

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>	12
<i>The theme of the lesson</i>	Anatomy of the ear. Pathways of hearing and balance.
<i>Course</i>	I
<i>Faculty</i>	Medical1,2,3,4, military
<i>Amount of hours</i>	3

2017

1. Relevance of the topic:

With the help of auditory analyzer man adequately focused in the external environment, performing his professional duties. Knowledge of the parts of the ear normal structure is necessary for hearing. In certain internal diseases, infectious diseases, injuries of the skull suffering the parts of the ear. A side effect of many medications, especially of antibiotics leads to disruption of the structure and function the inner ear. Quite often determined congenital malformations of the ear.

2. Specific objectives:

- to classify parts of the ear.
- to classify parts of the outer ear and to analyze their structure and function.
- to classify part of the middle ear.
- to analyze the structure and function of the tympanic membrane.
- to analyze the structure of the tympanic cavity.
- to analyze the structure and function of the auditory ossicles.
- to classify the parts of the inner ear.
- to classify the parts of the bony labyrinth, to analyze their structure and functions.
- to classify the parts of the membranous labyrinth, to analyze their the structure and function.
- to draw a diagram of the conductive path of the auditory analyzer
- to draw a diagram of the conductive path of the statokinetic analyzer
- to explain the development of the organ of hearing and equilibrium.
- to analyze the congenital malformations of the ear.

3. Basic training level:

From biology – phylogenesis and general structure of the senses;
From medical physics describe the physical characteristics of sound wave. Describe the physical basis of the resonance phenomenon from the course of human anatomy: osteology - the bones of the skull. Be able to describe the structure of the rocky part of temporal bone. To describe the skull channels the temporal bone. To classify the nervous system from the standpoint of structure and function. Schematically draw the structure of a reflex arc.

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
EAR (AURIS)	Sophisticated apparatus which senses sound fluctuations, and the direction of force of the earth gravity and acceleration of the human body.
THE OUTER EAR (AURIS EXTERNUS)	Captures, concentrates and conducts sound wave.
THE MIDDLE EAR (AURIS MEDIA)	Provides mechanical transfer of vibrations of the eardrum to the window of the vestibule, and for involvement of the middle ear muscles is devices conductive apparatus to sounds of varying strength and height.
AUDITORY TUBE (TUBA AUDITIVA)	Ensures the balancing of the pressure drum cavity with the nasal part of the pharynx, that it is necessary for the free vibration of the drum membrane
THE INNER EAR (AURIS INTERNUS)	Transform the mechanical vibrations into neural boost. Plays a major role in the orientation of the human body in space, in maintaining his balance, perceives the pull of gravity and head position

4.2. Theoretical questions to the lesson:

1. To identify the parts of the outer ear and demonstrate it on the preparations.
2. To describe the structure and functions of the ear sink, to demonstrate it on the preparations.
3. To describe the parts, structure and functions of the external auditory stroke.
4. To describe the topography, parts, structure, functions of the eardrum.
5. To name the middle ear and demonstrate it on the preparations.
6. To determine and demonstrate on the preparations the walls of the tympanic cavity and its combinations.

7. To determine the contents of the tympanic cavity.
8. To name and describe the structure of auditory ossicles.
9. To name and describe the joints of the auditory ossicles, muscles of auditory ossicles.
10. To determine the localization of the auditory tube, name the parts of it, describe the structure of the communications and function of the auditory tube and demonstrate on the preparations.
11. To identify the parts of the inner ear.
12. To name the parts of bony labyrinth and demonstrate it on the dummy and tables.
13. To name a half-circular channels, describe their localization, structure, communications and functions.
14. To determine the location of the vestibule, describe the structure of the walls, the inner texture, pairing and functions and demonstrate on the dummy and tables.
15. To determine the localization of the curls, describe its structure, communications and functions and demonstrate on the dummy and tables.
16. To name the parts, determine the localization of the membranous labyrinth and demonstrate it on dummies and tables.
17. Perilymphatic space: describe its formation, composition and connection.
18. Endolymphatic space: describe its formation, composition and connection.
19. To determine the localization of the vestibular labyrinth, name its parts, structure, function and demonstrate it on dummies and tables.
20. To determine the localization of the cochlear labyrinth, describe structure of the walls, functions and demonstrate it on dummies and tables.
21. To determine the localization of the spiral organ, describe its structure and function.
22. To describe the path of sound vibrations.
23. To describe and draw the conducting tracts of auditory analyzer.
24. To describe and draw the conducting tracts of stato-kinetic analyzer.

4.3. The list of standardized practical skills:

The outer ear (auris externus)

- Auricular
- Helix
- Antihelix
- Tragus
- Antitragus

- Lobulus auriculæ
- Meatus acusticus externus
- Porus acusticus externus
- Membrana tympanica

The middle ear (auris media)

- Cavitas tympani
- Paries tegmentalis.
- Paries jugularis.
- Paries labyrinthicus.
- Paries mastoideus.
- Paries caroticus.
- Paries membranaceus.
- Tuba auditiva

The inner ear (auris internus)

- Labyrinthus osseus
- Vestibulum
- Canales semicirculares
- Cochlea
- Labyrinthus membranaceus

5. The content of the topic:

The ear can be split into three parts; external, middle and inner. This article is about the **external** ear. We shall look at its structural anatomy, vasculature, innervation, and the clinical conditions that can occur.

The external ear can be functionally and structurally split into two sections; the auricle (or pinna), and the external acoustic meatus.

The auricle is an external, lateral paired structure. Its function is to capture and transmit sound to the external acoustic meatus.

Most of the auricle has a cartilaganious framework, with the lobule the only part not supported by cartilage. The outer curvature of the ear is called the helix. Moving inwards, there is another curved elevation, which is parallel to the helix – this is known as the antihelix. The antihelix divides into two cura – the inferoanterior crus, and the superoposterior crus.

In the middle of the auricle is a hollow depression, called the concha of auricle. It continues into the skull as the external acoustic meatus. The concha acts to direct sound into the external acoustic meatus. Immediately anterior to the start of the external acoustic meatus is an elevation of tissue – the tragus. Opposite the tragus is the antitragus. Cutaneous innervation to the skin of the auricle comes from the greater auricular, lesser occipital and branches of the

facial and vagus nerves. Patients can complain of an involuntary cough when cleaning their ears – this is due to stimulation of the auricular branch of the vagus nerve, the nerve responsible for the cough reflex.

With respect to the vasculature, the main vessels involved are the posterior auricular, superficial temporal and occipital arteries and veins.

The external acoustic meatus is a sigmoid shaped tube that extends from the deep part of the concha to the tympanic membrane. The walls are given their structure by cartilage from the auricle, and bony support from the temporal bone. This part of the external ear gets its sensory innervation from branches of the mandibular and vagus nerves.

The external acoustic meatus does not have a straight path, and travels in an S-shaped curve:

- Initially travels in a superoanterior direction.
- Turns slightly to move superoposterior.
- Ends in an inferoanterior direction.

The external acoustic meatus ends at the tympanic membrane. The tympanic membrane has a double layered structure, covered with skin on the outside and a mucus membrane on the inside. At the core of the membrane is connective tissue. It is connected to the surrounding temporal bone by a fibrocartilaginous ring.

The tympanic membrane is translucent, therefore structures within the middle ear can be seen. On the inner surface of the membrane, the handle of malleus attaches to the tympanic membrane, at a point called the umbo of tympanic membrane.

The handle of malleus continues superiorly, and at its highest point, a small projection can be seen, called the lateral process of malleus. The parts of the tympanic membrane moving away from the lateral process are called the anterior and posterior malleolar folds.

The middle ear lies within the temporal bone, and extends from the tympanic membrane to the lateral wall of the internal ear. The main function of the middle ear is to transmit vibrations from the tympanic membrane to the inner ear – it does this via the three bones of the ear.

The middle ear can be split into two; the tympanic cavity and epitympanic recess.

The tympanic cavity lies medially to the tympanic membrane. It contains the majority of the bones of the middle ear. The epitympanic recess is found superiorly, near the mastoid air cells. The middle ear can be visualised as a rectangular box, with a roof and floor, medial and lateral walls and anterior and posterior walls.

Roof – Formed by a thin bone from the petrous part of the temporal bone. It separates the middle ear from the middle cranial fossa.

Floor – known as the jugular wall, it consists of a thin layer of bone, which separates the middle ear from the internal jugular vein

Lateral Wall – This is made up of the tympanic membrane and the lateral wall of the epitympanic recess.

Medial Wall – Formed by the lateral wall of the internal ear. It contains a prominent bulge, produced by the facial nerve as it travels nearby.

Anterior Wall – The anterior wall is a thin bony plate with two openings; for the auditory tube and the tensor tympani muscle. It separates the middle ear from the internal carotid artery.

Posterior Wall – Also known as the mastoid wall, it consists of a bony partition between the tympanic cavity and the mastoid air cells. Superiorly, there is a hole in this partition, allowing the two areas to communicate. This hole is known as the aditus to the mastoid antrum. The bones of the middle ear are called the auditory ossicles. They are the malleus, incus and stapes. They are connected in a chain-like manner, linking the tympanic membrane to the oval window of the internal ear.

The malleus is the largest and most lateral of the ear bones, attaching to the tympanic membrane, via the handle of malleus. The head of the malleus lies in the epitympanic recess, where it articulates with the next auditory ossicle, the incus.

The next bone, the incus, consists of a body and two limbs. The body articulates with the malleus, the short limb attaches to the posterior wall of the middle ear, and the long limb joins the last of the ossicles; the stapes.

The stapes is the smallest bone in the human body. It joins the incus to the oval window of the inner ear. It is stirrup-shaped, with a head, two limbs, and a base. The head articulates with the incus, and the base joins the oval window. The mastoid air cells are located **posterior** to the epitympanic recess. They are a collection of **air-filled** spaces in the mastoid process of the temporal bone. The air cells are contained within a cavity called the mastoid **antrum**. The mastoid antrum communicates with the middle ear via the **aditus** to the mastoid antrum.

The mastoid air cells act as a '**buffer system**' of air – releasing air into the tympanic cavity when the pressure is too low.

There are two muscles which serve a protective function in the middle ear; the tensor tympani and stapedius. They contract in response to loud noise, inhibiting the vibrations of the malleus, incus and stapes, and reducing the transmission of sound to the inner ear. This action is known as the acoustic reflex.

The tensor tympani originates from the auditory tube and attaches to the handle of malleus, pulling it medially when contracting. It is innervated by a branch of the mandibular nerve. The stapedius muscle attaches to the stapes, and is innervated by the facial nerve.

The auditory tube (eustachian tube) is a cartilaginous and bony tube that connects the middle ear to the nasopharynx. It acts to equalise the pressure of the middle ear to that of the external auditory meatus.

It extends from the anterior wall of the middle ear, in anterior, medioinferior direction, opening onto the lateral wall of the nasopharynx. In joining the two structures, it is a pathway by which an upper respiratory infection can spread into the middle ear.

The inner ear is located within the petrous part of the temporal bone. It lies between the middle ear and the internal acoustic meatus, which lie laterally and medially respectively. The inner ear has two main components – the bony labyrinth and membranous labyrinth.

Bony labyrinth – consists of a series of bony cavities within the petrous part of the temporal bone. It is composed of the cochlea, vestibule and three semicircular canals. All these structures are lined internally with periosteum and contain a fluid called perilymph.

Membranous labyrinth – lies within the bony labyrinth. It consists of the cochlear duct, semicircular ducts, utricle and the saccule. The membranous labyrinth is filled with fluid called endolymph.

The inner ear has two openings into the middle ear, both covered by membranes. The oval window lies between the middle ear and the vestibule, whilst the round window separates the middle ear from the scala tympani (part of the cochlear duct).

The bony labyrinth is a series of bony cavities within the petrous part of the temporal bone. It consists of three parts – the cochlea, vestibule and the three semicircular canals.

Vestibule

The vestibule is the central part of the bony labyrinth. It is separated from the middle ear by the oval window, and communicates anteriorly with the cochlea and posteriorly with the semicircular canals. Two parts of the membranous labyrinth; the saccule and utricle, are located within the vestibule.

Cochlea

The cochlea houses the cochlear duct of the membranous labyrinth – the auditory part of the inner ear. It twists upon itself around a central portion of bone called the modiolus, producing a cone shape which points in an anterolateral direction. Branches from the cochlear portion of the vestibulocochlear (VIII) nerve are found at the base of the modiolus.

Extending outwards from the modiolus is a ledge of bone known as spiral lamina, which attaches to the cochlear duct, holding it in position. The presence of the cochlear duct creates two perilymph-filled chambers above and below:

Scala vestibuli: Located superiorly to the cochlear duct. As its name suggests, it is continuous with the vestibule.

Scala tympani: Located inferiorly to the cochlear duct. It terminates at the round window.

Semicircular Canals

There are three semicircular canals; anterior, lateral and posterior. They contain the semicircular ducts, which are responsible for balance (along with the utricle and saccule).

The canals are situated superoposterior to the vestibule, at right angles to each other. They have a swelling at one end, known as the ampulla.

The membranous labyrinth is a continuous system of ducts filled with endolymph. It lies within the bony labyrinth, surrounded by perilymph. It is composed of the cochlear duct, three semicircular ducts, saccule and the utricle.

The cochlear duct is situated within the cochlea and is the organ of hearing. The semicircular ducts, saccule and utricle are the organs of balance (also known as the vesicular apparatus).

Cochlear Duct

The cochlear duct is located within the bony scaffolding of the cochlea. It is held in place by the spiral lamina. The presence of the duct creates two canals above and below it – the scala vestibuli and scala tympani respectively. The cochlear duct can be described as having a triangular shape:

Lateral wall – Formed by thickened periosteum, known as the spiral ligament.

Roof – Formed by a membrane which separates the cochlear duct from the scala vestibuli, known as the Reissner's membrane.

Floor – Formed by a membrane which separates the cochlear duct from the scala tympani, known as the basilar membrane.

The basilar membrane houses the epithelial cells of hearing – the Organ of Corti. A more detailed description of the Organ of Corti is beyond the scope of this article.

Saccule and Utricle

The saccule and utricle are two membranous sacs located in the vestibule. The utricle is the larger of the two, receiving the three semicircular ducts. The saccule is globular in shape and receives the cochlear duct.

Endolymph drains from the saccule and utricle into the endolymphatic duct. The duct travels through the vestibular aqueduct to the posterior aspect of the petrous part of the temporal bone. Here, the duct expands to a sac where endolymph can be secreted and absorbed.

Semicircular Ducts

The semicircular ducts are located within the semicircular canals, and share their orientation. Upon movement of the head, the flow of endolymph within the ducts changes speed and/or direction. Sensory receptors in the ampullae of the semicircular canals detect this change, and send signals to the brain, allowing for the processing of balance.

6. Materials for self-control:

1. The patient has the destruction of the tympanic cavity wall with the spread of pus in the cave of the mastoid process. Which of the walls is destroyed?
 - A. Paries jugularis.
 - B. Paries membranaceus.
 - C. Paries labyrinthicus.
 - D. Paries tegmentalis.
 - E. Paries mastoideus.
2. Purulent otitis eardrum is damaged. Which wall of the tympanic cavity is destroyed?
 - A. Paries jugularis.
 - B. Paries labyrinthicus.
 - C. Paries tegmentalis.
 - D. Paries membranaceus.
 - E. Paries caroticus.
3. In the ENT department got a patient, 43 years old, complaining of hearing loss. At the objective examination the physician found no damage. With the help of computer tomography was discovered a brain tumor in the region of the subcortical centers of hearing. What area affected by the tumor?
 - A. The lateral geniculate body.
 - B. The media geniculate body.
 - C. Striatum.
 - D. The upper plate tubercles of the midbrain roof.
 - E. The thalamus.
4. At the patient the inflammation of perichondrium of the external ear after mechanical injury. Marked swelling and redness, which spread to the whole ear sink, except the part that does not contain cartilage. What part of the ear is not involved to the pathological process?
 - A. Helix.
 - B. Antihelix.
 - C. Lobulus auriculae.
 - D. Tragus.
 - E. Antitragus.
5. The patient's eardrum is damaged, it is normally takes sound vibrations and transmits them to the perilymph of vestibule of the inner ear through the auditory ossicles. What muscles provide the degree of tension the tympanic membrane and the volume displacement of strumica?
 - A. M. tensor tympani, m. stapedius.

B. M.transversus auriculae

C. M.temporalis

D. M. tensor veli palatini.

E. M. uvulae.

6. The child lost hearing due to degenerative changes of g.spirale cochleae.

Where is g.spirale cochleae?

A. Canalis spiralis modioli.

B. Basis modioli.

C. Scala vestibuli.

D. Scala tynpani.

E. Apertura interna canaliculi cochlea.

7. Spasm of blood vessels of the inner ear leads to irritation of the endings vestibule part of the VIII cranial nerve, the manifestations of which is dizziness, nausea, lack of balance, the appearance of nystagmus. Where are the receptors of the pars vestibularis n. vestibulocochlearis?

A. Organum spirale.

B. Ganglion spirale.

C. Ganglion oticum.

D. Ganglion vestibulare.

E. Cristae ampullaris ductus semicircularis, macula sacculi, macula utriculi.

8. Child, 5 years old, was admitted in the ENT department of the clinical hospital with a diagnosis of purulent inflammation of the middle ear. The disease began with inflammation of the nasal part of the pharynx. Through what canal of the temporal bone the infection has got to the tympanic cavity?

A. The carotid.

B. Tympanic canaliculus strings.

C. Muscle-tube.

D. The tympanic canaliculus.

E. Carotid-tympanic canaliculi.

9. A man, 35 years old, with a history of meningoencephalitis, there is an abrupt decrease in hearing. Examination eliminates the pathology of sound leading and sound perceiving apparatus of the organ of hearing. What gyrus of the cerebral cortex is the disruption in?

A. Angular.

B. Middle temporal.

C. The upper front.

D. Over-the-edge.

E. Superior temporal.

10. Purulent otitis destroyed with pus the upper wall of the tympanic cavity. In what fossa of the skull spread the pus from the tympanic cavity?
- A. In the opthalmic fossa.
 - B. In the posterior cranial fossa.
 - C. In the anterior cranial fossa.
 - D. In the middle cranial fossa.
 - E. In the wing-palatine fossa.

Keys to the tests:

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

LITERATURE

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