

Bogomolets National Medical University

Department of human anatomy

GUIDELINES

<i>Academic Subject Matter</i>	HUMAN ANATOMY
<i>Module N^o</i>	2
<i>Content module N^o</i>	15
<i>Theme of the lesson</i>	I, II, III, IV, VI, VIII cranial nerves
<i>Course</i>	I-st
<i>Amount of hours</i>	3

1. The relevance of the topic: Cranial nerves belong to the peripheral part of the nervous system. They are divided into true (I-II) and false (III-XII pairs). I and II pairs of cranial nerves are outgrowths of the olfactory and intermediate brain, and the myelin, which covers them, is the origin of the oligodendroglial cells. In these nerves myelin sheath is forming Schwann cells. This is taken into account in the diagnosis of certain nervous system's diseases.

2. Specific objectives :

After lesson the student should know and be able to:

1. Describe and demonstrate the ways the olfactory and visual analyzers.
2. Describe and characterize the nuclei III, IV, VI, VIII pairs of cranial nerves to determine their function.
3. Demonstrate the I, II, III, IV, VI, VIII cranial nerve on preparations of brain and skull.
4. Describe and demonstrate the course and the areas of innervation III, IV, VI pairs of cranial nerves.
5. Determine the functional significance of somatic and autonomic fibers of the oculomotor nerve.

3. A basic training level (interdisciplinary integration) of the student includes knowledge of medical biology and histology of the development of the cranial nerves, especially their structure and development.

Before class the student should know and be able to:

1. Identify the main challenges of modern neurology and neurosurgery, its clinical direction.
2. Describe and demonstrate the walls and posts of the nasal cavity, the orbit, the structure and connections of the cranial fossae.
3. Know the names of the 12 pairs of cranial nerves.
4. Describe and demonstrate the structure of the olfactory, vision, hearing organs.
5. Demonstrate the location of the nuclei III, IV, VI, VIII pairs of cranial nerves in the brain stem, its projection; exit of cranial nerves from the brain, skull, course I, II pairs of cranial nerves.
6. Describe in neuron the peripheral portion of the olfactory analyzer path.
7. Describe in neuron the visual analyzer path.

N.olfactorius	Olfactory nerve
N. opticus	Optic nerve
N. oculomotorius	Oculomotor nerve
N. trochlearis	Trochlear nerve
N. abducens	Abducens nerve
N. vestibulocochlearis	Vestibulo-cochlear nerve

The content of the topic:

Olfactory Nerve (I)

Olfaction is part of the special senses cranial nerve group and represents the chemical senses of olfaction (smell) and gustation (taste). When chemical substances interact with our bodies they stimulate special sensory cells which in turn generate an action potential. The resultant impulse is sent to the brain via sensory afferent fibres and it is these fibres that represent the olfactory cranial nerve. Note: an action potential is only generated where a special sensory cell for that particular chemical substance exists. If no sensory cell exists, that chemical substance will go undetected. The olfactory neurosensory cells are found within the olfactory epithelium. The olfactory epithelium contains cilia on the surface of the cells to increase the surface area for chemical interactions.

The olfactory nerve runs to the olfactory bulb which is found within the telencephalon. The olfactory nerve is a sensory nerve and is composed of many Special Visceral Afferent fibres. The fibres are formed into bundles that are referred to as 'Olfactory filaments'. The olfactory nerve passes through the Cribriform plate and is surrounded by meningeal sheets including the sub-arachnoid space. There for the route of the olfactory nerve represents a potential site for an infection to track towards the brain. Injury of this nerve can lead to 'anosmia', or loss of smell.

The olfactory organ in dogs is extremely well developed and species such as canines use olfaction to orientate themselves in an environment in a way that humans do not. Olfactory cells are continuously replaced and are only viable sensory cells for between 30 - 60 days. This point is of importance as this is the only area in which nerve cells are able to be replaced or regenerated in adult animals and this area is now under research at Cambridge University for the treatment of damaged nerves and/or nerve disorders in nerves other than those involved in olfaction.

Optic nerve (II)

The optic nerve is formed by the convergence of axons from the **retinal ganglion cells**. These cells in turn receive impulses from the photoreceptors of the eye (the rods and cones).

After its formation, the nerve leaves the bony orbit via the **optic canal**, a passageway through the sphenoid bone. It enters the cranial cavity, running along the surface of the middle cranial fossa (in close proximity to the pituitary gland).

Within the middle cranial fossa, the optic nerves from each eye unite to form the optic chiasm. At the chiasm, fibres from the nasal (medial) half of each retina cross over, forming the optic tracts:

- Left optic tract – contains fibres from the left temporal (lateral) retina, and the right nasal (medial) retina.
- Right optic tract – contains fibres from the right temporal retina, and the left nasal retina.

Each optic tract travels to its corresponding cerebral hemisphere to reach the Lateral Geniculate Nucleus (LGN), a relay system located in the thalamus; the fibres synapse here.

Axons from the LGN then carry visual information via a pathway known as the optic radiation. The pathway itself can be divided into:

Upper optic radiation – carries fibres from the superior retinal quadrants (corresponding to the inferior visual field quadrants). It travels through the parietal lobe to reach the visual cortex.

Oculomotor nerve (III)

The oculomotor nerve originates from the anterior aspect of the midbrain. It moves anteriorly, passing below the posterior cerebral artery, and above the superior cerebellar artery. The nerve pierces the dura mater and enters the lateral aspect of the cavernous sinus. Within the cavernous sinus, it receives sympathetic branches from the internal carotid plexus. These fibres do not combine with the oculomotor nerve – they merely travel within its sheath.

The nerve leaves the cranial cavity via the superior orbital fissure. At this point, it divides into superior and inferior branches. Once within the orbital cavity, both branches innervate accessory structures of the eye:

- Superior branch: Motor innervation to the superior rectus and levator palpebrae superioris. Sympathetic fibres run with the superior branch to innervate the superior tarsal muscle.

Inferior branch: Motor innervation to the inferior rectus, medial rectus and inferior oblique. Parasympathetic fibres to the ciliary ganglion, which ultimately innervates the sphincter pupillae and ciliary muscles. The oculomotor nerve innervates the majority of the extra-ocular muscles. These muscles move the eyeball and upper eyelid.

Superior branch:

- Superior rectus – Elevates the eyeball

- Levator palpebrae superioris – Raises the upper eyelid.

There are sympathetic fibres that run with the superior branch of the oculomotor nerve. They innervate the superior tarsal muscle, which acts to keep the eyelid elevated after the levator palpebrae superioris has raised it.

Inferior branch:

- Inferior rectus – Depresses the eyeball
- Medial rectus – Adducts the eyeball

Inferior oblique – Elevates, abducts and laterally rotates the eyeball

There are two structures in the eye that receive parasympathetic innervation from the oculomotor nerve:

- Sphincter pupillae – constricts the pupil, reducing the amount of light entering the eye.
- Ciliary muscles – contracts, causes the lens to become more spherical, and thus more adapted to short range vision.
- The parasympathetic fibres travel in the inferior branch of the oculomotor nerve. Within the orbit, they branch off and synapse in the ciliary ganglion. The fibres are carried from the ganglion to the eye via the short ciliary nerves.

Trochlear nerve (IV)

The trochlear nerve arises from the trochlear nucleus of the brain, emerging from the posterior aspect of the midbrain (it is the only cranial nerve to exit from the posterior midbrain).

It runs anteriorly and inferiorly within the subarachnoid space before piercing the dura mater adjacent to the posterior clinoid process of the sphenoid bone.

The nerve then moves along the lateral wall of the cavernous sinus (along with the oculomotor nerve, the abducens nerve, the ophthalmic and maxillary branches of the trigeminal nerve and the internal carotid artery) before entering the orbit of the eye via the superior orbital fissure.

The trochlear nerve innervates a single muscle – the superior oblique, which is a muscle of oculomotion. As the fibres from the trochlear nucleus cross in the midbrain before they exit, the trochlear neurones innervate the contralateral superior oblique.

The tendon of the superior oblique is tethered by a fibrous structure known as the trochlea, giving the nerve its name. Although the mechanism of action of the superior oblique is complex, in clinical practice it is sufficient to understand that the overall action of the superior oblique is to depress and intort the eyeball.

Abducens nerve (VI)

The abducens nerve arises from the abducens nucleus in the pons of the brain, and exits the brainstem at the junction of the pons and the medulla.

It then enters the subarachnoid space and pierces the dura mater to run in a space known as Dorello's canal. The nerve travels through the cavernous sinus at the tip of

the petrous temporal bone, before entering the orbit of the eye through the superior orbital fissure. Within the bony orbit, the abducens nerve terminates by innervating the lateral rectus muscle. The abducens nerve innervates a single muscle – the lateral rectus, one of the muscles of oculomotion. This muscle takes its origin from the common tendinous ring, and acts to abduct the eyeball (i.e. to rotate the gaze away from the midline).

Vestibular cochlear nerve (VIII)

The Vestibulocochlear Nerve is the eighth of the twelve cranial nerves. The fibers consist of only Afferent Sensory Fibers. The word Afferent means toward the centre, as in from a peripheral area of a limb to the central nervous system. The word Efferent is the opposite of Afferent, meaning away from the centre and toward the periphery; when the stimulus is carried back to the brain from a peripheral area. The pathway for the afferent fibers of the vestibulocochlear nerve before and after its division is the following (from the Initiation in the Periphery to the Termination in the brain):

- The vestibule is filled with endolymphatic fluid and is responsible for the somatic balance of the Human Body. It is also innervated by small sensory branches that innervate the parts of the vestibule which include the saccule, the utricle, the anterior, posterior and lateral membrane of the ampulla.
- Those small branches merge into superior and inferior branches, before entering the vestibular ganglion.
- The cochlea is responsible for sensory hearing and is innervated by a small branch of postganglionic fibers, which exit the lamina spiralis ossea after innervating the inner and outer hair cells of the spiral organ of Corti; upon the hair cells sits the tectorial membrane.

The cochlear nerve synapses in the cochlea upon the spiral ganglia before running alone and eventually running adjacent to the motor root of the facial nerve, the intermediate nerve and the vestibular nerve.

The vestibulocochlear nerve consists mostly of bipolar neurons and splits into two large divisions: the cochlear nerve and the vestibular nerve. The cochlear nerve travels away from the cochlea of the inner ear where it starts as the spiral ganglia.

Processes from the organ of Corti (the receptor organ for hearing) conduct afferent transmission to the spiral ganglia. It is the inner hair cells of the organ of Corti that are responsible for activating the afferent receptors in response to pressure waves reaching the basilar membrane through the transduction of sound.

The vestibular nerve travels from the vestibular system of the inner ear. The vestibular ganglion houses the cell bodies of the bipolar neurons and extends processes to five sensory organs.

Three of these are the cristae, located in the ampullae of the semicircular canals. Hair cells of the cristae activate afferent receptors in response to rotational acceleration.

The other two sensory organs supplied by the vestibular neurons are the maculae of the saccule and utricle. Hair cells of the maculae activate afferent receptors in response to linear acceleration.

The vestibulocochlear nerve has axons that carry the modalities of hearing and equilibrium. Damage to the vestibulocochlear nerve may cause hearing loss, vertigo, a false sense of motion, loss of equilibrium in dark places, nystagmus, motion sickness, and gaze-evoked tinnitus.

A benign primary intracranial tumor of vestibulocochlear nerve is called a vestibular schwannoma (also called acoustic neuroma).

LITERATURE

1. Tests "KROK-1" - human anatomy: textbook / under the editorship of V. G. Cherkasova, I. V. Dzevulska., O.I. Kovalchuk. 5-th Edition, revised.
2. Human anatomy: in 3 volumes / ed. by V. G. Koveshnikov. – Lugansk: Virtual reality, 2008. – T. 3.
3. Netter F. Atlas of human anatomy / F. Netter; [transl. from eng. A. A. Tsegelsky]; ed. by U.B. Tchaikovsky. – Lviv: Nautilus, 2004.
4. International anatomical nomenclature. Ukrainian standard / edited by I. I. Bobryk, V. G. Koveshnikov. - Kiev: Health, 2001.

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Questions for the control of final level knowledge of the students.

1. What cranial nerves are derivatives of the brain?
2. To describe in neuron the olfactory analyzer path.
3. What cranial nerves are homologues of the anterior roots of the spinal cord?
4. To find the roots of the oculomotor cranial nerves on the lower surface of the brain and its exit from the skull.
5. Describe and demonstrate on preparation the nucleus of the III cranial nerve.
6. Describe and demonstrate on preparation the nucleus of the IV cranial nerve.
7. Describe and demonstrate on preparation the nucleus of the VI cranial nerve.
8. Name the muscles, innervated by the III pair of cranial nerves.
9. Name the muscles, innervated by the IV pair of cranial nerves.
10. Name the muscles, innervated by the VI pair of cranial nerves.
11. Name the muscles, whose function is disturbed by damage of the oculomotor, trochlear, abducent nerves.
12. Describe and demonstrate on preparation the nuclei of the VIII cranial nerve.
13. Specify directions of the paths, that start from the vestibular nuclei of the VIII-th cranial nerve.
14. Indicate the direction of paths, starting from the auditory nuclei of the VIII-th cranial nerve.

Test tasks

№1

In patient, after prolonged use of gentamicin. developed a progressive hearing loss. After the examination diagnosed with optic neuritis. The lesion of what cranial nerve is diagnosed in a patient?

A.: VI pair of cranial nerves.

B: V pair of cranial nerves.

C.: X pair of cranial nerves.

D.: IX pair of cranial nerves.

E.: VIII pair of cranial nerves.

№2

During the examination of the injured in a traffic accident, doctor found lose outer wall of the orbit. The victim lost the opportunity to exhaust the eyeball on the injured side. Which nerve could be hurt?

A.:N. trochlearis.

B.:E. N. infraorbitalis.

C.:N. abducens.

D.:N. ophthalmicus.

E:N. oculomotorius.

№3

In a patient with epidemic encephalitis has been observed one - or bilateral ptosis (dropping of the eyelid), strabismus distinctive, violation of accommodation. The pupils are dilated. Nucleus of what cranial nerve affected?

A.:VI.

B.:IV.

C.:III.

D.:VII.

E.:V.

№ 4

The patient has a chronic runny nose. Swelling of the mucous membrane of the nasal cavity leads to dysfunction of the olfactory nerve receptors, which are located in the olfactory region of the nasal cavity. Through what formation the fibers of this nerve enter into the anterior cranial fossa?

A.:Foramen ethmoidale anterior.

B.:Lamina cribrosa ossis ethmoidalis.

C.:Foramen ethmoidale posterior.

D.:Foramen incisivum.

E.:Foramen sphenopalatinum.

№ 5

Male, 50 years old, diagnosed with Shegren's syndrome ("dry syndrome"). The patient's insufficiency of the glands of external secretion - the reduction of tearing, salivation, anatsidnyh gastritis, xerodermia atrophy of sweat and sebaceous glands, polyarthritis. The cause of the disease is unclear. Allowed pathology of the hypothalamus. Which way the central nervous system connects the hypothalamus to autonomic nuclei of brain stem and spinal cord?

A.:Fasciculus longitudinalis medialis.

B.:Tractus mamillothalamicus.

C.:Tractus thalamocorticalis.

D.:Tractus thalamospinalis.

E.:Fasciculus longitudinalis dorsalis.

№ 6

The patient was diagnosed with a loss of medial field of vision on the right and lateral field of vision on the left side. What part of the visual analyzer suffered pathological changes?

A.: Left visual pathway.

B.: The right optic nerve.

C.: Visual intersection.

D.: Ostrogov furrow.

E.: Right visual pathway.

№ 7

A patient with epidemic parotitis (mumps) was sudden and unilateral total deafness; it is associated with acute purulent labyrinthitis, which hits receptors of the auditory analyzer. What formations are the receptors of the auditory analyzer?

A.:Organum spirale.

B.:Cristae ampullaris ductus semicirculares.

C.:Ganglion spirale cochleae.

D.:Macula sacculi.

E.:Macula utriculi.

№ 8

The patient had bleeding in the occipital region of the cerebral cortex in the strogova furrow's area. What functions of the body are broken by such a damage?

A.: Deaf.

B.: No sensitivity.

C.: No sense of smell.

D.: Missing vision.

E.: No movement.

№ 9

The patient complained of blurred vision, that is accompanied by a dropping of the eyelid, inability to turn the eye upwards and inwards. During the inspection noted that the designated eye out, pupil dilated, not responding to light, the patient can't see close. Which nerve is damaged?

A.: Oculomotor.

B.: Trochlear

C.: Abducens.

D.: Trigeminal.

E.: Optic.

№ 10

To the ophthalmology department came a patient, 59 years old, with an eye injury. The examination revealed damage of the retina. Specify what cells is in the body of third neuron of the visual pathway?

A.: Bipolar.

B.: Osteocytes.

C.: Ganglioside.

D.: The ciliary.

E.: Sticks, cones.