Learning objectives

Neurosciences-1 Module

Year-2 (MBBS)

Total Weeks-6

Central Curriculum Committee, Khyber Medical University

Themes

1) Numbness and tingling---1 week
2) Paraplegia----------1 week
3) Syncope----------1 week
4) Hemiplegia / Aphasia----------1 week
5) Tremors ----------1 week
6) Headache ----------1 week

General learning outcomes

At the end of this module, the 2nd year MBBS students will be able to:

1) Explain the gross and microscopic structural and functional features of peripheral nerves, spinal cord and brain.
2) Describe the development of forebrain, midbrain and hindbrain
3) Describe the basic functions of synapses, neurotransmitters and mechanisms of electrical events during neuronal excitation
4) Explain the structure and functions of different receptors during neuronal excitation
5) Describe the mechanisms and pathways of sensory inputs in the nervous system
6) Explain the organization, structure, functions, and neurotransmitters of autonomic nervous system
7) Describe the blood supply and venous drainage of brain and spinal cord
8) Describe the organization, structure and functions of motor system of the brain and spinal cord
9) Explain the organization, structure and functions of cerebellum and basal ganglia
10) Explain the structure, formation and drainage of cerebrospinal fluid in the brain and spinal cord
11) Describe the functions of limbic system and reticular activating system
12) Describe the pathophysiology and prevention of common diseases like stroke, epilepsy, hydrocephalus and brain injuries
13) Identify the microscopic structure of spinal cord, cerebral and cerebellar cortex
14) Examine nervous system of a standardized patient (sensations, motor functions, and higher cortical functions and tendon reflexes)

Specific Learning objectives

Theme-1 (numbness and tingling)

Subject	Topic	S. No	Learning objectives
Gross anatomy	Overview of nervous system		Describe the general features of neurons and its classification
			Differentiate between central and peripheral nervous system.
			Describe the general features of brain (forebrain, midbrain and hindbrain)
			Describe the general features of spinal cord including its enlargements at different levels
			Describe the general features of cranial and spinal nerves
			Differentiate between the anatomical aspects of sympathetic and parasympathetic system
Embryology	Forebrain, midbrain and hindbrain		Describe the development of primary and secondary brain vesicles
			Enlist the derivatives of the brain vesicles
			Describe the development of prosencephalon, mesencepahalon and rhombencephalon
			Discuss congenital anomalies associated with each region of brain
Physiology	Organization of the Nervous System		Describe general design of the nervous system
			Describe various divisions of the nervous system.
			Describe structural and functional unit of CNS.

			Describe Functional components of Neuron.
			Describe Functional and Structural classification of Neurons
			Describe major levels of central nervous system function
			Describe Glial cells and their functions.
			Compare nervous system to a computer
	Basic Functions of Synapses		Define and classify synapses
			Explain physiological structure of synapse
			Describe Mechanism by Which an Action Potential Causes Transmitter Release from the Presynaptic Terminals
			Describe synaptic transmission and explain properties of synaptic transmission.
			Describe mechanism of action of neurotransmitter on the post synaptic membrane.
			Describe Second messenger system in the post synaptic neuron
	Functions of Neurotransmitters		Define the characteristics of a neurotransmitter
			Enumerate the neurotransmitters involved in central nervous system.
			Classify neurotransmitters and describe the actions of some common neurotransmitters in central nervous system.
	Electrical Events during Neuronal Excitation and Inhibition		Describe resting membrane potential of the neuronal soma.
			Describe Effect of Synaptic Excitation on the Postsynaptic Membrane—Excitatory Postsynaptic Potential.

			Describe Effect of Inhibitory Synapses on the Postsynaptic Membrane—Inhibitory Postsynaptic Potential.
			Describe Generation of Action Potentials in the Initial Segment of the Axon Leaving the Neuron—Threshold for Excitation
	Sensory Receptors		Define and classify receptors.
			Classify receptors according to their location in the body.
			Describe specific functions of receptors.
			Describe Receptor or generation potential
			Discuss mechanism of action of sensory transduction.
	Coding of Sensory Information		Describe Doctrine of specific nerve energies
			Describe Modality of Sensation—The "Labeled Line Principle"
			Define and discuss law of projection
			Discuss properties of stimulus; modality, Stimulus location Stimulus intensity Stimulus duration
			Describe Frequency of action potentials with threshold level of receptor potential
	Transmission and Processing of Signals in CNS		Describe Relaying of signals through Neuronal pools; Divergence, Convergence, Prolongation of Signals
	Types of nerve fibers, its regeneration and degeneration		Describe the mechanism of degeneration & regeneration.
			Describe the duration required for regeneration inside & out of CNS.
			Enumerate the causes of degeneration.
			Discuss Wallerian degeneration
			Identify the microscopic appearance of degenerating neurons
	Somatic		Describe Tactile receptors in the skin and

	Sensations		their functions: Pacinian corpuscles, Meissner's corpuscles, Ruffini endings, Merkle cell, A-delta and C free nerve endings
	Transmission in the Dorsal column–medial Lemniscal system		Describe ascending pathways and enumerate the differences between the two.
			Describe Transmission in the Dorsal column–medial Lemniscal system
			Describe Spatial Orientation of the Nerve Fibers in the Dorsal Column–Medial Lemniscal System
			Describe two-point discrimination
	Somatosensory Cortex		Identify the diagrammatic representation of different areas of the body in the somatosensory cortex I
			Identify Broadman's areas of cerebral cortex and correlate each one of them with their respective functions.
			Describe the functions of somatosensory area I.
			Describe layers of the somatosensory cortex and their function.
			Describe the functions of somatosensory association area
	Transmission of Sensory signals in the Anterolateral pathway		Differentiate the submodalities of nondiscriminative touch, temperature and nociception based on receptor transduction mechanism, localization within the spinal gray matter, and central termination of the pathways.
			Describe functional organization at all levels and sub-modalities served by the anterolateral system and the equivalent components of the spinal trigeminal system.
Biochemistry	Neurotransmitters		Explain the biosynthesis of different

			neurotransmitters
	Brain and nervous tissues metabolism		Describe the metabolism of brain and nervous tissues
General Medicine	Peripheral neuropathies		Describe the etiology and types of peripheral neuropathies
			Discuss the clinical presentation and complications of diabetic neuropathies
Skills and affective domain			
Histology	Transverse section of spinal cord (cervical level) -1		Identify the slide of transverse section of cervical spinal cord under the microscope
Physiology	Examination of sensations		Examine the sensations (tactile, position, pain, thermal, vibration) of lower limb on a standardized patient

Theme-2 (Paraplegia)

Gross anatomy	Externals features of Spinal Cord		Describe the shape, grooves and sulci and extension of spinal cord
			Enlist the segments of spinal cord
			Differentiate between white and grey matter of spinal cord
			Describe the meningeal covering of spinal cord
			Describe the blood supply of spinal cord
	Grey Matter of Spinal Cord		Describe the distribution of spinal cord into horns
			Differentiate between anterior, lateral and posterior horns
			Describe the distribution of sensory and motor neuron within the grey matter
			Explain formation of Rexed lamina of spinal cord
	White matter of spinal cord		Enumerate the ascending tracts
			Explain the origin, pathway and termination of dorsal column medial lemniscal system Explain the origin, pathway
			and termination of anterolateral spinothalamic tract.
			Enumerate the descending tracts
			Explain the origin, pathway and termination of pyramidal tracts
			Explain the origin, pathway and termination of extrapyramidal tracts
			Differentiate between pyramidal and extrapyramidal tracts
Embryology	Spinal cord		Discuss the development of alar and basal plate and its derivatives
Histology	Spinal cord		Identify the light microscopic transverse

			section of spinal cord at cervical, thoracic, lumbar and sacral regions
			Draw and label the transverse section of spinal cord at different levels
Physiology	Introduction to Motor Nervous System (General Principles)		Describe organization of the spinal cord for motor functions
			Give an overview of the components of nervous system involved in motor control
			Identify and differentiate upper and lower motor neurons
			Describe the types of anterior horn cells
			Describe the concept of Final Common Path
			Describe broad types of motor activities
	Motor functions of Spinal cord I: Stretch Reflex		Describe structural organization of the muscle spindle
			Define a reflex action and enlist components of reflex arc.
			Describe types of reflexes and their level of integration.
			Describe Stretch Reflex
			Differentiate between Static (Tonic) and Dynamic (Phasic) stretch reflex
			Describe Functions of muscle spindle
			Discuss physiological significance of these reflexes.
			Describe Functions of Gamma efferent system
			Describe the role of the muscle spindle in voluntary motor activity
	Motor functions of Spinal cord II: Golgi Tendon Reflex,		Describe Golgi Tendon Reflex

	Withdrawal Reflexes		
			Differentiate between muscle spindle and Golgi tendon organ.
			Describe types of polysynaptic reflexes and their level of integration.
			Discuss physiological significance of these reflexes.
			Describe reciprocal inhibition and reciprocal innervation
	Support of the body against gravity, Reflexes of Posture And Locomotion		Describe Positive Supportive Reaction
			Describe Cord “Righting” Reflexes.
			Describe stepping and walking movements
			Describe Excitatory-Inhibitory Antagonism Between Pontine and Medullary Reticular Nuclei
	Vestibular Sensations and Maintenance of Equilibrium		Describe the physiologic anatomy of vestibular apparatus
			Describe function of the utricle and saccule in the maintenance of static equilibrium
			Describe function of semicircular ducts
			Describe Neuronal Connections of the Vestibular Apparatus
			Describe Vestibular mechanism for stabilizing the eyes
	Lesions of the Spinal Cord: Upper and Lower		Define muscle tone and describe its significance.

	Motor Neuron lesion		
			Explain the sequence of events during development of muscle tone.
			Discuss spinal shock
			Differentiate between signs of the upper and lower motor neurons.
General medicine	Hemi-section of spinal cord		Describe the clinical features of Brown Sequard syndrome
			Describe the etiology, clinical features, investigations and management of a patient with paraplegia
Skills and affective domain			
Histology	Transverse section of thoracic segment of spinal cord-2		Identify the slide of transverse section of thoracic segments of spinal cord under the microscope
Physiology	Examination of deep tendon reflexes-1		Examine a standardized patient for deep tendon reflexes of lower limbs

Theme- 3 (Syncope)

Gross anatomy	Medulla		Enlist the components of brain stem
			Describe the external features of brainstem
			Describe the transverse section of medulla at the level of sensory decussation, motor decussation and inferior Olivary nuclei
			Enumerate the cranial nerves nuclei present within the medulla
	Pons		Describe the transverse section of pons at the level of cranial and caudal parts
			Enumerate the cranial nerves nuclei present within the pons
	Midbrain		Describe the transverse section of pons at the level of superior colliculus and inferior colliculus
			Enumerate the cranial nerves nuclei present within the midbrain
Physiology	Involuntary function of brain		Describe the involuntary functions of the brain
	Functions of reticular activating system		Describe the structure and functions of RAS
	Coma and brain death		
	The Autonomic Nervous System 1		Describe the differences in the locations, level and organization of sympathetic and parasympathetic nervous system.
			Identify the target organs of sympathetic and parasympathetic nervous system.
			Describe the distribution of afferent and efferent sympathetic and parasympathetic fibers to their respective target organs.
			Contrast the sympathetic and

			parasympathetic branches of the autonomic nervous system based on: spinal cord division of origin, length of preganglionic and postganglionic neurons, neurotransmitters and receptors at the ganglionic and target organ synapse.
	The Autonomic Nervous System 2		Discuss basic characteristics of sympathetic and parasympathetic functions
			Describe receptors on the effector organs
			Describe function of the adrenal medullae
			Describe sympathetic and parasympathetic “tone”
			Describe “alarm” or “stress” response of the sympathetic nervous system
Pharmacology	Drugs acting on sympathetic nervous system		Enlist the drugs acting on SNS and describe their mechanism of actions
	Drugs acting on parasympathetic nervous system		Enlist the drugs acting on PNS and describe their mechanism of action
Forensic medicine	Brain death		Certify brain death
			Describe the medicolegal importance of brain death
Skills and affective domain			
Histology	Transverse section of lumbar spinal cord-3		Identify the slide of transverse section of Lumbar segment of spinal cord under the microscope
Physiology	Examination of deep tendon reflexes-2		Examine a standardized patient for upper limbs tendon reflexes

Theme-4 (Hemiplegia)

Gross anatomy	Cerebrum • Grey matter of cerebrum • White matter of • cerebrum		Division of cerebrum into different lobes, its surfaces, sulci and gyri
			Distribution of grey matter in cerebral hemispheres
			Enumerate the types of white matter fibers
			Differentiate between association, projection and commissural fibers
			Detailed account of corpus callosum
	Diencephalon		Structure and important nuclei of Thalamus and Hypothalamus
	Blood supply of brain		Describe the formation of circle of Willis
Histology	Cerebral cortex		Identify the cerebral cortex on light microscope
			Enlist the different histological layers of cerebral cortex
Physiology	Cortical Control of Motor Functions		Describe Motor Functions of Specific Cortical Areas
			Describe transmission of signal from the motor cortex to the muscles. (Pyramidal and extrapyramidal).
			Explain the excitation of the spinal cord motor control areas by the primary motor cortex and red nucleus.
	Functions of Descending Tracts		Describe the functions of Descending Tracts
			Describe Decerebrate and Decorticate Rigidity

Community medicine	Risk factors of cerebrovascular diseases		Describe risk factors for the development of cerebrovascular diseases
			Explain the strategies to prevent cerebrovascular diseases
General medicine	Stroke		Differentiate between hemorrhagic and ischemic stroke
			Describe the etiology, clinical features, investigations and prevention of stroke
Skills and affective domain			
Histology	Cerebral cortex		Identify the histological layers of cerebral cortex under the microscope
Physiology	Examination of motor functions of the brain and spinal cord		Examine a standardized patient for power, tone and movements of upper and lower limbs, speech, memory and other higher cortical functions

Theme- 5 (Tremors)

Gross anatomy	Basal nuclei		Enumerate the components of basal nuclei Describe the structure and relation of corpus striatum, red nucleus and substantia nigra
	Cerebellum		Describe the general features of cerebellum
			Name the lobes of cerebellum and discuss its anatomical and physiological classification
			Enumerate the intracerebellar nuclei of cerebellum
			Describe the input and output of cerebellum
Histology	Histology of cerebellum		Identify the cerebellar cortex on light microscope
			Enlist the different histological layers of cerebellar cortex
Physiology	Cerebellum I: Basic Circuit and Connections		Describe the divisions of cerebellum into 3 lobes and their connections.
			Describe Interconnections of neurons of cerebellar cortex
			Describe Cerebellar afferent fibers
			Describe Cerebellar efferent fibers
			Describe the functional circuits of cerebellum
	Cerebellum II: Functions and Disorders		Explain the functional differences between vermis and cerebellar hemispheres.
			Describe Functions of vestibulocerebellum
			Describe Functions of spinocerebellum
			Describe Functions of

			cerebrocerebellum
			Describe the clinical abnormalities of cerebellum
	Basal Ganglia I: Pathways and connections		Describe the anatomical and physiological classification of basal ganglia.
			Describe the functional circuits of basal ganglia.
			Describe connections of putamen circuit.
			Describe connections of caudate circuit.
			Enlist the differences between direct and indirect pathways
	Basal Ganglia II: Functions and Diseases		Describe functions of putamen circuit.
			Describe functions of caudate circuit.
			Explain the clinical problems related to basal ganglia
Biochemistry	Phosphosphingolipids		Describe the metabolism of phosphosphingolipids
	Neurotransmitters of CNS		Describe the Neurotransmitters of CNS, its mechanisms of action and biochemical functions
	Neuromuscular junctions		Describe the neurotransmitters released at the neuromuscular junctions, their mechanism of actions and biochemical actions
Pharmacology	Drugs used in Parkinson’s disease		Describe the groups of drugs used in Parkinson`s disease and their mechanism of actions
General medicine	Parkinson`s disease		Describe the pathology, clinical features and treatment of Parkinson`s disease
			Differentiate between cerebellar and parkinsonian tremors

Skills and affective domain			
Histology	Cerebellar cortex		Identify the histological layers of cerebellar cortex under the microscope
Physiology	Examination of cerebellum		Illicit cerebellar signs in a standardized patient

Theme-6 (Headache)

Gross anatomy	Dural venous sinus		Differentiate between paired and unpaired venous sinuses Discuss the structure and drainage of individual venous sinuses
	CSF in ventricular system		Discuss the structure of choroidal plexus and the formation of CSF in ventricles
Physiology	Pain Sensation Pathways		Describe pain receptors and type of stimuli causing pain.
			Describe types of pain.
			Explain in detail the pathway for pain.
	Pain suppression (analgesia) System in the brain and Spinal cord		Define analgesia
			Explain pain suppression system in the brain and spinal cord.
			Describe Gate control theory and Brain Opiate system
			Describe clinical abnormalities of pain: Primary and Secondary Hyperalgesia
	Headache, Referred Pain		Define referred pain and describe its mechanism.
			Describe the clinical significance of referred pain with examples.
			Enumerate the causes of referred pain.
			Enlist the causes of intra-cranial and extra-cranial headache and correlate with the

			underlying mechanism of pain.
	Thermal Sensations		Describe thermal receptors and their excitation
			Describe mechanism of stimulation of thermal receptors
			Describe transmission of thermal signals in the nervous system
	Functions of Specific Cortical Areas (Concept of Dominant Hemisphere)		Name the association areas of brain. Briefly describe their location and function?
			Draw the diagram of cerebral cortex to show the different functional areas
	Language and Speech		Define and classify speech
			Describe how the brain performs the function of speech.
			Describe Broca's area in the brain, and its function.
			Describe wernicke's area in the brain, and its function.
			Describe the speech pathways for perceiving a heard word and then speaking the same word & perceiving a written word and repeating it and correlate it with their clinical significance
			Describe the effects of damage to broca's area and wernicke's area
			Describe disorders related to speech.
	Learning and Memory		Define and classify memory and explain its basic mechanism.
			Describe the mechanism of synaptic facilitation and synaptic inhibition
			Describe consolidation of memory, and briefly describe one of its most important features.

			Describe Codifying of new memories
			Role of specific parts of the brain in the memory process
			Explain disorders related to memory.
	Activating-Driving Systems of the Brain		Describe bulboreticular facilitatory area. Explain continuous stimulation from lower brain by four neurohormonal systems.
			Explain continuous stimulation from lower brain by four neurohormonal systems.
	Limbic System		Describe the principal components of the limbic system: hippocampus, amygdala, prefrontal cortex, and nucleus accumbens), the pathways connecting them and their functions.
			Discuss the anatomy of memory and emotion in relation to the limbic system
			Describe Functions of limbic system
			Describe the connection of hypothalamus with different areas of brain.
			Describe the vegetative and endocrine functions of hypothalamus.
			Describe the behavioral functions of hypothalamus.
	Brain Waves and Sleep		Describe brain waves.
			Describe the clinical significance of EEG.
			Define sleep. Describe its various types and characteristics.
			Describe basic theories of sleep.
			Describe genesis of n-REM and REM sleep.
			Enumerate the neurotransmitters involved in sleep.
			Describe various sleep disorders.
	Seizures and Epilepsy		Define seizure and epilepsy.
			Classify seizures & epilepsies
			Enumerate causes of seizure and epilepsy.

			Discuss the clinical features of patient presents with epilepsy.
			Discuss the significance of electrophysiologic studies imaging and other investigations in epilepsy.
			Describe briefly about pharmacologic treatment.
	CSF formation, circulation and functions		Describe regulation of cerebral blood flow
			Describe formation, flow, and absorption of cerebrospinal fluid
			Describe Blood–Cerebrospinal Fluid and Blood-Brain Barriers
	CSF		Describe the biochemical composition of CSF
	Prostaglandins and pain		Define Prostaglandins
			Describe the role of Prostaglandins in initiation of pain
Pathology	Alzheimer's disease		Explain the pathogenesis and microscopic findings of Alzheimer`s disease and its types
	Inflammation of brain		Describe the inflammatory processes related to meninges and brain parenchyma
			Describe the pathogenic mechanisms of meningitis and encephalitis
General medicine	Epilepsy		Explain the types of epilepsy
			Describe the investigations and enlist anti-epileptic drugs
	Hydrocephalus		Describe the etiology, pathogenesis and clinical features of hydrocephalus
Radiology	Neuroradiology-CT scans		Describe relevant CT scan findings of intracerebral bleeds, hematomas and subarachnoid hemorrhage
			Describe relevant CT scan findings of

			ischemic strokes
	Neuroradiology-MRI scans		Describe relevant MR scan findings of intracerebral bleeds, hematomas
			Describe relevant MR scan findings of ischemic strokes
Neurosurgery	Brain injuries		Describe the types, clinical presentations and investigations of a patient with head injury
	Brain and spinal tumors		Explain the types, clinical features and investigations of brain and spinal tumors
Skills and affective domain			
Histology	Slides of sacral segments and overview of nervous tissues		Identify the slides of different neural structures under the microscope
Physiology	Neurological examination of upper and lower limbs		Examine a standardized patient for neurological system of upper and lower limbs