Bogomolets National Medical University

The Department of human anatomy

GUIDELINES

Academic Subject Matter	HUMAN ANATOMY
Module №	2
Content module No.	11
The theme of the lesson	Midbrain et diencepahalon
Course	I
Faculty	Medical1,2,3,4, military
Amount of hours	3

2017

1. Relevance of the topic:

The anatomy of higher nervous activity is the basic academic science for the subsequent studying of theoretical and clinical disciplines, and is necessary for training of highly qualified specialists. A perfect knowledge of the anatomical features of the middle and intermediate brain is necessary for the physician for setting physiological and clinical diagnosis and choice of treatment in violation of the activities of these levels of regulation, and ensure high professional level of doctors-neurosurgeons, neurologists, and anesthesiologists.

2. Specific goals:

1. To know the structural features of gray matter of the midbrain, to be able to draw a diagram of the "cross-section of the midbrain at the level of the upper tubercles"
2. To know features of the structure of white matter of the midbrain, to be able to draw a diagram of the penducles cerebri pathways.
3. To identify and show parts of the diencephalon.
4. To identify and demonstrate the structures thalamic brain and hypothalamus.
5. To demonstrate the III ventricle and describe its walls.
6. To identify the group of nuclei of the thalamus in functional and filogenetic signs and explain their functions.
7. To identify the constituent parts of epithalamus, metathalamus, subthalamus.
8. To describe the nuclei of a subthalamus and explain their functional communications.
9. To describe the nuclei and pathways of the papillary body.
10. To describe the nuclei and pathways of the subthalamic site and its communication with a pituitary body.
11. To open the definition "gipothalamo-pituitary system".

3. Basic training level:

The biology, anatomy of the central nervous system.

The human anatomy: osteology - the bones of the skull and their compounds.

4. Tasks for self-control during preparation to practical classes.
4.1. A list of the main terms, parameters, characteristics that need to learn by the student during the preparation for the lesson.

Term	Definition
THE MIDBRAIN *(MESENCEPHALON)*	Least the upper section of the brain stem located between the pons and the intermediate brain; performs vascular and reflex functions; there are subcortical centers of hearing and vision.
THE INTERMEDIATE BRAIN *(DIENCEPHALON)*	It is the largest and most functionally important part of the brain stem: regulates autonomic and endocrine systems.
THE THALAMUS *(THALAMUS) (VISUAL HUMP)*	The main part of the diencephalon that is responsible for the redistribution of information from the senses, except the smell, to the cerebral cortex.
PULVINAR THALAMI *(METATHALAMUS)*	Thalamic part of the brain that includes medial and lateral geniculate bodies, the nuclei of which are associated with cortical centres of visual and auditory analyzers.
THE EPITHALAMUS (*EPITHALAMUS)*	A small part of the brain located between the third ventricle and midbrain; the path of the olfactory analyzer pass through it; it connects the limbic system to other parts of the brain that perform hormonal functions.
THE HYPOTHALAMUS (HYPOTHALAMUS)	The highest vegetative center, carrying out a complex integration of the functions of various internal systems and their adaptation to the holistic activity of the organism.

4.2. Theoretical questions to the lesson:

1. What are the boundaries of the midbrain, its parts and cavity.
2. What are the nuclei and paths provide the possibility of protective visual-auditory reflex?
3. What parts are included in the composition of the black substance? What are their connections and functions.
4. What parts are included in the composition of the red nucleus? What are their connections and functions.
5. What the reticular formation of the midbrain consist of?
6. To determine the communication, function of the nucleus of the medial longitudinal bundle and the intermediate nucleus.
7. What are the components has the central cover path?

8. What is formed by the intersection of the cover (tegmentum)?
9. What fibers are in pedunculus cerebri?
10. What are the parts of the diencephalon?
11. What are the surface and parts of the thalamus?
12. What groups the thalamus is divided into? What are their functions?
13. What ways are the media lemniscus consist of? Where are they end?
14. What parts the metathalamus is divided into? What is their functional significance?
15. What formation the epithalamus consist of? What is the functional significance of the pineal gland?
16. What are the nuclei the subthalamus consist of? What is the function of the subthalamic nucleus?
17. What are the nuclei and the path of the papillary body?
18. What are the nuclei and the path of hypothalamic area? Describe its relationship to the pituitary gland.
19. Give a name and describe the wall of III ventricle, nooks and messages of the III ventricle.

4.3. The list of standardized practical skills:

The roof of the midbrain (tectum mesencephali)

- plate roof (lamina tecti):
- the upper tubercle (colliculum superior);
- the lower tubercle (colliculum inferior);
-brachium colliculi superioris;
-brachium colliculi inferioris;

The cerebral aqueduct (aqueductus cerebri).

Fossa interpeduncularis.

The back is laced substance (substantia perforata posterior)

Crus (pedunculus) cerebri:

- the cover of the midbrain: the red nucleus; the black substance
- basis pedunculi

The thalamus:

- anterior tubercle of thalamus;
- pillow of thalamus (pulvinar thalami);
- brain stripe of the thalamus.

The epithalamus: leash (habenualae); leash triangle (trigonum habenulare); the pineal gland.

The metathalamus: lateral geniculate (corpus geniculatum laterale); media geniculate (corpus geniculatum mediale).

The hypothalamus: visual intersection (chiasma opticum); visual pathway (tractus opticus); gray hill (tuber cinereum); lake (infundibulum); corpus mamillaris.

Third ventricle: the walls; interventricular hole (foramen interventriculare); hole of the cerebral aqueduct.

The content of the topic:

The midbrain or mesencephalon represents the connection between the brain stem and the higher centres of the brain and is involved in most body systems including sleep/consciousness, vision, hearing and temperature regulation.
The midbrain is located between the diencephalon and the hind brain, or brain stem. More specifically, it can be found ventral to the cerebral cortex and between the cerebral pedicles of the diencephalon and the pons. It is a relatively short portion of the upper brain stem and connects higher brain centres with the lower centres and the spinal cord. In most species the midbrain is found most centrally within the cranial cavity.
The midbrain has a stratified structure comprising various layers including the tectum, tegmentum and cerebral peduncle. These structures are found in a dorsoventral sequence. The tectum lies dorsally to the cerebral aqueduct and it has four major rounded surface swellings; colliculi (see below). The tegmentum is the core of the midbrain and a large proportion of it is made up by the reticular formation.

The major cranial nerve nuclei within the midbrain are the mesencephalic nuclei of the trigeminal nerves (V), the trochlear nuclei (IV), the principle and parasympathetic oculomotor nuclei (Cranial Nerve III), the 'red nuclei' (so named due to its pronounced vascularity) and the periaqueductal gray nuclei. The periaqueductal gray nucleus is a core of gray nervous tissue located adjacent to the cerebral aqueduct. The oculomotor nerve emerges from the mid brain rostral to the pons.
Within the lumen of the midbrain lies the cerebral aqueduct which acts as a simple passage between the spinal cord and the third and fourth ventricles.
The tectum (roof) has four colliculi, two rostral and two caudal.

Caudal Colliculi

The caudal colliculi are widely spaced and are joined by a substantial commissure. The caudal colliculi act as integration centres for auditory pathways. The caudal colliculi also have a further connection to the thalamus via the 'ipsilateral medial geniculate body'. This body is effectively a swelling of the thalamus.

Rostral Colliculi

The rostral colliculi are placed closer together in comparison to the caudal. The rostral colliculi are also joined to the thalamus, but by the 'lateral

geniculate bodies' rather than the medial. The rostral colliculi help to integrate the visual pathways and also are involved in somatic reflexes that are caused by visual cues. The rostral colliculi have also been suggested to be involved in spatial integration.

Substantia Nigra

The substantia nigra is a prominent area of the mid brain and is identifiable on cross sections by its darker pigmentation. This pigmentation is due to the gradual accumulation of pigmentation of neurons and is associated with basal nuclei within the tissue. The substantia nigra nuclei are involved in the control of voluntary movement.

Crura Cerebri

These are visible on the ventral surface of the mid brain and consist of fibre tracts that are in passage between the telencephalon and the brain stem. The oculomotor nerves (see above) also emerge in this region of the mid brain, directly rostral to the pons.

The diencephalon of the brain consists of four components. These are the thalamus, the epithalamus, the hypothalamus and the subthalamus. Overall, the diencephalon co-ordinates unconscious vegetative and sensomotoric functions.

Throughout the embryological development, the brain, the medulla and the central nervous system arise from the neural tube, which itself stemmed from the dorsal surface ectoderm. Three primary brain vesicles develop from the cranial segment of the neural tube.

One of these brain vesicles grows into the prosencephalon (forebrain). The other two brain vesicles form the rhombencephalon (hindbrain) and the mesencephalon (midbrain). The diencephalon and telencephalon proceed to grow from the prosencephalon.

The thalamus, the epithalamus, the hypothalamus and the subthalamus develop from the diencephalon, which grew from the prosencephalon.

The halved structure of the thalamus makes up the majority of the diencephalon and has been dubbed the “gate to the conscience”, as a large amount of sensitive information passes through it before it is further processed in the cortex to make it to the conscience.

The thalamus is not visible as such from the outside, as it is surrounded by the telencephalon. The corpus callosum of the telencephalon, as well as the two lateral ventricles, borders the thalamus on the cranial side. The hypo- and subthalamus are located on the caudal side of the thalamus. The separation of the thalamus and hypothalamus is called the sulcus hypothalamicus.

Medially, the thalamus is bordered by the outer wall of the 3rd ventricle. This is also the location of the adhesio interthalamica, which connects the two thalami together. However, they do not share any function, i.e. there are no commissural fibres between the two thalami.
Laterally, the v. thalamostriata forms the border between the di- and telencephalon, whereby the capsula interna of the telencephalon is located here.
Function of the thalamus
The switch of sensory and motoric information occurs in the thalamus before it passes into the telencephalon, and thus into the conscience (radiatio thalami). On the way there, this information is filtered in the thalamus to prevent too much information from passing into the telencephalon. This is why the thalamus is called the "gate to the conscience".
If the thalamus is harmed, e.g. during a stroke, there may be disruptions in sensory perception. The sense of smell is an exception to the sensory system, as the information from the olfactory tract is not carried over into the thalamus.
Nuclei of the thalamus and their projections
With regard to its nuclei and their connections, the thalamus can be divided into a specific and a non-specific area. The specific area (palliothalamus) is connected to certain areas of the cerebral cortex, whereas the non-specific area (truncothalamus) primarily communicates with the brain stem. The thalamus consists of a total of 120 nuclei. Thalamus nuclei of the palliothalamus
There are four different core groups in the area of the palliothalamus named for their topographic location and which each project into different areas of the brain.
The anterior group (nuclei anteriores) chiefly transmits information into the limbic system, the medial group (nuclei mediales) projects to the frontal lobe, and the dorsal group (nuclei dorsales) to the visual cortex.
The ventral group (nuclei ventrolaterales) does not project solely into one area, but rather can be divided into different nuclei; each connected to specific regions of the brain. Among the nuclei of the ventral group are the nucleus ventralis anterior (NVA), the nucleus ventralis lateralis (NVL) and the nucleus ventralis posterior (NVP). The projection to the NVA serves the premotor cortex, the NVL the motor cortex and the NVP which is the sensitive area of the cortex.
Located in the most lateral location are the nucleus reticularis thalami, which is externally complexed with the other nuclei. Its impulses can be deviated in the EFG.
The corpus geniculatum laterale and mediale also number among the

thalamus nuclei of the palliothalamus, whereby the corpus geniculatum laterale (CGL) is projected to the visual cortex, and the corpus geniculatum mediale (CGM) to the auditory pathway. Together, both are called the metathalamus.
Located above the CGL and the CGM is the pulvinar thalami, which is also allocated to the specific thalamus nucleus (lateral group). The pulvinar thalami receive afferents via the CGL and the colliculi superiores. Its efferents primarily move into the cortex area of the temporal, occipital and parietal lobes. A portion of the efferents also moves into the frontal lobe – yet solely to the frontal eye field.
Together, the fibres that move from the specific thalamus nucleus to the cerebral cortex are called radiatio thalami, and these can be further divided by projection area.
The radiatio thalami anterior moves through the nuclei mediales to the frontal lobe, the radiatio thalamica posterior to the occipital lobe, the radiatio thalami centralis through the nuclei ventrales to the parietal lobe, and the radiatio thalami inferior to the temporal lobe, meaning that all areas of the brain are reached.
A portion of the radiatio thalami inferior is the radiatio acustica, whereas the radiatio optica is part of the radiatio thalami posterior.

Thalamus nuclei of the truncothalamus
The non-specific thalamus nuclei are connected to the basal ganglia, the formatio reticularis (primarily the ARAS) and the cerebellum via afferents from these areas. The efferents from the truncothalamus lead to the specific thalamus nuclei – whereby these stimulate the respective nuclei – to other nuclei of the diencephalon, to the brain stem and to the corpus striatum.
Contrary to the specific nuclei, these do not have any direct connection to the cerebral cortex and thus only have a non-specific influence on the cortex. Among the non-specific nuclei are, among others, the nuclei mediani and the nuclei intralaminares. The nucleus centromedianus is the largest nucleus of the intralaminar group.
Structure of the epithalamus
The epithalamus is, as the name suggests (epi = atop), located above the thalamus. It includes the epiphysis, the stria medullaris thalami, and the habenulae with their nuclei habenulares, the area praetectalis and the commissura posterior (epithalamica).
The epiphysis (glandula pinealis) is responsible for the production of melatonin, which is primarily distributed at night and has a soothing effect on the function of the central nervous system. The information concerning the brightness and darkness of the individual's surroundings, and thus the circadian rhythm, is received by the epiphysis via the nucleus

suprachiasmaticus of the hypothalamus.
The olfactory system is connected to the epithalamus through the stria medullaris. This fibre pathway begins in the area of the substantia perforata anterior and ends dorsal of the thalamus in the form of the habenulae, which forms a thickening in the fibre pathway.
The nuclei habenulares are located in the area of the habenulae. These are the changeover area for the information of the olfactory system. From here, the information is forwarded to the motoric and salivatory nuclei, where the secretion of saliva is triggered by the scent of food, for instance. The two habenulae are connected through the commissura habenularum.
The area praetectalis is located on the border of the mesencephalon and diencephalon, and is involved in the formation of the pupillary light reflex. To this end, it receives information (afferents) via the tractus opticus and the colliculi superiores. From the area praetectalis, its efferents are transmitted to the nucleus accessorius nervi oculomotorii (Edinger-Westphal nucleus) on the ipsilateral and contralateral side.
Consensual light reaction – i.e. upon illumination of an eye, the ipsilateral and contralateral pupils narrow – occurs through the Edinger-Westphal nucleus.
Areas of the formatio reticularis, the quadrigeminal bodies and the area praetectalis on both sides are connected through the commissura posterior.
Structure of the subthalamus
The subthalamus consists of the nucleus subthalamicus and the globus pallidus. Both are components of the basal ganglia loop, which is responsible for the co-ordination of specific, voluntary and fine-motor processes.
Structure of the hypothalamus
The hypothalamus comprises the corpora mammillaria, the tuber cinerum, the infundibulum, the neurohypophysis and the eminentia mediana.
Function of the hypothalamus
An integration of vegetative functions occurs through the hypothalamus, so that the majority of the nuclei of the hypothalamus are connected with vegetative centres in the area of the brain stem and the medulla. One example of a vegetative function transmitted through the hypothalamus is the feeling of thirst.
Nuclei of the hypothalamus
The nuclei of the hypothalamus are the anterior, intermediate and posterior core group.
The anterior core group includes the nuclei preoptici, the nucleus suprachiasmaticus, the nucleus supraopticus and the nucleus paraventricularis.
The nuclei preoptici regulate body temperature and sexual behaviour.

Topographically, they are located beneath the chiasma opticum.
The nucleus suprachiasmaticus regulates circadian rhythm. Processes subordinate to this regulation include body temperature, the sleep-wake cycle and the distribution of hormones. The nucleus suprachiasmaticus draws afferents from the retina of the eye and projects into the epiphysis through its efferents. Structure of the hypophysis
The hypophysis is divided into an anterior and posterior lobe, both of which have different origins. The anterior lobe (adenohypophysis) stems from the epithelium of Rathke's pouch (roof of the throat), whereas the posterior lobe (neurohypophysis) forms an eversion of the diencephalon and is allocated to the hypothalamus.
The two sections also differ in function. The adenohypophysis is a production site for various hormones (see below), whereas the area of the neurohypophysis merely stores and secretes the hormones produced in the hypothalamus (ADH and oxytocin).
The pars tuberalis and the pars intermedia are located between the neurohypophysis and the adenohypophysis. The two parts of the hypophysis are connected to the hypothalamus via the infundibulum.
In terms of a topographical location, the hypophysis is located within the sella turcica and above the sinus sphenoidalis (sphenoidal sinus). The sinus sphenoidalis also serves as an operative pathway to tumours in the area of the epiphysis.

Materials for self-control:

1. The patient has hypothalamic-pituitary syndrome (Babinski-Frohlich): deposits of fat in the shoulder girdle, the breast, the disappearance of secondary sexual characteristics, a tendency to hypothermia. In what department of the brain is there a hypothalamus?
A. Diencephalon.
B. Mesencephalon.
C. Pons.
D. Medulla oblongata.
E. Telencephalon.

2. Patient has a pituitary adenoma, that caused the defeat of the visual pathways. Which department of the diencephalon refers to the affected area?
A. Thalamus.
B. Metathalamus.
C. Epithalamus.
D. Hypothalamus.

E. Mesencephalon.

3. The patient, 12 years old, marked premature puberty. Which gland of an intermediate brain produces a hormone that stops premature puberty?
A. Epiphysis
B. Hypophysis.
C. Gl. suprarenalis.
D. Hypothalamus.
E. Mesencephalon.

4. The patient, 50 years old, MRI examination of the cranial cavity revealed the increase of dimensions of sella, deformation of the front inclined shoots. Tumor of what endocrine gland can cause such destruction of the skull bones?
A. Epiphysis.
B. Hypophysis.
C. Gl. suprarenalis.
D. Thymus.
E. Gl. thyroidea.
5. The patient, female, 50 years old, discovered a brain tumor in the region of the optic part of the hypothalamus. In the patient's blood increased vasopressin level. What nucleus of the hypothalamus produces this hormone ?
A. Nucl. preopticus.
B. Nucl. supraopticus.
C. Nucl.paraventricularis.
D. Nucl.corporis mamillaris.
E. Nucl.infundibularis.

6. In the LOR department there is a patient, 43 years old, complaining of hearing loss. MRI research was discovered a brain tumor in the region of the subcortical centers of hearing. What part of the brain is affected?
A. Colliculus superiores tecti mesencephali.
B. Colliculus inferiores tecti mesencephali, corpus geniculatum mediale.
C. Colliculus inferiores tecti mesencephali, corpus geniculatum laterale.
D. Nucl.corporis mamillaris.
E. Nucl.infundibularis.

7. The patient due to the damage of a.cerebri posteriores (supplies the lamina quadrigemina of the midbrain), symptoms of lesions the nuclei of the oculomotor nerve (syndrome posterior comissura-Parino). Which wall of the third ventricle forms the comissura cerebri posterior?

A. Posterior.
B. Inferior.
C. Superior.
D. Anterior.
E. Lateral.

8. In a patient with bulimia – increased hunger. Identified lesions of the hypothalamic receptors of the site, that signal the brain about the accumulation of carbohydrates in the blood. Which of the brain is affected?
A. Diencephalon.
B. Mesencephalon.
C. Pons.
D. Medulla oblongata.
E. Telencephalon.

9. In a patient with a malignant exophthalmos caused by excessive secretion of pituitary thyroid-stimulating hormone. Which department of the diencephalon the pituitary gland is?
A. Thalamus.
B. Metathalamus.
C. Epithalamus.
D. Hypothalamus.
E. Mesencephalon.

10. The patient has bouts of sleepiness, even while he walking. The examination revealed tumor of the third ventricle in the posterior wall. What formed the posterior wall of the third ventricle?
A. Commissura habenularum, commissura cerebri posterior, apertura agueductus cerebri.
B. Commissura habenularum, commissura cerebri posterior.
C. Epithalamus.
D. Hypothalamus, commissura cerebri posterior, apertura agueductus cerebri.
E. Hypothalamus, commissura cerebri posterior.

Key to the tests:

1	2	3	4	5	6	7	8	9	10
A	**D**	**A**	**B**	**B**	**B**	**A**	**A**	**D**	**A**