PSYC 456/556A: Advanced Biological  
Bases of Behavior

Spring 2017

# **Location and Times**

Times: Mondays & Wednesdays, 2:30-3:50

Location: 127 Psychology Building

# **Instructor**

# Matthew McMurray, PhD

# Assistant Professor

# Department of Psychology

Office: Psychology, Room 221

E-mail: matthew.mcmurray@miamioh.edu

# **Instructor Office Hours**

Times: Tuesdays 3-5pm or by appointment

Location: Dr McMurray’s office is located on the second floor of the Psychology Building, Room 221. He maintains an active research laboratory. Therefore, on occasion, his office hours will be held in the Behavioral Neuroscience laboratories (basement of Psychology Building). He will send an email and leave a note on his office door in that case.

Note: Dr McMurray strongly encourages each of you to stop by early and often. Not only will this help you better understand difficult material, but it also lets him get to know you and get feedback on the course during the semester. This is a very large class, so forming a productive relationship with each of you will be challenging. However, he would ideally like to get to know each of you! Please help this happen by coming to his office hours at least once during the semester, but more often if possible.

# **Course Description**

Behavioral Neuroscience (aka biopsychology) represents the merging of Psychology and Biology, driven by our understanding that all behavior is caused by biological processes. Thus, at its core, the field seek to explain complex behaviors by the physiological processes that underlie them, including both healthy and unhealthy behaviors. During the semester, you will gain a significant understanding of the nervous system, how it is organized, and how it works. We will discuss how our bodies are built to receive information from the senses, which convert that information into plans to move our bodies in reaction to those sensations. We will also discuss how the endocrine system, which releases hormones, interacts with the nervous system and influences behavior. Finally, we will consider a biological basis for higher order function (e.g. decision-making, learning, and memory), as well as psychological disorders such as schizophrenia and drug addiction. This course will be organized around instructor led discussions of the processes involved in each topic, followed by group presentations of original research articles that demonstrate and expand upon the topics we discuss, providing students with experience reading and evaluating primary literature in the field, while ensuring a sufficient breadth of content to serve as a foundation for deeper exploration into the field.

# **Learning Outcomes**

1. Describe the locations and primary functions of neural circuits, discrete brain regions, and parts of the neuron.
2. Demonstrate how neurons communicate using electrical and chemical signals.
3. Compare and contrast the roles of various hormonal systems in the regulation of anxiety, sleep, feeding, and sexual behavior.
4. Identify the biological bases of learning and memory, language, and higher order cognitive functions, including neuroanatomical, neurochemical, hormonal, and evolutionary explanations.
5. Describe the biological bases of psychological disorders, in particular mood disorders, addiction, and traumatic brain injury, including neuroanatomical, neurochemical, and genetic explanations. Build on this information to explain current approaches to the treatment of these diseases.
6. Gain experience reading, analyzing, and presenting primary research literature in neurosciences.

# **Required Text**

All required readings will be provided on Canvas, as well as suggested background readings. Additionally, students may find consultation of a textbook helpful, and are thus referred to the below, both of which are available at the library:

* Pinel, JP (2013) Biopsychology, 9th Edition. Upper Saddle River, NJ: Pearson Education, Inc.
  + This is an undergraduate level textbook and will provide a good overview for students that need a refresher on fundamental topics related to the course.
* Kandel, E; Schwartz, J; Jessell, T; Siegelbaum, S; Hudspeth, AJ (2012) Principles of Neural Science, 5th Edition. New York: McGraw-Hill, Health Professions Division.
  + This is a graduate level textbook that focuses on cellular and molecular neuroscience, and will serve as an excellent reference for these topics; however, it is very in depth and may be challenging for students without significant previous coursework in this field.

# **Evaluation**

Participation & Attendance (100pts total): All students are expected to attend every class meeting and come prepared to discuss the day’s topics. Thus, attendance will be collected at the start of every class. 5 points will be deducted from this score for every missed class, and participation points will be awarded at the discretion of the instructors.

Presentations (50pts each): The foundation of this course will be based on readings of the primary literature and its discussion. In groups, students will present research papers and guide their discussion. Assignments of papers will be randomized, but can be traded as groups see fit. More information on these presentations will be discussed in class.

Manuscript Reviews (10pts each): To ensure that all students are adequately prepared to discuss the readings, all students are required to write brief summaries of the articles associated with each week's discussion. For undergraduate students, separate summaries are required for each reading (including background readings and all readings you are not presenting). This summary should contain a review of the justification, methods, results, limitations, implications of each manuscript, and highlight on things learned by reading the article. For graduate students, only one summary is required per week, but it must describe each reading and how they relate to each other, with a heavy focus on the big picture. Undergraduate students are expected to complete a ½ page review for each reading, while graduate students are expected to complete a full page review of the week's readings. More details on these will be provided in class.

Exams (100pts each): There will be 4 semester exams, one for each block of the course (see course schedule below). All exams are essay format. Students will be given one week to complete the exam at home, and will be submitted through canvas. Exams are open-book and open-note; however, students are expected to adhere to Miami’s policies on Academic Misconduct (see below). **No makeup exams will be given without gaining explicit permission from the instructor PRIOR to the exam date**. If you do not contact the instructor ahead of time, and fail to take any exam on the date specified, you will receive a 0 for the exam. Late exam submissions will not be accepted. If class is cancelled during the exam period, the deadline for submission will not be extended. Please bear in mind that normal class sessions will continue during the exam period, including group presentations and manuscript reviews. Thus, students are encourage to plan their schedules accordingly to manage stress levels.

Final Grades: The scores of all score-able course materials will be summed, and then this score will then be divided by the total number of points possible for the semester to generate your final grade. Final grades will be earned according to the standard undergraduate and graduate grade scales.

# **Academic Dishonesty**

Academic Integrity is at the heart of the mission and values of Miami University and is an expectation of all students. As the [Code of Love and Honor](http://www.miamioh.edu/iammiami) states, “We stand for honesty, integrity, and the importance of moral conduct.” This is an expectation for all Miami community members. Maintaining academic integrity is a reflection of your character and a means to ensuring that you are achieving the outcomes of this course and that your grades accurately reflect your learning and understanding of the course material.

Both Miami University and the Psychology department are dedicated to providing a learning environment based not only upon academic excellence, but academic integrity as well. In this course it is expected that you will adhere to all Miami University guidelines regarding academic misconduct. For more information about academic integrity, please review the [Academic Integrity Information Guide](http://miamioh.edu/integrity/student-resources/) and the [Policy](http://blogs.miamioh.edu/miamipolicies/?p=1994).

Academic dishonesty is defined as any activity that compromises the academic integrity of the institution or subverts the educational process. Examples of academic dishonesty include, but are not limited to:

1. Cheating: using or attempting to use or possessing any aid, information, resources, or means in the completion of an academic assignment that are not explicitly permitted by the instructor or providing such assistance to another student.
2. Plagiarism: presenting as one’s own work ideas, representations, or words of another person/source without proper attribution.
3. Fabrication: falsification, invention, or manipulation of any information, citation, data, or method.
4. Unauthorized collaboration: working with another individual or individuals in any phase of or in the completion of an individual academic assignment without explicit permission from the instructor to complete the work in such a manner.
5. Misrepresentation: falsely representing oneself or one’s efforts or abilities in an academic assignment.
6. Gaining an unfair advantage: completing an academic assignment through use of information or means not available to other students or engaging in any activity that interferes with another student’s ability to complete his or her academic work.

Attempts to engage in any of the above actions will be treated the same as completed acts. Any suspected instances of academic dishonesty will be handled under Miami University’s Academic Integrity policy found in [Part 1, Chapter 5 of the Student Handbook](http://blogs.miamioh.edu/miamipolicies/?p=1994). Please review this policy, and note that lack of knowledge or understanding of the appropriate academic conduct is not an excuse for committing academic dishonesty. Students who are found responsible for committing academic dishonesty will receive a sanction that ranges from a zero on the assignment to an F in the course, which could also include the AD transcript notation. Students who commit academic dishonesty twice will automatically be suspended from Miami. If you have questions about how to complete an assignment or what could constitute academic dishonesty for a particular assignment, please feel free to visit Dr McMurray during office hours. Dr McMurray also encourages you to meet with him if you suspect that another student in the course has engaged in academic misconduct.

# **Attendance Policy**

To succeed in this class, you must attend all class meetings and read the assigned material. You will be tested on instructor led discussions as well as information from the assigned readings. Instructor led discussions will lay the foundation upon which the readings will be based, and will be supplemented by review papers when available, to serve as additional resources for student learning. If you must miss class for any reason, it is your responsibility to find out what you missed from a classmate. The instructor will not review the material that you missed in class. Additionally, you are responsible for all announcements made during class meetings, whether you are present or not (e.g. changes to syllabus, exam dates, or assignments).

# **Students with Disabilities**

Miami University is committed to maintaining a barrier-free environment so that individuals with disabilities can fully access programs, courses, services, and activities. Students with disabilities who require accommodations for full access and participation in the course must be registered with Student Disability Services. Accommodations are available for students who have disabilities; however, accommodations can only be granted if requested through Student Disability Services (SDS). If you choose to disclose your disability to the instructor to receive accommodations, SDS will provide you with a letter to present to the instructor. This letter will confirm that you are registered with SDS and will list reasonable accommodations recommended by SDS. You should plan to meet with the instructor during office hours ASAP to discuss the accommodations and make sure a plan is in place. Please notify the instructor during the first week of class if you need any accommodation for the course, or immediately after a diagnosis has been made during the semester, so that the expectations for all parties are clear. It is YOUR responsibility to initiate this process.

# **Other Important Notes**

The instructor will make every effort to post materials (e.g. powerpoint slides, supplemental readings, etc) on Canvas prior to each class meeting. However, there is no guarantee that they will be posted in time for you to print them out ahead of time. Additionally, the instructor reserves the right to make changes to materials at any time, including after the content has been discussed in class. This allows for materials to be updated based on the amount of material covered, and helps the instructor remember the topics you have struggled with, so they know how better to present them in future semesters. Therefore, when studying, you are encouraged to use the most up to date versions of each material. When new versions are posted, an announcement will be made on Canvas.

Cell phone use during class is prohibited. Students may be asked to leave if disruptions persist. Please put your phones into airplane mode before entering the classroom.

Communicating professionally (via email or otherwise) is one of the most important skills to develop in modern society. The instructor expects you to use the same respect in email or online that you would in the classroom (e.g., addressing emails to Dr. McMurray or Professor McMurray, saying “please” and “thank you”, etc). The instructor also expects that you will consult this syllabus and the Canvas site for announcements *before*emailing. Canvas will be used to make important announcements about the course. You should therefore check this important communication channel at least daily. If you decide to email an instructor, and your email is justified, the instructor will usually respond by the end of the next business day; however, because complex questions are often difficult to answer succinctly over email, don’t be alarmed if we suggest that you ask a question in class or in office hours. Additionally, we may suggest this if we get the same question from multiple students. Instructors will not respond to email received after 9pm until the following morning, and longer delays may occur on weekends.

# **Course Schedule (subject to change):**

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| **Block** | **Week** | **Topic** |
| **Foundations of biopsychology** | 1 | BIO101 Review and neuroanatomy |
| 2 | Neural Processing and electrical signaling |
| 3 | Neurotransmitters, receptors, and pharmacology |
| 4 | Neurodevelopment across the lifespan |
| **Fundamental cognition** | 5 | Neuroplasticity of sensory processing |
| 6 | Motivation and appetite |
| 7 | Learning and memory I |
| 8 | Learning and memory II |
| **Higher order function** | 9 | Social behavior I |
| 10 | Social Behavior II |
| 11 | Emotion and stress |
| 12 | Decision-making |
| **Dysfunction** | 13 | Motor disorders and addictions presentations |
| 14 | Psychosis and neurodegenerative disorders presentations |
| 15 | Anxiety and depression presentations |

**Reading List**

Bulleted references are background reading, while numbered references will be discussed in class, with the number of the reading matching the number of the group presenting.

Biology 101

* Squire L (2009) The Legacy of Patient H.M. for Neuroscience. Neuron 61(1): 6–9.
* Hyman SE (1999) Introduction to the complex genetics of mental disorders. Biological Psychiatry 45(5): 518-21.
* Tsankova N, Renthal W, Kumar A, Nestler EJ (2007) Epigenetic regulation in psychiatric disorders. Nature Reviews Neuroscience 8(5):355-67.
* Kim JS (2016) Genome editing comes of age. Nature Protocols 11(9): 1573-8.

Neural Processing and Electrical Signaling

* Barnett MW, Larkman PM (2007) The action potential. Practical Neurology 7(3) 192-7.

Neurotransmitters, Receptors, and Pharmacology

* Sudhof TC (2008) Neurotransmitter release. Handbook of Experimental Pharmacology 184: 1-21.

Neurodevelopment

* Anderson DJ (2001) Stem cells and pattern formation in the nervous system: the possible versus the actual. Neuron 30: 19-35.
* Bale TL, Baram TZ, Brown AS, Goldstein JM, Insel TR, McCarthy MM, Nemeroff CB, Reyes TM, Simerly RB, Susser ES, Nestler EJ (2010) Early life programming and neurodevelopmental disorders. Biological Psychiatry 68:314–319.

1. Eriksson PS, Perfilieva E, Björk-Eriksson T, Alborn AM, Nordborg C, Peterson DA, Gage FH (1998) Neurogenesis in the adult human hippocampus. Nature Medicine 4(11): 1313-7. (Instructor Presenting)

Neuroplasticity of Sensory Processing

* Hubel DH (1982) Exploration of the primary visual cortex, 1955-78. Nature 299(5883): 515-24.

1. Sharma J, Angelucci A, Sur M (2000) Induction of visual orientation modules in auditory cortex. Nature 404(6780): 841-7.
2. von Melchner L, Pallas SL, Sur M (2000) Visual behaviour mediated by retinal projections directed to the auditory pathway. Nature 404(6780): 871-6.

Motivation and Appetite

* Wise RA (2004) Dopamine, learning and motivation. Nature Reviews Neuroscience 5: 483-494.
* Sohn JW (2015) Network of hypothalamic neurons that control appetite. BMB Reports 48(4): 229-33.

1. Day JJ, Roitman MF, Wightman RM, Carelli RM (2007) Associative learning mediates dynamic shifts in dopamine signaling in the nucleus accumbens. Nature Neuroscience 10(8):1020-8.
2. Egecioglu E, Prieto-Garcia L, Studer E, Westberg L, Jerlhag E (2016) The role of ghrelin signaling for sexual behaviour in male mice. Addiction Biology 21(2): 348-59.

Learning and Memory

* Fernández RS, Boccia MM, Pedreira ME (2016) The fate of memory: Reconsolidation and the case of Prediction Error. Neuroscience and Biobehavioral Reviews 68:423-41.

1. Reijmers LG, Perkins BL, Matsuo N, Mayford M (2007) Localization of a stable neural correlate of associative memory. Science 317(5842): 1230-3.
2. Liu X, Ramirez S, Pang PT, Puryear CB, Govindarajan A, Deisseroth K, Tonegawa S. (2012) Optogenetic stimulation of a hippocampal engram activates fear memory recall. Nature 484(7394): 381-5.
3. Ramirez S, Liu X, Lin PA, Suh J, Pignatelli M, Redondo RL, Ryan TJ, Tonegawa S (2013) Creating a false memory in the hippocampus. Science 341(6144): 387-91.
4. Deadwyler SA, Berger TW, Sweatt AJ, Song D, Chan RH, Opris I, Gerhardt GA, Marmarelis VZ, Hampson RE (2013) Donor/recipient enhancement of memory in rat hippocampus. Frontiers in Systems Neuroscience 7: 120.

Social Behavior

* Allen LS, Hines M, Shryne JE, Gorski RA (1989) Two sexually dimorphic cell groups in the human brain. Journal of Neuroscience 9(2): 497-506.

1. Nugent BM, Wright CL, Shetty AC, Hodes GE, Lenz KM, Mahurkar A, Russo SJ, Devine SE, McCarthy MM. (2015) Brain feminization requires active repression of masculinization via DNA methylation. Nature Neuroscience 18(5): 690-7.
2. Itoh Y, Mackie R, Kampf K, Domadia S, Brown JD, O'Neill R, Arnold AP (2015) Four core genotypes mouse model: localization of the Sry transgene and bioassay for testicular hormone levels. BMC Research Notes 8(69).

* Storm EE, Tecott LH (2005) Social circuits: peptidergic regulation of mammalian social behavior. Neuron 47(4): 483-6.
* McCall C, Singer T (2012) The animal and human neuroendocrinology of social cognition, motivation and behavior. Nature Neuroscience 15: 681–8.

1. Insel TR, Shapiro LE (1992) Oxytocin receptor distribution reflects social organization in monogamous and polygamous voles. PNAS 89: 5981-5.
2. Baumgartner T, Heinrichs M, Volanthen A, Fischbacker U, Fehr E (2008) Oxytocin shapes the neural circuitry of trust and trust adaptation in humans. Neuron 58: 639-50.

Emotion and Stress

* Dalgleish T (2004) The emotional brain. Nat Rev Neurosci. 2004 Jul;5(7):583-9.
* Glaser R, Kiecolt-Glaser JK (2005) Stress-induced immune dysfunction: implications for health. Nature Reviews Immunology 5(3):243-51.

1. Whitney MS, Shemery AM, Yaw AM, Donovan LJ, Glass JD, Deneris ES (2016) Adult brain serotonin deficiency causes hyperactivity, circadian disruption, and elimination of siestas. Journal of Neuroscience 36(38): 9828-9842.
2. McGowan PO, Sasaki A, D'Alessio AC, Dymov S, Labonté B, Szyf M, Turecki G, Meaney MJ (2009) Epigenetic regulation of the glucocorticoid receptor in human brain associates with childhood abuse. Nature Neuroscience 12(3): 342-8.

Decision Making

* Pearson JM, Watson KK, Platt ML (2014) Decision making: the neuroethological turn. Neuron. 2014 Jun 4;82(5):950-65.
* Macpherson T, Morita M, Hikida T (2014) Striatal direct and indirect pathways control decision-making behavior. Frontiers in Psychology 5:1301.

1. Koenigs M, Young L, Adolphs R, Tranel D, Cushman F, Hauser M, Damasio A (2007) Damage to the prefrontal cortex increases utilitarian moral judgements. Nature 446(7138): 908-11.
2. Zalocusky KA, Ramakrishnan C, Lerner TN, Davidson TJ, Knutson B, Deisseroth K (2016) Nucleus accumbens D2R cells signal prior outcomes and control risky decision-making. Nature 531: 642–6. (Instructor Presenting)

Animal Models of Psychiatric Illness

* Nestler EJ, Hyman SE (2010) Animal models of neuropsychiatric disorders. Nature Neuroscience 13(10):1161-9.

Alzheimer’s Disease

* Masters CL, Bateman R, Blennow K, Rowe CC, Sperling RA, Cummings JL (2015) Alzheimer's disease. Nature Reviews Disease Primers 1: 15056.

1. Kunz L, Schröder TN, Lee H, Montag C, Lachmann B, Sariyska R, Reuter M, Stirnberg R, Stöcker T, Messing-Floeter PC, Fell J, Doeller CF, Axmacher N (2015) Reduced grid-cell-like representations in adults at genetic risk for Alzheimer's disease. Science 350(6259): 430-3.

Anxiety / PTSD

* Bas-Hoogendam JM, Blackford JU, Brühl AB, Blair KS, van der Wee NJ, Westenberg PM (2016) Neurobiological candidate endophenotypes of social anxiety disorder. Neuroscience and Biobehavioral Reviews 71:362-378.

1. Doehrmann O, Ghosh SS, Polli FE, Reynolds GO, Horn F, Keshavan A, Triantafyllou C, Saygin ZM, Whitfield-Gabrieli S, Hofmann SG, Pollack M, Gabrieli JD (2013) Predicting treatment response in social anxiety disorder from functional magnetic resonance imaging. JAMA Psychiatry 70(1): 87-97.

Addictions

* Koob GF, Volkow ND (2016) Neurobiology of addiction: a neurocircuitry analysis. Lancet Psychiatry 3(8): 760-73.

1. Yip SW, Worhunsky PD, Xu J, Morie KP, Constable RT, Malison RT, Carroll KM, Potenza MN (2017) Gray-matter relationships to diagnostic and transdiagnostic features of drug and behavioral addictions. Addiction Biology [Epub ahead of print].

Schizophrenia

* Kahn RS, Sommer IE, Murray RM, Meyer-Lindenberg A, Weinberger DR, Cannon TD, O'Donovan M, Correll CU, Kane JM, van Os J, Insel TR (2015) Schizophrenia. Nature Reviews Disease Primers 1: 15067.

1. Ford JM, Palzes VA, Roach BJ, Potkin SG, van Erp TG, Turner JA, Mueller BA, Calhoun VD, Voyvodic J, Belger A, Bustillo J, Vaidya JG, Preda A, McEwen SC, Functional Imaging Biomedical Informatics Research Network, Mathalon DH (2015) Visual hallucinations are associated with hyperconnectivity between the amygdala and visual cortex in people with a diagnosis of schizophrenia. Schizophrenia Bulletin 41(1): 223-32.

Depression

* Otte C, Gold SM, Penninx BW, Pariante CM, Etkin A, Fava M, Mohr DC, Schatzberg AF (2016) Major depressive disorder. Nature Reviews Disease Primers 2: 16065.

1. Delgado PL, Price LH, Miller HL, Salomon RM, Aghajanian GK, Heninger GR, Charney DS (1994) Serotonin and the neurobiology of depression. Effects of tryptophan depletion in drug-free depressed patients. Archives of General Psychiatry 51(11): 865-874.

Motor disorders

* Poewe W, Seppi K, Tanner CM, Halliday GM, Brundin P, Volkmann J, Schrag AE, Lang AE (2017) Parkinson Disease. Nature Reviews Disease Primers 3: 17013.

1. di Val Cervo PR, Romanov RA, Spigolon G, Masini D, Martín-Montañez E, Toledo EM, La Manno G, Feyder M, Pifl C, Ng YH, Sánchez SP, Linnarsson S, Wernig M, Harkany T, Fisone G, Arenas E. (2017) Induction of functional dopamine neurons from human astrocytes in vitro and mouse astrocytes in a Parkinson's disease model. Nature Biotechnology [Epub ahead of print].