

Neuroscience Honors

Course Description

This full year course offers an accelerated and in-depth survey of the human brain and nervous system. Students gain a broad understanding of major concepts in Neuroscience and Biopsychology, and they develop quantitative, analytical, and laboratory skills as well as the ability to communicate scientific findings clearly. Principles learned include anatomy & physiology, brain mapping, neurotransmitter/ hormones & drugs, disease & disorders, vision, motor system, sensory system, learning and memory, sleep, emotions, homeostasis, rhythms & drives, and altered states of consciousness. The Honors Neuroscience course teaches and reinforces skills and dispositions aligned with the **Portrait of the Crusader**, including thinking critically about information presented and solving problems through innovation. Laboratory investigations and in-class activities promote fostering relationships, collaboration, team work, and respect for other students' ideas

Essential Questions

- How are cellular and gross anatomy related to body function in the nervous system?
- What are the brain/ body connections needed to maintain homeostasis in the human body?
- How do neurons communicate? Contrast neurotransmitters with organization and function.
- How does the nervous system function in achieving homeostasis?
- How are organisms structured to ensure efficiency and survival?
- How has technology helped to increase our knowledge of neuroscience?

Curriculum Framework

Q1, Unit 1- The History of Neuroscience

Focus Questions

- What are neuroscience, biopsychology, behaviorism, and psychology?
- What are the divisions of neuroscience?
- What are the major contributions of scientists from the origins of neuroscience?
- How does neuroscience utilize the scientific method?

Concepts and Skills

- Compare and contrast the divisions of neuroscience.
- Analyze the six divisions of neuroscience.
- Explore the historical ideas of philosophers, scientists, and physicians as they analyzed the malfunctioning brain.
- Discuss and respond to the story of Jimmie G.
- Explain the differences between clinical and experimental neuroscience.

Laboratory

- The Phineas Gage Experiment

Assessments

- Written Assessment focused on the terminology, concepts and skills learned in the unit.
- Written laboratory report based on the Phineas Gage Experiment.

Q1, Unit 2: Anatomy of the Neuron and Brain Mapping

Focus Questions

- What are the essential components and functions of a neuron?
- What is the function of myelin and what role does it play in neural transmission?
- What are the essential named areas of the brain and what are their functions?
- Differentiate between the Central Nervous System and the Peripheral Nervous System
- What is the anatomy of the spine and what role does it play in human function.
- What are the functions of the four different types of Glia cells?

Concepts and Skills

- Identify and explain the anatomy and function of the five major classes of neurons.
- Determine how basic functions of the brain connect to human homeostasis.
- Explain the role of the five sections of the human spinal cord, including the role in reflexes.
- Differentiate between white and grey matter and explain myelinated origin disorders.
- Organize the hierarchy of the Peripheral Nervous System and demonstrate a thorough knowledge of the Autonomic, Somatic, Sympathetic, and Parasympathetic Nervous Systems.
- Describe the role of “Critical End” in Central Nervous System cells.
- Analyze the roles of the four major glia cells in maintaining a homeostatic environment for the neuron.
- Investigate the causes, symptoms, and treatments of specific disorders and/or diseases associated with the nervous system.

Laboratory

- Anatomy of the Neuron

Assessments:

- Written assessments focused on terminology, concepts and modeling taught in the unit.
- Written laboratory report based on the anatomy of the neuron.
- Disease and Disorder Project

Q2, Unit 3: Neural Transmission and Diseases of the Nervous System

Focus Questions

- What are the major steps to a neuron sending a transmission?
- What are the roles of dendrites, axons, and synapse during a nerve impulse?
- How does the myelin sheath affect nerve conduction?
- What are the differences between an excitatory and inhibitory impulse?
- What are the roles of Thresholds in a nerve impulse?
- What are the roles executed in a synapse?
- What are the three ways a nerve conserves neurotransmitter during an impulse?
- How does Resting Potential affect the flow of ions during an impulse?

Concepts and Skills

- Analyze and explain how a nerve impulse is generated, maintained, and distributed to target areas of the body.
- Contrast IPSP and EPSP while applying resting potentials.
- Describe the management of cellular laws including concentration gradient and electrostatic pressure.
- Analyze the relationship between the synapse and the three types of neurotransmitter conservation.
- Discuss the conduction velocity characteristics myelin can provide to a nerve cell.

Laboratories

- Nerve Conduction Lab
- Lights, Camera, Action Potential Lab

Assessments:

- Written laboratory reports
- Written assessment focused on terminology, concepts and modeling taught in the unit.
- Disease and Disorder Presentation

Q2, Unit 4: Neurotransmitters, Hormones, and Drugs

Focus Questions

- What are the major classifications of Neurotransmitters?
- How do neurotransmitters function in the nervous system and at target cells?
- What are the major functions or behaviors caused by neurotransmitters and hormones?
- What are the major categories of drugs?
- What role do drugs have on human behaviors?
- How do drugs affect neurotransmitters and hormones?

Concepts and Skills

- Analyze and explain the role of protein in the formation of neurotransmitters and hormones.
- Describe how the nervous system utilizes neurotransmitters to communicate excitatory or inhibitory messages.
- Explain how brain anatomy and nervous system organization require neurotransmitters and hormones to function based on biofeedback.
- Analyze the major processes involved in a drugs response in the body, including behaviors caused by individual neurotransmitters.
- Determine the connections between drugs and brain physiology, including short and long term consequences of drug use.

Laboratory

- Electrical stimulation lab

Assessments:

- Written laboratory report
- Written assessment focused on terminology, concepts and modeling taught in the unit.
- Neurotransmitter Disorder Presentation

Q3, Unit 5: Vision

Focus Questions

- What are the major steps to a neuron sending a transmission?
- How is light energy transferred into a neural impulse?
- How does the brain process light energy?
- What are the functions of the Corpus Callosum and Optic Chiasm?
- What are the roles of the Occipital Lobe related to vision?

Concepts and Skills

- Analyze and explain/model the functions of the eye and roles of the retina.
- Describe how light waves relate to color as perceived by the brain, and analyze why specific animals have greater or lesser light sensitivity.
- Analyze brain processes from the filtration of light energy to perception and application.
- Describe the survival value of vision and compare it to case studies with loss of vision.

Laboratories

- Sheep's eye dissection
- Color blindness lab

Assessments:

- Written laboratory reports
- Written assessment focused on terminology, concepts and modeling taught in the unit.

Q3, Unit 6: Sensorimotor System

Focus Questions

- What are the relationships between afferent and efferent pathways in the nervous system related to kinesthetics?
- What are the roles of the filters and premotor and motor regions of the brain?
- What are gross and fine motor skills and where is the circuitry involved in generating a motor response?
- How does temperature, pressure, and sound cause the human nervous system to respond?
- What is the role of the cerebellum related to motor skills?

- How does pain affect individuals? What are the genetic or developmental links related to pain perception?
- What is a reflex and how does it differ from afferent/efferent information?

Concepts and Skills

- Analyze the circuitry involved in afferent and efferent pathways and discuss local circuitry as related to motion and sensory perception.
- Discuss the roles of the superior colliculi, frontal lobe, temporal lobe as related to motion.
- Analyze the anatomy and physiology of the neuron and discuss the function of circuitry related to sensory and motor responses.
- Differentiate between conscious motor skills and sub/unconscious motor responses related to brain function.
- Understand the role of reflexes and how each reflex provides a survival value.

Laboratories

- Electrical Muscular Stimulation Lab
- Reflex Lab

Assessments:

- Written laboratory reports
- Written assessment focused on terminology, concepts and modeling taught in the unit.

Q3, Unit 7: Memory System

Focus Questions

- What are neurological memories and how are they made?
- What are the modes of memories?
- What are the roles of the hippocampus when making memories?
- How are long term memories made different from short term memories?
- Where in the brain are memories stored?

Concepts and Skills

- Define and contrast Working Memory, Short Term Memory, and Long Term Memory.
- Understand the brain map and circuitry related to each of the modes of memory.
- Compare and contrast memories made in conjunction with the limbic system and memories made without influence of emotions.
- Connect brain anatomy and physiology with Long Term Memory capacity.

Laboratories

- Neuroscience Memory (Spatial Working Memory)

Assessments:

- Written laboratory report focused on spatial working memory
- Written assessment focused on terminology, concepts and modeling taught in the unit.

Q4, Unit 8: Cranial Nerves

Focus Questions

- What is the role of each cranial nerve?
- How are the cranial nerves different from CNS or PNS nerves?
- How do certain cranial nerves provide survival values for respiration?

Concepts and Skills

- Describe the role of the 12 cranial nerves.
- List an acronym related to cranial nerves.
- Discuss the role of the Vagus Nerve as related to life function.
- Compare and contrast Bell's Palsy and cranial nerve function.
- Use Christopher Reeves as a case study to understand how cranial nerve function can maintain life when the primary plan is disrupted.

Laboratories

- Sheep's Brain Dissection

Assessments:

- Written laboratory reports
- Written assessment focused on terminology, concepts and modeling taught in the unit.

Q4, Unit 9: Sleep, Dreaming and Circadian Rhythms

Focus Questions

- Do humans require sleep for survival?
- What is the difference between awake and asleep in the nervous system?
- What are the benefits of sleeping?
- What are the main benefits of dreaming? What do symbols mean within a dream?
- What is Jet Lag and How does it affect the nervous system?
- What is the neurological sleep-wake cycle and how does it affect energy systems and overall brain function?

Concepts and Skills

- Analyze the process and function of sleep; determine how sleep dysfunction affects health.
- Explain the human Circadian Rhythm
- Describe the phases of sleep including dreaming.
- Apply positive habits to sleep and recognize resulting personal changes in behavior or mood.
- Recognize the signs and symptoms of sleep deprivation.

Assessments:

- Powerpoint presentation on specific sleep dysfunctions
- Written assessment focused on terminology, concepts and modeling taught in the unit.

Resources

- *Biopsychology, 10th Edition*, Pinel & Barnes
- Current articles related to topics studied
- Websites accessed during research

Grading Policy

- Tests: 35 - 50 %
- Quizzes: 15 - 20%
- Labs: 15 - 20 %
- Classwork: 15 - 25 %
- Student Preparation: 15 - 25%