Spiral I	
MODULE TITLE	**Nervous system-1**
INTRODUCTION	The Nervous system module is developed to provide the learners with in-depth knowledge about how the brain is structured and how it works under normal circumstances. Students learn the developmental processes of the brain in order to understand where the structures come from and how each is linked with the others. This module deals not only with the brain but also with the peripheral & autonomic nervous systems. Students get to know how the human body carries out its myriad functions, some of which are under our control (e.g. walking) while others are not (e.g. beating of the heart). The Autonomic Nervous system, one of the essential systems maintaining our homeostasis, is dealt with in detail. One of the main reasons for this is because many medications alter Autonomic functions. A doctor has to have detailed knowledge about such medications and their interactions.
RATIONALE	The aim of this module is to enable students to apply the knowledge of the nervous system to solve clinical problems commonly seen in real life practice.
TARGET STUDENTS	2nd year MBBS
DURATION	7 weeks; March to May 2022
MODULE OUTCOME	By the end of the module students will be able to describe the normal structure and functions of the central, peripheral and the Autonomic Nervous Systems.
DEPARTMENTS	Anatomy, Physiology, Biochemistry.
OBJECTIVES	By the end of the module, students will be able to:

LECTURES

ANATOMY

1. **General organization of Nervous system, different types of nerve tissue cells (Neurons & Neuroglia)**

- Explain the general components of nervous system
- Discuss the division of nervous system into CNS, ANS & PNS
- Discuss the structural/ cellular organization of nervous system

2. **Development of Brain and Spinal cord & anomalies (Embryology)**

- Describe the formation of primary & secondary vesicles and flexures
- Relate the components of ventricular system with the cavities of secondary vesicles.
- Describe the differentiation of the layers from neuro-epithelium in primitive spinal cord.
- Describe derivation of alar & basal plates, neuron and neuroglia cells
- Discuss positioning of spinal cord
- Describe the congenital anomalies of spinal cord viz. Spina bifida occulta, spinal bifida cystica, Myeloschisis

3. **Gross External features of spinal cord**

- Discuss the extent (starting & terminating point) of spinal cord
- Describe the gross features of spinal cord and its blood supply
- Discuss the regional enlargements of spinal cord

4. **Histology of spinal cord**

- Describe the distribution and components of gray and white matter in spinal cord.
- Compare the sections at different segmental levels (cervical ,thoracic)

5. **Internal features of spinal cord I- (Ascending tracts)**

- Discuss the internal features of spinal cord, gray(groups) & white(columns) matter.
- Discuss 1st ,2nd & 3rd order neurons of sensory pathway.
- Discuss in detail the ascending (sensory) tracts of the spinal cord and their lesions

6. **Internal features of spinal cord II- (Descending tracts)**

- Discuss in detail the descending (motor) tracts of the spinal cord and their lesions

7. **Development of forebrain (Embryology)**

- Discuss the process of development of forebrain and its anomalies

8. **Development of midbrain & hindbrain (Embryology)**

- Discuss the process of development of midbrain & hindbrain and their anomalies

9. **Blood supply (arterial supply & venous drainage) of spinal cord and clinical manifestations of ischemia**

- Describe the Vertebral Systems of arteries
- Describe the area of spinal cord supplied by different branches.
- Discuss the role of radicular and feeder arteries.
- Describe the venous drainage of spinal cord
- Describe the clinical consequences of ischemia of spinal cord

10. Gross anatomy of Cerebellum

- Describe the gross anatomy of the cerebellum location, structural & functional division(lobes)and its blood supply
- Describe the folia, tracts and nuclei of cerebellum
- Discuss the clinical conditions associated with cerebellar dysfunction

11. Histology of Cerebellum

- Describe the layers of cerebellar cortex.
- Describe the cellular organization in each layer.

12. Diencephalon I- Thalamus

- Describe the gross features, boundaries and division of diencephalon and its blood supply
- Describe the gross features and relations of Thalamus.
- Discuss the nuclei, connections and functions of thalamus
- Discuss the clinical conditions associated with thalamus

13. Diencephalon II- Sub thalamus, Hypothalamus & Epithalamus

- Describe the location, relations, components and structure of subthalamus, hypothalamus & epithalamus.
- Discuss their nuclei, connections and functions.
- Discuss the lesions of sub thalamus, hypothalamus & Epithalamus

14. Limbic system & Reticular formation

- Describe the various parts of limbic system
- Describe the hippocampal formation
- Discuss the disorders of limbic system

15. Basal ganglia & its nuclei

- Describe the location and components of basal ganglia and their blood supply
- Discuss their connections and functions
- Discuss the lesions of basal ganglia

16. Histology of cerebrum

- Describe the layers of cerebral cortex.
- Discuss the variation of layers in different cortical regions.
- Describe the types of neurons and fibers distributed in different layers

17. White matter of cerebrum -I (Projection fibers and Internal capsule)

- Discuss the basic concepts of white matter of cerebrum.

- Describe the location, parts, connections and relations of internal capsule and its blood supply
- Discuss the common lesion associated with the internal capsule

18. White matter of cerebrum- II (Commissural & Association fibers)

- Discuss the commissural fibers and their connections
- Describe corpus callosum and its parts
- Explain the association fibers and their connections
- Discuss the common lesions associated with commissural and association fibers

19. Blood supply of brain

- Discuss the carotid and vertebral systems of vessels
- List the branches arising from them
- Describe the formation of circle of Willis.
- Discuss the area of supply of the 3 cerebral arteries.
- Tabulate the veins of brain and their area of drainage.
- Discuss the clinical manifestations of ischemia of brain

20. Meninges of brain & spinal cord

- List the meninges of brain & spinal cord
- Describe the Dural layers, folds, extensions and spaces (subdural etc.)
- Discuss pia mater and its modifications (ligamentum denticulatum, tela choroidea).
- Describe the arachnoid mater, subarachnoid space and cisterns.
- Describe the blood and nerve supply of meninges.

21. Dural venous sinuses

- Describe the location, relations, and drainage of Dural venous sinuses of brain.
- Describe the contents of cavernous sinus and extra cranial communication.
- Discuss the clinical importance of different sinuses.

22. Autonomic nervous system

- Describe the divisions of ANS (sympathetic & parasympathetic)
- Describe the components of sympathetic nervous system (thoracolumbar outflow: lateral gray horn, paravertebral sympathetic chain, prevertebral ganglia and plexuses)
- Describe the varied fate of preganglionic and post ganglionic fibers.
- Discuss the components of parasympathetic part of nervous system (craniosacral outflow: cranial nerve nuclei and sacral spinal segments)
- List the parasympathetic ganglia
- Describe the pathways of pre and postganglionic parasympathetic fibers.
- Differentiate the 2 system on the basis of structure and function

BIOCHEMISTRY

1. Lipids of the nervous system: Chemistry of Brain Lipids

- Classify brain lipids with examples
- Explain the chemistry of brain lipids
- Describe the chemical composition and functions of myelin
- Discuss the clinical significance of lipid storage diseases

2. Blood Brain Barrier

- Define and give the biochemical composition of the Blood Brain Barrier
- Explain the functions of the Blood Brain Barrier
- Explain the impact of Blood Brain Barrier disruption
- Discuss the clinical disorders associated with Blood Brain Barrier disruption

3. Cerebrospinal fluid

- Describe the chemical composition of CSF
- Discuss the biochemical functions of CSF
- Explain the mechanism of production, route of flow and re-absorption of CSF
- Explain the procedure of lumbar puncture
- Interpret the laboratory investigations of CSF in different diseases

4. Introduction of Neurotransmitters

- Define Neurotransmitters
- Classify Neurotransmitters with examples
- Describe the mechanism of action and functions of Neurotransmitters
- Classify receptors of Neurotransmitters
- Explain the synthesis and degradation pathways of Neurotransmitters
- Discuss the disorders associated with Neurotransmitter

5. Acetylcholine & Dopamine

- Describe the chemical structure of Acetylcholine and Dopamine
- Describe the metabolism of Acetylcholine and Dopamine
- Explain the mechanism of action and functions of Acetylcholine & Dopamine
- Discuss the receptors of Acetylcholine and Dopamine
- Explain the clinical disorders associated with Acetylcholine and Dopamine

6. Serotonin & GABA

- Describe the chemical structure of Serotonin and GABA
- Describe the metabolism of Serotonin and GABA
- Explain the mechanism of action and functions of Serotonin and GABA
- Discuss the receptors of Serotonin and GABA
- Explain the clinical disorders associated with Serotonin and GABA

7. Neurodegenerative diseases of CNS

- List the common Neurodegenerative diseases
- Discuss the common mediators of Neurodegenerative diseases

- Discuss the biochemical changes in Neurodegenerative diseases
- Describe the biochemical phenomenon of ageing

8. Role of free radicals & Vitamins in CNS disorders

- Explain the role of free radicals in Neurodegenerative diseases
- List the free radicals causing degenerative diseases
- List the sources of free radicals
- Explain the mechanism of free radical injury
- Describe the role of free radicals in diseases
- Classify the antioxidants with examples
- Discuss the process of oxidative stress response
- Discuss the biochemical importance of vitamins in neurological disorders
- Discuss the sources, biochemical role and daily requirements of vitamins B1, B6, B9, B12 and folic acid
- Explain the deficiency diseases related to these vitamins

PHYSIOLOGY

1. Neurons membrane, generation & propagation of nerve impulse

- Elaborate the structure and functions of a neuron
- Discuss the classification & functions of nerve fibers
- Describe the threshold & initiation of action potential in neuronal cells
- Describe the propagation of nerve impulse/ saltatory conduction

2. Synapsis, properties of synapses

- Describe the properties of chemical and electrical synapses

3. Sensory receptors and neuronal circuits

- Discuss the classification of sensory receptors
- Describe the functions & properties of different types of receptors
- Explain the properties of different types of neuronal circuit

4. Somatic sensations

- Explain the general organization of somatic sensation: tactile and position senses
- Discuss the dorsal-column medial lemniscal pathway
- Discuss the anterolateral pathway
- Describe the mechanism of thermal receptors & their excitation

5. Physiology of pain – I & headache

- Discuss the types of pain (slow & fast) and their characteristics
- Explain the mechanism of stimulation of pain receptors
- Discuss the clinical abnormalities of pain: hyperalgesia, headache & its causes

6. Physiology of pain II- Brain analgesic system

- Explain the analgesic system of brain
- Discuss the opiate system of brain
- Describe visceral & referred pains

7. Spinal cord and reflexes

- Describe the motor function of spinal cord
- Discuss the mechanism of flexor reflex, crossed extensor reflex, scratch reflex, postural & locomotive reflexes
- Discuss spinal cord transection & spinal shock (Brown Sequard syndrome)

8. Muscles proprioceptors (muscle spinal & Golgi tendon organ)

- Explain the structure & function of muscle spindle
- Discuss the muscle, stretch reflex & its clinical applications
- Explain the mechanism of Golgi tendon reflex& its significance in controlling motor activities

9. Somatosensory cortex

- Discuss the orientation of various areas of cortex and their associated function
- Describe the layers of somatic sensory cortex and their functions

10. Function of brain stem

- Explain the role of brain stem nuclei in controlling motor functions
- Discuss the vital and non- vital functions of brain stem (respiratory, cardiac, vasomotor centers & coughing, sneezing & vomiting reflexes)

11. Cerebellum and its functions

- Explain the functions of cerebellum & its associated disorders
- Discuss the afferent and efferent pathways of cerebellum

12. Vestibular system and maintenance of equilibrium

- State the names of the parts of vestibular system
- Explain the functions of the vestibular system
- Discuss the role of utricle & saccule in static equilibrium
- Discuss the role of semicircular ducts in angular acceleration

13. Functions of diencephalon

- Discuss the function of thalamus and its nuclei

14. Limbic system

- Describe the functions of limbic system
- Discuss the role of hypothalamus in limbic system
- Discuss the importance of reward and punishment centers
- Elaborate the role of hippocampus and amygdala
- Discuss the effects of Kluver-Bucy syndrome

15. Basal ganglia and its nuclei

- Explain the functions of caudate & putamen pathways
- List the functions of specific neurotransmitters of basal ganglial system
- Explain the disorders associated with basal ganglia (hypokinetic and hyperkinetic)

16. Motor cortex, pyramidal tract, Upper and lower Motor Neurons

- Explain the functions of pyramidal tract
- List the functions of specific cortical areas
- Differentiate between upper & lower motor neuron lesions (UMN & LMN)

17. Physiology of sleep & sleep disorders

- Explain the physiology of slow wave sleep & rapid eye movement (REM)sleep
- Explain the basic theories of sleep &origin of brain waves

18. Learning and memory

- Determine the role of cerebral cortex in higher intellectual functions
- Classify the different types of memories

19. CSF: formation, circulation & function

- Describe the mechanism of CSF formation, its circulation & functions

20. Autonomic Nervous System

- Describe the functions of sympathetic & parasympathetic nervous system

21. Speech &its disorders

- Explain the physiology of speech and associated disorders

DEMONSTRATION/ TUTORIAL

ANATOMY

1. Skull as whole, vault of skull + Anterior cranial fossa

- Describe the gross anatomy of skull
- Discuss the sutures of skull
- Discuss different views (normal) of skull
- Discuss the division of the cranial cavity
- Describe the boundaries, bony prominences and foramina of the anterior cranial fossa

2. Middle & Posterior cranial fossa

- Describe the boundaries, bony prominences and foramina of the middle & posterior cranial fossa

3. Spinal cord lesions, transection & spinal shock

- Discuss the lesions of anterior & posterior nerve roots
- Elaborate the lesions of ascending & descending tracts
- Discuss the mechanism & consequences of tabes dorsalis, spinal shock syndrome, Brown

Sequard syndrome, poliomyelitis, syringomyelia

4. Brainstem I- Medulla Oblongata

- Discuss the formation and parts of brainstem.
- Describe the gross anatomical features of Medulla Oblongata and its blood supply
- Discuss in detail the internal features of Medulla Oblongata.
- Discuss the cranial nerves emerging from Medulla Oblongata.
- Discuss the clinical importance of Medulla Oblongata

5. Brainstem II-Pons

- Describe the location of Pons
- Discuss the external & internal features of Pons and its blood supply
- Discuss the relation of Pons with 4th ventricle
- Discuss the cranial nerves emerging from Pons
- Discuss the clinical conditions associated with Pons

6. Brainstem III -Midbrain

- Describe the location of midbrain
- Discuss the external & internal features of midbrain with its supply
- Discuss the relation of Pons with cerebral aqueduct
- Describes the cranial nerves emerging from midbrain
- Discuss the clinical conditions associated with midbrain

7. Gross anatomy of Cerebrum (external features, surfaces, gyri & sulci)

- Discuss the gross anatomical features of cerebrum (surfaces, borders, poles, lobes, sulci & gyri)
- Describe the blood supply of cerebrum

8. Functional cortical areas of cerebrum & their lesions

- Describe different functional areas of cerebral cortex (motor, sensory, auditory, visual)
- Discuss the lesions of the functional cortical areas of cerebral cortex

9. Ventricular system I- Lateral ventricle

- Describe the ventricles of brain
- Discuss the location, boundaries and relations of lateral ventricles and its blood supply
- Discuss the clinical conditions associated with lateral ventricles

10. Ventricular system II- 3rd& 4thventricles and CSF circulation

- Describe the structure and location of 3rd and 4th ventricles, and cerebral aqueduct
- Briefly discuss the normal CSF secretion, circulation & blood brain barrier
- Discuss the applied anatomy of ventricles of brain and CSF flow

11. Cranial nerves (I to VI)

- Mention the names of all the cranial nerves in sequence
- List the locations of the cranial nerve nuclei (I to VI)

- Discuss their distribution
- Describe the main effects of lesions of cranial nerves

12. Cranial nerves (VII to XII)

- List the location of the cranial nerve nuclei (VII to XII)
- Discuss their distribution
- Describe the main effects of lesions of VII to XII cranial nerves

13. Functional cortical areas of cerebellum

- Discuss the location and lesions of the functional cortical areas of cerebellar cortex

14. Ventricular system and CSF circulation

- Discuss the ventricular system included lateral, 3rd and 4th ventricles with CSF circulation

15. Blood supply of brain and formation of circle of Willis

- Describe the formation of circle of Willis
- Discuss its branches

16. Spinal cord and its cut sections (Demonstration on Sectra)

- Discuss the various cut sections of spinal cord and associated lesion

BIOCHEMISTRY

1. Neurotransmitters-1 Acetylcholine & Catecholamine

- Discuss the clinical importance of Acetylcholine & Dopamine
- Interpret clinical conditions correlated with their laboratory investigations

2. Neurotransmitters-2 Serotonin & GABA

- Discuss the clinical importance of Serotonin & GABA
- Interpret clinical conditions correlated with their laboratory investigations

3. Cerebrospinal fluid

- Discuss the clinical importance of Cerebrospinal fluid
- Interpret clinical conditions correlated with their laboratory investigations

4. Neurodegenerative diseases of CNS

- Discuss the clinical importance of neurodegenerative diseases
- Interpret clinical conditions correlated with their laboratory investigations

PRACTICALS

HISTOLOGY

1. Structure of neuron & neuroglia

- Describe the structure of neuron & neuroglia

- List the types of neuron & neuroglia
- List the functions of neuron & neuroglia
- Discuss the formation of blood brain barrier
- Identify the histological sections of neuron & neuroglia under light microscope

2. Spinal cord, spinal nerve & ganglia

- Discuss the histological features of spinal cord, spinal nerve & ganglia
- Identify the histological features of spinal cord, spinal nerve & ganglia under light microscope

3. Microscopic anatomy of cerebellar cortex

- Discuss the histological features of cerebellum; its layers, cells & nuclei
- Identify the histological features of cerebellar cortex under light microscope

4. Microscopic anatomy of cerebral cortex

- Discuss the histological features of cerebrum; its layers, cells & nuclei
- Identify the histological features of cerebral cortex under light microscope

BIOCHEMISTRY

1. Lumbar Puncture

- Explain the procedure of Lumbar Puncture (LP)
- Identify the chemical tests and bio-techniques to detect analytes in CSF
- Identify the parts of LP needle
- Interpret the laboratory report in different CNS diseases
- Interpret clinical conditions correlated with their laboratory investigations

2. CSF Glucose Estimation

- Identify the procedure & bio-technique to detect glucose in CSF
- Estimate glucose in CSF
- Interpret the laboratory report of glucose in CSF
- Interpret clinical conditions correlated with their laboratory investigations

3. CSF Protein Estimation

- Identify the procedure & bio-technique to detect proteins in CSF
- Estimate proteins in CSF
- Interpret the laboratory report of proteins in CSF
- Interpret clinical conditions correlated with their laboratory investigations

4. CSF Chloride Estimation

- Identify the procedure & bio-technique to detect chloride in CSF
- Estimate chloride in CSF
- Interpret the laboratory report of chloride in CSF
- Interpret clinical conditions correlated with their laboratory investigations

PHYSIOLOGY

1. Examination of Superficial reflexes

- Elicit superficial reflexes viz. Corneal reflexes, Abdominal reflexes & Plantar reflexes
- Describe their significance in different neurological disorders

2. Examination of Deep reflexes

- Perform deep reflexes
- Describe their significance

3. Cerebellar function tests

- Perform cerebellar function tests
- Identify disorders of cerebellar function

4. Body temperature

- Determine the body temperature by using oral mercury thermometer

5. EEG

- Interpret brain waves with the help of power lab

6. Examination of Cranial Nerves (V, VII, IX, X)

- Perform different tests for examination of the cranial nerves

Internal Assessment	• It can be in the form of MCQs, OSPE, viva etc. • Internal evaluation carries 20% weight age in summative examination
Annual Examination	MCQs and OSPE (observed + un-observed)
Course Evaluation	Course evaluation will be obtained through a feedback form which will be posted on the JSMU website

SUGGESTED READINGS	
SUBJECT	**RESOURCES**
ANATOMY	**A. GROSSANATOMY** 1. K.L. Moore, Clinically Oriented Anatomy 2. Neuro Anatomy by Richard Snell **B. HISTOLOGY** 1. B. Young J. W. Health Wheater's Functional Histology **C. EMBRYOLOGY** 1. Keith L. Moore. The Developing Human 2. Langman's Medical Embryology
BIOCHEMISTRY	1. Harper's Illustrated Biochemistry 2. Lippincott's Illustrated reviews of Biochemistry 3. Lehninger's Principles of Biochemistry 4. Biochemistry by Devlin
PHYSIOLOGY	**A. TEXTBOOKS** 1. Textbook Of Medical Physiology by Guyton And Hall 2. Ganong ' S Review of Medical Physiology 3. Human Physiology by Lauralee Sherwood 4. Berne & Levy Physiology 5. Best&Taylor Physiological Basisof Medical Practice **B. REFERENCEBOOKS** 1. Guyton & Hall Physiological Review 2. Essentials Of Medical Physiology by Jaypee 3. Textbook Of Medical Physiology by InduKhurana 4. Short Textbook Of Physiology by Mrthur 5. NMS Physiology