American College of Osteopathic Surgeons
Neurological Surgery: Neurosciences

Development of professional collaboration is an important component of surgical training. When considering the broad realm of patient care, both within and outside the operating room, the surgeon must understand and be able to use specific concepts and skills related to neurosciences and specialties including anatomy, neurology, pathology, pharmacology, physiology, radiation physiology, and radiology.

Integration of the neurosciences and associated specialties by the neurosurgery resident into all aspects of practice will enhance his or her ability to appropriately diagnose, organize a management plan, perform necessary surgical procedures, and care for the postoperative surgical patient in the short and long term. Neurosurgery residents learn neuroscience concepts and skills on all clinical rotations and in didactic settings. Knowledge and skills are assessed informally and on a daily basis by faculty and attending surgeons as well as formally. Since these neurosciences and associated specialties are part of a core curriculum related to each and every principal surgical area, they are grouped together and not repeated in separate surgical areas.

American College of Osteopathic Surgeons
Neurological Surgery Residency

Neurosciences:
Neuroanatomy

Developed by:
Steve Schneider, M.D.
Stephen J. Eichert, D.O., FACOS

Resident Competencies
- Osteopathic Principles and Practices
- Patient Care
- Medical Knowledge
- Practice-Based Learning and Improvement
- Interpersonal and Communication Skills
- Professionalism
- Systems-Based Practice

Prerequisites
Prior to entering a neurological surgery residency, the resident should:
- Understand the organization and development of the nervous system
- Understand the anatomic structures, their connections and relationship to function within the nervous system

Learning Outcomes
Upon completion of the neurosurgery residency, the resident will:
- Understand the anatomy that is pertinent to the diagnosis of diseases of the nervous system and the practice of neurological surgery
- Understand clinical syndromes as a correlate to neuroanatomy

Phase I: Performance Indicators	Phase II: Performance Indicators
Cognitive <u>Embryology</u> Analyze the embryological development of the brain, cerebellum, brain stem, glial elements, spinal cord, conus medullaris, cauda equina, sympathetic and parasympathetic systems and the peripheral nervous system Analyze the embryologic development of the skull, craniovertebral junction, and spine <u>Histology</u> Describe and differentiate the types of neurons Understand the microanatomy of the neuron including the cell body, dendritic process and axonal process Diagram and describe the microanatomy of the synapse Identify the microglial elements and their microanatomy Describe the anatomical basis for the blood brain barrier <u>Vascular Anatomy</u> Diagram and describe the carotid and vertebral arteries and their branches which provide blood supply to the face, scalp, skull, meninges, brain, brain stem, cerebellum, and rostral spinal cord Describe the arterial blood supply to the spinal cord including the spinal and radicular arteries and explain the concept of watershed ischemia Identify the venous drainage of the central nervous system <u>Osseous Anatomy</u> Identify the bones and sutures of the skull Identify each named foramen of the skull and list its contents <u>Extracerebral Anatomy</u> Describe the anatomy of the meninges including the dura mater, arachnoid mater, pia mater Describe the anatomy of the dura including the falx cerebri and tentorium	**Cognitive** Discuss the clinical presentation in anatomical terms of syndromes of the brain and its coverings Discuss the syndromes produced by mass lesions affecting the cranial nerves Predict the expected effects of stroke or mass lesion at different locations within the brain stem and cerebellum Predict the expected effects of destructive lesions in the basal ganglia and cerebellum Predict the expected effects of ischemic or destructive lesions of the white matter tracts of the cerebellum Predict the expected effect of destructive lesions of specific regions of the cerebral cortex Recognize the clinical presentation of strokes in the distribution of the supratentorial cerebral blood vessels Describe the relationship of the spinal nerves to the vertebral level of exit Diagram the structures comprising the boundaries of the spinal neural foramina Recognize the clinical manifestation of injury for each of the major peripheral nerves Describe the anatomy and presentation of common entrapment syndromes of peripheral nerves Describe the surgical exposure of common peripheral nerve entrapments Recognize the clinical presentation and neurological deficits associated with common lesions of and injuries to the spinal cord and nerve roots

Identify the layers of the scalp and discuss scalp innervation Diagram the cerebral ventricles Describe the major arachnoid cisterns and the anatomy of the arachnoid villi Analyze the anatomic correlates pertinent to the production, flow, and reabsorption of cerebrospinal fluid <u>Spinal Anatomy</u> Identify and describe the gross anatomy of the spine Identify the muscles related to the skull and spine including suboccipital, anterior cervical, and posterior cervical Describe the gross anatomy of the neck <u>Central Nervous System</u> Describe the anatomy of cerebrum, cerebellum, olfactory pathways, hippocampal formation, and amygdala Describe the anatomy of the corpus striatum Describe the anatomy of the hypothalmus and pituitary Describe the anatomy of the diencephalons and mesencephalon Identify the location and connections of each cranial nerve nuclei Trace the course of each cranial nerve from nucleus to end organ termination. Describe the external topography and landmarks of the fourth ventricle Describe the anatomy of the brain stem including pons and medulla Describe the anatomy of the spinal cord <u>Autonomic Nervous System</u> Distinguish pre- and postganglionic neurons Describe the sympathetic nervous system and the	**Technical** Identify at the time of surgery structures visible in the lateral ventricles and understand the flow of cerebrospinal fluid (CSF) through: • Foramen of Monro • Fornix • Caudate • Thalamus • Choroidal fissure • Named veins • Glomus of choroid plexus • Hippocampus

parasympathetic nervous system Identify the visceral afferent fibers Describe the structure of the autonomic ganglia and the central autonomic pathways <u>Peripheral Nervous System</u> Differentiate between segmental and peripheral innervation Diagram the anatomy of the spinal nerve root Diagram and discuss the cervical, brachial, and lumbosacral plexi Outline the anatomy of the major peripheral nerves of the upper and lower extremities Describe the microanatomy of the peripheral nerves Compare myelinated and unmyelinated nerves Describe the anatomy of the Schwann cell Identify the peripheral afferent receptors and describe the anatomy of each Segregate peripheral neurons by size and explain the rationale for such a classification scheme <u>Muscle</u> Explain the concept of the motor unit and describe the anatomy of the motor end plate Compare the microscopic anatomy of striated and smooth muscle Describe the subcellular components of muscle	Identify the parts of the vertebral column, spinal cord, and nerve roots at the time of surgery Identify at the time of surgery: • Occipital artery • Superficial temporal artery • Frontalis muscle • Pterion • Inion • Asterion • Coronal suture • Sagittal suture • Middle meningeal artery • Sagittal sinus • Transverse sinus • Foramen rotundum • Foramen ovale • Foramen spinosum • Superior orbital fissure • Jugular foramen • Internal auditory canal • Superior sagittal sinus • Sigmoid sinus • Incisura • Each cranial nerve • Each named cerebral artery and vein • Components of the brain stem • Named structures on the floor of the fourth ventricle • Foramina of Magendie and Luschka • Cerebral peduncles • Components of the cerebellum • Cerebellar tonsils • Brachium cerebelli • Vermis • Major supratentorial gyri • Supratentorial lobes • Sylvian fissure • Central sulcus

Adapted from the American Association of Neurological Surgeons/Congress of Neurological Surgeons Neurosurgery Residency Curriculum Guide

Learning Experiences (list titles of teaching conferences, labs, procedure workshops, etc.)

Resident Assessment
Written exams and slide/photograph identifications
Quarterly evaluations, case review, focused chart review, lecture attendance
Oral boards
Written boards
Annual In-service exams

Resources

American College of Osteopathic Surgeons
Neurological Surgery Residency

Neurosciences:
Neurology

Developed by:
Stephen E. Eichert, D.O., FACOS; Dan Miulli, D.O., FACOS; Javed Siddiqi, HBSc, M.D., Ph.D., FRCSC

Resident Competencies
- Osteopathic Principles and Practices
- Patient Care
- Medical Knowledge
- Practice-Based Learning and Improvement
- Interpersonal and Communication Skills
- Professionalism
- Systems-Based Practice

Prerequisites
Prior to entering a neurological surgery residency, the resident should:
- Understand localization within the central and peripheral nervous systems
- Perform a basic neurological exam
- Recognize the major categories of neurology disease: infections, neoplastic, traumatic, degenerative and developmental
- Recognize major congenital malfunctions and the cause of hydrocephalous
- Recognize the major categories of headaches and epilepsy
- Understand the causes of stupor and coma
- Distinguish metabolic from structural presentation of coma

Learning Outcomes
Upon completion of the neurosurgery residency the resident will:
- Understand the anatomy, physiology and pathology of the nervous system
- Describe the etiology and pathogenesis of cerebrovascular disease
- Integrate the neurological examination with laboratory, physiologic and radiographic studies to precisely locate lesions within the nervous system
- Form specific treatment plans and accurate prognoses based on localization, pathophysiology and naturalization of a neurological disorder occurring in any specific patient

Phase I: Performance Indicators	Phase II: Performance Indicators
Cognitive Stroke Understand and recognize the major causes of stroke Compare the differences between hemorrhage infraction and primary hemorrhage Identify the appropriate diagnostic studies to support the clinical impression of stroke Select the appropriate therapeutic maneuvers for effecting treatment of stroke in individual patients and categories of patients Educate patients and families about the risks of recurrences and appropriate prophylactic measures Localize affected area based on clinical presentation Describe the etiology, pathogenesis, clinical presentation, radiologic evaluation, clinical evaluation, and management of the following: • Transient ischemic attacks • Cerebral infarction • Cerebral and cerebellar hemorrhage • Subarachnoid hemorrhage • Venous infarction Identify the primary causes of stroke in the pediatric population Meningitis and Encephalitis Recognize bacterial and viral meningitis Order appropriate laboratory and diagnostic studies in patients with meningitis Appropriately use antibiotics in meningitis Describe the clinical manifestations of viral encephalitis Define the major viral causes of encephalitis Describe the major magnetic resonance imaging (MRI) and computerized tomography (CT) findings in encephalitis	**Cognitive** Oncology Recognize the clinical presentation of patients with mass lesions including intraaxial supratentorial, extraaxial supratentorial, intraaxial intracerebellar, extraaxial intratentorial, intraaxial brain stem Develop a differential diagnosis based on location of the lesion, patient age, and associated medical condition Explain the role of corticosteroids in patients with cerebral and spinal cord masses Define the cerebrocutaneous syndrome and their neoplastic accompaniments: • Neurofibromatosis I and II • Tuberous sclerosis • Von Hippel-Lindau Syndrome • Sturge-Weber Syndrome Explain the major sources of metastatic carcinoma to the brain Identify and describe the clinical manifestations and laboratory investigations of the remote effects of cancer: • Eaton-Lambert Syndrome • Cerebellar degeneration • Polyneuropathies • Limbic encephalitis • Marantic endocarditis Acquired Immune Deficiency Syndrome (AIDS) Understand the manifestations of AIDS encephalopathy Establish the differential diagnosis and understand the respective radiologic presentation of mass lesions in patients with AIDS Describe the pathology and the clinical picture of AIDS myelopathy Identify the clinical indicators for nerve biopsy

Define the electro encephalogram (EEG) findings peculiar to herpes encephalitic and Jacob–Kreatzfold disease

Describe the clinical presentation of polioencephalomyelitis

Disorders of CSF:
Describe the diagnosis and management of pseudotumor cerebri

Describe the diagnosis and management of normal pressure hydrocephalus

Cerebral & Epidural Abscess
Define the routes of infection including direct extensions, post traumatic, and hematogenous

Explain the expectations of organisms including bacterial, fungal, and parasitic

Use the indictions for surgical interevention

Prescribe appropriate antibiotics

Explain paradoxic embolization in the context of cerebral abscess and hematogenous dissemination

Define neurosarcoidosis and its systemic accompaniments

Explain the expected clinical presentation, diagnostic adjuncts and prognosis of neurosarcoidosis

Trauma
Compare concussive cerebral injuries from classic concussion to diffuse axonal injury (DAI)

Explain the expected radiographic findings in concussion and DAI

Plan treatment in concussion and DAI

Describe the anatomic considerations, the clinical presentation, and treatment for epidural hematoma and acute subdural hematoma

Explain the role of secondary injury following acute head injury including anoxia, ischemia, metabolic insult

in patients with AIDS

Major Disorders
Categorize, define, and explain the clinical presentation and the pathophysiology of the major degenerative disorders

Define the clinical presentations, relevant diagnostic studies, the therapeutic measures, and prognostic indicators in the major autoimmune disorders of the nervous system:

Understand the various movement disorders and their associated clinical manifestations

Recognize the major peripheral neuropathies in clinical practice

Analyze the role of alcohol in disease of the nervous system
- Wernicke's Encephalophy
- Korsakoff's Psychosis
- Central Pontine Myelinolysis
- Alcoholic Peripheral Neuropathy
- Delirium Tremens

Understand the pathophysiology, clinical presentation, diagnosis, treatment, and prognosis various muscular disorders

Distinguish the major cerebral degenerative disorders of childhood

Describe the neurological manifestations of each of the major storage disorders

Define the major categories of headache, their presentation, relevant diagnostic studies and treatment
- Tension
- Cluster
- Migraine
- Analgesic Rebound
- Post-cerebral Hemorrhage
- Cerebral Neoplasm

Define the major categories of epilepsy, their presentation and treatment as well as relevant diagnostic studies

Compare cerebral contusion and delayed cerebral parenchymal hemorrhage based on their clinical and radiographic presentations; plan treatment for both Define the anatomic considerations, the clinical and radiographic appearance, and treatment for chronic subdural hematoma Identify the cause of subdural hematoma and rate of reoccurrence Explain Kernohan's Notch Counsel families of patients about treatment and prognoses in acute head injury <u>Spine Trauma</u> Use a directed neurologic examination for patients with acute and subacute spine trauma Compare acute injury clinical presentations including spinal shock, Brown-Sequard Syndrome, central cord syndrome, and cauda equina syndrome Identify the spinal level of injury based on physical examination Distinguish between acute polyneuropathyies and myelopathy <u>Diagnostic Testing and Monitoring</u> Understand the indications, pathologic changes, how test is performed, diagnostic use of the following: • Electroencephalography • sensory evoked potential testing (SEP) • visual evoked potential testing (VEP) • motor evoked potential testing (MEP) • electromyographic testing (EMG) • nerve conduction velocity testing (NCV) **Technical** Perform lumbar puncture and differentiate among viral meningitis, bacterial meningitis, and encephalitis based on the result of the lumbar puncture	Define status epilepticus, its causes, pathophysiology, clinical presentation, diagnostic studies and treatment <u>Delirium and Dementia</u> Define delirium and dementia. List the differential diagnoses for each Describe coma and altered states of consciousness and measure patient status using the Glasgow Coma Scale Evaluate a patient with syncope

Learning Experiences (list titles of teaching conferences, labs, procedure workshops, etc.)

Resident Assessment
Written exams and slide/photograph identifications
Quarterly evaluations, case review, focused chart review, lecture attendance
Oral boards
Written boards
Annual In-service exams

Resources

American College of Osteopathic Surgeons
Neurological Surgery Residency

Neurosciences:
Neuropathology

Developed by:
Stephen E. Eichert, D.O., FACOS; Dan Miulli, D.O., FACOS; Javed Siddiqi, HBSc, M.D., Ph.D., FRCSC

Resident Competencies
- Osteopathic Principles and Practices
- Patient Care
- Medical Knowledge
- Practice-Based Learning and Improvement
- Interpersonal and Communication Skills
- Professionalism
- Systems-Based Practice

Prerequisites
Prior to entering neurological surgery residency, the resident should:
- Recognize the correlation between neurological structure and function
- Analyze the variability of the effects on neurological function related to anatomic localization of the disease
- Understand how the nervous system responds to insult based on:
  - fixed size of space enclosing the central nervous system
  - limited mobility of the nervous system within that space
  - immobility of the dura and dural folds
  - uniformity of structural change and progression of most serious (biologic behavior)
- Recognize the major cytological components of the central and peripheral nervous system
- Analyze the blood brain barrier, its components and areas where it is defective
- Compare cytotoxic and cacogenic edema
- Understand the Monro-Kellie Doctrine

Learning Outcomes
Upon completion of a neurological surgery residency, the resident will:
- Compare relevant chromatic, chemical and immune-peroxides for specific tissues and disease processes
- Correlate gross and histologic specimens to the pathologic process
- Correlate the chemical laboratory and radiologic data with the underlying pathologic process in individual patients
- Explain the pathophysiology as it relates to the specific neurological clinical situations

Phase I: Performance Indicators

Cognitive

Understand CSF physiology as it relates to communicating hydrocephalus, non-communicating hydrocephalus, benign intracranial hypertension, and cerebral herniation

Compare intracranial pressure volume relationships in the context of trauma, intracerebral and subarachnoid hemorrhage, cerebral neoplasm, and cerebral herniation

Explain cerebral blood flow (CBF) in trauma, cerebral herniation, cerebral hemorrhage, and ischemic cerebral vascular disease & subarachnoid hemorrhage

Compare the effects of ischemia, hypoxemia, trauma, cerebral hemorrhage and tumors on cerebral autoregulation

Describe the effect of seizures on cerebral blood flow and cerebral autoregulation

Explain fluid and electrolyte disorders as they relate to central nervous system disorders including syndrome of inappropriate antidiuretic hormone secretion (SIADH), diabetes insidious, and cerebral salt wasting

Describe the major developmental anomalies, their recognition, origin and treatment

- Chairi Malformations
- Anencephaly
- Arachnoids Cysts
- Dandy Walker Syndrome
- Down's Syndrome
- Spinal Dysraphisms
- Agenesis of Corpus Callosum
- Klippel – Feil Syndrome
- Hydrocephalus
- Porencephaly
- Microcephaly
- Heterotopias
- Vein of Galen Aneurysm

Explain the major theories of development, the clinical presentation and the path physiology of cerebral aneurysms, capillary telangiectasias, artero-venous malfunctions, cavernous hemangiomas, venous angiomas

Describe the major theories and pathophysiology of cerebral vasospasm in relation to subarachnoid hemorrhage

Differentiate cytotoxic edema, vasogenic edema, interstitial edema and congestive brain swelling

Describe the etiology, pathophysiology and clinical presentations of ischemic cerebral infraction, ischemic cerebral infraction and secondary hemorrhage, primary intracerebral hemorrhage and venous occlusion

Compare the pathophysiology of ischemic and hypoxic brain injury

Differentiate the pathophysiology of indirect brain injuries including cerebral concussion, diffuse axonal injury, and acute subdural hemtoma

Differentiate secondary brain injuries including ischemic brain injury, cerebral herniation, contusional hemorrhage, posttraumatic swelling, and posttraumatic edema

Analyze the pathophysiology, the clinical presentations and the etiology of reoccurrence in the chronic subdural hematoma

Understand the pathophysiology of penetrating brain injury

Compare the pathophysiology and radiologic correlates of primary and secondary spinal cord injury

Differentiate the clinical presentation of and pathologic progression of spinal shock, Brown-Séquard syndrome, anterior spinal syndrome, central cord syndrome, Guillain-Barré syndrome, and Tabes Dorsalis

Understand the cell rest and field theories in the development of tumors of the nervous system

Explain the nature of local invasion of glial neoplasm and the structures of Scherer

Define the peaks of occurrence, locations, clinical presentations, histologic, cytologic and where relevant immunologic characteristics of primary glial neoplasm's including:

- Astrocytoma
- Oligodendroglioma
- Ependymoma
- Choroids Plexus Papillone
- Myxopapillary Eprndymomas
- Primitive Neuroectodermal Tumors (PNET)
- Germinomas
- Ganglioglioma
- Pleomorphic Xanthoastrocytoma
- Hemangioblastoma

Define the peaks of occurrence, locations, clinical presentation, development, histologic and cytologic characteristics of:

- Meningiomas
- Hemangiopericytomas
- Colloid Cysts
- Rathke cleft cysts
- Pineal cysts
- Craniopharyngioma
- Dermoids
- Epidermoids
- Chordomas
- Gliosarcomas
- Lymphomas

Differentiate the accepted grading systems for glial neoplasms based on rationale: World Health Orgniazation (WHO,) Kernahan, Danmas–Duport, Buerger

Compare of the pathophysiology and clinical correlates of carcinoma that is metastatic to the nervous system by type: parenchymal, leptomeningeal, epidural

Explain the pathophysiology of paraneoplastic nervous system diseases

Describe the laboratory, clinical, histologic, cytologic and immunologic abnormalities found in association with pituitary adenomas

Describe the laboratory studies indicative of the cause of hormone-secreting pituitary adenomas including prolactinomas, Cushings syndrome, and acromegaly

Describe the clinical presentation, radiographic picture, genetics and pathologic manifestations of the neurocutaneorus syndromes:

- Tuberous Sekrosis
- Neurofibromatosis I
- Neurofibromatosis II
- Von Hippe–Lindau's Angiomatosis
- Encephalo facial Angiomatosis
- Ataxia–Telauogiectasia

Explain the clinical presentation, laboratory abnormalities, pathophysiology and possible sequellae of:

- Bacterial meningitis
- Viral meningitis
- Sporadic and Epidemic Encephalitis
- Herpes Encephalitis

- Tuberculosis (TB) meningitis
- Fungal meningitis
- Poliomyelitis
- Crentzfeld–Jacob disease

Differentiate the types of cerebral abscesses (bacterial, fungal, tuberculosis, sarcoid, parasitic) based on the clinical presentation, pathophysiology, radiographic presentation and give the rationale for treatment

Discuss the clinical presentation and the pathologic correlates of AIDS as the well as associated infections and neoplastic entitles as the affect the nervous system

Compare the pathophysiology and clinical presentation of demyelinating disorders of the nervous system such as multiple sclerosis and central pontine myelinolysis

Describe the clinical and pathologic abnormalities in vitamin deficiency diseases of the central nervous system including subacute combined degeneration, Wernicke's encephalopathy, and Korsakoff's psychosis

Describe the clinical presentation and the pathologic substrate of the major degenerative central nervous system disorders:

- Alzheimer's Disease
- Vascular disease
- Parkinson's Disease
- Wilson's Disease
- Progressive Supranuclear Palsy
- Pick's Disease
- Huntington's Disease
- Motor Neuron Disease
- Post Polio Syndrome
- Spinocerebellar desecrations
- Striatonigral Degeneration

Describe the use of electron microscopy, and Nuclear Magnetic Resonance (NMR) spectroscopy as it pertains to neurological disease

Perform basic preparation, frozen sectioning and microscopic identification of nervous tissue.

Learning Experiences (list titles of teaching conferences, labs, procedure workshops, etc.)

Resident Assessment
Written exams and slide/photograph identifications
Quarterly evaluations, case review, focused chart review, lecture attendance
Oral boards
Written boards
Annual In-service exams

Resources
Lecture and slide material from Loyola University Medical center, Department of Pathology, Section of Neuropathology

Fuller G and Goodman C. *Practical Review of Neuropathology*. Lippincott Williams & Wilkins, 2001.

American College of Osteopathic Surgeons
Neurological Surgery Residency

Neurosciences:
Neuropharmacology

Developed by:
Javed Siddiqi, HBSc, M.D., Ph.D., FRCSC; Dan Miulli, D.O., FACOS; Keith Kattner, D.O., FACOS

Resident Competencies
- Osteopathic Principles and Practices
- Patient Care
- Medical Knowledge
- Practice-Based Learning and Improvement
- Interpersonal and Communication Skills
- Professionalism
- Systems-Based Practice

Prerequisites
Prior to entering a neurological surgery residency, the resident should:
- Understand basic pharmacology, physiology and neurology

Learning Outcomes
Upon completion of the neurological surgery residency, the resident will:
- Understand neuropharmacology that is pertinent to the treatment of neurological disorders and diseases which affect the nervous system

Phase I: Performance Indicators

Cognitive
Describe basic cellular neurotransmission including;
- The synapse
- Membrane potentials
- Ion pumps
- Ion channels
- Transmitter secretion
- Transmitter identification

Classify and identify receptors and receptor pharmacodynamics including:
- Receptor classification
- Receptor identification
- Dose response curves
- Agonists and antagonists
- Receptor modulation

Classify the neurotransmitter acetylcholine including:
- Cholinergic receptor classification
- Functional aspects of cholinergic receptors
- Synthesis, storage, and release of acetylcholine

Analyze the catecholamine neurotransmitters (norepinephrine and dopamine) including:
- Biosynthesis of catecholamines
- Storage and release of catecholamines

- Anatomy of catecholamine receptors
- Adrenergic receptors
- Dopaminergic receptors

Analyze the neurotransmitter serotonin including:
- Anatomy of serotonin receptors
- Biosynthesis, storage, and release of serotonin
- Sub-types of serotonin receptors

Analyze the neurotransmitter glutamate including:
- Biosynthesis, storage, and release of glutamate
- Ionotropic glutamate receptors including N-methyl-D-aspartate (NMDA) and non-NMDA receptors and subunits
- Metabotropic glutamate receptors: Groups I - III
- Role in neurological disorders

Analyze the neurotransmitters gamma-aminobutyric acid (GABA) and glycine including:
- Synthesis, uptake, and release
- Physiology and pharmacology
- Clinically relevant agonists and antagonists of GABA and glycine receptors

Analyze the peptide neurotransmitters

Evaluate the pharmacology of each of the drugs used to treat neurological disorders

Prescribe medication appropriately for nervous system diseases

Learning Experiences (list titles of teaching conferences, labs, procedure workshops, etc.)

Resident Assessment
Written exams and slide/photograph identifications
Quarterly evaluations, case review, focused chart review, lecture attendance
Oral boards
Written boards
Annual In-service exams

Resources

American College of Osteopathic Surgeons
Neurological Surgery Residency

Neurosciences:
Neurophysiology

Developed by:
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Resident Competencies
- Osteopathic Principles and Practices
- Patient Care
- Medical Knowledge
- Practice-Based Learning and Improvement
- Interpersonal and Communication Skills
- Professionalism
- Systems-Based Practice

Prerequisites
Prior to entering a neurological surgery residency, the resident should:
- Understand basic neuro-physiology including nerve cell and nervous system transmission, homeostasis and repair
- Understand nervous system histology
- Understand the anatomy of the nervous system on a cellular and macroscopic level
- Describe the basic biology of the nerves including:
  - Synthesis and movement of proteins in the nerve
  - Membrane potential and membrane properties
  - Ion channels
  - Generation and conduction of an action potential

Learning Outcomes
Upon completion of the neurological surgery residency, the resident will:
- Understand neurophysiology and how it relates to neurological diseases
- Analyze the physiological mechanisms in the treatment of functional disorders

Phase I: Performance Indicators

Cognitive
Describe synaptic transmissions including:
- Types of synaptic transmission
- Transmitter release and uptake
- Nerve-muscle transmission
- Chemical messengers
- Direct gated receptors
- Second messenger linked receptors

Describe the physiology of the sensory systems including:
- Sensory receptor physiology
- Anatomy of somatic sensory system
- Coding of modality specific sensory information
- Pain and analgesia

- Cortical integration of sensory perception
- Visual system
  - Processing of information in the retina
  - Processing of vision in the central visual pathways
  - Columnar units of visual cortex
  - Processing in the geniculate nucleus
  - Visual perception of motor and form
- Auditory system including the processing of hearing in the cochlea and the central auditory pathways
- Olfaction and taste

Describe the physiology of the motor system including:
- Mechanisms of muscle contraction
- Muscle receptors, spinal reflexes
- Spinal reflexes concerned with position
- Brain stem reflexes controlling motion
- Vestibular nuclei control of movement and posture
- Red nucleus control of movement
- Cortical control of movement
- Cerebellar control of movement
  - Regional and cellular organization of the cerebellum
  - Functional divisions of the cerebellum
  - The role of the cerebellum in planning movement
- Basal ganglia anatomy and neuro transmitters
- Thalamus

Compare the attributes of the autonomic nervous system including both the sympathetic and parasympathetic systems

Analyze the physiological basis of arousal and emotion, including:
- Noradrenergic systems
- Limbic system including the physiologic basis for emotion and memory
- Sleeping and sleep states
- Reticular activating system

Describe the higher cortical functions including:
- Anatomy of language
- Function of association cortex

Describe the physiological basis for cerebrospinal fluid production and re-absorption

Review the physiological control of the cerebral vasculature

Discuss the physiology of the hypothalmus and pituitary, particularly as related to endocrinology

Analyze the physiological dynamics of cerebral blood flow

Properly interpret tests of both global and regional blood flow:
- X-ray/CT scan method
- Thermal diffusion

- Laser and Transcranial Doppler
- Jugular bulb oximetry testing

Learning Experiences (list titles of teaching conferences, labs, procedure workshops, etc.)
Review the basic physiological sciences through attendance at board review courses

Participate in laboratory research projects

Develop knowledge of physiological testing through a dedicated neurology rotation

Attend courses focused on intraoperative physiological monitoring

Resident Assessment
Written exams and slide/photograph identifications
Quarterly evaluations, case review, focused chart review, lecture attendance
Oral boards
Written boards
Annual In-service exams

Resources
Intraoperative Monitoring: Basics and Performance Issues. American Society of Electroneurodiagnostic Technologists, 2001.

American College of Osteopathic Surgeons
Neurological Surgery Residency

Neurosciences:
Neuro-Radiation Physiology

Developed by:
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Resident Competencies
- Osteopathic Principles and Practices
- Patient Care
- Medical Knowledge
- Practice-Based Learning and Improvement
- Interpersonal and Communication Skills
- Professionalism
- Systems-Based Practice

Prerequisites
Prior to entering a neurological surgical residency, the resident should:
- Identify devices commonly used to provide radiotherapy and radiosurgery – external beam / whole brain, linac, gamma knife, cyberknife, intensity-modulated radiation therapy (IMRT)
- Understand use of ionizing radiation to induce potentially lethal mutations in cancerous and normal tissues
- Compare the characteristics of cancer cells and normal tissues with regards to deoxyribose nucleic acid (DNA) repairing capabilities following radiation injury

Learning Outcomes
Upon completion of the neurological surgical residency, the resident will:
- Analyze the indications, risks and benefits of radiotherapy and radiosurgery in treating neurosurgical lesions
- Analyze current literature and apply the information to patient care
- Plan treatment doses and treatment schedules with radiotherapy or radiosurgery
- Collaborate on the radiobiological treatment of neurosurgical patients with radiation oncologists, radiation physicists and oncologists
- Communicate with patients and their families in a knowledgeable, compassionate manner regarding the risks, benefits and goals of radiotherapeutics in the treatment of neurosurgical lesions

Phase I: Performance Indicators	Phase II: Performance Indicators
Cognitive Differentiate treatment options for meningiomas, gliomas, metastases, spinal cord tumors, arteriovenous malformations (AVM), acoustic neuromas, trigeminal neuralgia Differentiate external beam radiotherapy from stereotactic radiosurgery Describe differences among linear accelerator system (LINAC), GammaKnife, Cyberknife and intensity-modulated radiation therapy (IMRT) devices Describe photon beam therapy Describe the concept of brachytherapy Explain why children are more susceptible to radiation injury than adults	**Cognitive** Analyze late responding and early responding tissues & lesions and relate to different alpha / beta ratios Differentiate between intensity-modulated radiation therapy (IMRT) and Cyberknife Assess the indications for use of whole brain radiotherapy in the management of brain metastases Assess the indications for using hypofractionation Compare tissues that respond to single fraction radiosurgery versus hypofractionation Describe the onset, clinical manifestations and risks for developing radionecrosis Collaborate on the management of post radiation-related edema Understand the effect of lesion size on the choice of IMRT, single fraction radiosurgery and multi staging radiosurgery Describe common radiotherapeutic strategies for: • meningiomas of the convexity, cavernous sinus, dural sinuses • metastases to the brain and spine • gliomas – supratentorial and brainstem • trigeminal neuralgia • pituitary adenomas • acoustic neuromas • arteriovenous malformation (AVM) Differentiate radionecrosis from recurrent tumor on magnetic resonance imaging (MRI), positron emission tomography (PET), and single-photon emission computerized tomography (SPECT) studies

Learning Experiences (list titles of teaching conferences, labs, procedure workshops, etc.)
Interact with radiation oncologists, oncologists and neurosurgeons in an interdisciplinary approach to treat patients with complex neuro-oncologic diseases.

Attend national conferences where the indications and various approaches to use of radiotherapeutics are discussed.

Plan and treat under guidance of radiation oncologists, radiation physicists and neurosurgeons the delivery of radiosurgery or radiotherapy.

Resident Assessment
Oral boards

Written boards

Annual in-service exams

Resources
Local / regional linac, IMRT, Cyberknife, Gamma Knife facilities and the staff who manage and use these devices

Hall EJ, Brenner DJ. The radiobiology of radiosurgery: rationale for different treatment regimens for AVMs and malignancies. Int. *J. Radiat. Oncol. Biol. Phys.* 1993: 25: 381-385.

Mehta MP. The physical, biologic, and clinical basis of radiosurgery. *in*: *Current problems in cancer.* 5th edition, Vol. XIX, 1995.

American College of Osteopathic Surgeons
Neurological Surgery Residency

Neurosciences:
Neuroradiology

Developed by:
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Resident Competencies
- Osteopathic Principles and Practices
- Patient Care
- Medical Knowledge
- Practice-Based Learning and Improvement
- Interpersonal and Communication Skills
- Professionalism
- Systems-Based Practice

Prerequisites
Prior to entering a neurological surgical residency, the resident should:
- Relate neurological anatomy to imaging studies
- Understand the basic physics of magnetic imaging, computed tomography, and plain films
- Know the "gold standard" imaging for various neurological diseases

Learning Outcomes
Upon completion of the neurological surgery residency, the resident will:
- Recognize the appropriate imaging based on functional neuroanatomy findings
- Interpret magnetic resonance imaging (MRI), computed tomography (CT), and routine x-rays of the brain and spinal column
- Determine the appropriate imaging to best diagnose neurological diseases
- Develop a treatment strategy based upon imaging findings and correlate imaging to surgical techniques
- Utilize endovascular techniques in treating neurovascular disorders

Phase I: Performance Indicators	Phase II: Performance Indicators
Cognitive Identify normal neuroanatomical structures on magnetic resonance imaging, computer tomography, and x-rays Evaluate the limitations, sensitivity, and specificity and potential complications to intravenous contrast agents and discuss their management Plan the use of endovascular techniques to treat various neurovascular diseases Diagnose traumatic pathology to the nervous system during trauma resuscitation by means of CT scans and plain x-rays Describe the plan for endovascular techniques to treat various neurovascular diseases Diagnose traumatic pathology to the nervous system during trauma resuscitation by means of CT scans and plain x-rays Describe precautions that should be taken when performing radiographic evaluations Describe the use of myelogram in the treatment of spinal disease Identify diseased neuroanatomical structures on magnetic resonance imaging (MRI), computer tomography, cerebral angiogram, SPECT, PET, spectroscopy, functional imaging and x-rays Describe the concepts of ultrasonography Identify the spine fractures on routine x-rays and CT scan Describe the findings of normal and abnormal carotid ultrasound Distinguish the various stages of intracranial hematomas on MRI and CT scan	**Cognitive** Distinguish the findings of normal and abnormal neonatal cranial ultrasound Use of transcranial Doppler ultrasonography in the management of patients with subarachnoid hemorrhage, trauma, and occlusive vascular disease, brain death, and the significance of velocity changes and Lindergaard ratio Diagnose brain and spine tumors using MRI and CT scan Use diffuse weighted imaging and perfusion scanning to identify early ischemic stroke Use MR spectroscopy and PET scan to distinguish brain tumors Interpret MRI, CT angiography, and standard angiography to diagnose aneurysms and malformations Diagnose vasospasm with transcranial Doppler Determine specific pituitary, brain, spine, and skull base tumors based on characteristics in imaging Discuss the indications and technique of discography, epidural steroids, diagnostic selective nerve root blocks, facet blocks Discuss the indications and technique for percutaneous vertebroplasty **Technical** Use image guidance to resect brain and pituitary tumors Use image guidance in placing instrumentation in the spine Assist in the treatment of neurovascular diseases with endovascular techniques Perform provocative discography to diagnose discogenic disease

Learning Experiences (list titles of teaching conferences, labs, procedure workshops, etc.)

Resident Assessment

Written exams and slide/photograph identifications
Quarterly evaluations, case review, focused chart review, lecture attendance
Oral boards
Written boards
Annual In-service exams

Resources

Osborn, AG, Maack, J. *Diagnostic Neuroradiology*. CV Mosby Publishers, 1994.