

## Learning objectives

### Neurosciences-1A 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 2<sup>nd</sup> 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	1	Describe the general features of neurons and its classification
		2	Differentiate between central and peripheral nervous system.
		3	Describe the general features of brain (forebrain, midbrain and hindbrain)
		4	Describe the general features of spinal cord including its enlargements at different levels
		5	Describe the general features of cranial and spinal nerves
		6	Differentiate between the anatomical aspects of sympathetic and parasympathetic system
Embryology	Forebrain, midbrain and hindbrain	7	Describe the development of primary and secondary brain vesicles
		8	Enlist the derivatives of the brain vesicles
		9	Describe the development of prosencephalon, mesencephalon and rhombencephalon
		10	Discuss congenital anomalies associated with each region of brain
Physiology	Organization of the Nervous System	11	Describe general design of the nervous system
		12	Describe various divisions of the nervous system.
		13	Describe structural and functional unit of CNS.

		14	Describe Functional components of Neuron.
		15	Describe Functional and Structural classification of Neurons
		16	Describe major levels of central nervous system function
		17	Describe Glial cells and their functions.
		18	Compare nervous system to a computer
	Basic Functions of Synapses	19	Define and classify synapses
		20	Explain physiological structure of synapse
		21	Describe Mechanism by Which an Action Potential Causes Transmitter Release from the Presynaptic Terminals
		22	Describe synaptic transmission and explain properties of synaptic transmission.
		23	Describe mechanism of action of neurotransmitter on the post synaptic membrane.
		24	Describe Second messenger system in the post synaptic neuron
	Functions of Neurotransmitters	25	Define the characteristics of a neurotransmitter
		26	Enumerate the neurotransmitters involved in central nervous system.
		27	Classify neurotransmitters and describe the actions of some common neurotransmitters in central nervous system.
	Electrical Events during Neuronal Excitation and Inhibition	28	Describe resting membrane potential of the neuronal soma.
		29	Describe Effect of Synaptic Excitation on the Postsynaptic Membrane—Excitatory Postsynaptic Potential.
		30	Describe Effect of Inhibitory Synapses on

			the Postsynaptic Membrane—Inhibitory Postsynaptic Potential.
		31	Describe Generation of Action Potentials in the Initial Segment of the Axon Leaving the Neuron—Threshold for Excitation
	Sensory Receptors	32	Define and classify receptors.
		33	Classify receptors according to their location in the body.
		34	Describe specific functions of receptors.
		35	Describe Receptor or generation potential
		36	Discuss mechanism of action of sensory transduction.
	Coding of Sensory Information	37	Describe Doctrine of specific nerve energies
		38	Describe Modality of Sensation—The “Labeled Line Principle”
		39	Define and discuss law of projection
		40	Discuss properties of stimulus; modality, Stimulus location Stimulus intensity Stimulus duration
		41	Describe Frequency of action potentials with threshold level of receptor potential
	Transmission and Processing of Signals in CNS	42	Describe Relaying of signals through Neuronal pools; Divergence, Convergence, Prolongation of Signals
	Types of nerve fibers, its regeneration and degeneration	43	Describe the mechanism of degeneration & regeneration.
		44	Describe the duration required for regeneration inside & out of CNS.
		45	Enumerate the causes of degeneration.
		46	Discuss Wallerian degeneration
		47	Identify the microscopic appearance of degenerating neurons
	Somatic Sensations	48	Describe Tactile receptors in the skin and 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	49	Describe ascending pathways and enumerate the differences between the two.
		50	Describe Transmission in the Dorsal column–medial Lemniscal system
		51	Describe Spatial Orientation of the Nerve Fibers in the Dorsal Column–Medial Lemniscal System
		52	Describe two-point discrimination
	Somatosensory Cortex	53	Identify the diagrammatic representation of different areas of the body in the somatosensory cortex I
		54	Identify Brodman’s areas of cerebral cortex and correlate each one of them with their respective functions.
		55	Describe the functions of somatosensory area I.
		56	Describe layers of the somatosensory cortex and their function.
		57	Describe the functions of somatosensory association area
	Transmission of Sensory signals in the Anterolateral pathway	58	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.
		59	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	60	Explain the biosynthesis of different neurotransmitters
	Brain and nervous	61	Describe the metabolism of brain and

	tissues metabolism		nervous tissues
General Medicine	Peripheral neuropathies	62	Describe the etiology and types of peripheral neuropathies
		63	Discuss the clinical presentation and complications of diabetic neuropathies
<b>Skills and affective domain</b>			
Histology	Transverse section of spinal cord (cervical level) -1	64	Identify the slide of transverse section of cervical spinal cord under the microscope
Physiology	Examination of sensations	65	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	66	Describe the shape, grooves and sulci and extension of spinal cord
		67	Enlist the segments of spinal cord
		68	Differentiate between white and grey matter of spinal cord
		69	Describe the meningeal covering of spinal cord
		70	Describe the blood supply of spinal cord
	Grey Matter of Spinal Cord	71	Describe the distribution of spinal cord into horns
		72	Differentiate between anterior, lateral and posterior horns
		73	Describe the distribution of sensory and motor neuron within the grey matter
		74	Explain formation of Rexed lamina of spinal cord
	White matter of spinal cord	75	Enumerate the ascending tracts
		76	Explain the origin, pathway and termination of dorsal column medial lemniscal system Explain the origin, pathway
		77	and termination of anterolateral spinothalamic tract.
		78	Enumerate the descending tracts
		79	Explain the origin, pathway and termination of pyramidal tracts
		80	Explain the origin, pathway and termination of extrapyramidal tracts
		81	Differentiate between pyramidal and extrapyramidal tracts
Embryology	Spinal cord	82	Discuss the development of alar and basal plate and its derivatives
Histology	Spinal cord	83	Identify the light microscopic transverse section of spinal cord at cervical, thoracic, lumbar and sacral regions
		84	Draw and label the transverse section of

			spinal cord at different levels
Physiology	Introduction to Motor Nervous System (General Principles)	85	Describe organization of the spinal cord for motor functions
		86	Give an overview of the components of nervous system involved in motor control
		87	Identify and differentiate upper and lower motor neurons
		88	Describe the types of anterior horn cells
		89	Describe the concept of Final Common Path
		90	Describe broad types of motor activities
	Motor functions of Spinal cord I: Stretch Reflex	91	Describe structural organization of the muscle spindle
		92	Define a reflex action and enlist components of reflex arc.
		93	Describe types of reflexes and their level of integration.
		94	Describe Stretch Reflex
		95	Differentiate between Static (Tonic) and Dynamic (Phasic) stretch reflex
		96	Describe Functions of muscle spindle
		97	Discuss physiological significance of these reflexes.
		98	Describe Functions of Gamma efferent system
		99	Describe the role of the muscle spindle in voluntary motor activity
	Motor functions of Spinal cord II: Golgi Tendon Reflex, Withdrawal Reflexes	100	Describe Golgi Tendon Reflex
		101	Differentiate between muscle spindle and Golgi tendon organ.

		102	Describe types of polysynaptic reflexes and their level of integration.
		103	Discuss physiological significance of these reflexes.
		104	Describe reciprocal inhibition and reciprocal innervation
	Support of the body against gravity, Reflexes of Posture And Locomotion	105	Describe Positive Supportive Reaction
		106	Describe Cord "Righting" Reflexes.
		107	Describe stepping and walking movements
		108	Describe Excitatory-Inhibitory Antagonism Between Pontine and Medullary Reticular Nuclei
	Vestibular Sensations and Maintenance of Equilibrium	109	Describe the physiologic anatomy of vestibular apparatus
		110	Describe function of the utricle and saccule in the maintenance of static equilibrium
		111	Describe function of semicircular ducts
		112	Describe Neuronal Connections of the Vestibular Apparatus
		113	Describe Vestibular mechanism for stabilizing the eyes
	Lesions of the Spinal Cord: Upper and Lower Motor Neuron lesion	114	Define muscle tone and describe its significance.
		115	Explain the sequence of events during development of muscle tone.
		116	Discuss spinal shock

		117	Differentiate between signs of the upper and lower motor neurons.
General medicine	Hemi-section of spinal cord	118	Describe the clinical features of Brown Sequard syndrome
		119	Describe the etiology, clinical features, investigations and management of a patient with paraplegia
<b>Skills and affective domain</b>			
Histology	Transverse section of thoracic segment of spinal cord-2	120	Identify the slide of transverse section of thoracic segments of spinal cord under the microscope
Physiology	Examination of deep tendon reflexes-1	121	Examine a standardized patient for deep tendon reflexes of lower limbs

### **Theme- 3 (Syncope)**

Gross anatomy	Medulla	122	Enlist the components of brain stem
		123	Describe the external features of brainstem

		124	Describe the transverse section of medulla at the level of sensory decussation, motor decussation and inferior Olivary nuclei
		125	Enumerate the cranial nerves nuclei present within the medulla
	Pons	127	Describe the transverse section of pons at the level of cranial and caudal parts
		127	Enumerate the cranial nerves nuclei present within the pons
	Midbrain	128	Describe the transverse section of pons at the level of superior colliculus and inferior colliculus
		129	Enumerate the cranial nerves nuclei present within the midbrain
Physiology	Involuntary function of brain	130	Describe the involuntary functions of the brain
	Functions of reticular activating system	131	Describe the structure and functions of RAS
	Coma and brain death	132	Define coma and describe brain death
	The Autonomic Nervous System 1	133	Describe the differences in the locations, level and organization of sympathetic and parasympathetic nervous system.
		134	Identify the target organs of sympathetic and parasympathetic nervous system.
		135	Describe the distribution of afferent and efferent sympathetic and parasympathetic fibers to their respective target organs.
		136	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	137	Discuss basic characteristics of sympathetic and parasympathetic

			functions
		138	Describe receptors on the effector organs
		139	Describe function of the adrenal medullae
		140	Describe sympathetic and parasympathetic "tone"
		141	Describe "alarm" or "stress" response of the sympathetic nervous system
Pharmacology	Drugs acting on sympathetic nervous system	142	Enlist the drugs acting on SNS and describe their mechanism of actions
	Drugs acting on parasympathetic nervous system	143	Enlist the drugs acting on PNS and describe their mechanism of action
Forensic medicine	Brain death	144	Certify brain death
		145	Describe the medicolegal importance of brain death
<b>Skills and affective domain</b>			
Histology	Transverse section of lumbar spinal cord-3	146	Identify the slide of transverse section of Lumbar segment of spinal cord under the microscope
Physiology	Examination of deep tendon reflexes-2	147	Examine a standardized patient for upper limbs tendon reflexes

#### **Theme-4 (Hemiplegia)**

Gross anatomy	Cerebrum Grey matter of cerebrum White matter of cerebrum	148	Division of cerebrum into different lobes, its surfaces, sulci and gyri
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		149	Distribution of grey matter in cerebral hemispheres
		150	Enumerate the types of white matter fibers
		151	Differentiate between association, projection and commissural fibers
		152	Detailed account of corpus callosum
	Diencephalon	153	Structure and important nuclei of Thalamus and Hypothalamus
	Blood supply of brain	154	Describe the formation of circle of Willis
Histology	Cerebral cortex	155	Identify the cerebral cortex on light microscope
		156	Enlist the different histological layers of cerebral cortex
Physiology	Cortical Control of Motor Functions	157	Describe Motor Functions of Specific Cortical Areas
		158	Describe transmission of signal from the motor cortex to the muscles. (Pyramidal and extrapyramidal).
		159	Explain the excitation of the spinal cord motor control areas by the primary motor cortex and red nucleus.
	Functions of Descending Tracts	160	Describe the functions of Descending Tracts
		161	Describe Decerebrate and Decorticate Rigidity
Community medicine	Risk factors of cerebrovascular diseases	162	Describe risk factors for the development of cerebrovascular diseases
		163	Explain the strategies to prevent cerebrovascular diseases
General medicine	Stroke	164	Differentiate between hemorrhagic and ischemic stroke
		165	Describe the etiology, clinical features, investigations and prevention of stroke

Skills and affective domain			
Histology	Cerebral cortex	166	Identify the histological layers of cerebral cortex under the microscope
Physiology	Examination of motor functions of the brain and spinal cord	167	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	168	Enumerate the components of basal nuclei Describe the structure and relation of corpus striatum, red nucleus and substantia nigra
	Cerebellum	169	Describe the general features of cerebellum

		170	Name the lobes of cerebellum and discuss its anatomical and physiological classification
		171	Enumerate the intracerebellar nuclei of cerebellum
		172	Describe the input and output of cerebellum
Histology	Histology of cerebellum	173	Identify the cerebellar cortex on light microscope
		174	Enlist the different histological layers of cerebellar cortex
Physiology	Cerebellum I: Basic Circuit and Connections	175	Describe the divisions of cerebellum into 3 lobes and their connections.
		176	Describe Interconnections of neurons of cerebellar cortex
		177	Describe Cerebellar afferent fibers
		178	Describe Cerebellar efferent fibers
		179	Describe the functional circuits of cerebellum
	Cerebellum II: Functions and Disorders	180	Explain the functional differences between vermis and cerebellar hemispheres.
		181	Describe Functions of vestibulocerebellum
		182	Describe Functions of spinocerebellum
		183	Describe Functions of cerebrocerebellum
		184	Describe the clinical abnormalities of cerebellum
	Basal Ganglia I: Pathways and connections	185	Describe the anatomical and physiological classification of basal ganglia.
		186	Describe the functional circuits of basal ganglia.
		187	Describe connections of putamen circuit.

		188	Describe connections of caudate circuit.
		189	Enlist the differences between direct and indirect pathways
	Basal Ganglia II: Functions and Diseases	190	Describe functions of putamen circuit.
		191	Describe functions of caudate circuit.
		192	Explain the clinical problems related to basal ganglia
Biochemistry	Phosphosphingolipids	193	Describe the metabolism of phosphosphingolipids
Pharmacology	Drugs used in Parkinson's disease	194	Describe the groups of drugs used in Parkinson's disease and their mechanism of actions
General medicine	Parkinson's disease	195	Describe the pathology, clinical features and treatment of Parkinson's disease
		196	Differentiate between cerebellar and parkinsonian tremors
<b>Skills and affective domain</b>			
Histology	Cerebellar cortex	197	Identify the histological layers of cerebellar cortex under the microscope
Physiology	Examination of cerebellum	198	Illicit cerebellar signs in a standardized patient

## **Theme-6 (Headache)**

Gross anatomy	Dural venous sinus	199	Differentiate between paired and unpaired venous sinuses Discuss the structure and drainage of individual venous sinuses
	CSF in ventricular system	200	Discuss the structure of choroidal plexus and the formation of CSF in ventricles
Physiology	Pain Sensation Pathways	201	Describe pain receptors and type of stimuli causing pain.

		202	Describe types of pain.
		203	Explain in detail the pathway for pain.
	Pain suppression (analgesia) System in the brain and Spinal cord	204	Define analgesia
		205	Explain pain suppression system in the brain and spinal cord.
		206	Describe Gate control theory and Brain Opiate system
		207	Describe clinical abnormalities of pain: Primary and Secondary Hyperalgesia
	Headache, Referred Pain	208	Define referred pain and describe its mechanism.
		209	Describe the clinical significance of referred pain with examples.
		210	Enumerate the causes of referred pain.
		211	Enlist the causes of intra-cranial and extra-cranial headache and correlate with the underlying mechanism of pain.
	Thermal Sensations	212	Describe thermal receptors and their excitation
		213	Describe mechanism of stimulation of thermal receptors
		214	Describe transmission of thermal signals in the nervous system
	Functions of Specific Cortical Areas (Concept of Dominant Hemisphere)	215	Name the association areas of brain. Briefly describe their location and function?
		216	Draw the diagram of cerebral cortex to show the different functional areas
	Language and Speech	217	Define and classify speech
		218	Describe how the brain performs the function of speech.

		219	Describe Broca's area in the brain, and its function.
		220	Describe wernicke's area in the brain, and its function.
		221	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
		221	Describe the effects of damage to Broca's area and Wernicke's area
		223	Describe disorders related to speech.
	Learning and Memory	224	Define and classify memory and explain its basic mechanism.
		225	Describe the mechanism of synaptic facilitation and synaptic inhibition
		226	Describe consolidation of memory, and briefly describe one of its most important features.
		227	Describe Codifying of new memories
		228	Role of specific parts of the brain in the memory process
		229	Explain disorders related to memory.
	Activating-Driving Systems of the Brain	230	Describe bulboreticular facilitatory area. Explain continuous stimulation from lower brain by four neurohormonal systems.
		231	Explain continuous stimulation from lower brain by four neurohormonal systems.
	Limbic System	232	Describe the principal components of the limbic system: hippocampus, amygdala, prefrontal cortex, and nucleus accumbens), the pathways connecting them and their functions.
		233	Discuss the anatomy of memory and emotion in relation to the limbic system
		234	Describe Functions of limbic system
		235	Describe the connection of hypothalamus with different areas of brain.

		236	Describe the vegetative and endocrine functions of hypothalamus.
		237	Describe the behavioral functions of hypothalamus.
	Brain Waves and Sleep	238	Describe brain waves.
		239	Describe the clinical significance of EEG.
		240	Define sleep. Describe its various types and characteristics.
		241	Describe basic theories of sleep.
		242	Describe genesis of n-REM and REM sleep.
		243	Enumerate the neurotransmitters involved in sleep.
		244	Describe various sleep disorders.
	Seizures and Epilepsy	245	Define seizure and epilepsy.
		246	Classify seizures & epilepsies
		247	Enumerate causes of seizure and epilepsy.
		248	Discuss the clinical features of patient presents with epilepsy.
		249	Discuss the significance of electrophysiologic studies imaging and other investigations in epilepsy.
		250	Describe briefly about pharmacologic treatment.
	CSF formation, circulation and functions	251	Describe regulation of cerebral blood flow
		252	Describe formation, flow, and absorption of cerebrospinal fluid
		253	Describe Blood–Cerebrospinal Fluid and Blood-Brain Barriers
Biochemistry	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	257	Explain the pathogenesis and microscopic findings of Alzheimer's disease and its types
	Inflammation of brain	258	Describe the inflammatory processes related to meninges and brain parenchyma
		259	Describe the pathogenic mechanisms of meningitis and encephalitis
General medicine	Epilepsy	260	Explain the types of epilepsy
		261	Describe the investigations and enlist anti-epileptic drugs
	Hydrocephalus	262	Describe the etiology, pathogenesis and clinical features of hydrocephalus
Radiology	Neuroradiology-CT scans	263	Describe relevant CT scan findings of intracerebral bleeds, hematomas and subarachnoid hemorrhage
		264	Describe relevant CT scan findings of ischemic strokes
	Neuroradiology-MRI scans	265	Describe relevant MR scan findings of intracerebral bleeds, hematomas
		266	Describe relevant MR scan findings of ischemic strokes
Neurosurgery	Brain injuries	267	Describe the types, clinical presentations and investigations of a patient with head injury
	Brain and spinal tumors	268	Explain the types, clinical features and investigations of brain and spinal tumors
<b>Skills and affective domain</b>			
Histology	Slides of sacral segments and overview of nervous tissues	269	Identify the slides of different neural structures under the microscope
Physiology	Neurological examination of upper and lower limbs	270	Examine a standardized patient for neurological system of upper and lower limbs

