



UNIVERSITY OF  
SOUTH DAKOTA

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## Behavioral Neuroscience

BIOL 432 3 credits Spring 2023

room UCL 154

Meeting Time and Location: TTh 12:00-11:50 PM

Office hours: Open (afternoons are preferred)

Course Description: BIOL 432: An advanced course on integrative neuroscience, focusing on the neurocircuitry, neurotransmitters and modulators, and neuroendocrine actions necessary to produce behavior or environmentally relevant neural function. This course will include description of the integrative mechanisms that produce circadian rhythms, neuroendocrine reflex, sexual behavior, addiction, anxiety, learning, aggression, depression and social hierarchy.

Course Prerequisites: one of the following: BIOL 430 Neurobiology, BIOL 428 Comparative Physiology, BIOL 456 Mammalian Physiology, BIOC 430 Biochemistry, BIOL 426 Endocrinology - All prerequisites must have a grade of C or better

### 2023 Lectures in Behavioral Neuroscience ↓↓

<u>TAIL/GILL/SIPHON REFLEXES IN THE SEA HARE, <i>Aplysia</i></u>		
Jan 10, 12	<u>Defensive Behaviors in <i>Aplysia</i></u>	<u>Species / Behavior Figures</u>
Jan 12, 17	<u>Fundamentals of Neurocircuitry</u>	<u>circuit diagrams</u>
Jan 12	<u>Sensory Stimulation of Siphon Withdrawal</u>	<u>circuit diagrams</u>
Jan 21, 24	<u>Glutamate (Glu): Excitatory Transmission</u>	<u>Glutamate Figures</u>
Jan 24, 26	<u>Motor output driving Siphon Withdrawal</u>	<u>circuit diagrams</u>
Jan 26	<u>Acetylcholine (ACh)</u>	<u>ACh Figures</u>
Jan 26, 31	<u>Gating</u>	<u>circuit diagrams</u>
Feb 2	<u>Serotonin (5-HT): Neuromodulation</u>	<u>5-HT Figures</u>
Feb 7, 9, 14	<u>Classical Conditioning and Long-Term Memory</u>	<u>circuit diagrams</u>

<u>YAWNING</u>		
Feb 14	<u>Yawning Behavior</u>	<u>Yawning Figures</u>



Feb 14	<a href="#">Evolution of/Purpose for Yawning</a>	<a href="#">Yawning Figures</a>
Feb 16, 21	<a href="#">Sensory Afferents to Yawn</a>	<a href="#">Yawning Circuitry</a>
	<a href="#">Glutamate (Glu): Excitatory Transmission</a>	<a href="#">Glutamate Figures</a>
Feb 21, 23	<a href="#">Gating the Yawn</a>	<a href="#">Yawning Circuitry</a>
Feb 23	<a href="#">Norepinephrine (NE)</a>	<a href="#">NE Figures</a>
Feb 28	<a href="#">Oxytocin (OT)</a>	<a href="#">OT Figures</a>
Feb 28, Mar 2	<a href="#">ACTH &amp; <math>\alpha</math>MSH</a>	<a href="#">ACTH &amp; <math>\alpha</math>MSH Figures</a>
Mar 2, 7	<a href="#">Regulating Yawn Gating</a>	<a href="#">Yawning Circuitry</a>
Mar 7, 9	<a href="#">Efferent Yawn Output</a>	<a href="#">Yawning Circuitry</a>
	<a href="#">Acetylcholine (ACh)</a>	<a href="#">ACh Figures</a>
Mar 9, 21, 23	<a href="#">Neuromuscular Production of Yawns</a>	
Mar 23, 28	<a href="#">Integration of Yawn Circuitry and Behavior</a>	<a href="#">Yawning Circuitry</a>

<a href="#">FEAR CONDITIONING</a>		
March 28, Apr 4	<a href="#">Fear and Fear Behaviors</a>	<a href="#">examples</a>
Apr 4, 6	<a href="#">Afferent Pathways (CS) for Fear Association Learning</a>	<a href="#">circuitry</a>
Apr 11, 13	<a href="#">Amygdala</a>	<a href="#">Amygdalar circuitry</a>
Apr 13, 18	<a href="#">Fear Conditioning</a>	<a href="#">circuitry</a>
Apr 18	<a href="#">BDNF</a>	<a href="#">Amygdalar circuitry</a>
Apr 20	<a href="#">Afferent Shock (US) Pathway</a>	<a href="#">afferent shock circuitry</a>
Apr 25	<a href="#">Substance P</a>	<a href="#">SP figs</a>
Apr 25	<a href="#">Efferent Output</a>	<a href="#">circuitry</a>



	<a href="#">Acetylcholine (ACh)</a>	<a href="#">ACh figs</a>
Apr 27	<a href="#">Neuromuscular Production of Fear Potentiated Startle</a>	<a href="#">circuitry</a>
Apr 27	<a href="#">Integrated Behavior: Fear Conditioned Startle</a>	<a href="#">Fear circuitry</a>

Course Requirements: 3 drawings of complete neurocircuitry must be made

These include one each for:

1. Simple Behavioral Circuitry
2. Moderately Complex Behavioral Circuitry
3. Complex Behavioral Circuitry

Each drawing must include:

### Drawing a Neural Circuit

#### 1. Cells

- a. Neurons must look like neurons
  - i. contain soma, axon, and bouton (terminal)
  - ii. round soma
    - 1) large enough to show 2<sup>nd</sup> messengers
    - 2) large enough to depict molecular mechanisms (DNA + gene expression)
    - 3) scale is not important for drawings
    - 4) dendrites are optional
      - a) but sometimes necessary
  - iii. long axon
    - 1) with some internal space
  - iv. roughly triangular, **directional** bouton/terminal/synapse
    - 1) large enough to show presynaptic molecular mechanisms
    - 2) include tripartite elements (astrocytes) at least once
- b. Astrocytes should look like stars
- c. other cells should appear as they do in life (round, cuboidal etc)

#### 2. Brain regions

- a. Brain regions contain
  - i. nuclei and neuropil
- b. nuclei contain cell bodies
  - i. axons project to other nuclei or brain regions
    - 1) projection axons
    - 2) and connect to neurons in those brain regions
    - 3) synapses in neuropil is optional for drawings
      - a) but sometimes necessary
  - ii. axons of interneurons or local neurons
    - 1) stay within a nucleus or brain region
    - 2) synapses of interneurons are also local
- c. brain regions or nuclei must be drawn as entities that contain neurons
  - i. a single neuron may not be used to represent a nucleus
  - ii. a single neuron may not be used to represent a brain region

#### 3. Neural Circuits

- a. contain at least 3 kinds of neurons
  - i. sensory neurons
    - 1) usually afferent

- a) toward the central nervous system (CNS)
  - ii. gating or integrating neurons
  - iii. motor neurons
    - 1) usually efferent
      - a) away from the CNS
  - b. the smallest circuit is 3 neurons
    - i. each of your drawings will have many more than 3
    - ii. must complete the entire circuit
  - c. neurons within the circuit must actually connect
    - i. ie. they must have synapses
    - ii. never draw a neuron that has no synapse
  - d. use natural anatomy to orient your drawings
    - i. but don't let scale limit the most important elements
    - ii. scale is not required or useful!
5. Rules for your drawing
- a. must be on a single 8.5 X 11" sheet of white paper
  - b. put your name on somewhere
  - c. no figure legends
  - d. everything must be labeled
    - i. but NO other text
  - e. no expanded views or blow-ups
6. Purpose of the drawing
- a. when you are finished you should have a visual representation of the machinery necessary to drive a particular behavior
  - b. from this drawing the behavior should be instantly recognizable to anyone with a knowledge of neurocircuitry and behavior

**Course Goals:** To produce integrative knowledge of the neuroanatomy, integrated neurocircuitry, neurochemistry, cell signaling, molecular biology, and behavioral consequences of 3 unique behaviors. This will include behaviors and circuits that are easy to understand (Simple Circuitry), moderately difficult to understand (Moderately Complex Behavioral Circuitry), and very difficult to understand (Complex Behavioral Circuitry)

**Student Learning Outcomes:** The students learn integrative neuroscience.

1. To integrate information from lectures on sensory neurons, sensory receptor organs, Gating or integrative neurons, Motor neurons, neuromuscular junctions, synapses, neurotransmitters, transmitter receptor systems, 2<sup>nd</sup> messengers, appropriate DNA – promoters, transcription factors, and genes, and molecular mechanisms that promote changes in behavior and learning
2. To use that integrated information to produce a visual representation of the information
3. To use that information to discuss specific matters of neural function, molecular function, behavior, and learning

**Evaluation Procedures:** Each drawing will be graded based on a rubric that includes detailed analysis of

1. Sensory neurons, sensory receptor organs, synapses, neurotransmitters, transmitter receptor systems, 2<sup>nd</sup> messengers, appropriate DNA – promoters, transcription factors, and genes, and molecular mechanisms that promote changes in behavior an learning
2. Gating or integrative neurons, synapses, neurotransmitters, transmitter receptor systems, 2<sup>nd</sup> messengers, appropriate DNA – promoters, transcription factors, and genes, and molecular mechanisms that promote changes in behavior an learning



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3. Motor neurons, neuromuscular junctions, neurotransmitters, transmitter receptor systems, 2<sup>nd</sup> messengers, appropriate DNA – promoters, transcription factors, and genes, and muscle systems that create changes in behavior

Each drawing is worth 100 points

The average of 3 drawings is your final score:

90% or greater = A
80 – 89% = B
70 – 79% = C
60 – 69% = D
Below 60% = F

### **Academic Integrity**

The College of Arts and Sciences considers plagiarism, cheating, and other forms of academic dishonesty inimical to the objectives of higher education. The College supports the imposition of penalties on students who engage in academic dishonesty, as defined in the “Conduct” section of the University of South Dakota Student Handbook.

No credit can be given for a dishonest assignment. A student found to have engaged in any form of academic dishonesty may, at the discretion of the instructor, be:

- a. Given a zero for that assignment.
- b. Allowed to rewrite and resubmit the assignment for credit.
- c. Assigned a reduced grade for the course.
- d. Dropped from the course.
- e. Failed in the course.

### **Freedom in Learning**

Under Board of Regents and University policy, student academic performance may be evaluated solely on an academic basis, not on opinions or conduct in matters unrelated to academic standards. Students should be free to take reasoned exception to the data or views offered in any course of study and to reserve judgment about matters of opinion, but they are responsible for learning the content of any course of study for which they are enrolled. Students who believe that an academic evaluation reflects prejudiced or capricious consideration of student opinions or conduct unrelated to academic standards should contact the dean of the college or school that offers the class to initiate a review of the evaluation.

### **Disability Accommodation**

Any student who feels s/he may need academic accommodations or access accommodations based on the impact of a documented disability should contact and register with Disability Services during the first week of class or as soon as possible after the diagnosis of a disability. Disability Services is the official office to assist students through the process of disability verification and coordination of appropriate and reasonable accommodations. Students currently registered with Disability Services must obtain a new accommodation memo each semester.

Please note: if your home institution is not the University of South Dakota but one of the other South Dakota Board of Regents institutions (e.g., SDSU, SDSMT, BHSU, NSU, DSU), you should work with the



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disability services coordinator at your home institution.

Disability Services, The Commons Room 116

(605) 658-3745

Web Site: [www.usd.edu/ds](http://www.usd.edu/ds)

Email: [disabilityservices@usd.edu](mailto:disabilityservices@usd.edu)

### **Accessibility Statement**

The University of South Dakota strives to ensure that physical resources, as well as information and communication technologies, are accessible to users in order to provide equal access to all. If you encounter any accessibility issues, you are encouraged to immediately contact the instructor of the course and the Office of Disability Services, which will work to resolve the issue as quickly as possible.

### **Concern/Complaint Resolution Process**

To resolve any concerns, complaints, or questions regarding a course experience, the student should initially attempt addressing issues of concern directly to the instructor or the appropriate decision maker as defined by the chart appended to the university's [academic appeal form](#). Together the student and the instructor should establish a timetable for resolving the issues of concern. If a student feels the conflict has not been resolved, the student should communicate this concern to the chair of the department offering the course. If questions or concerns remain, or if the instructor is the department chair, the student may contact the dean's office for the college or school in which the course is offered.

Contact information for questions or concerns:

Department Chair: Dr. Jacob Kerby Department Chair

Dean or Associate Dean: Dr. Jessica J. Messersmith [jessica.messersmith@usd.edu](mailto:jessica.messersmith@usd.edu)

### **Grade Appeal**

Under Board of Regents ([Student Appeals for Academic Affairs Policy 2:9](#)) and University policy ([Student Academic Appeals](#)), students have the right to appeal such matters as course grades and dismissal from a program. Students wishing to appeal an academic decision must use the appropriate [appeal form](#). The form should be used only if informal discussion with the academic decision-maker does not produce a satisfactory resolution and the student wishes to pursue the matter further. Appeals must be initiated by the student through discussion with the individual responsible for the decision (i.e., the academic decision-maker/instructor) to question the decision and explain the basis for doing so. The student must have this discussion within 30 calendar days of being notified of the decision that is being appealed. If notification occurs within 15 calendar days before the end of a term, the discussion must occur at the latest within 15 calendar days of the start of the next term. If a student wishes to pursue the appeal following the discussion with the academic decision-maker, they should complete Step 2 of the [appeal form](#) and submit within 5 working days of the discussion a signed copy to the mediator designated on the form.

### **Diversity and Inclusive Excellence**

The University of South Dakota strives to foster a globally inclusive learning environment where opportunities are provided for diversity to be recognized and respected. To learn more about USD's diversity and inclusiveness initiatives, please visit the website for the Office of Diversity.



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### **COVID-19 Statement**

Mitigating the spread of COVID-19 is everyone's responsibility. In order to ensure the health and safety of each individual student and our overall campus community, we ask you to monitor your health daily and abide by the following protocols: If you are exposed to COVID-19 or develop COVID-19 symptoms, you are expected to immediately communicate this to [covid19@usd.edu](mailto:covid19@usd.edu). You may also report to the Dean of Students at [deanofstudents@usd.edu](mailto:deanofstudents@usd.edu). In either case, the Dean of Students office will communicate with all instructors and provide appropriate University communication to impacted parties while also preserving student privacy about any medical condition. If you miss class due to medical reasons, please also inform your instructor in a timely fashion. Students who have been asked to quarantine cannot attend classes in person and should ask instructors if there is an option to participate remotely. Instructors will work with students to determine whether remote participation, an incomplete grade, or withdrawal is most appropriate. Thank you for following these important measures to keep our community healthy and safe. For the latest guidance, please check USD's [COVID-19 web site](#).

### **Statement on Recording of Lectures by Students**

Lectures, presentations, and other course materials are protected intellectual property under South Dakota Board of Regents Policy. Accordingly, recording and disseminating lectures, presentations or course materials is strictly prohibited without the express permission of the faculty member or as the result of an approved disability accommodation through Disability Services. Violation of this prohibition may result in the student being subject to Student Conduct proceedings under SDBOR Policy 3:4.