

NS

Nervous System

Course Goals

Goals

1. Understand the functional anatomy and physiology of the nervous system and their relation to therapeutic interventions.
2. Understand the components of the neurologic exam, and demonstrate proficiency in performing a neurologic exam.
3. Be able to identify the constellation of deficits that result from a lesion in the nervous system at the following loci: muscle, neuromuscular junction, spinal cord, brainstem, basal ganglia, cerebellum, cortex.
4. Understand the major pathologic conditions that afflict the nervous system and recognize the basic principles of diagnosis and treatment for these disorders.
5. Recognize the relationship between the structure of the nervous system and behavior.
6. Understand the difference between behavioral neurology and psychiatry and recognize the different methods employed by each in the evaluation of behavioral disorders.
7. Understand the dynamics of synaptic plasticity, and how changing structure leads to changes in behavior.
8. Understand the overlap and differences between physical, pharmacologic, and behavioral manipulation of the nervous system.

Spring 2019

Nervous System

Session Learning Objectives

ADHD

1. Describe approaches for identifying and describing attentional dysfunction, especially attentional dysfunction associated with attention deficit-hyperactivity disorder.
2. Describe the functional impact of attention deficit-hyperactivity disorder.
3. Describe at least 5 models for understanding why co-morbidity with other psychiatric disorders is high for individuals with attention deficit-hyperactivity disorder.
4. State the likely need for long-term treatment for individuals with attention deficit-hyperactivity disorder.

Alcoholics Anonymous

1. Distinguish between spirituality and religion in 12 step programs
2. Identify factors that are associated with the success of 12 step programs.
3. Identify barriers to talking about substance use disorders and their treatment.
4. Describe an open Alcoholics Anonymous(AA) or other 12 step meeting.

Anterior Horn Cell and Peripheral Nerve Disorders

1. Recognize the clinical features of: amyotrophic lateral sclerosis, Charcot-Marie-tooth disease, diabetic neuropathies, Duchenne muscular dystrophy, and myasthenia gravis.
2. Differentiate a mononeuropathy from a radiculopathy and plexopathy.
3. Recognize the pathologic changes of amyotrophic lateral sclerosis, Charcot-Marie-tooth disease, Duchenne muscular dystrophy, and myasthenia gravis.
4. Discuss the common genetic defects in Charcot-Marie-tooth disease and Duchenne muscular dystrophy.
5. Describe the immune-pathogenesis and treatment of myasthenia gravis.
6. Describe symptomatic management of limb weakness and difficulty speaking, swallowing, and breathing.

Antidepressants and Mood Stabilizers

1. Recognize the different classes of antidepressants and discuss the general ideas about mechanism of action.
2. Describe the general timeline of response to antidepressants.
3. Recognize and describe important side effects of antidepressants.
4. Discuss issues around treatment of bipolar disorder, and that different phases require different medications.
5. Describe basic medication strategies for treating bipolar mania and depression.

Antiseizure Medications

1. For the anticonvulsant agents listed above describe the general mechanisms of action (cellular target), list the distinctive side effects, explain their safe use in pregnancy, compare and contrast the time to attain steady state (short vs long), and describe their administration characteristics (absorption, GI irritation, routes).
2. List drugs of choice for grand mal [tonic-clonic] (valproate, lamotrigine, levetiracetam), petit mal [absence] (ethosuximide, valproic acid), partial (carbamazepine, lamotrigine, levetiracetam) and status epilepticus (diazepam-lorazepam-midazolam) plus alternative agents (phenytoin, gabapentin, phenobarbital).
3. Relate the postulated mechanisms underlying seizure pathophysiology for simple and complex partial, absence, tonic-clonic, and status epilepticus seizure disorders to the mechanisms of actions of the drugs of choice for their treatment.

Anxiety Disorders

1. Summarize the available knowledge concerning the etiology and pathophysiology of panic disorder, generalized anxiety disorder, social phobia, and obsessive-compulsive disorder.
2. Discuss the diagnosis and management of panic disorder, agoraphobia, social phobia, generalized anxiety disorder, and obsessive-compulsive disorder.
3. List the common general medical and substance-induced causes of anxiety, and assess for these causes in evaluating a person with an anxiety disorder.
4. Outline the psychotherapeutic and pharmacologic treatments (as appropriate) for each of the anxiety disorders.
5. Discuss the role of anxiety and anxiety disorders in the presentation of general medical symptoms, the decision to visit a physician, and health care expenditures.

Assessment of Developmental Disorders

1. Describe normal development and how you evaluate and assess it.
2. Describe abnormal development.
3. Compare and contrast developmental disabilities, intellectual disabilities, cerebral palsy, and autism, including how you diagnose and the cause of each.

Auditory I - III

1. Describe the physical nature of sound, including concepts of intensity (dB SPL) and frequency (Hz).
2. Define auditory threshold and describe how it is measured in the audiogram.
3. Describe the concept of acoustic impedance mismatch and the role of the middle ear in overcoming impedance mismatch between the air-filled middle ear and fluid-filled inner ear.
4. Differentiate between sensorineural and conductive hearing loss.
5. Discuss how sound elicits movement of the basilar membrane, define the tonotopic map, and describe why hair cells located along the length of the basilar membrane respond maximally to different frequencies.
6. Discuss how the inner hair cells respond to bending of the stereocilia, describe the properties of the transduction channels located at the tips of the stereocilia, and explain the role of the endocochlear potential in auditory transduction.
7. Describe the "cochlear amplifier," discuss the role of outer hair cells in the cochlear amplifier, and recognize that outer hair cells are of clinical significance because of their susceptibility to damage by ototoxic antibiotics and prolonged exposure to loud sounds.
8. Recognize the response of spiral ganglion cells to sounds of different frequencies and that information on frequency for high frequency sound is determined by which spiral ganglion cells respond maximally, while for low frequency sounds (below 1 kHz) it is determined by the temporal pattern of action potential firing.
9. Describe the anatomical pathway for the auditory system in the brainstem, diencephalons and cerebral cortex, where axons decussate in this pathway, and the clinical significance for decussation of axons in the brainstem in the auditory pathway.
10. Describe the two main mechanisms involved in sound localization, when a difference in intensity is used by the auditory system to localize sound, when the time of arrival is used, and where and how these cues are encoded in the ascending auditory pathway.
11. Describe the role for the auditory cortex and recognize that the auditory cortex is arranged in a tonotopic map.

Brainstem Review

1. Describe the names and functions of the cranial nerves. Know where each is found to enter/exit the brainstem relative to surface landmarks.
2. Explain the basic techniques for clinical examination of each cranial nerve
3. Identify the cranial nerve nuclei, long tracts (corticospinal, spinothalamic, and medial lemniscal), and cerebellar pathways on 9 axial sections through the brainstem (2 midbrain, 3 pons, 4 medulla)
4. Review learning objectives from self-paced powerpoint exercises on the brainstem and cerebellum/basal ganglia

Cerebral Cortex

1. Recognize how rhythmically bursting and randomly discharging families of brainstem and thalamic neurons appear to select and stabilize particular EEG patterns that relate to states of arousal and attention.
2. Identify the basic classification of EEG rhythms, and relate their rough correspondence to different behavioral states.
3. Describe the architecture of the cerebral cortex and the relationship between cortical architecture and the generation of electrical potentials measured by the EEG.

Chemosenation

1. Describe some simple tests you can do in a clinical setting that will enable you to distinguish a deficit of olfaction from a deficit of taste and recognize the clinical terms for losses of these senses (ageusia = loss of taste; anosmia = loss of smell).
2. Describe the differences in morphology and functioning of receptor cells for taste, trigeminal and olfactory modalities.
3. Describe the difference in route of access of odorants to the olfactory epithelium during orthonasal and retronasal stimulation.
4. Describe the way odor information is transmitted from the receptor epithelium to the olfactory bulb and compare how different odors are represented within the receptor sheet and within the bulb.
5. List the output pathways and targets of the olfactory bulb and describe the behaviors or cognitive events that are associated with each of the telencephalic olfactory target areas.
6. List the three types of gustatory papillae and indicate which cranial nerve provides their gustatory and general cutaneous innervation to that area of the tongue.
7. Trace the neural pathways and name the central nuclei conveying taste information from taste buds to primary gustatory cortex.

Clinical Pathology Correlate-DEMO

1. Describe the common presenting signs and symptoms of the pathologic entity shown in this case.
2. Discuss the pathogenesis of this condition. Describe risk factors and mechanisms by which it is acquired.
3. Discuss the diagnosis and treatments of different forms of this condition.

CNS Injury I - III

1. Define concussion, or mild traumatic brain injury.
2. Identify the peak age groups in which head injuries occur and describe the mechanisms whereby these injuries are received.
3. Discuss the pathophysiology of various types of head injury and how they occur.
4. Recognize the goal of treatment in head injuries.
5. Discuss the reason for the control of intracranial pressure in the treatment of head injury.
6. Recognize the signs and symptoms of increased intracranial pressure and describe the clinical and pathologic features of the four herniation syndromes presented here.
7. Recognize the Glasgow Coma Scale and discuss its utility in predicting injury severity and outcome, and the elements of the clinical evaluation of concussion.
8. List five of the most common symptoms of concussion.

Coma

1. Describe the anatomical pathways tested with: the corneal blink reflex, cold water calorics, the cough and gag reflexes.
2. Discuss ethical, legal, and cultural issues related to brain death and organ transplantation.
3. Discuss the criteria for establishing brain death.
4. Define the following terms: delirium, stupor, coma, decerebrate posturing, decorticate posturing.

Congenital Disorders & Perinatal and Postnatal Pathology

1. Describe the following prototypical congenital malformations, including the period during embryogenesis and development when they occur: Neural tube defects, holoprosencephaly, disorders of neuronal proliferation, disorders of neuronal migration, and disorders of elaboration of neurons and glia.
2. Describe the association between Chiari I malformation and syringomyelia, and the association between Chiari II malformation and myelomeningocele.
3. Recognize the normal levels at which the conus medullaris is found with respect to the vertebral column at different stages of development and describe the concept of tethering of the spinal cord that can be associated with neural tube defects.
4. Recognize symptoms that result when a process such as syringomyelia or tethering affects the spinal cord.
5. Discuss the principal causes and consequences of stroke in the perinatal period.

Cortical Lesions

1. Describe the role the frontal, temporal, parietal, and occipital lobes in human cognition.
2. Describe the three major frontal lobe syndromes.
3. Recognize the major cognitive disorders related to temporal lobe lesions.
4. Recognize the syndrome of hemineglect as a prototype parietal lobe syndrome.
5. Differentiate between visual field deficits and visual agnosia.

CPC Movement Disorders (plus Gait exam-DUI)

1. Describe the basic examination of coordination and gait.
2. Describe the “Extrapyramidal signs” that accompany disorders of the cerebellum and basal ganglia. How do these differ from “pyramidal” dysfunction?
3. Describe the eight basic patterns of disordered gait. Give examples of the underlying pathology that can give rise to each type.

CPC: Brainstem

1. Describe the correlation between physical exam findings, anatomic localization, and formulation of a differential diagnosis in this case.

Decisions in Patients with Neurologic Impairments

1. Analyze the ethical issues in cases involving patients with neurological impairments.
2. Describe the impact of various religious traditions on treatment decisions.
3. Identify professional obligations in the face of religious diversity and pluralism.

Degenerative Disease

1. Recognize the fundamental concepts of neurodegenerative disorders.
2. Discuss, on a general level the clinical features, genetics, neurochemistry and neuropathology of neurodegenerative diseases.

Delirium and Dementia

1. Define the syndrome of delirium.
2. Discuss the common etiologies and evaluation of delirium.
3. Define the syndrome of dementia.
4. Discuss the common etiologies and evaluation of dementia.
5. Discuss the principles guiding treatment of delirium and dementia.

Delirium/Dementia

1. Recognize the clinical presentation of delirium and how it differs from dementia.
2. Identify mental status testing procedures that could help differentiate delirium from dementia.
3. Appreciate the long-term outcomes for patients who experience an in-hospital delirium.

DEMO - Neoplasms

1. Discuss the correlation between physical exam findings, anatomic localization and formulation of a differential diagnosis in this case.

Developmental Disorders

1. Discuss the signs and symptoms associated with autism spectrum disorders (ASD) at different ages, including basic facts about prevalence, etiology and outcome.
2. Discuss shared symptomology and individual differences in individuals presenting with autism spectrum disorders (ASD).
3. Identify available resources and support services to assist in the provision of quality health care to patients with developmental disabilities, such as autism spectrum disorders ASD.

Dr. Stabio's Pilot Brainstem Small Group (Pilot)

1. Correlate a pathologic brain CT with the locations of cranial nerve nuclei.
2. Describe the importance of time in the management of acute ischemic stroke.
3. Describe the deficits that will be encountered due to ischemia of the corticospinal/bulbar tract, facial nucleus, and trigeminal nucleus.

Drugs of Abuse

1. Describe treatments available for withdrawal and relapse prevention.
2. Explain the risk for development of tolerance and dependence, and describe the relative severity of withdrawal (if present).
3. For the major drug classes of abused substances, discuss major acute toxicities and treatment.
4. For the major drug classes of abused substances (opioids, CNS depressants, CNS stimulants, nicotine, hallucinogens, marijuana, anticholinergics) describe:
Major reinforcing effects / CNS action (neurotransmitters involved), with emphasis on the neurotransmitter role in mediating toxic effects and potential interaction with concomitant medical conditions.

Embryology I

1. Describe the primary axes of the central nervous system, the planes of section used to view the nervous system, and the designations dorsal, ventral, rostral, and caudal.
2. Describe the way in which the nervous system is segmented into rostrocaudal segments of telencephalon, diencephalons, mesencephalon, metencephalon, myelencephalon, and spinal cord.
3. Discuss the components of the ventricular system and describe how these relate to the rostrocaudal segments of the neural tube.
4. Describe the significance of the rhombomeres, in terms of the segmental development of the hindbrain and its relationship to specific cranial nerves.
5. Describe the general scheme of dorsoventral patterning of the neural tube into alar and basal plates, and how this scheme is modified at the level of the midbrain, pons, medulla, and spinal cord.
6. Describe the basic scheme of dorsoventral patterning of the prosencephalon, and how this relates to the adult three-dimensional structure.

Epilepsy I (overview plus CPC with patient)

1. Differentiate between a complex partial seizure and a primary generalized absence seizure.
2. Regarding the classification of epilepsies, identify the two major types of seizures: partial onset and primary generalized, and describe the difference between a primary generalized tonic-clonic seizure and a secondarily generalized tonic-clonic seizure.
3. Describe the various etiologies of an epileptic seizure.
4. Recognize the signs of epileptic seizures (paroxysmal change in behavior or movement, or an alteration of consciousness).

Epilepsy II (adult)

1. Differentiate key terminology surrounding seizures, epilepsy and other spells.
2. Relate the relevance of seizure and epilepsy pathophysiology to clinical phenomenon and interventions.
3. Relate clinical manifestations of seizures to functional neuroanatomy.
4. Describe the correct approach to patients with seizures.

Epilepsy III (pediatric)

1. Recognize that there are non-medication treatments available for intractable seizures such as ketogenic diet, vagal nerve stimulation and epilepsy surgery.
2. Define Lennox Gastaut syndrome and recognize that this is an intractable seizure disorder.
3. Discuss the definition and risk for recurrence of febrile seizures.
4. Recognize that status epilepticus is a medical emergency and the potential causes of status epilepticus as well as treatment options.
5. Recognize that intractable epilepsies can be defined as seizures which do not respond to a trial of at least 3 anticonvulsants and that approximately 30% of new onset seizure patients may develop intractable epilepsy.
6. Recognize that epilepsy is a disorder of recurrent, spontaneous seizures and that epilepsy can be classified by generalized and partial syndromes or by etiologies.

Exteroception

1. Describe the classification of sensory receptors of the skin in terms of adaptation properties and receptive fields.
2. Explain how sensory information is conveyed along the medial lemniscal and trigeminal lemniscal pathways.
3. Describe somatotopy, including why the representations of some regions (e.g. mouth and hands) are enlarged compared to others in the somatotopic map in primary somatosensory cortex.
4. Describe the “barrel” and columnar organization of somatosensory cortex.

Eye Movements I & II (plus Ophthalmology exam)

1. List the four types of eye movements.
2. Compare and contrast conjugate and vergence eye movements.
3. Explain a saccade and how it is generated.
4. Discuss smooth pursuit eye movements, how fast can they be, and why they are limited to relatively slow speeds.
5. Describe the control of the VOR for a person sitting on a chair that is rotated to the right (clockwise rotation if you look down on them from above).
6. Discuss the internuclear ophthalmoplegia and describe what you observe for the patient, how you can decide if the medial rectus motoneurons and/or nerve are intact, and what is the most likely structure that is affected.
7. Describe nystagmus and give examples where it occurs.

Forebrain and Diencephalon Anatomy

1. Identify the major structures of the telencephalon and diencephalon on coronal and sagittal preparations: thalamus, hypothalamus, components of the basal ganglia, internal capsule, neocortex, hippocampus.
2. Prepare a table showing for each of the following systems, the name of the associated thalamic nucleus and the ultimate cortical target of the system: visual, auditory, somatosensory for the face, somatosensory for the body, taste, hippocampal limbic and amygdalar.
3. Identify the following limbs of the internal capsule: anterior, posterior, retrolenticular and sublenticular limbs and list the contents of these four regions.
4. List the functional significance of each of the following Brodmann’s areas and identify the associated thalamic relay nucleus: 1-3, 4, 17, and 41.
5. Identify the following structures in coronal and horizontal sections through the brain: 1) thalamic nuclei: anterior nuc., lateral and medial geniculate nuclei, VA-VL, pulvinar, VPL-VPM, centromedial, dorsomedial (DM), and 2) parts of the internal capsule: anterior, posterior, retrolenticular, and sublenticular limbs.

General Anesthetics I & II

1. Describe the ideal characteristics of a general anesthetic.
2. Describe the fundamental physical principles that determine uptake and elimination of inhaled anesthetics.
3. Describe the physicochemical properties of inhaled general anesthetics that determine anesthetic potency.
4. Describe the methods of application of inhaled anesthetics.
5. Describe the rationale for use of a combination of pharmacological agents to achieve effective surgical anesthesia.
6. Describe the basic mechanisms of action of distinct classes of intravenous general anesthetics and adjunctive agents.
7. Describe the advantages, disadvantages and problems associated with specific anesthetics on the drug list.
8. Describe the differences between tissue groups that are important in determining uptake of general anesthetics.
9. Describe the signs and stages in the development of general anesthesia.
10. Describe the current thinking regarding the mechanism of action of inhaled anesthetics in producing anesthesia.

Headache

1. Differentiate between a primary and secondary headache syndrome.
2. Recognize the following common primary headache syndromes: tension type, migraine, and cluster headache.
3. Describe the following potentially dangerous conditions often presenting with a headache: meningitis, concussion, subarachnoid hemorrhage, giant cell arteritis, and idiopathic intracranial hypertension.
4. Recognize the appropriate clinical evaluation or treatment options for the following: migraine, subarachnoid hemorrhage, and giant cell arteritis.
5. Recognize the epidemiological implications of headache.

Hypothalamus & Temperature Regulation

1. Describe the location of the hypothalamus and some key nuclei (those with functions discussed in detail).
2. Describe the pathways connecting the hypothalamus with the autonomic and somatic motor systems, the endocrine system, and the limbic system.
3. Describe the role of the autonomic nervous system in homeostasis and emotional responses.
4. Describe the neuroendocrine function of the hypothalamus, how it controls the anterior pituitary, and its role in posterior pituitary hormone secretion.
5. List the endocrine, autonomic, and somatic motor responses initiated by the hypothalamus for maintenance of water balance, body temperature, and body weight.
6. Define fever and pyrogens and describe the changes in the hypothalamic mechanisms regulating body temperature that result in fever and its associated symptoms.
7. Describe the role of the hypothalamus in generation of circadian rhythms.
8. Describe the role of the hypothalamus in emotional and motivated responses and discuss "sham rage."

Infectious Disease

1. Discuss the clinical presentation, most common organisms, basic CSF profile (cell number and type, glucose, protein), and basic medical management for bacterial meningitis in different age groups.
2. Discuss the clinical features, most common organisms, basic CSF profile, and key diagnostic tests for viral meningitis and encephalitis.
3. Discuss how to distinguish the clinical features and most common viruses in cases of viral meningitis and viral encephalitis.
4. Describe the basic clinical and CSF profile for chronic meningitis cases and know the most common causes of chronic meningitis in the US.
5. Discuss the basic medical management for bacterial meningitis in different age groups.

Infectious Disease - Case Studies

1. Discuss the correlation between physical exam findings, anatomic localization and formulation of a differential diagnosis in a central nervous system parasitic infection case.

Inflammatory/ Demyelinating Diseases

1. Describe the basic subtypes of Multiple Sclerosis (MS).
2. Describe the basic epidemiology of Multiple Sclerosis (MS).
3. Describe the typical clinical symptoms, neurologic exam abnormalities, and laboratory study abnormalities seen in Multiple Sclerosis (MS).
4. Describe the basic approaches to therapy in Multiple Sclerosis (MS), and what to expect from immunotherapy in MS.

Interrogating the Nervous System

1. Review the differences between an EPSP, IPSP, and an action potential.
2. Describe the "coupling" between electrophysiologic activity in the nervous system and CNS hemodynamics.
3. Describe those techniques for evaluating "brain activity" that measure the electromagnetic properties of the nervous system.
4. Describe those techniques for evaluating "brain activity" that measure the hemodynamic properties of the nervous system.
5. Describe at a basic level the physiologic basis for the signal recorded in the EEG, the MEG, the fMRI, and the PET scan.
6. Describe at a basic level the method of Diffusion Tensor Imaging, or DTI.
7. Describe at a basic level the objectives of "Connectomics" and discuss the potential for this technique to act as a biomarker for certain disease states.

Introduction (plus CPC with patient)

1. Define the following terms: Cortex, Grey Matter, White Matter, Thalamus, Cerebellum, Ipsilateral, Contralateral, Commissure, Decussation, Homunculus, Somatotopy, Afferent, Efferent, Synapse, and Synaptic Plasticity.
2. Describe the basic conceptual framework for understanding the nervous system, on which this course is based.
3. Describe the basic components of the neurologic exam, neuroanatomical localization, and neuropathological categories that will be covered in the course, and how these are employed in the formulation of a differential diagnosis.
4. Recognize the relationship between the conceptual framework for the course and the three major types of therapeutic intervention: counseling, pharmacotherapy, and physical manipulation.

Introduction to Brainstem Anatomy I & II

1. Locate and identify the attachment points of all the brainstem cranial nerves CNIII – CNXII.
2. Locate and identify the following features on the intact brainstem: approximate dividing lines between medulla, pons and midbrain; optic chiasm, mammillary body, superior and inferior colliculi; crus cerebri (cerebral peduncle), basal pons, superior, middle, and inferior cerebellar peduncles, pyramid and olive.
3. Be able to locate brainstem structures on a representative section, identify in what region of the brainstem they occur (medulla, pons or midbrain), describe what functional role they play, and what they are connected to, both in terms of input and output.
4. Starting at the receptor endorgan and ending in cortex, identify the components of and trace the pathways taken by systems serving somatosensory functions for the body and head, including: pain & temperature for the body, pain and temperature for the face, touch and vibration sensation for the arms and for the legs, and touch and vibration sensation for the face.
5. Starting from auditory receptors and ending in cortex, identify the components of and trace the pathways taken by the auditory system including: cochlear nuclei, superior olive, trapezoid nucleus, lateral lemniscus, inferior colliculus, medial geniculate, and auditory cortex.
6. Describe the role of the MLF in the circuitry of the vestibuloocular reflex.
7. Name the cranial nerve nuclei that give rise to preganglionic parasympathetic fibers and describe their function.
8. Define corticonuclear (corticobulbar) fiber systems and describe how their distribution to ipsilateral and contralateral motoneurons is different for the upper and lower parts of the face.
9. Trace corticospinal fibers through all levels of the brainstem and identify whether they arise from ipsilateral or contralateral motor cortex for all levels of the brainstem and spinal cord.
10. Trace the pathways and identify key components of the pupillary light reflex.
11. Trace the arterial blood supply from the vertebral arteries to the Circle of Willis including the major brainstem branches: posterior inferior cerebellar A (PICA), anterior inferior cerebellar A (AICA), superior cerebellar A (SCA), and posterior cerebral artery.
12. For each level of the brainstem, indicate the approximate territory served by median vs. lateral vessels (e.g. vertebral vs. PICA) and identify the major fiber systems passing through each of these territories with special attention to: corticospinal tract, dorsal column/medial lemniscus, anterolateral system (incl. spinothalamic tr. and trigeminothalamic tr.), and spinal trigeminal tr.

Introduction to Cerebellum-Basal Ganglia Neuroanatomy

1. Trace the circuit interconnecting the cerebral motor cortex and the cerebellar cortex. Identify the thalamic relay nucleus for this system and identify the minimum number of synapses from a cerebellar Purkinje cell (output cell of the cerebellar cortex) to the cerebral cortex.
2. Identify the source of climbing fibers reaching the cerebellum.
3. Describe the interlocking circuits of the basal ganglia including the caudate, putamen, globus pallidus, subthalamic nucleus and substantia nigra and identify Which of these contains dopaminergic cell bodies.
4. Locate and identify each of the following structures:
vermis, hemispheres, flocculus, nodulus; cerebellar peduncles (inferior, middle, and superior); primary fissure, anterior lobe, posterior lobe, flocculonodular lobe;
cerebellar vermis and hemispheres.
5. Locate and identify each of the following structures: inferior, middle, and superior cerebellar peduncles; deep cerebellar nuclei (dentate, interposed, and fastigial);
inferior olivary nucleus (also called simply, inferior olive); pontine nuclei; head, body and tail of the caudate nucleus; the putamen;
globus pallidus; substantia nigra;
subthalamic nucleus.

Introduction to Gross Brain and Spinal Cord Labs (Required)

1. Locate the central sulcus, precentral and postcentral gyri and paracentral lobules on the surface of the brain. Understand the relationship between these locations and the primary motor cortex and primary somatosensory cortices.
2. Describe the appearance of the internal capsule as visualized on coronal and axial sections of the brain, particularly the relationship to the caudate nucleus, putamen/globus pallidus, and thalamus.
3. Describe the anatomy of the lateral corticospinal tract.
4. Describe the difference between an Upper Motor Neuron syndrome and a Lower Motor Neuron syndrome.
5. Describe the anatomical pathway for relaying discriminative touch, vibration sense, and joint position sense. How does this pathway vary above and below the T6 dermatome?
6. Describe the anatomical pathway for relaying pain and temperature sensation.
7. Explain the reason for dissociated sensory loss encountered in a Brown-Sequard syndrome.

Introduction to Mood and Psychotic Disorders

1. Prepare an initial interview for persons with psychotic, bipolar, and depressive disorders.
2. Recall screening questions for psychotic, bipolar, and depressive disorders.
3. List the DSM-5 criteria for the paradigmatic disorders: schizophrenia, bipolar I disorder, and major depressive disorder.
4. Appraise the effects of one paradigmatic treatment for schizophrenia, bipolar I disorder, and major depressive disorder.

Introduction to Neuropathology

1. Identify neurons and all type of glial cells, and describe their normal functions and reactions to injury.
2. Discuss the significance of the rough endoplasmic reticulum (RER aka Nissl substance) and how it reacts to axotomy.
3. Identify the basic components of the neuronal cytoskeleton and describe how alterations of some of these components are associated with neurodegenerative diseases.
4. Discuss the uses of silver stains in the histological study of the CNS.
5. Recognize that GFAP is a key protein of astrocytes.
6. Describe how myelin is formed and what cells make myelin in the CNS and PNS.
7. Describe the role of microglia in CNS inflammation and repair.

Ischemic Stroke & Hemorrhagic Stroke

1. Recognize the general presentation of a large vessel or small vessel ischemic stroke and Transient Ischemic Attack (TIA).
2. Recognize the presentation of a ruptured intracranial aneurysm, intracerebral hemorrhage, subdural hemorrhage, and epidural hemorrhage.
3. Discuss the non-atherosclerotic causes of stroke in a young patient.
4. Discuss the importance of mechanism of stroke in both resuscitation and prevention.
5. Discuss the basic principles of emergency treatment of ischemic stroke or hemorrhage.
6. Discuss how to modify metabolic, lifestyle, and structural risk factors for stroke.

Limbic System - Hippocampus and Memory

1. Differentiate between declarative and procedural memory and describe the kind of memory impaired in lesions of the hippocampus versus the cerebellum/basal ganglia.
2. Recognize the concepts of short-term, working, and long-term memory and discuss the kind of memory affected by lesions of the frontal cortex.
3. Discuss the experimental evidence showing that the neocortex is the site for long term memory storage.
4. Discuss the reason for the memory deficits displayed by patient HM.
5. Describe how Long Term Potentiation (LTP) can account for associative memory.
6. Discuss under what circumstances hippocampal synapses undergo Long Term Potentiation (LTP).
7. Describe the molecular basis for Long Term Potentiation (LTP).
8. Describe how synapse formation and adult neurogenesis are involved in learning and memory.
9. Discuss the amyloid hypothesis of Alzheimer's and the implications of this hypothesis for development of new treatments for this disease.
10. Recognize the role of the limbic system and amygdala in emotion.
11. Describe the mechanism of conditioned flavor aversion.

Limbic System and Physiology of Emotion

1. Recognize the anatomical relationships between the insula, ventromedial prefrontal cortex, olfactory tract, amygdalae, and ventral striatum.
2. Describe the roles of the amygdalae, ventral striatum, ventral tegmental area, and ventromedial prefrontal cortex in current theories of emotion and theories of decision-making.
3. Recognize the basic principles of optogenetic neuromodulation, and its utility in studying neuronal populations of mixed cell types.
4. Describe the “communication through coherence” hypothesis. Describe the role oscillations in local fields appear to play in integration of sensory, motor, and physiologic components of an emotional state.

Local Anesthetics

1. Describe how local anesthetics differ in action from tetrodotoxin and saxitoxin.
2. Describe the side effects of local anesthetics.
3. Describe the rationale for use of a vasoconstrictor with a local anesthetic.
4. Describe the methods of local anesthetic application.
5. Describe the physicochemical properties of local anesthetics that determine potency, onset, and duration of drug action.
6. Describe the molecular target and structure-based mechanism of action of local anesthetics.
7. Describe the role of pH in determining the effectiveness of local anesthetics.
8. Describe the structural and chemical differences between amide and ester local anesthetics.
9. Describe the general structure of local anesthetics, and key chemical properties of the structures.

Mood Disorders

1. Discuss the epidemiology of mood disorders and disability, both world wide and in the United States.
2. Discuss common signs and symptoms of depression and bipolar disorder, and criteria for diagnosis.
3. Discuss subcategorization of depression (atypical, psychotic, melancholic) and bipolar disorder (bipolar I and II disorder).
4. Discuss the differential diagnosis of mood disorders.
5. Discuss current theories concerning etiology and pathophysiology of major depression and bipolar disorder.
6. Discuss risk factors for suicide, demographics, epidemiology.

Motor System I: Spinal Cord; Motor System II: Spinal Cord/Brainstem; Motor System III: Motor Cortex

1. Define a motor unit. Relate the motor unit concept to the “size principle” for recruitment of muscles. Recognize how exercise influences the motor unit.
2. Illustrate what is meant by “somatotopy” of motor neurons. Identify where within the motor system alpha motor neurons are organized somatotopically
3. Compare and contrast muscle spindles and Golgi tendon organs in terms of what sensory information they encode, where they are located, and their innervation of motor neurons and interneurons.
4. Describe the basic stretch reflex circuit.
5. Describe how coactivation of alpha and gamma motor neurons leads to rapid error correction in movements.
6. Describe extensor-flexor coupling circuits and the crossed-extensor reflex.
7. Define a central pattern generator. Describe a behavior that uses one and where it resides.
8. Justify what is meant by the term ‘hierarchical organization’ of the motor system.
9. Compare descending pathways that control finger movement vs axial musculature. Identify where these pathways are situated within the spinal cord.
10. Summarize an organizational principle of motor cortex.
11. Name two ways in which motor cortical plasticity is advantageous for recovery and/or treatment of diseases or damage to the motor system.

Motor System IV: Basal Ganglia

1. Describe the role of the basal ganglia in motor control.
2. Discuss the major source of input to the basal ganglia.
3. Describe the character and probable cause of Parkinson's disease.
4. Discuss whether the basal ganglia inhibitory or excitatory.
5. Discuss the genetic cause of Huntington’s Disease and describe the areas of the basal ganglia affected.
6. Describe the “direct path” from the cortex to basal ganglia and eventually back to cortex (which synapses are excitatory and which are inhibitory).
7. Describe the role that dopaminergic neurons in the VTA/SNc play in conveying reward prediction errors to the striatum.
8. Describe similarities between the role the ION plays in modifying cerebellar circuitry and the role that VTA/SNc neurons play in modifying corticostriatal circuitry.

Motor System V: Cerebellum

1. Discuss the connections of the cerebellar deep nuclei.
2. Discuss the types of deficits arise from cerebellar damage.
3. Recognize the cellular constituents of the cerebellar cortex.
4. Identify cells of the cerebellar cortex that have inhibitory actions.
5. Identify inputs to the cerebellum that are carried by climbing fibers.
6. Describe the role of the climbing fiber input in motor learning and explain the sequence of events that occurs in the cerebellar cortex during visual-motor learning.
7. Describe how the inferior olivary nucleus might contribute to this adaptation.

Movement Disorders

1. Define movement disorder.
2. Evaluate the phenomenology of movement disorder.
3. Differentiate between hyper and hypokinetic movement disorders.
4. Define Parkinsonism and list the cardinal motor symptoms of Parkinson's disease.
5. Recognize the clinical features of Parkinson's Disease and Parkinson's Plus disorders.
6. Evaluate the phenomenology of tremors.
7. Recognize the clinical features of hyperkinetic movement disorders: Essential tremor, Tics/Tourette's, Chorea/Huntington's disease, dystonia.
8. Recognize the features of functional movement disorders (also known as psychogenic).

Neoplasms I & II

1. Recognize the World Health Organization (WHO) grading system for selected examples of primary CNS neoplasms.
2. Compare and contrast the WHO grade I tumor that is usually amenable to cure by surgical resection alone to the diffuse astrocytomas and oligodendrogliomas grades II through IV that are NOT curable by resection alone.
3. Discuss how the histological typing and grading of the Grade I - IV tumors correlates strongly with prognosis and affects treatment.
4. Identify which tumor type(s) tends to spread throughout the Cerebrospinal Fluid (CSF) axis.

Nervous System Development I-III

1. Discuss when and where neurogenesis occurs.
2. Describe the changes in nuclear position that occur during the cell cycle of neuronal precursors.
3. Describe methods used to study neurogenesis.
4. Describe what is meant by a neuron's birthdate and discuss whether a neuron's birthdate influences its differentiation.
5. Identify which brain regions are areas of secondary neurogenesis.
6. Describe what is known about neurogenesis in the adult brain and discuss key questions for future research.
7. Draw and describe an asymmetric cell division.
8. Describe factors/mechanisms that determine when a cell stops dividing and begins differentiating.
9. For both the cerebral cortex and retina, describe where the first-born cells are found with respect to the ventricular zone.
10. Define preplate and subplate with respect to neuronal migration.
11. Describe the role that radial glia play in neuronal migration.
12. Define and describe 3 stages of neuronal migration in the cerebral cortex.
13. Describe genes that play a role in neuronal migration in the cerebral cortex and which stages of migration they affect.
14. Define radial, tangential and chain migration and identify what class of neurons undergoes radial migration, tangential migration, and chain migration.
15. Describe neural crest cells and the neuronal populations they give rise to.
16. Contrast migration of neural crest cells to radial migration in the cerebral cortex.
17. Compare and contrast "apoptosis" with "necrosis".
18. Describe when cell death occurs in the nervous system.
19. Define and describe what are neurotrophins and the roles they play in neuronal development.
20. Provide examples of long-range and short-range axon guidance molecules and identify which are attractive or repulsive.
21. Identify factors that influence the ability of axons to regenerate.
22. Describe normal postnatal changes in brain morphology and how Autism Spectrum Disorder (ASD) and Down Syndrome affect these normal developmental changes in neuronal morphology.
23. Describe when myelination occurs.
24. Describe two ways in which function of GABA receptors is developmentally regulated.
25. Define synapse elimination and discuss when and where it occurs.

Neurodegenerative Pathology

1. Describe the neuropathologic features of Alzheimer disease and the criteria neuropathologists use at autopsy to make the diagnosis.
2. Describe the range of clinical and neuropathologic presentations of frontotemporal lobar degeneration.
3. Recognize the anatomic regions affected by amyotrophic lateral sclerosis as well as the microscopic features necessary for the diagnosis.
4. Describe the brain regions involved by and histopathologic features of Lewy body disease -- including Parkinson disease and Dementia with Lewy Bodies.
5. Describe the neuropathologic features of Huntington disease as well as the fundamental genetic abnormality underlying the disease.

Neuromuscular Junction and Muscle Disorders

1. Recognize the tempo and pattern of weakness in myasthenia gravis (MG).
2. Discuss the immunopathogenesis and treatment of myasthenia gravis (MG).
3. Recognize the pattern of weakness in Duchenne/Becker dystrophy.
4. Describe the specific genetic defect in Duchenne muscular dystrophy (DMD).
5. Identify pathologic changes of muscle that occur in Duchenne/Becker dystrophy.

Neurons, Glia & Brain Tissue

1. For each of the following, identify which is gray matter and which is white matter: nucleus, lemniscus, ganglion, peduncle, cortex, funiculus, body, fasciculus, tract.
2. Describe the function and distribution of each of the following cell types: astrocyte, microglia, oligodendrocyte, Schwann cell.
3. Describe the general function of each of the following parts of a neuron: dendrite, axon, axon terminal, Nissl substance.
4. Describe the relationship between cerebral blood flow and fMRI and PET scans.
5. Discuss why substances in the circulatory system do not freely enter the brain parenchyma.
6. Describe how astrocytes can regulate local blood flow in proportion to the neuronal activity in the area.
7. Describe the differences in neural regeneration and glial response comparing the peripheral and central nervous systems.

Neuro-Ophthalmology

1. Describe the appropriate clinical examination steps and causes of pupillary disturbances.
2. Describe the key features of visual field loss due to neurologic visual pathway disturbances and key clinical features of optic nerve disturbances.
3. Explain steps involved in the clinical approach to complaints of diplopia and describe features of the most common cause for the complaint of oscillopsia.

NMJ Neuropharmacology

1. Describe how botulinum toxin and black widow spider venom affect cholinergic neurotransmission.
2. Explain what happens with brief versus prolonged stimulation of nicotinic cholinergic receptors.
3. List the 3 categories of cholinesterase inhibitors and describe the relation between the nature of the inhibitor interaction with AChE and its duration of action and clinical utility [edrophonium - neostigmine - organophosphates].
4. Describe the different properties of curare, atracurium and rocuronium all nondepolarizing (competitive) neuromuscular blocking agents that make them useful/not useful in different clinical situations.
5. Describe the properties that make succinylcholine distinct from other clinically used neuromuscular blocking agents.
6. Explain the distinct effects of cholinesterase inhibitors on nondepolarizing vs. depolarizing neuromuscular blocking agents.
7. Outline the physiological events leading to skeletal muscle contraction and describe potential drug targets for pharmacotherapy.
8. Describe the pharmacologic actions of cholinesterase inhibitors and why they affect both muscarinic and nicotinic cholinergic transmission.
9. Describe the management of organophosphate poisoning.
10. Describe the properties that make succinylcholine distinct from other clinically used neuromuscular blocking agents.

Nociception I - III

1. Recognize the pathways for processing of pain and temperature information and, describe where pain and temperature information is first detected, where the information first enters the central nervous system, and how the information gets to the brain.
2. Recognize the type of receptors that detect temperature information.
3. Describe how temperature receptors code their information.
4. Discuss the types of manipulations that distinguish first pain from second pain.
5. Discuss the stimuli that activate polymodal receptors.
6. Identify chemicals that act as pain activators and sensitizers.
7. Identify the stimuli that activate the VR-1 receptor and where the VR-1 receptor is located.
8. Differentiate between A-delta and C pain fibers and the types of pain information they carry.
9. Identify the location of the first synapse in the pain pathway and the neurotransmitters that operate at this synapse.
10. Describe the differences between and the properties of AMPA and NMDA receptors at the dorsal horn synapse.
11. Discuss the basis for peripheral sensitization.
12. Discuss the basis for central sensitization (e.g., at the dorsal horn synapse).
13. Describe the basis for the analgesic action of aspirin.
14. Describe the basis for the triple response.
15. Identify the location of action and describe the effects of Substance P.
16. Describe the role of the periaqueductal gray (PAG) in modulation of pain.
17. Describe the bases for the placebo effect and stress-induced analgesia.
18. Describe mechanisms underlying neuropathic pain.
19. Describe what is meant by “modality segregation” in the spinal cord and its relationship to referred pain.
20. Describe the mechanistic basis for why dorsal column stimulation and TENS produce analgesia.
21. Identify the chemicals that act to produce analgesia.
22. Discuss the mechanistic basis for why rubbing a painful area can produce analgesia.

Ocular Pharmacology

1. Describe the special aspects of ocular pharmacokinetics that influence the effectiveness of the topical route of administration.
2. Relate the anatomy and function of the eye to the drug targets for pharmacotherapy for glaucoma, especially the production and outflow of aqueous humor and the role of autonomic nervous system regulation.
3. For the following drugs: Describe their mechanism of action, their role in glaucoma treatment, and list their use-limiting systemic side effects and contraindications.
Prostaglandin analogs: Latanoprost (Xalatan,,μ)
Alpha-adrenergic agonists: Brimonidine (Alphagan,,μ)
Beta-adrenergic antagonists. Timolol (Timoptic,,μ)
Carbonic anhydrase inhibitors: Dorzolamide (Trusopt,,μ)
Cholinomimetics: Pilocarpine (Ocuser,,μ)
4. Discuss the pharmacology of the antimicrobial agents antihistamines, vasoconstrictors, anti-inflammatory glucocorticoids, and NSAIDs with respect to their use in ocular pharmacotherapeutics (use-administration-side effects).

Ophthalmology I - Anterior Segment

1. Discuss common eye diseases including glaucoma and cataracts.
2. Recognize ocular emergencies and the need for emergent Ophthalmology referral.
3. Develop a differential diagnosis and treatment options for patients presenting with a “red eye”.
4. Review a basic eye exam for the anterior segment.

Ophthalmology II - Posterior Segment

1. Describe basic eyelid, lacrimal, and orbital anatomy and physiology (e.g. eyelid, orbicularis, orbital structures, meibomian glands, lacrimal glands, glands of Zeiss, Whitnall's ligament, Muller's muscle, Lockwood's ligament, canaliculi, puncta, orbital bones, orbital foramina, paranasal sinuses, annulus of Zinn, arterial and venous vascular supply, lymphatics, nerves, extraocular muscles).
2. Describe basic mechanisms and indications for treatment of eyelid, orbital and lacrimal trauma.
3. Describe the clinical characteristics and treatment of common adult and pediatric orbital tumors.
4. Describe the clinical characteristics and treatment of common adult and pediatric eyelid malpositions and tumor.
5. Describe features of, evaluate, and treat more complicated cases of nasolacrimal duct obstruction, canaliculitis, dacryocystitis, acute and chronic dacryoadenitis, preseptal cellulitis, and orbital cellulitis.
6. Recognize, evaluate, and treat thyroid ophthalmopathy (e.g. epidemiology; symptoms and signs; associated systemic diseases; orbital imaging; differential diagnosis; surgical, medical, and radiation indication; side effects of treatment).

Opioid Analgesics I & II

1. Recognize the medical circumstances in which opioids are indicated and contraindicated.
2. Discuss the potential adverse interactions of opioids with other drugs.
3. Discuss the life-threatening side effects of opioid drugs and the appropriate means to avoid/treat these actions.
4. Describe the mechanism by which opioids act upon the central and peripheral nervous systems.
5. Define tolerance and dependence, and discuss the degree to which these phenomena develop in various opioid-sensitive systems.
6. Identify the sites of opioid action in the CNS and periphery.
7. Recognize that in chronic pain associated with terminal malignancy, the responsibility of the physician is to ensure that the patient is pain-free and comfortable.
8. Recognize the different classes of endogenous opioids and list representatives of each class.
9. Recognize the names and describe the uses of opioid agonists from each classification.

Otology

1. Describe the common types of pathology underlying sensory hearing loss.
2. Discuss the most common causes of conductive, sensory and neural hearing loss.
3. Recognize conductive versus sensory hearing loss on an audiogram.

Overview of Sensory Systems and Receptors

1. Describe the basis for the receptor (generator) potential in terms of the opening or closing of ion channels.
2. Explain how, in different sensory systems, stimulation by the sensory stimulus results in either depolarization, hyperpolarization or oscillatory changes in membrane potential.
3. Describe how we perceive the modality of a stimulus, using the concept of “labeled lines.”
4. Explain how stimulus intensity is encoded by sensory receptors.
5. Explain how receptive fields differ between sensory receptor cells and cortical neurons.
6. Explain how peripheral nerves innervating the skeletal muscles and the skin are classified with respect to diameter, myelination, and conduction velocity.

Pain Management

1. Describe the classification schemes of pain relating to duration, intensity, and origin of the pain.
2. Compare and contrast the components of nociceptive pain vs neuropathic pain emphasizing those aspects that are most relevant to targeting pharmacotherapy.
3. Describe the mechanistic approach to multimodal management of acute pain.
4. Describe the role of each of the following pharmacotherapeutic categories in the management of acute pain (review the pharmacology that has been presented in other lectures – efficacy / pharmacokinetics / side effects): Opioid analgesics; NSAIDs - Acetaminophen - COX-2 inhibitors; Local anesthetics; and α -2 adrenergic agonists / NMDA receptor antagonists.
5. Describe the mechanistic approach to the treatment of chronic pain.
6. Describe the role of each of the following pharmacotherapeutic categories in the management of chronic pain (review the pharmacology that has been presented in other lectures – efficacy / pharmacokinetics / side effects): Adjuvant medications (TCADs / SNRIs / SSRIs / anticonvulsants / local anesthetics); Nonopioid analgesics; and Opioid analgesics.

Pathology of Stroke - Demo

1. Discuss the correlation between physical exam findings, anatomic localization and formulation of a differential diagnosis in this case.

Personality Disorders

1. Describe the general diagnostic criteria for a personality disorder.
2. Name the ten DSM-5 personality disorders and the 3 clusters into which they are grouped.
3. Summarize what is meant by “Axis II disorder” and why DSM-5 no longer uses the axis system.
4. Discuss the continuum from personality styles to personality disorders, and how to tell when a “style” has crossed the border into a pathological “disorder”.
5. Outline key points of each of the ten personality disorders.

Pharmacologic Management of Headaches

1. List the recommended pharmacotherapeutic agents for prophylaxis and abortive therapy of migraine, cluster, and tension headaches.
2. Describe the role of serotonin neuronal systems in the pathogenesis of migraine headache and identify the primary targets for therapeutic intervention.
3. Describe the general treatment approach to termination of migraine headaches.
4. Describe the general treatment approach to prophylaxis of migraine headaches, including a discussion of the following drugs or drug classes utilized and their relative efficacy and safety: Beta blockers (propranolol), calcium channel blockers (verapamil), antidepressants (amitriptyline) and anticonvulsant agents (topiramate).
5. For the following abortive agents or class of agents: Triptans (sumatriptan/zolmitriptan), NSAIDS (ibuprofen/naproxen), and ERGOT ALKALOIDS (dihydroergotamine); discuss mechanisms of action, route of administration, rate of onset and duration of action, and most and use-limiting side effects.
6. Describe medication overuse headache and the relative risk of associated with use of the various pharmacotherapeutic classes used to treat headaches.

Pharmacology of Ethanol

1. Describe the management of acute alcohol intoxication and withdrawal.
2. List the major drug-drug interactions associated with alcohol use.
3. Explain tolerance to, dependence on, and withdrawal from ethanol.
4. Describe the effects of ethanol on: the CNS (esp. the mechanism of acute neuronal actions), liver, kidney, GI tract, and fetus (Fetal Alcohol Syndrome).
5. Describe the role of NADH in alcohol metabolism and the metabolic disruptions associated with alcohol abuse.
6. Describe the site of action of Antabuse,™ (disulfiram) and the aversive actions of acetaldehyde.
7. Describe the absorption, distribution, and metabolism of ethanol and their relationship to the blood alcohol concentration (BAC).

Pharmacology of Parkinson's Disease (plus CPC with patient)

1. Describe neurochemistry of Parkinson's Disease.
2. Discuss the rationale for drugs to improve clinical symptoms.
3. Recognize Parkinson's drugs in a drug list.
4. Recognize the pathways of excitation/inhibition in the basal ganglia.

Pharmacology of Psychoses

1. Explain the dopamine theory of schizophrenia and its limitations and describe the mechanism of antipsychotic drug action (including a description of brain dopamine systems affected).
2. For chlorpromazine, haloperidol, clozapine, risperidone, olanzapine, and aripiprazole: 1) compare and contrast the relative incidence of side effects (sedation, autonomic, cardiovascular, extrapyramidal symptoms (EPS) and describe their treatment, 2) identify the neurotransmitters and receptors affected, 3) list their uses (including non-psychiatric), and 4) explain factors in drug choice and dosing considerations.
3. Discuss the potential role of abnormalities in glutamate neuronal systems in the symptomatology of psychoses.
4. Describe the relationship between receptor blocking potency-selectivity (esp. 5HT vs DA), efficacy in schizophrenia, and side effect profile for typical and atypical antipsychotic agents.

Pharmacology of Reward

1. Identify the brain structures and systems that are thought to comprise the brain reward pathway.
2. Describe the central role of brain dopamine systems in learning physiologically relevant behaviors and possible contributions of other neurotransmitter systems.
3. Describe the interaction of drugs of abuse with brain reward pathways in the development of addictive behaviors.
4. Describe the contribution of pharmacodynamics, pharmacokinetics (rapidity of onset-route of administration and half-life) and pharmacogenetics to the abuse liability of an individual drug.

Pharmacotherapy of Anxiety and Insomnia

1. Relate the pharmacokinetic profile of benzodiazepines (BDZs) and nonbenzodiazepine receptor agonists (NBRAs) to their clinical utility in the treatment of insomnia.
2. Relate the effects of benzodiazepines and nonbenzodiazepine receptor agonists on sleep stages to their clinical utility in the treatment of insomnia.
3. Compare the side effect profiles of the three broad categories of drugs for insomnia (BDZs, NBRAs, and non-GABA drugs) as they relate to limitations on the clinical utility of each.
4. Review the pharmacodynamics of benzodiazepine and nonbenzodiazepine receptor agonist interaction with the GABA-chloride channel complex presented in anti-anxiety drug lecture.

PNS Neuropharmacology

1. Describe the responses of end organs to physiologic activation of the sympathetic and parasympathetic nervous systems.
2. List the steps in the synthesis, storage, release and inactivation of acetylcholine, and drugs that affect these processes.
3. List the locations of and the differences between nicotinic and muscarinic cholinergic receptors.
4. Describe the signal transduction mechanisms activated by stimulation of nicotinic versus muscarinic cholinergic receptors.
5. List the pharmacologic actions of direct acting muscarinic agonists and antagonists.
6. Describe the pharmacokinetic disposition of muscarinic agonists and antagonists and the relevance to their uses and side effects.

Psychiatry Interviews - AA Members (Required)

1. Use the "alcohol/drug abuse" screen and any other screen found appropriate from the CU Assessment of Common Psychiatric Problems booklet.

Psychiatry Interviews - Anxiety Disorders (Required)

1. Begin utilizing the 30 minute 3-part interview in the CU log.
2. Identify what led to the misdiagnosis.
3. Describe diagnostic pitfalls distinguishing pseudo from "real" movement disorders.
4. Actively participate in the post interview discussion.
5. Generate a SOAP note.

Psychiatry Interviews - Autism (Required)

1. Employ basic interviewing skills in the generation of a differential diagnosis of a child with a developmental disorder.
2. Employ basic interviewing skills to elicit some understanding of the impact of the disorder on the patient's family.
3. Recognize the common symptoms and presentations of patients with developmental disorders.

Psychiatry Interviews - Chronic Pain (Required)

1. Utilize the "depression" screen, the "anxiety" screen and any other screen found appropriate from the CU Assessment of Common Psychiatric Problems booklet.
2. Employ basic interviewing skills in the generation of a differential diagnosis of patients with somatic complaints.

Psychiatry Interviews - Cognitive Disorders (Required)

1. Employ the "mini-mental state examination", the "frontal assessment battery", and any other screen found appropriate from the CU Assessment of Common Psychiatric Problems booklet.
2. Employ basic interviewing skills to elicit some understanding of the impact of the disorder on the patient's family.
3. Discuss the common symptoms and presentations of patients with cognitive disorders (delirium and dementia).

Psychiatry Interviews - Psychiatric Disorders (Required)

1. Use the "depression" screen, the "suicide" screen, the "psychosis" screen, and any other screen found appropriate from the CU Assessment of Common Psychiatric Problems booklet.

Psychiatry Interviews - Psychotic Disorders (Required)

1. Use the "depression" screen, the "suicide" screen, the "psychosis" screen, and any other screen found appropriate from the CU Assessment of Common Psychiatric Problems booklet.

Psychiatry Interviews - PTSD (Required)

1. Utilize the "Trauma & PTSD" screen, the "suicide" screen and any other screen found appropriate for your patient interview from the CU Assessment of Common Psychiatric Problems booklet.

Psychotic Disorders I

1. Discuss the diagnostic criteria for schizophrenia, its prevalence, and usual age of onset.
2. Discuss the proposed causes of schizophrenia, including genetic and environmental factors.
3. Discuss the proposed role of the major neurotransmitters and neural circuits involved.
4. Recognize the major classes of antipsychotic drugs, and describe their side effects and proposed mechanism of action.

Psychotic Disorders II (plus CPC with Patient)

1. Discuss the diagnostic criteria for schizophrenia, its prevalence, its symptoms, and usual age of onset.
2. Discuss the role of pyramidal and inter-neurons in psychosis.
3. Explain the neurodevelopmental hypothesis of schizophrenia.
4. Recognize which symptoms current antipsychotic treatments are effective for and which are relatively resistant to current treatments.

PTSD: The Changed Brain

1. Utilize the PTSD screen for primary care.
2. Describe the diagnostic criteria for PTSD.
3. Describe the major neurophysiologic changes associated with PTSD.

Rotation: Gross Brain Lab (Required)

1. Identify the circle of Willis as well as the major vessels leaving it.
2. Identify areas of the brain that are irrigated by the anterior cerebral artery, middle cerebral artery, and posterior cerebral artery.
3. Describe the venous drainage through the superior sagittal sinus and transverse sinus.
4. Identify cerebral arteries on cerebral angiograms.
5. Identify the major structural features of the Brain's Lateral surface.
6. Identify the major structural features of the Brain's ventral surface.
7. Identify the major structural features of the Brain's mesial (hemisected) surface.
8. Identify the cerebellar hemispheres, vermis, anterior and posterior lobes, flocculus and nodulus.
9. Identify the lateral, third, and fourth ventricles, the foramina of Munro, Magendie, and Luschka.
10. Locate the cisterna magna and interpeduncular cistern, describe the path of CSF flow through the ventricles into subarachnoid space, and discuss what happens if there is an obstruction to CSF flow.
11. Identify the structures listed in the handout on coronal and axial (horizontal) sections of the brain and distinguish between an axial and coronal section.

Rotation: Pharmacology (Required)

1. Referring to the bolded drugs from the drug lists, list the subtype specific agonists and antagonists for the SNS (alpha1, alpha2, beta1, beta2) and PNS (M and Nn).
2. Referring to the bolded drugs from the drug lists, describe the mechanism and site of action (direct vs indirect for agonists - receptors and effector organs involved).
3. Referring to the bolded drugs from the drug lists, describe the pharmacokinetic factors (if clinically relevant) including: distribution to CNS (central vs peripheral activity), organ of elimination (renal dosing-metabolic drug interactions), and duration of action - short vs long.
4. Referring to the bolded drugs from the drug lists, describe the major clinical uses.
5. Referring to the bolded drugs from the drug lists, describe the most common and most severe side effects (including treatment of overdose / toxicity).
6. Referring to the bolded drugs from the drug lists, describe the significant contraindications for each.

Rotation: Spinal Cord Lab (Required)

1. Describe the functions and pathways within the spinal cord of the 3 major spinal tracts: Anterolateral system, Dorsal column-medial lemniscus, and Corticospinal tract.
2. Discuss the functional consequence for hemileSIONS of the cord at different levels (Brown-Sequard syndrome).
3. Describe the general layout of gray matter in the spinal cord in anterior (or ventral) horn, intermediate gray, and the dorsal horn.
4. Recognize where along the length of the spinal cord a section is taken from: sacral/lumbar, thoracic, lower cervical, upper cervical, and discuss why the cord is enlarged in lumbar and lower cervical levels.
5. Describe 1) the flow of information from sensory receptors in the skin and muscle to brain stem and spinal cord, 2) the function of the axon collaterals originating in the dorsal (posterior) root ganglia (PRG) that terminate in spinal cord, and 3) the function of axons originating in the neurons in the PRG that ascend and terminate in brain stem.
6. In representative sections of the spinal cord at different levels, identify the posterior fasciculus and its two subdivisions [fasciculus gracilis (FGr) and fasciculus cuneatus (FCu)] and the information these carry, and discuss the effects of lesions of these structures.
7. In reference to the pathways of the anterolateral system, describe the ascending flow of information from pain and temperature sensory receptors with soma in the PRG and sensory endings in the skin to spinal cord, and subsequently to thalamus.
8. In representative sections of the spinal cord at different levels, identify dorsolateral tract (Lissauer's tract), the substantia gelatinosa, and the location of the anterolateral tract, and describe the effects of lesions at different levels of this pathway.
9. Describe the symptoms occurring after damage of either upper motor neurons or lower motor neurons.
10. Identify the location of neuron cell bodies for preganglionic parasympathetics.

Rotation: Synaptic Physiology Lab (Required)

1. Recognize and understand the events that underlie the visually-observed transition from individual muscle twitches to a tetanus as the frequency of stimulation to the motor nerve is increased.
2. Describe the main experimental observations that underlie the Quantum Hypothesis of transmitter secretion.
3. Differentiate between spontaneous miniature end plate potentials (MEPPs) and nerve-evoked end plate potentials (EPPs).
4. Describe the effects on synaptic transmission of bathing a preparation in a solution containing curare, and a solution containing elevated Mg/low Ca ion concentrations.
5. Describe the mechanisms by which curare and elevated Mg/low Ca solutions produced their effects.
6. Recognize the effects of neostigmine on synaptic transmission, and describe the drug's mechanism of action.
7. Describe synaptic facilitation and synaptic depression and how they interact during repetitive stimulation in curare and in elevated Mg/low Ca solutions.
8. Describe the causes of myasthenia gravis and the myasthenic syndrome, and the effects of these diseases on synaptic transmission at the neuromuscular junction.

SNS Neuropharmacology

1. Describe the elements of adrenergic neurotransmission (neurotransmitter synthesis, storage, release, inactivation, interaction with receptors, and signal transduction mechanisms) that represent targets for adrenergic agonist and antagonist drug action.
2. Distinguish the different mechanisms of actions for direct-acting versus indirect acting adrenergic agonists.
3. Describe the relationship of drug structure to pharmacokinetics with regards to absorption, distribution, and duration of action of adrenergic agonists.
4. Compare the modes of action of adrenergic antagonists (sympatholytic agents vs receptor blocking agents) with respect to selectivity of action and overall clinical utility.
5. Describe how an agonist of α_2 adrenergic receptors can have antagonistic effects on the SNS.

Somatic Complaints and Pain

1. Describe the general prevalence of pain and other somatic complaints.
2. Describe three ways in which physical pain and emotional pain interact.
3. Name three DSM-5 disorders in which psychological distress is the primary cause of the patient's pain or other physical symptoms.
4. Summarize the difference between factitious disorder and malingering.
5. Outline key points in a sensitive and effective interview of a patient with chronic pain.

Speech and Aphasia

1. Be familiar with the primary progressive aphasia.
2. Recognize the distinction between aphasia and amnesia.
3. Explain the relationship between handedness and cerebral language dominance.
4. Define the syndrome of aphasia.
5. Describe the neuroanatomy of Broca's, Wernicke's, conduction, and global aphasia.

Spinal Cord I & II

1. Discuss the meaning of the following terms: paresthesia, dysesthesia, paresis, dermatome, myotome, radiculopathy, and myelopathy.
2. Describe the functions of the three major spinal tracts and identify where they cross the spinothalamic tract (pain and temperature), posterior columns (vibration and position), and the corticospinal tract (motor).
3. Identify where the nerve roots exit (e.g., C6 root exits between C5-C6 and T2 roots between T2-T3).
4. Identify the spinal cord level that each vertebral body overlies (e.g., C6 bone overlies C7 cord).
5. Recognize the symptoms of a radiculopathy and describe Lhermitte's symptom.
6. Recognize the neurologic signs used to distinguish lesions affecting the lower motor neurons versus those affecting the upper motor neurons.
7. Describe the major tract deficits associated with ten spinal cord syndromes.
8. Distinguish conus medullaris syndrome from cauda equina syndrome.
9. Recognize the basic neural pathways involved in the control of micturition and differentiate between upper motor neuron and lower motor neuron lesions affecting bladder function.
10. Recognize the sensory territory, unique motor territory, and reflex components of the C5,C6,C7 and L4,L5,S1 nerve roots.
11. Describe the thoracic dermatomes that typically cover the nipple line, xyphoid, and umbilicus.
12. Describe ALL of the material presented in neuroexam.com under "reflexes" (except the material on "reflexes tested in special situations").

Stroke and Interventional Radiology

1. Recognize the treatment of acute infarcts.
2. Describe the appearance of infarcts on CT and MR.
3. Discuss the use of Perfusion CT and CT Angiography in the workup of acute infarcts.

Substance Use Disorders I

1. Name commonly use screening instrument for substance use disorders and at-risk drinking.
2. Discuss how the following matters influence substance-taking and what treatment interventions may address which items: substance availability, acceptability, pharmacological reinforcement, history of prior substance use, genes, sex, age, a risk-taking predisposition, stress, pharmacological punishment of substance use, social punishment of substance use, and social reinforcement of non-use of substances.
3. Describe basic biologic mechanisms that contribute to substance use disorder risk.
4. Describe the clinical definition of a substance use disorder.
5. Describe symptoms of alcohol and opioid withdrawal.

Substance Use Disorders II

1. List the available agents and their mechanisms of action for treatment of alcohol use disorders.
2. List the available agents and their mechanisms of action for treatment of opioid use disorders.
3. List the available agents and their mechanisms of action for treatment of nicotine use disorders.
4. Describe the basic principles of motivational interviewing.
5. Describe the basic principles of contingency management.

Synaptic Physiology I-III

1. Describe the mechanism of the action potential and the Nernst equation.
2. Define electrical synaptic transmission, name a limitation of this form of intercellular communication (compared to chemical transmission), and describe why it would be ineffective at the neuromuscular junction and whether this method of communication is important in the mammalian CNS.
3. Name the presynaptic events involved in transmitter release, from the time of the arrival of an action potential to exocytoses, and describe the subsequent presynaptic events involved in cleanup operations, both outside the cell (consider the neurotransmitter molecules) and inside the cell (consider sodium ions, calcium ions, synaptic vesicles, and neurotransmitter).
4. Describe the 'job description' for a motor nerve terminal.
5. Describe how the neuromuscular synapse amplifies the incoming signal in order to depolarize the muscle fiber to threshold for an action potential.
6. Define facilitation and synaptic depression of transmitter release. Name the underlying mechanism of each.
7. Describe the basic mechanism that determines whether a synapse is direct (fast) or indirect (slow) and name a typical physiological response mediated by each.
8. Describe the conductance (permeability) characteristics of the channel opened in fast excitation, and define the electrical "driving force" and the reversal potential for direct excitation.
9. Describe the kind of channel that is opened during fast inhibition in the CNS.
10. Describe why inhibition is often more powerful than one might predict from the size of an individual inhibitory postsynaptic potential (IPSP).
11. Define temporal and spatial summation of postsynaptic potentials.
12. Describe the three mechanisms for removing transmitters from synaptic clefts.
13. Describe how activation of NMDA receptors can lead to synaptic strengthening and how such a mechanism might lead to behavioral associative conditioning.
14. Define a coincidence detector and describe how the NMDA receptor works as a coincidence detector.
15. Name examples of electrical synaptic transmission.
16. Name the postsynaptic events involved in synaptic transmission.
17. Describe how the tetanus toxin and botulinum toxin act.
18. Define the safety factor at the neuromuscular junction, and discuss whether and why/why not safety factors are present at CNS synapses.
19. Define LTP and LTD and how each is involved in learning and memory.

Thalamocortical Physiology

1. Describe why the thalamus, which is a deep structure and therefore cannot contribute directly to the EEG, does contribute to the signals recorded in an EEG and recognize that the contribution of thalamus to EEG recording is due to thalamocortical connections.
2. Recognize that thalamic relay neurons have conductances that endow them with the ability to respond to a hyperpolarization with slow Ca²⁺ spikes that fire at a frequency of ~3 Hz (the delta frequency).
3. Recognize that unless thalamic relay neurons are hyperpolarized by inhibitory interneurons in the thalamic reticular nuclei, the thalamic relay neurons cannot fire the slow Ca²⁺ spikes that give rise to the slow delta wave recorded in the EEG during slow wave sleep.
4. Describe how thalamocortical connections – between the thalamic relay neurons and the pyramidal cortical neurons – are such that the Ca²⁺ spikes occurring in thalamic relay neurons at the delta frequency give rise to a slow wave in the delta frequency in the EEG.
5. Discuss how slow EEG waves recorded in absence epilepsy (at the δ frequency ~3 Hz) are thought to stem from thalamocortical oscillatory activity and describe why a mutation in the T type Ca²⁺ channel could give rise to this type of epilepsy.
6. Recognize that ascending brain-stem circuits sending axons to the thalamus regulate the thalamocortical circuit.

The Frontal Lobes and Hippocampus

1. Describe the result of bilateral hippocampal dysfunction.
2. Describe the basic deficits observed with selective injury to the dorsolateral, ventromedial, or anterior cingulate components of the prefrontal cortices.
3. Identify the basic architecture of, inputs to, and outputs from the hippocampus, and discuss how different sensory components of an episode appear to be combined in the hippocampus.
4. Discuss the apparent importance of sleep in hippocampal-dependent memory consolidation.

The Vestibular System

1. Recognize and name the components of the vestibular system.
2. Describe the hair cell and its physiology.
3. Explain how the vestibular sensors communicate motion information.
4. Discuss the three vestibular motor reflexes.

Toxic/Metabolic/Nutritional Disease

1. Describe the effects of alcohol on the CNS both acutely and chronically.
2. Describe the clinical, radiographic, and pathologic findings in Wernicke's encephalopathy and Korsakoff's psychosis and discuss the treatment of these conditions.
3. Describe the etiology and pathologic findings in central pontine myelinolysis.
4. Describe the etiology, treatment, clinical, and pathologic findings associated with Cobalamin deficiency.
5. Describe the etiology and pathogenesis of hepatic encephalopathy and Wilson's disease.
6. Describe the etiology and pathogenesis of Central Pontine Myelinolysis (CPM).

Vesicles to Ventricles -CSF and Blood Supply

1. Trace the path a corpuscle might take from the internal carotid artery to somatosensory cortex to the jugular vein and discuss if it matters whether it is the "foot" or "hand" region of somatosensory cortex.
2. Describe how blood from the left vertebral artery reaches the frontal lobe of the right side in case of occlusion of an internal carotid artery.
3. Draw and label the components of the circle of Willis.
4. Trace the path of CSF from its place of formation in the lateral ventricles to its site of resorption in the arachnoid granulations.
5. Be able to identify on MRI images, CAT scans and sections through the brain: lateral ventricle, third ventricle, fourth ventricle, interventricular foramen, cerebral aqueduct, cisterna magna, interpeduncular cistern.
6. Describe the relationship between ependymal cells and capillaries in the choroid plexus and how CSF is formed by this structure, the volume and rate of production of CSF, and what happens to the composition of CSF as the ionic composition of plasma changes.
7. Distinguish between communicating and non-communicating hydrocephalus.
8. Describe the difference in physical relationships between the CNS, layers of the meninges and the bone, comparing the situation in the cranium to that for the spinal column.

Vision I-II

1. Discuss the major steps in phototransduction in the outer segments of rods.
2. Describe the receptive field properties of retinal ganglion cells.
3. Describe color-opponent ganglion cells.
4. Identify where color is processed in the cortex.
5. Discuss the receptive field characteristics of cortical simple and complex cells and describe how these receptive field properties are achieved by synaptic inputs from lower order cells.
6. Draw the major features of a hypercolumn.
7. Describe the meaning of a sensitive period in the development of the cortex and discuss the importance of this concept in diagnosing and treating abnormal development.
8. Explain the meaning of "ocular dominance" in cells of the visual cortex and indicate its physical basis. Discuss the changes in ocular dominance caused by monocular deprivation, binocular deprivation, and alternating monocular deprivation.