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 form a range of disciplines including paleontology, 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:

1:00-2:20 PM on Tuesday and Thursday throughout Spring Semester 2025 in Olds Hall Room# 111
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: Hanna Dobson
Office hours: Tuesdays 11AM-12PM: https://msu.zoom.us/j/91043078954
Meeting ID: 910 43078954
E-mail: dobsonh1@msu.edu

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

Top Hat:

We will be using Top Hat Pro (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/31TGMlw).

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: **961487**

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), 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%): Throughout the course of the semester a total of three exams will be delivered. These exams will cover material dealt with during lecture periods (lectures, movies, discussion, etc). These exams will be delivered in class, for dates see class schedule.

(ii) **Class participation** (20%): During each class, students will receive several questions or discussion topics based on the material discussed or class activities. Students will receive half credit for providing a response, and half credit if the response is correct.

(iii) **In class symposium** (15%): Towards the end of the semester, there will be an in-class symposium which may include video presentations, controversial, and 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 proficient 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 module quizzes.

(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.

(vi) **Extra credit** (2%): Throughout the semester, a series of questionnaires will be uploaded onto D2L. The questionnaires will ask for feedback on the topics and material discussed in the previous class modules. Students that provide feedback for all of the questionnaires will receive the extra credit.

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, Hanna Dobson: dobsonh1@msu.edu. Please note that the TA and instructor will endeavor to return e-mails within 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 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).

Please note that any material provided on D2L in this course should not be published elsewhere and disseminated to students that are not part of this class.

The use of generative AI tools (such as ChatGPT, DALL-E, etc.) is not permitted in this class; therefore, any use of AI tools for work in this class may be considered a violation of Michigan State University's policy on academic integrity, the Spartan Code of Honor Academic Pledge and Student Rights and Responsibilities, since the work is not your own. Any student caught using generative AI tools may receive the maximum punishment, including a grade of 0.0 in the course.

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. **Please note that these readings are supplementary to class discussion and may cover topics beyond what is described in the lecture material**

Module 1: The origins of Feeding behavior

Kay, R. F. (1985). Dental evidence for the diet of Australopithecus. Annual Review of Anthropology, 315-341.

An Evolutionary Whodunit: How Did Humans Develop Lactose Tolerance? https://www.npr.org/sections/thesalt/2012/12/27/168144785/an-evolutionary-whodunit-how-did-humans-develop-lactose-tolerance

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.

Module 2: Genes that affect you Jeans

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 3: Epigenetics of ingestive behavior and obesity

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 4: Taste and feeding

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

Module 5: The chemosensation of feeding

Prescott, J. (2012). Chemosensory learning and flavour: Perception, preference and intake. *Physiology & Behavior*, *107*(4), 553-559.

Module 6: The gut-brain axis—the hunger signal 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 7: The gut-brain axis—satiety signals

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.

Module 8: The gut-brain axis—regulators or body fat and glucose

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.

Müller, T. D., Finan, B., Bloom, S. R., D'Alessio, D., Drucker, D. J., Flatt, P. R., ... & Tschöp, M. H. (2019). Glucagon-like peptide 1 (GLP-1). *Molecular metabolism*, *30*, 72-130.

Module 9: The gut-brain axis—the microbiome and feeding

Mathur, R., & Barlow, G. M. (2015). Obesity and the microbiome. *Expert Review of Gastroenterology & Hepatology*, *9*(8), 1087-1099.

Module 10: The history of the brain's feeding and satiety centers

Brobeck, J. R. (1946). Mechanism of the development of obesity in animals with hypothalamic lesions. *Physiological reviews*, *26*(4), 541-559.

Module 11: Cutting-edge science and contemporary feeding mechanisms

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

Beutler, L. R., Corpuz, T. V., Ahn, J. S., Kosar, S., Song, W., Chen, Y., & Knight, Z. A. (2020). Obesity causes selective and long-lasting desensitization of AgRP neurons to dietary fat. *Elife*, *9*, e55909.

Module 12: Hedonic, reward and stress-based feeding

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.

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.

George, S. A., Khan, S., Briggs, H., & Abelson, J. L. (2010). CRH-stimulated cortisol release and food intake in healthy, non-obese adults. Psychoneuroendocrinology, 35(4), 607-612.

Module 13: Understanding the basis of our food-related decisions

Robinson, T. N., Borzekowski, D. L., Matheson, D. M., & Kraemer, H. C. (2007). Effects of fast food branding on young children's taste preferences. *Archives of pediatrics & adolescent medicine*, *161*(8), 792-797.

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

Grabenhorst, F., Rolls, E. T., & Bilderbeck, A. (2008). How cognition modulates affective responses to taste and flavor: top-down influences on the orbitofrontal and pregenual cingulate cortices. Cerebral Cortex, 18(7), 1549-1559.

Module 14: The obesogenic diet and ultra-processed foods

Contreras-Rodriguez, O., Solanas, M., & Escorihuela, R. M. (2022). Dissecting ultra-processed foods and drinks: Do they have a potential to impact the brain?. *Reviews in Endocrine and Metabolic Disorders*, *23*(4), 697-717.

Module 15: The obesogenic environment—the how, what, and where

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.

Module 16: Anti-obesity drugs

Müller, T. D., Blüher, M., Tschöp, M. H., & DiMarchi, R. D. (2022). Anti-obesity drug discovery: advances and challenges. *Nature Reviews Drug Discovery*, *21*(3), 201-223.

Module 17: Exercise, brain and the body

Hillman, C. H., Erickson, K. I., & Kramer, A. F. (2008). Be smart, exercise your heart: exercise effects on brain and cognition. Nature reviews neuroscience, 9(1), 58-65.

Module 18: Food for thought—using allostasis to shape our food-related decisions

Sterling, P. (2012). Allostasis: a model of predictive regulation. Physiology & behavior, 106(1), 5-15.

Class schedule

Week beginning	Course topic(s)	Activities
1/13/25	- Class Introduction - The origins of feeding behavior	- Module 1 reading material
1/20/25	- Genes that affect your Jeans	- Module 2 reading material - Video: Can't stop eating
1/27/25	- Epigenetics of ingestive behavior and obesity	- Module 2 and 3 reading material **- 1/30/25 Quiz 1 (Modules 1-3)**
2/3/25	- Taste and feeding	- Module 4 reading material **- Supertaster activity**
2/10/25	- The chemosensation of feeding	- Module 5 reading material **- 2/13/25 No class**
2/17/25	- The gut-brain axis: The hunger signal ghrelin Satiety signals CCK and PYY	- Module 6 and 7 reading material
2/24/25	-Regulators of body weight and glucose: Leptin and insulin	- 2/25/25 **Quiz 2 (Modules 4-7)** - Module 8 reading material - Video: Leptin video
3/3/25	-Spring Break	**- No classes**
3/10/25	- The microbiome and feeding - The brain and feeding, traditional accounts	- Module 9 and 10 reading material
3/17/25	- The history of the brain's feeding and satiety centers - Cutting-edge science and contemporary feeding mechanisms	- Module 10 and 11 reading material
3/24/25	- Hedonic, reward and stress-based feeding	- Module 12 reading material **- 3/27/25 Quiz 3 (Modules 8-11)**
3/31/25	- Understanding the basis of our food-related decisions - The obesogenic diet and ultra-processed foods	-Module 13 and 14 reading material
4/7/25	- The obesogenic environment—the how, what, and where - Anti-obesity drugs	- Module 15 and 16 reading material
4/14/25	- Exercise, brain and body - Food for thought—using allostasis to shape our food-related decisions	- Module 17 and 18 reading material
4/21/25	- The obesity symposium	**- 4/22/25 Quiz 4 (Modules 12-18)** - Videos, class discussion
4/28/25		**- Final Exam, 4/30/25 @ 10AM**