Topics for the MCQ I

(Listed below chapters and pages refer to Guyton and Hall, Textbook of Medical Physiology, 11th edition)

Physiology of neurons and neural networks

1. The cell membrane of the neuron: its significance for maintaining the resting potential
2. Electric and chemical synapses
3. Ionotropic and metabotropic postsynaptic receptors.
4. The release of neurotransmitter from presynapric endings
5. Excitation of the neuron. Excitatory Postsynaptic Potential (EPSP). Action potential
   - – Flow of ions across the cell membrane in the course of the action potential
   - – The sodium-potassium pump
   - – The role of dendrites in the excitation of the neuron
6. Postsynaptic inhibition
   - – Inhibitory Postsynaptic Potential (IPSP)
   - – How does IPSP prevent excitation of the neuron?
7. Presynaptic inhibition
8. Conduction of action potential in myelinated and unmyelinated nervous fibers
9. The function of metabotropic receptors
   - – The role of G proteins
   - – Secondary messengers
   - – The adenyl cyclase and phosphatidyl inositol system
   - – Signal transduction in the cell; amplification of the signal
10. Organization of nervous networks
    - – Divergent and convergent networks
    - – Lateral, recurrent and forward inhibition
    - – Facilitation

Textbook of Medical Physiology, Chapter 45: Organization of the Nervous System; Basic Functions of Synapses and Transmitter Substances (pages 555 – 571)

Motor system – the spinal cord

1. Spinal reflexes. Components of the reflex arc. Why are the impulses conducted in the reflex arc in one direction only; that is, from the receptor to the effector, and not *vice versa*? Monosynaptic and polysynaptic reflexes
2. What do you mean by the motor unit?
   – How are motor units organized in the hand, finger and tongue muscles, and how are they organized in trunk muscles?
3. Spinal motor neurons - alpha and gamma motoneurons: location, structure, function
4. Interneurons in spinal motor centers– excitatory and inhibitory – their role in the motor activity of the spinal cord. Particular function of Renshaw cells
5. Sensory innervation of the muscle
   – Muscle spindles
   – Stretch receptors, their location and innervation
   – Ia and II fibers: functional difference between them
   – Golgi tendon organs – their functional significance; Ib fibers
6. Organization and function of gamma innervation; static and gamma motor neurons
7. Collaboration between group of muscles
   – Agonist, antagonist and synergic muscles
   – Flexor reflex, crossed extensor reflex and reciprocal innervatian; that is, why don't you fall down when standing on one leg?

Textbook of Medical Physiology, Chapter 54: Motor Functions of the Spinal Cord; the Cord reflexes (pages 673 – 684)

Motor system – the brain stem

1. Descending reticular system
   – Excitation of spinal motor neurons by the pontine reticulospinal tract; the role of the vestibular nuclei and of the cerebellum
   – Inhibition of spinal motor neurons by the bulbar reticulospinal tract; the role of cortical influences;
2. What is the decerebrate rigidity and when does it develop?

Textbook of Medical Physiology, Chapter 55: Cortical and Brain Stem Control of Motor function; Subchapter: Role of the Brain Stem in Controlling motor function (pages 691 – 697)

Motor system – the cerebral cortex

1. What do you mean by involuntary, voluntary and automated movements?
2. Motor and somatosensory functions of the cerebral cortex; what is the sensorimotor cortex and which are its components?
3. Primary motor cortex, its location and somatotopic organization.
4. Premotor area and its functional role;
5. The role of the prefrontal cortex in the control of motor activity?
6. The corticospinal (pyramidal) tracts, their anatomy and how they excite the spinal motoneurons.

Textbook of Medical Physiology, Chapter 55: Cortical and Brain Stem Control of Motor function (pages 685 – 691)

Motor system – the basal ganglia

1. Anatomy of basal ganglia: Caudate nuleus, putamen, globus pallidus; thalamus
2. Neural connections between the basal ganglia and related structures: nucleus subthalamicus, substantia nigra, reticualr formation
3. Functional loops involved in the control of movement: Caudate loop, putamen loop
4. Control of muscle tone by basal ganglia
5. Pathology of basal ganglia: Parkinson disease, Huntington chorea,
6. Neurotransmitters in the basal ganglia circuits with particular emphasis on the striatonigral GABAergic and dopaminergic systems

Textbook of Medical Physiology, Chapter 56 Contributions of the Cerebellum, The Basal Ganglia to Overall Motor Control (pages 707 – 713)

Motor system: the cerebellum

1. Anatomy of the cerebellum; connections of the cerebellum with the spinal coed, brain stem nuclei and the cerebral cortex.

2. Classical disturbances of cerebellar functions: asthenia, astasia, abasia.
3. Cerebellar control of alternating movenens: diadochokinesis
4. Cerebellar control of termination of movement: Holmes'symptom.
5. Cerebellum and body balance; cerebellar ataxia and dysmetria
6. Mechanism of correction of to-be-executed and intendent movements. Cerebellum as a comparator

Textbook of Medical Physiology, Chapter 56 Contributions of the Cerebellum, The Basal Ganglia to Overall Motor Control (pages 698 – 707)

Sensation – General

1. What is reception, sensation and perception?
2. General organization of the sensory systems
   – Receptors as nerve endings and specialized sensory cells
   – Mechanoreceptors, chemoreceptors, thermoreceptors, photoreceptors
   – What are ganglion cells and what is the origin of their name?
   – What is the role of subcortical sensory centers?
   – Sensory functions of the cerebral cortex: the role of primary (or projection) and secondary (association) areas

Somatic sensation

1. Categories of somatic sensation
   – Superficial (skin) sensation: touch, pressure, vibration, temperature, pain
   – Deep sensation (proprioception). Sensation of body position and movements.
2. Tactile (touch) receptors: Meissner's corpucles, Merkel's discs. Ruffini's end-organs
   – Mechanism of excitation of a tactile receptor: deflection of the cell membrane and opening of sodium channels; receptor potential; analog coding of the stimulus force;
   – Generation of action potentials in the sensory fibers; digital coding of the stimulus force;
   – Adaptation of receptors. The role of slowly and fast adapting receptors in precise sensation of different touch qualities.
3. Thermal and pain receptors; nervous fibers conducting impulses from skin receptors.

4. Sensory pathways in the spinal cord. The dorsal column conducting tactile and deep sensation. The lateral columns conducting temperature and pain sensation

5. The somatosensory cortical area

– Primary somatosensory area, its somatotopic organization. Localization of skin and deep sensation.

– Secondary (association) somatosensory areas

– Sensation of the scheme of the body. The phantom limb.

6. Sensory deficits after lesions of a) sensory nerve, b) dorsal column, c) lateral column, primary sensory cortex, d) secondary sensory areas.

Textbook of Medical Physiology, Chapter 46: Sensory Receptors; Neuronal Circuits for Processing Information (pages 572 – 584) and Chapter 47: Somatic Sensations: I. General Organization: the Tactile and Position Senses (pages 585 – 597)

Pain

1. The reasons for distinguishing physiological and pathological pain.

2. Physiological pain. Fast pain (A*delta* fibers) and slow pain (C fibers)

3. Control (spinal gate) – its neuronal organization; why is acupuncture efective in pain relief?

4. Central pain inhibitory analgesic system. The role of the periaqueductal gray, the raphe nuclei and the paragigantocellular nucleus in pain inhibition

5. Neurotransmitters involved in pain transmission and pain inhibition

- Glutamate and substance P as neurotransmitters in spinal pain centers

- Opioids and their role in pain inhibition

beta-endorphin, enkephalins, dynorphins. Opoid receptors

6. Pathological pain

– Substances present in inflammatory area: bradykinin, interleukin-1, prostaglandin E2

– What do you mean by overactivity of C fibers in pathological pain?

– What happens in the spinal pain center during pathological pain. The “wind-up” phenomenon

– What is the mechanism of hyperalgesia

7. Visceral pain. Referred pain.

8. Neuropathic pain (due to a lesion of a peripheral nerve); what do you mean by allodynia?

9. Opiate and non-opiate analgesics – morphine *versus* non-steroid antiinflammatory agens (e.g. aspirin)
10. What is the strategy of pain therapy in cancer patients? The problem of morphine tolerance and addiction.

Textbook of Medical Physiology, Chapter 48: Somatic sensations: II. Pain, Headache and Thermal sensations (pages 598 – 609)

Vision

1. The optics of vision
   – The refractive power of human eye
   – What do you mean by a diopter?
   – Errors of refraction – emmetropia, hyperopia, myopia; astigmatism
   – How do you measure visual acuity?
2. Binocular vision;
   – How do you estimate the distance of near objects (less than 60 meters from the eye) and far objects (more that 60 meters from the eye)?
   – Accomodation of the eye and its changes with aging..
   – Why is squint dangerous for visual acuity in children?
3. Clinical importance of intraocular pressure
4. Anatomy and physiology of the retina
   – The center and the periphery of the retina with respect to the acuity of vision
   – Rods and cones – functional difference between them
   – The mechanism of excitation of rods; the rhodopsin cycle; hyperpolarization (not depolarization !) is the excitatory potential
   – What is the role of lateral inhibition between the horizontal cells in the retina?
   – Ganglion cells of the cells; differential role of magnocellular(Y) and parvicellular (X) cells
   – The mechanism of color vision at the level of the retina
5. The function of cortical visual areas
   – Primary and secondary (association) areas in the occipital, the parietal and the t temporal lobes.

– Two paths of visual information – the magnocellular path for place and movement, the parvicellular path for color, shape and texture of objects

– Responses of cortical cells to visual stimuli: simple, complex and hypecomplex cells.

6. Visual field

– How are the retinas represented in the visual cortex. What does "see" the left and right hemisphere?

– How do you determine the visual field?

– Why is the determination of the visual field important in ophthalmology and neurology?

7. Pupillary reflexes

Textbook of Medical Physiology, Chapter 49: The eye: I. Optics of vision (pages 613 – 625), Chapter 50: The eye: II. Receptor and neural function of the retina (pages 626 – 639), and Chapter 51: The Eye III. Central Neurophysiology of Vision (pages 640 - 650)

Audition

1. Anatomy of the ear: external ear, middle ear, internal ear
2. The basilar membrane and the Corti organ
3. Resonance theory of hearing. Vibrations of the basilar membrane. The travelling wave
4. Different roles of inner and outer hair cells
5. Why do the outer cells "dance" and what is their significance for pitch discrimination.
6. Cortical auditory area: encoding of tones, sounds, human speech and music

Textbook of Medical Physiology, Chapter 52 The Sense of Hearing (pages 651 - 662)

Sleep and consciousness. Biological rhythms

1. Wakefulness and sleep – two basic states of the brain
2. What makes us conscious? Structure and function of the reticular formation
3. Principles of electroencephalographphy (EEG)
4. Brain waves as symptoms of wakefulness and sleep:

   alpha, beta, delta, theta, spindles

5. Stages of wakefulness: alertness, arousal, relaxed wakefulness

.6 Animal sleep: desynchronization and synchronization of EEG

7. Human sleep: Non-REM and REM sleep

8 . Physiology of dreams

9. The biological circadian clock – the role of the suprachiasmatic nucleus

10. Two sides of the sleep story: a biological need for sleep and sleep propensity

11 Pathology of sleep: narcolepsy, insomnia, jet-lag phnomenon, delayed and advanced phase of sleep propensity.

Textbook of Medical Physiology, Chapter 59 States of Brain Activity – Sleep; Brain Waves (pages 739 - 743)

Plasticity of the brain. Emotions. Learning and memory. Speech mechanisms

1. What do you mean by plasticity of the brain?
2. What is memory?
3. Categories of memory
   - – Short-term *versus* long-term
   - – Working memory
   - – Declarative *versus* nondeclarative
   - – Episodic
   - – Semantic
   - – Autobiographical
   - – Conditioning: classical and instrumental
4. Anatomy of memory – role of the hippocampus, the amygdala and the prefrontal cortex
5. Pathology of memory
   - – Alzheimer disease
   - – Korsakow syndrom
   - – anterograde and retrograde amnesia
   - – Patient HM – global amnesia
5. Physiology of human intelligence – the prefrontal cortex
6. Lateralization of cerebral functions
7. Speech mechanisms
   - – Motor speech area (Broca)

– Sensory speech area (Wernicke)

– The parieto-occipito-temporal junction

– Aphasias

8. Anatomy of the limbic system
9. Needs, drives and emotions – define these terma
10. Categories of drives

– Biological *versus* social

– Inherited *versus* acquired

12. Human drives and emotions
13. Mood and mood disorders. Depression

Textbook of Medical Physiology, Chapter 57 The cerebral cortex; intellectual functions of the brain; learning and memory (pages 733 -746)

Classic neurotransmitters in the central nervous system

[Excitatory aminoacids**,** gamma-aminobutyric acid (GABA), catecholamines (dopamine, noradrenaline)**,** serotonin**,** acetylcholine]

1. Synthesis release and removal of neurotransmitters from synaptic cleft. Role of astrocytes.
2. Localization of cells producing given type of neurotransmitter within CNS and their projections
3. Co-transmitters
4. Pre- and postsynaptic receptors
5. Participation of classic neurotransmitters in the regulation of physiological processes and emotional states
6. Clinical consequences of disturbances of the neurotransmission within some of these systems

Textbook of Medical Physiology, Chapter 45: Organization of the Nervous System; Basic Functions of Synapses and Transmitter Substances subchapter Chemical Substances that Function as Synaptic Transmitters (pages 562 – 564), Chapter 59 States of Brain Activity – Sleep; Brain Waves , subchapter Psychotic Behavior and Dementia- Role of Specific Neurotransmitter Systems (pages 745-746)

Homeostasis of the internal environment of the central nervous system – blood-brain (BBB) and blood –cerebrospinal fluid (CSF) barriers

1. Structure of brain capillaries. Structural and enzymatic BBB
2. Mechanisms of transport through the BBB
3. Areas of the brain devoid of the BBB
4. Function of choroid plexus. Mechanisms of secretion of CSF.
5. Circulation and absorption of CSF.
6. Intracranial pressure.
7. Role of CSF.
8. Disturbances of circulation or absorption of CSF – hydrocephalus
9. Consequences of disruption of the BBB – brain edema.

Textbook of Medical Physiology, Chapter 61 Cerebral Blood Flow, Cerebrospinal Fluid, and Brain Metabolism, subchapter Cerebrospinal fluid System (pages 763-767)

The material suggested for reading refers to the **11th edition** of the Guyton and Hall's Textbook.

It is of utmost importance to know what was discussed during lectures and seminars.