Summary of Neuroscience Course Learning Objectives

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This list provides our general expectations or outcomes from your participation within the neuroscience course. (More specificity can be contained through review of the specific sessions.) These objectives can be accomplished through reviewing the assigned material, attendance at lectures and labs and participating in small group case discussions.
You will soon find that this is a very unique course since this course, more than others, clearly demonstrates the relevance of basic science through its explicit clinical correlations.

Normal processes – embryonic development

- Be able to define or describe : blastocyst, inner cell mass, bilaminar embryo, neural plate, neurulation, formation of neural tube; somites, dermatome, sclerotome, myotome
- Be able to define or describe: three vesicles (prosencephalon, mesencephalon, rhombencephalon); five vesicles (telencephalon, diencephalon, mesencephalon, metencephalon, myelencephalon); neural crest and derivatives, ventricular zone, mantle layer, marginal layer
- Be able to describe: spina bifida, anencephaly, microcephaly, hydrencephaly, hydrocephalus

Normal processes – organ structure and function (cell/tissue)

- **Electrical events and transmitters**
  - Be able to define or describe: ionic basis of resting membrane potential and action potential; saltatory conduction; spatial summation, temporal summation, posttetanic potentiation, presynaptic inhibition; glutamate and EPSPs; GABA and IPSPs; neuromuscular junction
  - Be able to describe the effect: botulinum toxin, tetanus toxin, black widow spider toxin
- **Neurons and neuroglia**
  - Be able to define or describe: neurons (soma, axon, dendrite), astrocytes, radial glia, oligodendrocytes, microglia, Schwann cells, myelin sheath, satellite cells, synapses, neuromuscular junction, and blood-brain barrier
- **Peripheral somatosensory receptors and reflexes**
  - Be able to describe the function: Merkel's disks, Meissner's corpuscles, Pacinian corpuscles, free nerve endings, muscle spindles, Golgi tendon organs, hair follicle receptors; medial and lateral divisions of the dorsal root
  - Be able to define: alpha and gamma motoneurons, motor unit; size principle of motoneuron recruitment; two muscle fiber types
  - Be able to describe: muscle spindle and myotatic stretch reflex circuit; alpha-gamma co-activation; withdrawal reflex; clasp-knife reflex

Normal processes – organ structure and function (gross anatomy)

- **Gross anatomical structure**
  - Be able to identify: cerebral hemisphere (frontal, temporal, parietal, occipital), brainstem (medulla, pons, midbrain), basal ganglia (caudate, putamen and globus pallidus), thalamus, hypothalamus, pituitary gland, pineal gland, cerebellum spinal cord (cervical, thoracic and lumbar), and cerebral cortex
  - Be able to identify: meninges (dura, arachnoid, and pia); peripheral nerve epineurium,

perineurium, and endoneurium; ventricular system of the brain; choroid plexus; cerebrospinal fluid circulation
    - Be able to identify: Blood supply of the brain (including anterior and posterior circulation) and spinal cord
- **Cranial nerves**
    - Be able to describe: functional groups (GSE, SVE, GVE, GVA, SVA, GSA, and SSA)
    - Be able to describe the function and clinical examination:
        - *Oculomotor (III), Trochlear (IV), and Abducens (VI):* horizontal gaze paralysis; internuclear ophthalmoplegia; MLF; vestibulo-ocular reflex; nystagmus; diplopia; pupillary light reflex; Horner's syndrome
        - *Trigeminal (V):* sensory and motor innervation of the face and muscles of mastication; jaw closing and jaw opening reflexes; organization of pain afferents in spinal trigeminal nucleus; trigeminal neuralgia and its treatment;
        - *Facial (VII):* innervation of muscles of facial expression; facial paralysis after stroke vs. facial nerve damage;
        - *Vestibular (VIII)*: otolithic organs, semicircular canals, and hair cells; vestibular nuclei and pathways; vestibulospinal tract; optokinetic response; saccadic and smooth pursuit eye movements; vestibuloocular reflex
        - *Cochlea (VII):* cochlear nuclei; central auditory pathway including inferior colliculus, medial geniculate, and Heschl's gyrus
        - *Glossopharyngeal (IX)*: baroreflex circuitry
        - *Vagus (X) nerve*: visceral function
        - *Spinal accessory (XI):* innervation of sternocleidomastoid and trapezius
        - *Hypoglossal (XII):* innervation of the tongue

Normal processes – Pathways & functional/clinical correlates

- Be able to identify within the spinal cord: cross-section appearance of the spinal cord, dorsal horn, ventral horn, intermediate gray, intermediolateral cell column, substantia gelatinosa; nucleus proprius; nucleus dorsalis; dorsal columns, spinothalamic tract, dorsal and ventral spinocerebellar tracts, corticospinal tract
- Be able to identify and describe the function of the major ascending sensory pathways: dorsal-column/medial lemniscus system, spinothalamic tract
- Be able to identify and describe the function of the major descending motor pathways: pyramidal (corticospinal) tract, corticobulbar fibers, rubrospinal tract, vestibulospinal tract, reticulospinal tract, and tectospinal tract
- Be able to identify the anatomical structures and describe their function: thalamic nuclei of termination of important sensory, cerebellar, and basal ganglia pathways; origin of thalamocortical projections
- Be able to identify the anatomical structures and describe their (dys)function: basal ganglia nuclei; direct and indirect pathways; Parkinson's disease (resting tremor, rigidity, bradykinesia, impaired postural reflexes); dopaminergic system in schizophrenia; ventral striatal-pallidal system in reward; hemiballismus, dystonia, myoclonus, asterixis
- Be able to define terminology. identify the anatomical structures or describe their (dys)function: cerebellar cortex, deep cerebellar nuclei, transverse (anterior lobe, posterior lobe, flocculonodular lobe) and longitudinal (vermal, paravermal, lateral) organization of cerebellum; origin and termination of three cerebellar peduncles, mossy fiber system, climbing fiber system; midline (vermal) and hemispheric cerebellar damage; ataxia, dysmetria, kinetic tremor, dysdiadochokinesia, dysarthria, and nystagmus
- Be able to identify the anatomical structures or describe their (dys)function: cochlea, central auditory pathway; conductive versus nerve (sensorineural) hearing loss
- Be able to identify the anatomical structures or describe their (dys)function: organization of the parasympathetic (craniosacral) and sympathetic (thoracolumbar) division; location of major

parasympathetic and sympathetic ganglia; autonomic reflexes (pupillary light reflex, accommodation reflex, baroreflex, micturition, penile erection and ejaculation)

- Be able to define terminology, identify the anatomical structures or describe their (dys)function: neuronal circuitry of the retina, center-surround inhibition in the retina; central visual pathways (lateral geniculate and primary visual cortex); anatomy of the eye, lacrimal gland and tearing; glaucoma; blink reflex; fundus exam; cause and correction of myopia, hyperopia, and presbyopia; papilledema, scotoma, visual pathway lesions (homonymous and heteronomous hemianopsias, quadrantanopsia)
- Be able to define terminology, identify the anatomical structures or describe their (dys)function: reticular activating system, states of awareness (coma, persistent vegetative state, and brain death); brain stem monoaminergic pathways [noradrenergic (locus ceruleus), serotonergic (raphe), and dopaminergic (substantia nigra)]
- Be able to define terminology, identify the anatomical structures or describe their (dys)function: sleep (different phases of sleep and their EEG pattern, changes in sleep pattern with age); sleep disorders (sleep apnea, restless legs, narcolepsy, insomnia); orexin/hypocretin system and sleep

Normal processes – repair, regeneration and age related changes

- Be able to define or describe: end of life issues related to brain damage and disease; nutrition or sedation in patients with dementia or amyotrophic lateral sclerosis; role of physician in palliative care

Abnormal processes

- **Brain neoplasms**
  - Be able to define or describe: histology of different types of brain tumors (astrocytoma, ependymoma, medulloblastoma; meningioma); radiotherapy versus surgical treatment of brain tumors; primary and secondary brain tumors
- **Hypothalamus and neuroendocrine**
  - Be able to define or describe: releasing factors; energy homeostasis; water balance; reproduction; stress responses; thermoregulation; sickness behavior; circadian rhythms; sexual differentiation of the brain; fever
- **Limbic system**
  - Be able to define or describe: hippocampal anatomy and function in memory; Wernicke-Korsakoff syndrome; role of long-term potentiation for synaptic memory; amygdala function in emotion; Klüver-Bucy syndrome;
  - Be able to define or describe: pain processing by brain; subdivisions of the spinothalamic tract and their terminations; treatment of pain; types of headache (migraine, cluster, tension, post-lumbar puncture, arteritis) and their treatment

Clinical & therapeutic correlation

- **Cerebrovascular disease**
  - Be able to define or describe: transient ischemic attacks (TIA), collateral blood flow; lacunar infarction; amaurosis fugax, embolic causes of stroke, development of increased intracranial pressure in stroke, headache development in cerebral hemorrhage
  - Be able to explain treatment or rationale of care: TIA or ischemic stroke, carotid stenosis, use of warfarin (Coumadin) and antiplatelet drugs, nontraumatic subarachnoid hemorrhage
- **Cortical disorders**
  - Define or describe the cortical localization: somatosensory, visual, and auditory sensory areas, motor cortex, prefrontal cortical function

- Describe the clinical features: lateral brainstem syndrome (Wallenberg) and medial midbrain (Weber) syndromes
- Define or contrast: Broca's, Wernicke's, conduction or global aphasia; articulation, phonation, fluency, paraphasia, prosody and "aprosodia"
- Define or describe: contralateral neglect, catastrophic reaction, hemispheric specialization; dorsal and ventral streams of visual processing, visual cortical organization
- Define and contrast: dementia versus acute confusional state; coma, persistent vegetative state and brain death; decorticate posturing, decerebrate posturing

- **Epilepsy and paroxysmal disorders**
  - Explain and contrast the clinical features: simple partial seizures, complex partial seizures, generalized nonconvulsive seizures (absence), generalized tonic-clonic seizures
  - Define or describe: automatism, status epilepticus, “pseudoseizure”, primary versus secondarily generalized seizures, EEG abnormalities in patients with epilepsy
  - Define: generalized tonic-clonic status epilepticus, general treatment approach to status epilepticus

- **Peripheral nervous system**
  - Explain or contrast: upper verus lower motor neuron signs and symptoms; radicular versus referred pain; weakness of muscle versus neuromuscular junction.
  - Define or describe the clinical features, etiology an treatment: myasthenia gravis, Lambert Eaton myasthenic syndrome; myopathies; neuropathies (polyneuropathies, Guillain-Barré); amyotrophic lateral sclerosis

- **Spinal cord**
  - Contrast hemiplegia caused by lesions: cervical spinal cord, brain stem, subcortical areas, or cortical area
  - Define or describe the clinical features and etiology: intramedullary versus extramedullary spinal lesions; Brown-Sequard hemicord syndrome, syringomyelia, amyotrophic lateral sclerosis, tabes dorsalis, anterior spinal artery syndrome, subacute combined degeneration, spinal shock

- **Specific Clinical Disorders**
  - Define and contrast: tetanus versus botulism; viral verus bacterial meningitis
  - Describe features: carbon monoxide poisoning, lead poisoning, shingles, post-polio muscular atrophy, Creutzfeldt-Jakob dementia
  - Describe features, diagnosis and treatment: Alzheimer’s disease, headache (migraine, cluster, post-lumbar puncture), multiple sclerosis, Parkinson disease
  - Describe or define the etiology or current pathophysiology: Alzheimer's disease, Pick's disease, frontotemporal dementia; Parkinson's disease, Huntington's disease, progressive supranuclear palsy, multiple system atrophy; multiple sclerosis; spinocerebellar degenerations (Friedreich’s ataxia); amyotrophic lateral sclerosis
  - Describe features, diagnosis or treatment: skull fracture, epidural hematoma, cerebral concussion, diffuse axonal injury, hypoxic brain injury, elevated intracranial pressure, brain herniation syndromes
  - Describe features, diagnosis or treatment: hypoglycemia, shock, hypothermia, and drug intoxication or overdose in the unresponsive patient
  - Describe features, diagnosis: brain death

- **Neuroimaging (CT and MRI)**
  - Be able to identify: cerebrum, cerebellum, basal ganglia (caudate and lentiform), internal capsule, thalamus, brainstem, lateral, third and fourth ventricles, cerebellopontine angle, sella turcica, middle cerebral artery, basilar artery, cavernous sinus
  - Be able to distinguish or recognize: "bright" high signal appearance of brain lesions on T2 or FLAIR MRI, acute hemorrhage on CT versus ischemic infarction, brain edema on CT versus MRI, obstructive hydrocephalus versus hydrocephalus ex vacuo, typical appearance of a primary versus metastatic brain tumor, multiple sclerosis plaques on MRI

Neurological Examination and clinical correlates

- Describe how to examine: attention, language, memory, executive function
- Describe how to examine or grade: motor strength, muscle stretch reflexes, clonus, Jendrassik maneuver, Babinski sign
- Contrast the findings and significance: upper motor neuron versus lower motor neuron
- Explain the anatomical correlates of different patterns of weakness: monoparesis, paraparesis, quadriparesis, hemiparesis, proximal weakness or distal weakness
- Explain the clinical features of lower motor neuron pattern of weakness caused by lesions: peripheral nerve, brachial or lumbosacral plexus, spinal nerve root, anterior horn cell.
- Define the concepts and significance: spasticity, rigidity, ataxia, Romberg sign, fasciculation, fibrillation
- Describe the pathways and how to examine: basic sensations of light touch, pain (pin), temperature, vibration, and position sense
- Describe the anatomical correlate and how to examine: stereognosis, graphesthesia, and double simultaneous stimulation
- Describe the typical anatomical distribution of sensory deficits: mononeuropathy, polyneuropathy ("stocking and glove"), radiculopathy (dermatomal), myelopathy (intramedullary versus extramedullary spinal cord lesions), hemisensory syndrome (contralateral thalamic or parietal lobe), parietal cortex lesions (cortical or combined sensations)
- Define: paresthesia, dysesthesia, referred pain, clonus, Jendrassik maneuver
- Describe the pathway and how to elicit: superficial (pupillary, palpebral, corneal and gag) reflexes
- Explain how to examine an unresponsive patient and significance: asymmetric motor findings; pinpoint versus unilateral large fixed pupil
- Explain how to clinically elicit: irritation or inflammation of the meninges or nerve roots
- Describe the pathway and how to elicit: oculocephalic and oculovestibular reflexes