical Twins. *The New England Journal of Medicine*, 322(21), 1477–1482.

O'Rahilly, S., & Farooqi, I. S. (2006). Genetics of obesity. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 361(1471), 1095–1105.

## **Module 10 Reading: Epigenetics**

Heijmans, B. T., Tobi, E. W., Stein, A. D., Putter, H., Blauw, G. J., Susser, E. S., et al. (2008). Persistent epigenetic differences associated with prenatal exposure to famine in humans. *Proceedings of the National Academy of Sciences*, 105(44), 17046–17049.

## **Module 11 Reading: Obesogenic environment**

M. Ng, T. Fleming, M. Robinson, B. Thomson, N. Graetz, C. Margono, et al., Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the Global Burden of Disease Study 2013, *Lancet* 384 (2014) 766–781.

Drewnowski, A. (2004). Obesity and the food environment. *American Journal of Preventative Medicine*, 27(3), 154–162.

| <b>Week beginning</b> | <b>Course topic(s)</b>  | <b>Activities</b>   |
|-----------------------|---|---|
| <b>1/8/24</b>         | - Class Introduction  | - Module 1 reading material<br><b>- No class 1/9/24</b>   |
| <b>1/15/24</b>        | - Taste cells and receptors<br>- Taste, preferences and aversions               | - Module 1 reading material<br>- Video  |
| <b>1/22/24</b>        | - Taste hedonics and 'liking'<br>- Taste, brain and gut interactions            | - Module 1 reading material   |
| <b>1/29/24</b>        | - Taste, brain and gut interactions<br>- Traditional feeding centers            | - Module 2 reading material   |
| <b>2/5/24</b>         | - Ghrelin: The sole feeding signal in body                                      | - Module 3 reading material<br><b>- Guest lecture, 2/6/24</b><br><b>- Exam 1, Modules 1 &amp; 2, 2/8/24</b> |
| <b>2/12/24</b>        | - Leptin and insulin: Food intake inhibitors                                    | - Module 4 reading material<br><b>- No class, 2/13/24</b>   |
| <b>2/19/24</b>        | - Contemporary feeding mechanisms   | - Module 5 reading material<br><b>- Pre-recorded class, 2/20/24</b>   |
| <b>2/26/24</b>        | - Spring Break  | <b>- No classes</b>   |
| <b>3/4/24</b>         | - Neuropeptide reward and stress-evoked feeding                                 | - Module 6 and 7 reading material   |
| <b>3/11/24</b>        | - Learning and its influence on feeding behaviors                               | - Module 8 reading material<br><b>- Exam 2, Modules 3-6, 3/14/24</b>  |
| <b>3/18/24</b>        | - Cognitive disruptions in obesity<br>- Evolution and heritability              | - Module 8 reading material   |
| <b>3/25/24</b>        | - Evolution and heritability<br>- Genetic polymorphisms and human obesity genes | - Module 9 reading material   |
| <b>4/1/24</b>         | - Epigenetics and obesity<br>- The obesogenic environment                       | - Module 11 reading material  |
| <b>4/8/24</b>         | -The obesity symposium  | - Videos, questions and discussion forum<br><b>- Exam 3, Modules 6-11, 4/11/24</b>                          |
| <b>4/15/24</b>        | - How to treat the obesity epidemic<br>- Review sessions                        |   |
| <b>4/22/24</b>        | - Exam week   | <b>- Final Exam, 4/26/24</b>  |