UNIVERSITY OF SOUTH DAKOTA

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# Behavioral Neuroscience

BIOL 432 3 credits
Spring 2020

Meeting Time and Location: 12:00-12:50 PM room UCL 154
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

## 2020 Lectures in Behavioral Neuroscience ⇓

| HONEY BEE CONDITIONED DRINKING | | |
|---|---|---|
| January 13 - 15 | Honey Bee Ecology and Behavior | Species / Behavior Figures |
| January 22 - 24 | Honey Bee Neuroanatomy | Honey Bee Neuroanatomy |
| January 24, 27, 31 | Fundamentals of Neurocircuitry | |
| Jan 31 - Feb 3 | Sensory Afferent input for Proboscis Extension | Honey Bee Neurocircuitry |
| February 3 | Acetylcholine (ACh) | Honey Bee Neurocircuitry |
| February 5 | Octopamine (OA) | Honey Bee Neurocircuitry |
| February 7 | Gating Proboscis Extension | Honey Bee Neurocircuitry |
| February 7, 10, 12 | Learning What to Drink | Honey Bee Neurocircuitry |
| February 12 | Conditioned Proboscis Extenstion | Honey Bee Neurocircuitry |
| February 14 | Motor Neuron output for Proboscis Extension | Honey Bee Neurocircuitry |
| February 19 | Integration: Honey Bee Conditioned Drinking | Honey Bee Neurocircuitry |

| EYEBLINK CONDITIONING IN TURTLES | | |
|---|---|---|
| Feb 21 | Eye Blink Behavior in *Chrysemys* | Turtles and Ecology |

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| | | |
|---|---|---|
| Feb 24, 26 | Afferent Path in Turtles | circuitry |
| Feb 26, 28 | Glutamate (Glu): Excitatory Transmission | Glutamate Figures |
| Feb 28 - Mar 2 | Turtle Eyeblink Efferent Motor Output | Eyblink circuitry |
| | Acetylcholine (ACh) | ACh Figures |
| Mar 2, 4 | Neuromuscular Function | |
| Mar 4, 6, 16 | Brain Derived Neurotrophic Factor (BDNF) | BDNF Figures |
| Mar 18, 20 | *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 | | |
|---|---|---|
| March 23, 25 | Fear and Fear Behaviors | examples |
| March 27, 30 | Afferent Pathways (CS) for Fear Association Learning | circuitry |
| April 1, 3 | Amygdala | Amygdalar circuitry |
| Apr 6, 8, 13 | Fear Conditioning | circuitry |
| Apr 13, 15 | BDNF | Amygdalar circuitry |
| Apr 17 | Afferent Shock (US) Pathway | afferent shock circuitry |
| Apr 13 | Substance P | SP figs |
| Apr 15 | Efferent Output | circuitry |
| | Acetylcholine (ACh) | ACh figs |
| Apr 17 | Neuromuscular Production of Fear Potentiated Startle | circuitry |
| Apr 20 - May 1 | 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:

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# 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!

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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 a 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$^{nd}$ 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$^{nd}$ 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$^{nd}$ 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, 2$^{nd}$ 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**

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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
Service Center North, R119B
(605) 677-6389
Web Site: www.usd.edu/ds
E-mail: disabilityservices@usd.edu

**Diversity and Inclusive Excellence**

The University of South Dakota strives to foster a globally inclusive learning environment where

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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.