

Advanced Level Neuroscience Syllabus

Course Description:

This full year course presents an in-depth survey of the human brain and nervous system. Students will gain a broad understanding of major concepts in Neuroscience and Biopsychology, learn quantitative, analytical, and laboratory skills, and develop the ability to communicate scientific findings clearly. Principles learned will 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. This 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 student's ideas

Course 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? How do neurotransmitters contrast 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

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 origins of philosophers, scientists, and physicians when dealing with the malfunctioning brain.
- Analyze and discuss the story of Jimmie G.
- Identify the differences between clinical and experimental neuroscience.

Laboratory:

- The Phineas Gage Experiment

Assessments:

- Written Assessment (unit test) focused on the terminology, concepts and skills of the unit.
- Written laboratory report based on the Phineas Gage Experiment.

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.
- Analyze basic functions of the brain in relation to human homeostasis.
- Explain the role of the five sections of the human spinal cord and the role in reflexes.
- Differentiate between white and grey matter and define myelinated origin disorders.
- Organize the hierarchy of the Peripheral Nervous System including 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/Project:

- Anatomy of the Neuron
- Disease and Disorders Project

Assessments:

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

Unit 3: Neural Transmission

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 that a nerve conserves a neurotransmitter during an impulse?
- How does Resting Potential affect the flow of ions during an impulse?

Concepts and Skills:

- Conceptualize and explain the way 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 (unit test) focused on terminology, concepts and modeling taught in the unit.

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:

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

Laboratories:

- Electrical stimulation lab
- Neurotransmitter Disorder Presentation

Assessments:

- Written laboratory reports
- Written assessment (unit test) focused on terminology, concepts and modeling of the unit.
- Cooperative presentation

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:

- Understand and explain/model the functions of the eye and roles of the retina.
- Describe the reception of light waves as they relate to color perceived by the brain and differentiate between animals with greater and lesser light sensitivity.
- Analyze the role of brain processing 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 (unit test) focused on terminology, concepts and modeling taught in the unit.

Unit 6: Sensorimotor System

Focus Questions:

- What are the relationships between afferent and efferent pathways in the nervous system related to kinesthetics?
- Describe 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.
- Utilize the anatomy and physiology of the neuron to 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.
- Explain 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 (unit test) focused on terminology, concepts and modeling taught in the unit.

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:

- Differentiate between Working Memory, Short Term Memory, and Long Term Memories.
- 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 reports
- Written assessment (unit test) focused on terminology, concepts and modeling of the unit.

Unit 8: Cranial Nerves

Focus Questions:

- How are the cranial nerves different from CNS or PNS nerves?
- How do certain cranial nerves provide survival values for respiration?

Concepts and Skills:

- List an acronym related to cranial nerves. List and describe the role of the 12 cranial nerves.
- Discuss the role of the Vagus Nerve 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 (unit test) focused on terminology, concepts and modeling taught in the unit.

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:

- Describe and relate how sleep functions in the nervous system and how sleep dysfunction negatively affects human health.
- Understand human Circadian Rhythm
- Describe the phases of sleep including dreaming.
- Apply positive habits to sleep and recognize personal changes in behavior or mood.
- Recognize the signs and symptoms of sleep deprivation.

Assessments:

- Powerpoint presentation on defined sleep dysfunctions
- Written assessment (unit test) focused on terminology, concepts and modeling of 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 %