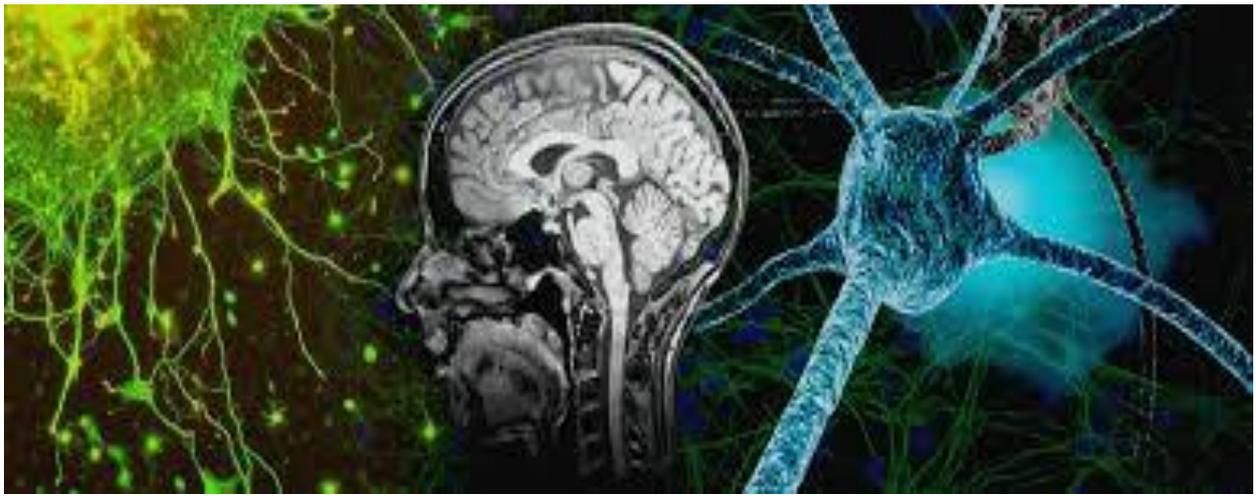




**Faculty of Medicine and Allied Medical Sciences (FM&AMS)**



## **Module 08: Neuroscience**

**Academic year 2019**

**Year 2**

# Neuroscience module

## **Purpose of this Study Guide**

The purpose of the study guide is to

- Organize your learning so you can access it in future practice.
- Develop a productive lifelong learning strategy.
- Develop your clinical reasoning skills in preparation for clinical rotation.
- To relate your thinking between the systems.

This guide is the result of untiring work of faculty members from all the departments involved in this module. These include Physiology, Anatomy and Medical Education departments at Isra University.



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## Module details

Course	<b>MBBS</b>
Spiral	<b>Two</b>
Year	<b>Two</b>
Term	<b>Four</b>
Commencement date	<b>Monday 17<sup>th</sup> June 2019</b>
Duration of module	<b>09 weeks</b>
Pre-requisites	<b>Successful completion of Module 1, III, IV, V &amp; VI</b>
Disciplines covered	<b>Anatomy and Physiology</b>
Competencies covered	<b>I (<i>Skilful</i>), and II (<i>Knowledgeable/ problem solver</i>),</b>
Module assessment	<b>16<sup>th</sup> August 2019</b>
Assessment methods	<b>One Correct Answer (MCQs) &amp; Structured Essay Questions (SEQs), Spot examination, Objective Structured Clinical Examination (OSPE); Viva examination</b>
Year 2 coordinator	<b>Dr. Yar Mohammad Nizamani</b>



## Introduction

Welcome to the Neuroscience module. This module introduces the development, structure and function of the nervous system. In the previous modules, you have studied briefly about the motor functions, sensation and other functions of the nervous system. This module in-depth discuss the development and abnormalities of the nervous system and its functional organization, control of motor functions, general and special senses and higher brain functions.

Similarly, this module would be revisited again during third-year with more focus on the pathological and pharmacological aspects. Main teaching and learning strategies include lectures, small group discussions, tutorials, laboratory practical and clinical skills laboratories.

The lectures provide an overview of the topics, however, in order to under the topic in-depth reading of the recommended material is essential. Small group activities include clinical cases where students are expected to apply the knowledge learned during the module to comprehend essential concepts and develop problem-solving skills. Lastly, each week of teaching is reinforced with clinical skills session during which students learn to examine motor, sensory (*general and special*), adequacy of cranial nerves and assess higher brain functions.

At the end of this module, students are expected to demonstrate knowledge about the development, organization and functions of the different parts of the nervous system. Secondly, they are expected to apply their clinical knowledge and skills to identify lesions in parts of the brain and solve clinical problems.

All the best for this module.



## Aim

The aim of this module is to

- Consolidate the basic understanding of the structure, organization and function of the nervous system.
- Link the structure and functional abnormalities of the nervous system based on the clinical history and signs and symptoms,
- Acquire clinical skills to perform neurological examination of patient using the correct technique. (motor system, sensory system, cranial nerves, higher brain function, hearing, balance and vision)

## Structure of the Course

To achieve these overall aims, this module comprises of 09 weeks. The course content is described as under

### **Content distribution:**

Week 1 & 2: Head and Neck

Week 3: Gross anatomy of the brain and its organization

Week 4: External and internal structure of the spinal cord and spinal tracts

Week 5: Brainstem & Cerebellum

Week 6: Special senses: Anatomy & Physiology of the Auditory system

Week 7: Special senses: Anatomy & Physiology of the visual system

Week 8: Cranial nerves & Higher motor functions

Week 9: End-module exam



## General objectives:

### Knowledge

At the end of this module, second-year medical student should be able to

- Describe the normal development of the nervous system over the period of and time and how it effects the structure and function,
- Describe the structure, organization and function of the nervous system
- Describe the microscopic structure of the nervous system,
- Describe the normal physiological functions of the endocrine system and specifically its importance in maintaining homeostasis.
- Apply the basic scientific knowledge regarding the metabolism of proteins and amino acids, cholesterol and fatty acids (*previously covered in Module 5: Metabolism and GIT*).

### Psychomotor skills

- Obtain a comprehensive history of patient with neurological disorders in a simulated environment, (not included for time being)
- Demonstrate appropriate technique for performing nervous system and cranial nerves examination,
- Demonstrate appropriate technique to perform Renne's and Weber's test.
- Interpret the electroencephalogram,

### Attitude/ Behaviours

- Display personal attributes of compassion, honesty, integrity with standardized patient and medical profession,
- Demonstrate professionalism in all aspects of medical practice specifically, honesty, compassion, integrity, respect for others, professional and social responsibility.



## Main Content Area

- Surface anatomy of the head and neck
- Skull, cervical vertebrae and their joints
- Muscle and fascia of the scalp, face and neck
- Microscopic structure of the cornea, sclera and retina
- Nerve and blood supply of the head and neck
- Development of face lip, nose, palate, tongue, skull and facial skeleton
- Gross anatomy of the brain – division and lobes,
- Meninges of the brain and meningeal space
- Blood-brain barrier
- Ventricular system & circumventricular organs & cerebrospinal fluid,
- Blood supply of the brain - Arteries of the brain, arterial circle of willis, veins of the brain and venous dural sinuses
- Macroscopic and microscopic (*histology*) structure of the nervous system,
- Developmental anatomy of the nervous system – neural tube, crest & placodes, metencephalon, mesencephalon and telencephalon
- Functions of the nervous system – nerve cell degeneration & regeneration, axonal transport
- Neurotransmitters of CNS
- Sensory system
- Spinal cord - External and internal morphology, ascending and descending tracts
- Spinal reflexes, spinal shock and mass reflex
- Motor and sensory pathways of the spinal cord
- Brainstem – Medulla, pons, mid-brain and reticular formation
- Auditory and vestibular system – Ear: external, internal and middle, auditory pathways & efferent cochlear bundle, labyrinth and vestibular pathways, efferent vestibular connections, medial longitudinal fasciculus
- Cranial nerves (I – XII)
- Cerebellum – functional and major divisions, cerebellar cortex and neuronal cerebellar network,



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- Visual system – errors of refraction, visual pathways, retina and layers of the eye, accommodation reaction, centres for ocular motility, dark and light adaptations and colour vision,
- Limbic system – structure and functions
- Thalamus – boundaries, nuclei, blood supply, internal capsule
- Hypothalamus – connections, functions and fiber system
- Basal ganglia – structure, function, and internal circuit
- Autonomic nervous system – pre and post-ganglionic fibers, receptors and neurotransmitters, visceral afferent fibers and innervation of selected fibers
- Cerebral cortex – structure, layers, functions, blood supply,
- Higher brain functions – Memory, language, sleep
- Pain and opioid receptors and neurotransmitters



Educational opportunities

Main Content Area	Lecture	Practical	Clinical Skills	Small Group Discussions	Tutorial	Self-study
Gross anatomy of the brain						
Functional organization of the nervous system – axonal transport, neurotransmitters and interneuronal communications						
Developmental anatomy of the nervous system						
Neurohistology						
External and internal structure of the spinal cord and tracts						
Sensory system						
Motor system						
Brain stem						
Auditory and visual system						
Cranial nerves (I – XII)						
Cerebellum						
Visual system						
Diencephalon – thalamus, hypothalamus, basal ganglia						
Anatomy and physiology of the limbic system						
Cerebral cortex and cognitive functions of the brain						
Higher brain functions – Speech, memory, sleep, cognition,						
Taste and smell						
<b>Total</b>						

Lectures 01 hour (50 minutes approximately)

Practical/ Laboratory 02 hours

Tutorials/ small group discussions (SGD) 02 hours

**A** – Must know,

**B** – Should know,

**C** – Nice to know

**L** – Lecture,

**SGD** – Small group discussion,

**SS** – Self-study



# Instructional Objectives of the module

Theme: Anatomy of the brain

Topic: Gross anatomy of the brain

## Content area:

1. Organization of the nervous system (A)
2. Terminology and subdivision (A)
3. Nerve cells, neuroglial cells and nerve fibers (A)

## Instructional Objectives:

- Describe the subdivisions and different parts of the nervous system,
- Describe the parts of forebrain, midbrain, hindbrain and spinal cord,
- Describe the structure of the central nervous system,

Topic: Meninges of the brain and meningeal space

## Content area:

1. Meninges of the brain (A)
2. Subarachnoid cisterns (A)

## Instructional Objective:

- Name the cerebral meninges and subarachnoid cisterns.

Topic: Ventricular system

## Content area:

1. Lateral ventricles – parts, relations of each part and connections (A)
2. Third ventricle – parts, boundaries, relations and communications (A)
3. Fourth ventricle – parts, boundaries, relations and foramina (A)

## Instructional Objective:

- Describe the parts and boundaries of each part of the lateral ventricle,
- Describe the parts and boundaries of the third and fourth ventricles,
- Recognize the connections of the fourth ventricle.

Topic: Cerebrospinal fluid

## Content area

1. Cerebrospinal fluid – formation, circulation, drainage and functions (A)
2. Pathological changes in CSF in diseased states (C)



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**Instructional Objective**

- Discuss the function, production and reabsorption of the cerebrospinal fluid,
- Describe the composition of the cerebrospinal fluid,
- Explain the cerebrospinal fluid circulation,
- Interpretation of pathological changes in the composition of the CSF in diseased states.

Topic: Blood-brain-barrier

Content to be provided by the respective department



## Theme: Function of the Central nervous system (CNS)

### Topic: Functional organization of the CNS

#### Content area:

1. Integration of brain and spinal cord at different levels (A)
2. Individual function of each brain center (A)
3. Interrelation between motor and sensory cortex (A)
4. Role of cerebellum and basal ganglia in the integrity of the motor system. (B)

#### Instructional objectives:

- List the various divisions of the nervous system,
- List the general functions of the cerebrum, diencephalons, basal ganglia, limbic system, thalamus, hypothalamus, spinal cord alpha and gamma motor neurons and motor and sensory cortex.

### Topic: Neurotransmitters

#### Content area:

1. Neurotransmitters – criteria and properties (excitatory and inhibitory) (A)
2. Synthesis, storage, release and catabolism of important neurotransmitters such as catecholamine (B)
3. Synthesis, storage, release and catabolism of – Acetylcholine, Serotonin and GABA (B)
4. Neuropeptides – enkephalins, endorphins and substance P (B)

#### Instructional objectives:

- Describe the criteria and properties of the neurotransmitters,
- Classify the neurotransmitter found in the brain and nervous tissue,
- Discuss the synthesis, storage, release and catabolism of some neurotransmitters – Catecholamine, Serotonin, GABA,
- Describe the neuropeptides in the brain which mediate sensory and emotional responses

### Topic: Axonal transport and interneuron communication

#### Content area:

1. Neuronal synapses – chemical and electrical (A)
2. Post-synaptic potentials – excitatory and inhibitory (A)

#### Instructional objectives:

- Explain the mechanism of action of chemical and electrical synapse,
- Compare between pre and post-synaptic receptors,
- List the types of post-synaptic potentials,
- Explain the mechanism of action of post-synaptic potentials,
- List the types of summation of post-synaptic potentials



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- Discuss the mechanism and types of synaptic inhibitions,
- List the properties of synaptic transmission and describe each.



## Theme: Blood supply of the central nervous system

### Topic: Blood supply of the brain

#### **Content area**

1. Arteries – carotid system, vertebrobasilar system and circulus arteriosus (A)
2. Anterior, middle and posterior cerebral arteries – course, distribution, branches and relations (A)
3. Venous drainage – superficial and deep veins (A)

#### **Instructional Objectives:**

- Describe the course and distributions of the cerebral blood vessels,
- Identify the arteries sharing in the circulus arteriosus,
- Describe the arterial supply of each cortical area
- Describe the venous drainage of the brain,

### Topic: Blood supply of the spinal cord

#### **Content area:**

1. Arterial supply of the spinal cord – spinal and radicular arteries (A)
2. Venous drainage of the spinal cord (A)

#### **Instructional objectives:**

- Describe the blood supply of the spinal cord.



## Theme: Neuro-histology and development of the nervous system

### Topic: Development of the nervous system

#### Content area

1. Development of neural tube (**A**)
2. Neural crest derivatives (**A**)
3. Development of brain vesicles (**A**)
4. Development of the spinal cord and its anomalies (**B**)
5. Congenital anomalies of central nervous system (**C**)

#### Instructional Objective:

- Describe the formation and differentiation of the neural tube,
- List the derivatives of the neural crest cells,
- Describe the development of brain vesicles,
- Discuss the derivatives of both motor and sensory laminae in the brain stem,
- Describe the development of cerebellum,
- Describe the development of diencephalons,
- Describe the development of cerebrum,
- Mention common congenital nervous system anomalies.

### Topic: Neuro-histology

#### Content area

1. Neuron – structure
2. Macroglial cells – astrocytes, oligodendrocytes and ependymal cells
3. Microglial cells
4. Choroid plexus cells
5. Meningeal cells

#### Instructional Objective

- Describe the microscopic structure of the glial cells.



## Theme: Spinal cord – morphology and tracts

### Topic: External and internal structure of the spinal cord

#### Content area:

1. Spinal cord – external features, enlargements, conus medullaris and spinal segments (A)
2. Relation of the spinal cord to the vertebral level (A)
3. Age changes, meninges and fixations (B)

#### Instructional objectives:

- Describe the external features of the spinal cord,
- Describe and identify the relation between spinal segment and vertebral level,
- Describe the meninges of the spinal cord and its fixations,

### Topic: Tracts of the spinal cord

#### Content area:

1. Spinal cord – internal structure, nuclei of the posterior, anterior and lateral horns and tracts of the posterior, lateral and anterior white matter (A)
2. Lemnisci of the brain stem (A)

#### Instructional objectives:

- List the different nuclei of the grey matter of the spinal cord and function of each,
- Discuss the different ascending tracts of the spinal cord,
- Describe the lemnisci of the brain stem.

### Topic: Spinal cord reflexes

#### Content area:

1. Basic components of reflex arc (A)
2. Functions of alpha, gamma motor neurons, motor units and Renshaw cells (A)
3. Superficial spinal cord reflexes (B)
4. Visceral spinal cord reflexes (B)

#### Instructional objectives:

- Explain the basic components of the reflex arc,
- Describe the functions of alpha and gamma motor neurons, motor units and Renshaw cells,
- List all the central human reflexes,
- Describe the different spinal cord reflexes (superficial visceral and deep),
- Describe the neural pathway involved in flexor withdrawal reflex and crossed extensor reflexes,
- Explain the role of reciprocal innervation.



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Topic: Stretch reflex and muscle tone

**Content area:**

1. Nervous pathway of stretch reflex (**A**)
2. Response of muscle spindles to stretch (**A**)
3. Control of the stretch reflex (**A**)
4. Loading reflex (**B**)
5. Stretch and inverse stretch reflexes (**B**)

**Instructional objectives:**

- Describe the muscle spindle,
- Explain the mechanism of stimulation of muscle spindle and its role in stretch reflex
- List the functions, types and properties of the stretch reflex,
- Explain the mechanism and list the importance of muscle tone,
- Explain the importance of supraspinal control of stretch reflex (gamma, and alpha motor neurons) during rest and voluntary movements,
- Explain the function and importance of Golgi tendon's organs.



## Theme: Sensory system

Topic: Sensory receptors, Sensory transduction and Information processing

### Content area:

1. Principles of sensory modalities (A)
2. Characteristics of sensory receptors (A)
3. Sensory unit, receptive fields and receptor potentials (B)

### Instructional objectives:

- Define sensory receptors,
- List the properties of sensory receptors,
- Explain the specificity of sensory receptors,
- Define receptor potential,
- Explain the mechanism of action of sensory receptors,
- Analyse the relationship between the sensation and the frequency of discharge in a sensory nerve and the intensity of stimulation,
- Define Weber-Fechner law and its modifications,
- Explain adaptation
- Classify sensory receptors based on the adaptation,
- Explain coding for sensory information.

Topic: Anatomy of the sensory cortex

### Content area:

1. Sensory and associated areas in the cerebral cortex (A)

### Instructional objectives:

- Describe the different sensory and associated areas of the cerebral cortex

Topic: Organization and transmission of pain and thermal sensations

### Content area:

1. Thermal sensations (A)
2. Pain perception (A)

### Instructional objectives:

- List the types of thermal sensations,
- Describe the site of thermal receptors,
- Explain the paradoxical cold sensation,
- List the tracts by which pain and thermal sensations are transmitted,
- Explain the mechanism of pain,
- List the types of pain and its site of perception



## Theme: Brainstem

### Topic: Anatomy of the brain stem

#### Content area:

1. Brainstem – external features (**A**)
2. Tracts passing through the brain stem (**A**)
3. Nuclei present in the brain stem (**B**)
4. Blood supply (**B**)

#### Instructional objectives:

- Describe the external features of the brain stem,
- Identify the corticospinal and corticobulbar tracts in the brain stem,
- Describe the nuclei in the different parts of the brain stem.

### Topic: Medulla oblongata, Pons and Mid-brain

#### Content area:

1. Medulla oblongata – external feature, internal structure and nuclei present, (**A**)
2. Pons – external features, internal structure and nuclei present (**A**)
3. Mid-brain – external features and internal structure and nuclei present (**A**)

#### Instructional objectives:

- Describe the external features of the medulla oblongata
- Describe the external features of the pons
- Describe the external features of the mid-brain
- Identify the nuclei present in medulla, the pons and the mid-brain
- Determine the nuclei of deep origin of each cranial nerve in the brain stem



## Theme: Auditory and vestibular system

Topic: Anatomy of the ear and auditory pathways (*partly covered in module 9*)

### Content area:

1. Structure of the external auditory meatus (**A**)
2. Walls and contents of the middle ear (**A**)
3. Auditory pathway and its different order neurons and its connection (**B**)

### Instructional objectives:

- Describe the anatomy of the external auditory meatus,
- Describe the walls and structures inside the middle ear,
- Discuss the parts of the auditory pathways
- Identify the order neurons

Topic: Physiological role of the external and middle ear in Hearing

### Content area:

1. Functions of the tympanic membrane, (**A**)
2. Functions of the middle ear structures – bones and muscles (**A**)
3. Protective reflexes against loud sound (**C**)

### Instructional objectives:

- Explain the role of tympanic membrane in conduction of the sounds,
- Explain the role of bony ossicles in the conduction of the sound,
- Describe the role of middle ear structure in the process of hearing,
- Describe the steps involves in the perception of the sound,
- Explain the mechanism of magnification sound by the middle ear ossicles and its significance.

Topic: Cochlea and the hearing process

### Content area:

1. Function of inner ear in relation to hearing process (**A**)
2. Stimulation of cochlea (**B**)
3. Pitch and loudness discrimination (**C**)

### Instructional objectives:

- Discuss the role of inner ear in the process of hearing,
- Explain how mechanical energy of sound is converted to nerve impulses by organ of Corti in the cochlea,
- Describe the mechanism of pitch and loudness discrimination.

Topic: Vestibular system

### Content area:



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1. Vestibular nuclei and connections (**A**)
2. Vestibular nerve (**B**)
3. Macula and semicircular canals (**B**)

**Instructional objectives:**

- Describe the different parts of the vestibular system
- Discuss the connections of the vestibular system.
- Describe the structure of the macula (otolith organ),
- Describe the structure of the semi-circular canal.

Topic: Physiology of posture and equilibrium

**Content area:**

1. Sensory organs of the inner ear, (**A**)
2. Maintenance of balance (**B**)
3. Nystagmus and Vertigo (**C**)

**Instructional objectives:**

- List the functions of utricle and saccule,
- Explain how the macula is stimulated or inhibited in rotation,
- Describe the function of the semi-circular canals,
- Discuss the role of semi-circular canals in the angular acceleration,
- List the methods of stimulation of semi-circular canals
- Describe the effects of stimulation of semi-circular canals,
- Define nystagmus and vertigo,
- List the causes of nystagmus and vertigo and its mechanism.



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## Theme: Cranial nerves

Topic: Nuclei of the cranial nerves & functions

### **Content area:**

1. Functional classification of cranial nerve nuclei (**A**)
2. Deep origin of each cranial nerve (**B**)
3. Function of cranial nerve (**A**)

### **Instructional objectives:**

- Arrange the cranial nerve nuclei in their function columns,
- Determine the nuclei of deep origin of each cranial nerve,
- Describe the function of each cranial nerve.



## Theme: Cerebellum

### Topic: Anatomy of the cerebellum

#### **Content area:**

1. Cerebellar cortex & nuclei – External features, lobes, fissures, functional subdivisions, internal structure
2. Cerebellar peduncles and fibers passing through them
3. Blood supply
4. Vestibular nuclei, connections and vestibular nerve

#### **Instructional objectives:**

- Describe the external features, lobes and subdivisions of the cerebellum,
- Describe the internal features of the cerebellum,
- List the nuclei present in the cerebellum
- Identify the cerebellar peduncles and fibers passing through each one,
- Describe the blood supply of the cerebellum,

### Topic: Functions of the cerebellum

#### **Content area:**

1. Functions of the cerebellum
2. Manifestations of cerebellar lesions

#### **Instructional objectives:**

- Describe the functions of each lobe of cerebellum
- Explain the functional importance of neuronal circuit in cerebellar cortex.
- Explain the role of spinocerebellar and cerebrocerebellum in voluntary control.



## Theme: Visual system

Topic: Anatomy of the orbit + Microscopic anatomy of the eye (*previously covered in module 9*)

### Content area:

1. Contents of the orbit – muscles, nerves, vessels and ligaments (**A**)
2. Histological structure of the eye (**B**)

### Instructional objectives:

- Describe the contents of the orbit,
- Describe the microscopic anatomy of the eye,
- Name the layers of the eyeball & retina.

Topic: Physiology of the eye (Anterior chamber accommodation)

### Content area:

1. Eye as camera (**A**)
2. Functions of the eye – accommodation, (**A**)
3. Functions of cornea, lens and aqueous humour (**A**)

### Instructional objectives:

- Describe the eye as a camera,
- Explain how anterior chamber accommodation allows the eye to focus on near objects,
- Explain the functions of cornea, lens and aqueous humour.

Topic: Visual acuity and error of refraction

### Content area:

1. Refraction – media and mechanism (**A**)
2. Formation of image on retina (**A**)
3. Myopia, Hypermetropia and Presbyopia (**C**)
4. Methods of correction (**B**)

### Instructional objectives:

1. Define refraction,
2. List the refraction media of the eye,
3. Explain the mechanism of formation of a clear image on the retina,
4. Explain the mechanism of myopia, hypermetropia, presbyopia,
5. Explain the physiological principle behind the methods of correction.

Topic: Light reflex & Dark adaptation

### Content area:

1. Light reflex – mechanism of direct and indirect light reflex (**A**)
2. Clinical significance of the reflex (**B**)



3. Dark adaptation (A)

**Instructional objectives:**

- Explain the mechanism of direct and indirect light reflex,
- Describe the clinical significance of the light reflex,
- Describe the mechanism of dark reflex.

Topic: Retinal functions – Electrophysiology of rods and cons

**Content area:**

1. Properties of retina (A)
2. Light sensitive receptors – rods and cones (A)

**Instructional objectives:**

- List the properties of the retina,
- Explain the mechanism of rods and cones stimulation,
- Explain the spectral sensitivities of the rods and cones.



## Theme: Diencephalon

### Topic: Anatomy of hypothalamus and thalamus

#### Content area:

1. Hypothalamus – structure, connections, and nuclei (A)
2. Thalamus – gross morphology, relations and thalamic nuclei (A)

#### Instructional objectives:

- Describe the structure of the hypothalamus and its location,
- Describe the gross morphology of the thalamus,
- Describe the nuclei present in the hypothalamus and thalamus and their position
- Describe the structure present in relation to the thalamus and hypothalamus.

### Topic: Functions of the hypothalamus and thalamus

#### Content area:

1. Functions of the hypothalamus (A)
2. Effects of hypothalamic lesions (A)

#### Instructional objectives:

- Describe the function of the hypothalamus – autonomic functions, control of endocrine glands, regulation of body temperature, water balance, food intake, control of circadian rhythm, sexual functions, sleep, motivation, memory, learning and emotional expression,
- Explain the effects of the hypothalamic lesion,
- Describe the functions of the thalamus,
- Explain the effects of the thalamic lesions.

### Topic: Anatomy of the Basal ganglia

#### Content area:

1. Basal ganglia – parts, functions, fibers passing through it (A)

#### Instructional objectives:

- Describe the different parts of the basal ganglia,
- Describe the different functions of the basal ganglia,
- Describe the fibers that pass through the basal ganglia.

### Topic: Motor functions of the basal ganglia

#### Content area:

1. Basal ganglia – structure, nuclei (A)
2. Fibers passing through it (A)
3. Function of basal ganglia (A)

#### Instructional objectives:



- Describe the structure and different parts of the basal ganglia,
- Describe the function of the basal ganglia and each of its parts,
- Describe the fibers passing through the internal capsule,
- Explain the role of basal ganglia in the modulation of motor movements,
- List the neurotransmitter present in the area of basal ganglia.

Topic: Anatomy of the limbic system

**Content area:**

1. Limbic system – components, piriform area, amygdaloid body, septum pellucidum (A)
2. Hippocampal formation and fornix (A)

**Instructional objectives:**

- Name the different components of the limbic system,
- Define the piriform area
- Describe septum pellucidum
- Describe the formation of the hippocampal area.

Topic: Function of the Limbic system

**Content area:**

1. Limbic system – components and functions (A)
2. Reticular formation (A)
3. Reticular activating system (RAS) (A)

**Instructional objectives:**

- Name the components of the limbic system,
- List the functions of the limbic system,
- List the connections in the reticular formation,
- List the functions of the reticular activating system,
- List the factors affecting the activity of the reticular activating system.



## Theme: Higher brain functions – Cerebral cortex

### Topic: Macroscopic and microscopic anatomy of the cerebral cortex

#### Content area:

1. Cerebral hemispheres – structure, lobes, surfaces, borders, gyri, sulci on each surface and insula (**A**)
2. Internal structures of the cerebral hemisphere (**A**)
3. Surface anatomy of the main sulci, interpeduncular fossa and base of the brain (**A**)
4. Layers and cells of the cerebral cortex (**A**)

#### Instructional objectives:

- Identify the different lobes of the cerebrum, sulci and gyri on the different surfaces of the cerebral hemisphere,
- Describe the sulci and gyri on the different surfaces of the brain,
- Describe the structures at the base of the brain and interpeduncular fossa,
- Identify the different layers and cells of the cerebral cortex.
- Describe the different types of white matter in the cerebrum,
- Describe the different parts of corpus callosum,
- Compare and contrast between different parts of horizontal section of the cerebral hemisphere,

### Topic: Cognitive functions of the brain

#### Content area:

1. Functional cortical areas (**A**)
2. Cognition (**A**)
3. Functions of different brain regions (**A**)
4. Coordination of complex motor movements (**B**)
5. Consciousness (**B**)
6. Memory organization (**B**)

#### Instructional objectives:

- Describe the functional areas of the cerebral cortex,
- Define cognition,
- Describe different regions of the brain that are responsible for distinct operations,
- Explain how one plan, coordinate complex motor movements,
- Define consciousness,
- Describe how memory is organized,
- Debate whether memory can be organized if one is trained.



## Theme: Motor system

### Topic: Anatomy of the motor cortex

#### Content area:

1. Motor centers of cerebral cortex (A)
2. Pyramidal tract – *pathway, decussations, neurons and laminations* (A)
3. Extrapramidal tracts – *rubrospinal, reticulospinal, olivospinal, vestibulospinal and tectospinal* (A)

#### Instructional objectives:

- Describe the different motor centers in the cerebral cortex,
- Trace the course of pyramidal tract,
- Define the parts of extrapyramidal tracts,
- Compare and contrast between both pyramidal and extrapyramidal tracts.
- Describe the nuclei and extrapyramidal tracts passing through the different parts of the brain stem,

### Topic: Motor descending tracts & their function and cortical control of motor functions

#### Content area:

1. Motor cortical area – functions and characters (A)
2. Functions of pyramidal and extrapyramidal tracts (A)
3. Upper and lower motor neuron lesions (B)
4. Role of afferent, interneuron and efferent neurons in the signal processing – divergence, convergence, summation, reverberating circuits, recruitment and after-discharge (C)

#### Instructional objectives:

- List the specific functions of cortical motor areas,
- Describe the effect of the lesion of motor areas,
- List the functions of pyramidal and extrapyramidal tracts,
- Describe the effect of the lesion of pyramidal and extrapyramidal tracts,
- Compare and contrast between upper and lower motor neuron lesion,
- Explain how the signal is processed and transmitted in the central nervous system within the reflex arc

### Topic: Motor functions of the cerebellum and basal ganglia

#### Content area:

1. Modulatory effects on motor reactions (A)

#### Instructional objectives:

- List the motor functions of the cerebellum



- Explain the mechanism of action of each function
- Explain the role of spinocerebellum and cerebrocerebellum in voluntary control.

### Topic: Memory

#### Content area:

1. Memory – types, mechanism, consolidation, encoding (A)
2. Memory disorders (C)
3. Methods of learning (A)

#### Instructional objectives:

- Define memory,
- List the types of memory
- Explain the mechanism of memory,
- Describe how memory can be consolidated,
- Describe how memory can be encoded
- Describe different methods of learning

### Topic: Sleep

#### Content area:

1. Sleep – types, stages and mechanism (A)
2. Physiological changes during sleep (B)
3. Sleep disturbances (C)

#### Instructional objectives:

- Define sleep,
- List the types of sleep – Random eye movements (REM) & non-REM,
- Describe different stages of the sleep, - sleep cycles,
- Explain the mechanism of sleep based on theories presented,
- List different reasons for sleep disturbances and their mechanism.

### Topic: Speech

#### Content area:

1. Speech – definition, types and mechanism (A)
2. Speech disorders – aphasia and dysphasia (C)

#### Instructional objectives:

- Define speech,
- List the types of speech – spoken and written
- Explain the mechanism of speech,
- List the types of speech disorders
- Explain the mechanism of speech disorders



Module 08: Neuroscience

Topic: Taste and smell

Content to be provided by the department.

Medical Education Department



## Recommended and additional Reading for the module

### Neuroscience

#### Recommended reading

- Barker, R. A., & Cicchetti, F. (2012). **Neuroanatomy and Neuroscience at a Glance** (Vol. 85). John Wiley & Sons.

### Embryology

#### Recommended reading

- Webster S & De Wreede R. (2012). **Embryology at a Glance**. John Wiley & Sons. (*pre-lecture reading*)
- Sadler, Thomas W. **Langman's medical embryology**. Wolters Kluwer Health, 2014. 13<sup>th</sup> edition

#### Additional reading

- Moore, Keith L., *et al.* **The developing human: clinically oriented embryology**. Philadelphia: *Saunders/Elsevier*, 2013 9<sup>th</sup> edition.
- **Snell's Clinical Embryology for medical students** (Latest Edition)

### Histology

#### Recommended reading

- Peckham, M. (2011). **Histology at a Glance (Vol. 50)**. John Wiley & Sons. (*pre-lecture reading*)
- Fawcett, D. W., and R. P. Jensch. "**Bloom and Fawcett's Concise Histology 2nd.**" *Arnold-Hodder Headline Group*. London (2002): 1-360.

#### Additional reading:

- Junqueira, C. L., J. Carneiro, and R. O. Kelley. "**Basic histology.**" *Basic histology* (2013) 13<sup>th</sup> edition.
- Young, Barbara, ed. **Wheater's functional histology: a text and colour atlas**. Elsevier Health Sciences, 2014. 6<sup>th</sup> edition

### Anatomy:

#### Recommended reading

- Faiz O, Blackburn S & Moffat D. (2011). **Anatomy at a Glance** (Vol. 66). John Wiley & Sons. (*pre-lecture reading*)
- Drake, Richard, A. Wayne Vogl, and Adam WM Mitchell. **Gray's anatomy for students**. Elsevier Health Sciences, 2015. 3<sup>rd</sup> edition.

#### Additional reading

- Moore, Keith L., Arthur F. Dalley, and Anne MR Agur. **Clinically oriented anatomy**. Wolters Kluwer Health, 2014. 7<sup>th</sup> edition.



Physiology:

Recommended reading

- Ward, J. P., & Linden, R. W. (2013). **Physiology at a Glance**. John Wiley & Sons. (*pre-lecture reading*)
- Sherwood L, **Human Physiology: From cells to systems** West Publishing Company, New York. 7<sup>th</sup> edition.

Additional reading

- Ganong's **Review of Medical Physiology**. Lange Medical Publications McGraw Hill
- Guyton, A.C., **Textbook of Medical Physiology**, Saunders, Philadelphia

Clinical skills

Recommended reading

- **Macleod's Clinical Examination**. Edited by Douglas *et al.* 2009, 12<sup>th</sup> edition. Published by Churchill Livingstone, Elsevier.

**Male and female students should refer to the main university library (or ask librarian) for interactive materials available in the form of Compact Discs (CDs). You are suggested to use self-study period to watch these videos in the IT laboratory after issuing them from the Library.**

**Note: You are notified to read the latest edition available.**

**All students are informed to come prepared for the lectures after reading the “at a glance” series mentioned in the recommended books. After the lectures, students are suggested to read the recommended textbook. The faculty members will provide the page numbers for the topics covered at the end of the lecture or an activity.**



## Teaching and Learning opportunities

Each week of the module will have specific theme/ topic. Each theme has a range of topics from different disciplines (Physiology, Anatomy and Biochemistry and Pharmacology for instance). Each topic will have its learning outcomes and objectives. A range of learning opportunities have been arranged in particular for understanding concepts and principles. In a typical week, there are:

- Lectures
- Small group discussions/tutorials
- Self-study period
- Clinical skills laboratory
- Laboratory sessions/ Experiments

### Lectures

The topics for each lecture has learning objectives, which can be found in this guide along with references for essential and reference reading. Lectures are scheduled to last no more than 50 minutes. There should be maximum of 10 lectures per week for both semesters.

### Small group discussions/ tutorials

The small group discussions and tutorials are very important learning opportunities. The small group discussions will sometime adopt a problem-solving approach to understand the concepts and principals involved that are difficult or not clear.

### Clinical skills sessions

The clinical skills laboratory sessions provide early introduction of the clinical teaching and patient exposure for undergraduate medical students. During the session, students will be learning clinical competencies such as history taking and physical examination during the course of the module.

### Self-study time

In each week, some time is allocated to private independent study. This time is for students, either alone or small groups, to consider the course material, prepare for the tutorial or laboratory activities or simply do some background reading. The time is precious and should be used carefully – **it is not time off by any means!** Facilities to help students with self-study include the library, IT laboratories for computer-assisted learning and common room (for girls only).

### Laboratory activities/ practical:

The teaching opportunities during the laboratory activities elaborates on the application of the knowledge gained during the lectures or self-study and particularly the skills involved.



## About attendance

From the academic year 2019, following guidelines will be strictly observed.

### Laboratory practical and Tutorials:

- All laboratory activities are mandatory to attend.
- At the sessions will be timed off.
- These activities are essential criteria eligible for semester examinations.
- Students will assessed on the material at the end of the module practical exams and semester exams.

### Clinical skills laboratory:

Almost all clinical skills sessions are mandatory to attend and attendance will be marked at the end of the session. The attendance at the clinical skills sessions is one of the eligibility criterion towards sitting in semester and end of the module OSCE.

### Small group discussion:

All small group discussion sessions are mandatory to attend. The students will be signed off at the end of the session. All students are instructed to attend all session and failure to attend a session may result in failure of the module.

### Lecture:

The students are instructed to attend the lectures since they form the cognitive base for rest of the activities in a week. **The desired attendance of 100% is necessary to sit for end of the module assessment and semester exam overall.**

**Only 20% (short) holidays will be accepted for the ill-health and emergency situation.**

**No candidate will be allowed to sit in the exam (Annual and re-sit), if the attendance is short.**

**From this point forward, only students with 80% attendance in the module will be allowed to sit in the module exam.**



Module 08: Neuroscience  
Teaching faculty:

Medical Education Department

**Anatomy**

Dr Zaheer Memon  
Dr Syna Amir  
Dr Shaukat Memon  
Dr Aftab Abbasi  
Dr. Jahanzeb  
Dr. Pirah

**Physiology**

Prof. Dr. Navaid Kazi  
Dr. Yar Mohammad Nizamani  
Dr Abroo Qazi  
Dr Arsalan  
Dr. Roomi

**Medical Education**

Dr Kabir Dherwani

[Timetable](#)  
[Three-year curriculum](#)  
[Academic Calendar 2019](#)

Please check Isra University website for up-to-date documents.