UNIVERSITY OF SOUTH DAKOTA

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UNIVERSITY OF SOUTH DAKOTA

Behavioral Neuroscience

BIOL 732 3 credits
Spring 2022

Office hours: Open (afternoons are preferred)

Course Description: BIOL 732: Based on the original research literature, this advanced course on integrative neuroscience focuses on the neurocircuitry, neurotransmitters and modulators, and neuroendocrine actions necessary to produce behavior or environmentally relevant neural function. Includes description of the integrative mechanisms that produce circadian rhythms, neuroendocrine reflex, sexual behavior, addiction, anxiety, learning, aggression, depression, social hierarchy, and other behaviors. Collecting and integrating information to describe a specific behavior is also required.

2022 Lectures in Behavioral Neuroscience ⇓

C R A Y F I S H E S C A P E		
Jan 10	Crayfish Ecology and Behavior	Crayfish examples
Jan 12	Crayfish Neuroanatomy	Crayfish Anatomy
Jan 14, 19, 21	Fundamentals of Neurocircuitry	Crayfish Anatomy
Jan 21, 24	Sensory Afferent input for Tail Flip	Crayfish Circuitry
Jan 28	Acetylcholine ACh	ACh figs
Jan 28, 31	Gating the Full Flip	Crayfish Circuitry
Jan 31, Feb 2	Gating the Tail Flip for Upward Thrust	Crayfish Circuitry
Feb 2, 4	GABA	GABA figures
Feb 4	Parallel Gating of Crayfish Escape	Crayfish Circuitry
Feb 7, 9	Motor Neurons and the Crayfish tail-flip Escape	Crayfish Circuitry
Feb 9	Serotonin = 5-HT	5-HT figures
Feb 9, 11, 14	INTEGRATION: Crayfish Tail-Flip Escape	Crayfish Circuitry

E Y E B L I N K C O N D I T I O N I N G I N TURTLES		
Feb 16	Eye Blink Behavior in *Chrysemys*	Turtles and Ecology
Feb 16	Afferent Path in Turtles	circuitry
Feb 16, 23	Glutamate (Glu): Excitatory Transmission	Glutamate Figures
Feb 23	Turtle Eyeblink Efferent Motor Output	Eyblink circuitry

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	Acetylcholine (ACh)	ACh Figures
Feb 23	Neuromuscular Function	
Feb 23, 25, 28	Brain Derived Neurotrophic Factor (BDNF)	BDNF Figures
Feb 28, Mar 2, 4	*In vitro* Classical Conditioning of Eyeblink Reflex in Turtles	*In vitro* circuit diagrams

F E A R C O N D I T I O N I N G		
Mar 7, 9	Fear and Fear Behaviors	examples
Mar 9, 11, 21, 23	Afferent Pathways (CS) for Fear Association Learning	circuitry
Mar 23, 25, 28	Amygdala	Amygdalar circuitry
Mar 28, 30 Apr 1	Fear Conditioning	circuitry
Apr 4, 6	BDNF	Amygdalar circuitry
Apr 8	Afferent Shock (US) Pathway	afferent shock circuitry
Apr 11	Substance P	SP figs
Apr 13	Efferent Output	circuitry
	Acetylcholine (ACh)	ACh figs
Apr 20	Neuromuscular Production of Fear Potentiated Startle	circuitry
Apr 22-29	Integrated Behavior: Fear Conditioned Startle	Fear circuitry

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 2nd 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). The graduate students also collect original research literature on a new, distinctive behavior, and create several lectures to describe the circuitry and neurochemistry of this new behavior.

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, 2nd 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
4. To use these new skills to create lectures on a new behavior

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, 2nd 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, 2nd messengers, appropriate DNA – promoters, transcription factors, and genes, and molecular mechanisms that promote changes in behavior an learning
3. Motor neurons, neuromuscular junctions, neurotransmitters, transmitter receptor systems, 2nd 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 disability services coordinator at your home institution.

Disability Services, The Commons Room 116
(605) 658-3745
Web Site: www.usd.edu/ds
Email: 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.

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.

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. You may also report to the Dean of Students at 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.