



Syllabus

France Brain Bee

Section 1: Cell biology, neural information processing and development of the nervous system

Educational objective : Students will be tested on this section through multiple choice or one answer type of questions

1. Cell biology of the nervous system:

- a. Neurones: cell morphology (soma, axon, dendrites, myelin sheath), types of neurons (inhibitory and excitatory), difference between myelinated and unmyelinated neurons.
- b. Glial cells: morphology and function of astrocytes, oligodendrocytes, microglia and Schwann cells

2. Communication between cells in the nervous system: ion channels, resting and action potentials, electrical synapses, chemical synapses, neurotransmitters (most important inhibitory and excitatory neurotransmitters) and types of receptors (pre-synaptic / post-synaptic), synaptic plasticity and memory

3. Perception: for each system students should be able to identify the parts of the system and the information pathways

- a. Visual system: anatomy and physiology of the eye, photoreceptors and retinal circuits, visual pathway (oculo/visual cranial nerves (II,III,IV,VI)optic chiasma, thalamus, visual cortex), structure of the visual cortex. .
- b. Auditory system: ear anatomy, auditory pathway (hair cells, VIII cranial nerve, brain stem, thalamus, auditory cortex) speech areas: Broca and Wernicke's area.
- c. Vestibular system
- d. Chemical senses:
 - i. Taste: taste buds and receptors, taste pathway (taste buds, cranial nerves: glossopharyngeal, vagus and facial nerves, medulla, thalamus, primary gustatory cortex)
 - ii. Smell: olfactory epithelium, olfactory pathway (olfactory receptors, olfactory bulb, I cranial nerve, primary olfactory cortex)
- e. Somatosensory:
 - i. Touch: skin receptors, sensory information pathway (skin receptors, spinal cord, medulla, thalamus, primary somatosensory cortex)
 - ii. Pain: nociceptors, pain and inflammation, endorphins

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4. Motor control:

- a. Motor unit and neuromuscular junction
- b. Stretch receptors and Golgi
- c. Voluntary movements and motor pathway (cerebellum, basal ganglia, primary motor cortex, corticospinal tract, motor neuron axon, muscle fibers)

5. Unconscious processing of neural information:

- a. Involuntary movements: Myotatic stretch reflex pathway (muscle and tendon stretch receptors)
- b. Autonomic nervous system:
 - i. Sympathetic nervous system; fight or flight response
 - ii. Parasympathetic nervous system: rest or digest
 - iii. Homeostasis: circadian rhythms and hypothalamus (pathway)

6. Learning and memory:

- a. Types of memory (episodic, working, procedural)
- b. Memory and brain structures involved: cortex (visual word form area, fusiform face area), basal ganglia, amygdala, hippocampus (dentate gyrus, place cells), parahippocampus,
- c. Synaptic plasticity and long term potentiation (NMDA and AMPA receptors)
- d. Emotions and memories: amygdala, insular cortex
- e. Reward pathways: nucleus accumbens, amygdala, hippocampus

7. Development of the nervous system:

- a. Neurogenesis: cell division and abnormal cell division, neural pruning, myelination.
- b. Areas of adult neurogenesis
- c. Brain plasticity and brain repair

8. Aging and the nervous system: normal and abnormal changes in the brain with age. Dementias

Section 2: Anatomy and histology

Educational objective : Students should be able to recognise the structures listed below on a given model, photographs or microscope slides

9. Brain gross anatomy:

- a. Central nervous system:
 - i. cerebrum: surface anatomy: hemisphere, lobes, gyrus and sulci, corpus callosum, olfactory bulb, optic nerve and optic chiasm), visual cortex, primary motor cortex, somatosensory cortex, prefrontal cortex, auditory cortex; medial surface: thalamus, hypothalamus,
 - ii. brainstem: midbrain, pons and medulla
 - iii. cerebellum
 - iv. spinal cord (segments)
 - v. Cranial nerves. Exploration and pathologies
- b. Peripheral nervous system: afferent and efferent nerves, ganglia

10. Brain neurohistology:

- a. Brain planes or anatomical references
- b. Cytology:
 - i. Cerebral cortex: gray matter, white matter, pyramidal neurones,
 - ii. Hippocampus: dentate gyrus, CA1, CA2, CA3, subiculum
 - iii. Retina: ganglion cells, bipolar cells, photoreceptors, pigmented epithelium, choroid
 - iv. Ear: cochlea
 - v. Spinal cord: grey and white matter, dorsal, ventral and lateral horns, ventral medial fissure, dorsal median sulcus
 - vi. Skin: Pacinian Corpuscle, Meissner corpuscle, dermal papilla
 - vii. Taste bud : taste pore, neuroepithelial cells, basal/stem cells
 - viii. Peripheral nerve: endoneurium, perineurium, epineurium, nerve fascicle
 - ix. Basal Ganglia: Putamen, Caudate Nucleus, Nucleus Accumbens
 - x. Diencephalon: Thalamus, Hypothalamus, Epithalamus
 - xi. Cerebellum: Purkinje Cell Layer, Granule Cell Layer, White Matter, Molecular Layer

Section 2: Anatomy and histology - To go further on the neuroanatomy part you can use the table below:

CENTRAL NERVOUS SYSTEM										
BRAIN							SPINAL CORD			
Lobes	Areas	Hemispheres	Ventricular system and cerebrospinal fluid formation	Vascular system	Brain protection structures	Cranial nerves	Spinal nerves	Spinal cord structure	Divisions	Roots
Frontal	Brodmann's areas	Left and right hemispheres	Lateral ventricles	Arterial supply: - Carotid - Vertebrobasilar systems - Circle of Willis	Meninges	From diencephalon: - Olfactory nerve (I) - Optic nerve (II)	Cervical	Grey matter	Parasympathetic	Dorsal
Parietal	Precentral gyrus and motor cortex	Communication through commissures: - Corpus callosum - Hippocampal commissure (fornix) - Habenular commissure - Anterior commissure - Posterior commissure	Third ventricle	Veinous drainage : - Internal jugular vein - Ophthalmic veins - Superior sagittal sinus - Transverse sinus - Sigmoid sinus	Blood brain barrier	From midbrain: - Oculomotor nerve (III) - Trochlear nerve (IV)	Thoracic	White matter	Sympathetic	Ventral
Temporal	Postcentral gyrus and sensory cortex		Fourth ventricle		Skull	From hindbrain: - Trigeminal nerve (V) (a) Ophthalmic nerve (b) Maxillary nerve (c) Mandibular nerve - Abducent nerve (VI) - Facial nerve (VII) - Vestibulocochlear nerve (VIII) - Glossopharyngeal nerve (IX) - Vagus nerve (X) - Accessory nerve (XI) - Hypoglossal nerve (XII)	Lumbar			
Occipital	Broca		Communications between ventricles : - Intraventricular foramina - Cerebral aqueduct - Median aperture - Right and left lateral aperture				Sacral			
	Wernicke									

Section 3: Pathology of the nervous system and patient diagnosis - DISEASE

Section 3: Pathology of the nervous system and patient diagnosis

Educational objective : For every disease listed below, students should be able to recognise the main symptoms and use them in coordination with the results of the tests to provide a diagnosis.

Neurodevelopmental (childhood) disorders:	Substance abuse:	Neurodegenerative diseases:	Psychiatric disorders:	Infectious diseases:	Genetic disorders:	Trauma:	Epilepsy:	Multifactorial :		
Autism,	Wernicke-korsakoff Syndrome (WKS)	Parkinson's,	Schizophrenia,	Meningitis,	Huntington's Disease,	Spinal Cord Injury,	Focal,	Sleep Disorders :		
Spina Bifida,		Alzheimer's,	Anxiety Disorder,	Tetanus,	Down Syndrome	Traumatic Brain Injury	Generalized,	Insomnia,		
Down Syndrome,		Multiple Sclerosis	Bipolar Affective Disorder,	Prion Diseases			Tourette's Syndrome (TS)	Restless Legs Syndrome,		
Adhd			Obsessive Compulsive Disorder,							Narcolepsy
			Post-traumatic Stress Disorder,							
			Eating Disorders,							

Section 3: Pathology of the nervous system and patient diagnosis - TEST

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Neuroimaging:	Neurophysiology:	Neuroanatomy:	Clinical:
CT scan,	EEG,	Biopsy,	Blood pressure measurement,
PET,	Angiography,	Cerebrospinal Fluid Analysis	Blood test,
MRI,	Electromyography (EMG)		Genetic Analysis,
			Intelligence Test,
			Memory Test,
			Motor Evaluation,
			Nerve Conduction Test,
			Ophthalmoscopy,
			Reflex Evaluation,
			Sensory Evaluation,
		Urine Analysis	