

ЛД-16 ИИ

**Federal State Budgetary Educational Institution of Higher Education
«North-Ossetia State Medical Academy»
of the Ministry of Healthcare of the Russian Federation
(FSBEI HE NOSMA MOH Russia)**

Department of Biology and Histology

WORKBOOK
for practical classes and independent work
“EVOLUTION OF VERTEBRATES”
of discipline “biology”

the main professional educational program of higher education - specialty program in
the specialty 31.05.01 General Medicine, approved in August 31, 2020

VLADIKAVKAZ, 2020

**TOPIC: RELATIONSHIP BETWEEN ONTOGENY AND PHYLOGENY.
EVOLUTION OF THE SKELETON AND SKIN OF VERTEBRATES.**

COMPETENCES:

GC-5, GPC-1.

PURPOSE OF THE CLASS:

- Study the relationship between ontogeny and phylogeny;
- Study progressive trends in the evolution of the chordal skeleton and covers;
 - To determine the ontogenetic and phylogenetic background of human malformations of the skeleton.

THE STUDENT SHOULD KNOW:

- Methods of morpho-functional transformations of organs and systems;
- The basic biogenetic law of Mueller-Haeckel and the law of embryonic similarity of K. Baer;
- Progressive trends in the evolution of chordal covers
- Progressive trends in the evolution of the chordal skeleton.

THE STUDENT MUST BE ABLE TO:

- Conduct a comparative analysis of the body coverings of Chordates;
- Conduct a comparative analysis of the chordal skeleton;
- Identify the main trends in the evolution of these systems;
- Explain otoprosthesis conditional defects of the skin and skeleton
- Solve situational problems.

THE QUESTIONS OF THE TOPIC:

1. What is phylogeny? What is the relationship between ontogeny and phylogeny?
 - a. Formulate the Mueller-Haeckel law.
 - b. Formulate the law of K. Baer
2. What is firebrigades? Given example.
 - a. Anabolics
 - b. Deviations
 - c. Harhalakis
3. Describe the methods of morphological and functional transformations of biological structures.
4. Give the definition of the terms "vestige", "atavism".
5. Define the concepts of "homologene" and "similar" bodies.
6. The structure of the body covers in representatives of different classes of the Chordal type.
7. The progressive direction of the evolution of the skin Chordate.
8. Malformations of the skin, their ontogenetic background.
9. The structure of the axial skeleton in representatives of different classes of the Chordal type.
10. Evolution of the visceral branchial arches.
11. Progressive trends in the evolution of the chordal skeleton
12. Skeletal malformations, their ontological and phylogenetic background.

Guidelines for performing independent work

TASK 1. Study the presented theoretical material.

Principles of evolutionary transformations of biological structures.

In the course of evolution, organs undergo changes under the influence of natural selection. Organs and systems can develop progressively, regressively, or undergo restructuring without changing the level of the organization. Prerequisites for evolutionary transformations of organs are multifunctionality—the property of each organ to perform several functions (for example, the skin of amphibians—the organ of respiration, isolation, sensitivity, protection) and quantitative changes in functions – one function can be performed with greater or less intensity (for example, the intensity of breathing depends on the surface area of the lungs). The morpho-functional transformations of organs are based on two principles:

- Differentiation – division of the body into specialized departments
- Integration-strengthening the relationship, interdependence and interaction of parts of the body.

TASK 2. "Evolution of the skin and its derivatives of Vertebrates»

List the main progressive trends in the evolution of skin

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TASK 3. "Evolution of the Vertebrate skeleton»

List the main progressive trends in the evolution of the skeleton:

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The visceral skull first appears in lower vertebrates.

It is formed from the mesenchyme of ectodermal origin, which is grouped in the form of clumps that have the shape of arcs, in the intervals between the Gill slits of the pharynx.

The first two arcs are particularly strong and give rise to the maxillary and sublingual arcs of adult animals.

The following arcs in the number of 4-5 pairs perform a supporting function for the gills and are called Gill.

1 the visceral arch the Maxillary arch consists of two cartilages.

The upper one is called Palatine-square, it performs the function of the primary upper jaw.

The lower, or Meckel, cartilage is the primary lower jaw.

2 the visceral arch-Sublingual on each side consists of a hyomandibular cartilage fused to the base of the cerebral skull, and a hyoid connected to the Meckel cartilage.

FISH.

- in cartilaginous fish, both primary jaws are connected to the axial skull via a second visceral arch, in which the hyomandibular cartilage acts as a suspension to the medullary skull. This type of connection between the jaws and the axial skull is called a hyostyle
- in bony fish, the replacement of primary jaws with secondary ones consisting of false bones — the maxillary and pre-maxillary above and the dental below—begins. The Palatine-square and Meckel cartilage are reduced in size and shifted posteriorly. Hyomandibula cartilage continues to perform the functions of suspension, so the skull remains gostilne.

AMPHIBIA

The Gill arches are partially reduced, and partially, changing functions, are part of the cartilage apparatus of the larynx

- The maxillary arch with its upper element — the Palatine-square cartilage — fuses completely with the base of the cerebral skull, and the skull thus becomes autostyle.
- The hyomandibular cartilage, strongly reduced and released from the suspension function, located in the area of the first Gill slit inside the auditory capsule, assumed the function of the auditory bone—a column-transmitting sound vibrations from the outer to the inner ear.

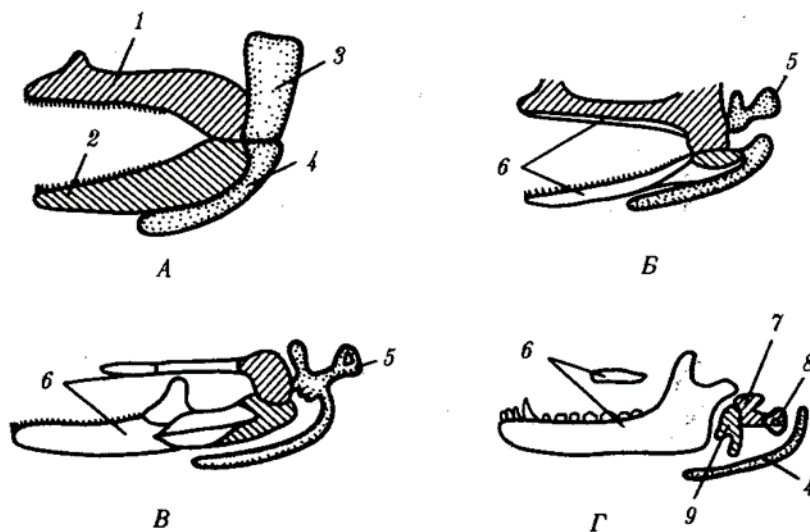
REPTILES

The visceral skull of reptiles is also autostyle.

The maxillary apparatus is characterized by a higher degree of ossification than that of amphibians. Part of the cartilage material of the Gill arches is part of not only the larynx, but also the trachea.

MAMMALS

- The lower jaw of mammals is connected to the temporal bone by a complex joint that allows not only to capture food, but also to perform complex chewing movements.
- the auditory bone—a column—shrinking in size, turns into a stirrup, and the rudiments of the Palatine-square and Meckel cartilage, completely leaving the composition of the jaw apparatus, are converted, respectively, into an anvil and hammer. Thus, a single functional chain of three auditory bones in the middle ear is created, which is characteristic only for mammals



A-cartilaginous fish;

B-amphibian;

B-reptile;

Г-mammal:

1-Palatine-square cartilage, 2-Meckel cartilage, 3-hyomandibular cartilage, 4-hyoid, 5—column, 6-false bones of the secondary jaws, 7-anvil, 8-stirrup, 9-hammer;

Violation of differentiation of elements of the maxillary Gill arch into the auditory bones is a mechanism for the formation of such a malformation of the middle ear as the location in the tympanic cavity of only one auditory bone — a column, which corresponds to the structure of the sound-transmitting apparatus of amphibians and reptiles.

TASK 4

Fill in the table " Onto-and phylogenetic prerequisites for skeletal malformations in humans»

Developmental malformation	Phylogenetic background (the stage of development of which ancestral forms recapitulates)	Ontogenetic background (cellular mechanisms of ontogenesis)
Spina bifida	<i>Primary existence of the notochord and the appearance of splitting vertebral arches in roundworms</i>	<i>splitting of the upper vertebral arches due to violation of embryonic induction, violation of the processes of cell reproduction and selective adhesion</i>
Additional ribs in the cervical or lumbar regions		
The persistence of the tail		
The presence of bone and cartilage arcs in the neck area		
One auditory bone in the middle ear		

TASK 5

Fill in the table " Onto-and phylogenetic prerequisites for malformations of human integuments»

<i>Developmental malformation</i>	<i>Phylogenetic background</i>	<i>Ontogenetic background</i>
<i>Polythelia</i>		
<i>Hypertrichosis</i>		
<i>Polymastia</i>		

TASK 6

Place the correct organs in the table in pairs:

<i>Analogous organs</i>	<i>Homologous organs</i>

Mammalian teeth, primary jaws, fish scales, amphibian skin glands, Palatine-square cartilage, lanceolate chord, reptile scales, mammalian spine, secondary jaws, mammalian sweat glands, placoid scales, anvil

TASK 7

Solve a situational problem

The Department of newborns received a child who was found to have a pronounced violation of the development of the nervous system in the form of a decrease in the function of motor neurons, the lack of reflexes from the lower extremities. On examination, a herniated mass was found, localized in the lumbosacral region, covered with skin and a soft cerebral membrane. Make a diagnosis and explain what this anomaly is associated with?

FINAL CONTROL:

- 1. What is the morphophysiological progress in replacing the chord with the spine?*
 - 2. Explain the changes in the functions of the ribs in a number of vertebrates. What abnormalities of rib development occur in humans and why?*
 - 3. What principles of phylogeny of organs are implemented in the process of transforming the lateral skin folds of the lower Chordates into paired limbs of terrestrial Vertebrates?*
 - 4. What are the progressive trends in the evolution of paired limbs in terrestrial vertebrates?*
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TOPIC: EVOLUTION OF THE RESPIRATORY AND DIGESTIVE SYSTEMS OF VERTEBRATES

COMPETENCES:

GC-5, GPC-1.

THE PURPOSE OF CLASS:

- to study progressive trends in the evolution of the digestive and respiratory systems of Chordates;
- to study the relationship of ontogeny and phylogeny in the development of the digestive and respiratory systems of Chordates.
- use this knowledge to understand the development of the digestive and respiratory systems in human ontogenesis;
- determine the ontological and phylogenetic prerequisites for human malformations of the digestive and respiratory systems.

THE STUDENT SHOULD KNOW:

- Progressive trends in the evolution of the respiratory and digestive systems of Vertebrates;
- Correlation of onto- and phylogeny in the development of the respiratory and digestive systems of Vertebrates.
- Major malformations of the respiratory and digestive systems.

THE STUDENT MUST BE ABLE TO:

- Use this knowledge to understand the development of the respiratory and digestive systems in human ontogenesis;
- Determine the ontological and phylogenetic prerequisites for human malformations of the respiratory and digestive systems.

THE QUESTIONS OF THE TOPIC:

1. Structure of the digestive system in representatives of different classes of Vertebrates.
2. Describe the methods of morpho-functional transformations of the digestive organs.
3. List the main progressive directions of the evolution of the digestive system.
4. Malformations of the digestive system.
5. Evolution of the respiratory system.
6. Describe the methods of morpho-functional transformations of the respiratory organs..
7. List the main progressive trends in the evolution of the respiratory system
8. Give examples of rudiments and atavisms found in the digestive and respiratory systems of Chordates.

Guidelines for performing independent work

TASK 1

List the main progressive directions of the digestive system:

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TASK 2

List the main progressive directions of the respiratory system:

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TASK 3

Fill in the table " Onto-and phylogenetic prerequisites for malformations of human integuments»

<i>Developmental malformation</i>	<i>Phylogenetic background</i>	<i>Ontogenetic background</i>
<i>cleft palate</i>		
<i>additional teeth in the alveolar row or behind the dentition</i>		
<i>Tongue splitting</i>		
<i>caecum malformation</i>		
<i>Heterotopia of the pancreas</i>		

TASK 4

Give examples of rudimentary and atavistic structures characteristic of the digestive and respiratory structures and write these examples in a table:

Rudimentary structures	atavistic structures

TASK 5

Solve situational problems

During the examination, the dentist found that the child's teeth are all the same shape. What is the reason for this anomaly?

FINAL CONTROL:

1. *What features in the organization of the oral cavity of fish, amphibians and reptiles recapitulate in human embryonic development?*
2. *List atavistic anomalies of the dental system in humans.*
3. *What is the evolutionary significance of the appearance of the caecum?*
4. *What principles of evolutionary transformations of organs are illustrated by the phylogeny of the vertebrate digestive tube?*
5. *What principles of morphofunctional transformations of organs are implemented during the emergence and further evolution of the lungs?*
6. *Give examples of reduction of structures in the phylogeny of the studied systems.*

TOPIC: EVOLUTION OF THE CIRCULATORY, URINARY AND SEXUAL SYSTEMS OF VERTEBRATES

COMPETENCES:

GC-5, GPC-1.

PURPOSE OF THE CLASS:

- to study progressive trends in the evolution of the circulatory and genitourinary systems of Chordates;
- to study the ratio of onto-and phylogeny in the development of the circulatory and genitourinary systems of Chordates.
- use this knowledge to understand the development of the circulatory and genitourinary systems in human ontogenesis;
- determine the ontological and phylogenetic prerequisites for the occurrence of blood and urogenital malformations in humans.

THE STUDENT SHOULD KNOW:

- Progressive trends in the evolution of the circulatory and genitourinary systems of Vertebrates;
- Correlation of onto-and phylogeny in the development of the circulatory and urogenital systems of Vertebrates.
- Major malformations of the circulatory and genitourinary systems.

THE STUDENT MUST BE ABLE TO:

- Use this knowledge to understand the development of the circulatory and genitourinary systems in human ontogenesis;
- Determine the ontological and phylogenetic prerequisites for the occurrence of blood and urogenital malformations in humans.

THE QUESTIONS OF THE TOPIC:

1. The structure of the heart in different classes of Vertebrates.
2. To characterize the evolution of arterial Gill arches in Chordates
3. Describe the methods of morpho-functional transformations of the circulatory system.
4. List the main progressive trends in the evolution of the circulatory system.
5. Malformations of the circulatory system.
6. Evolution of Vertebrate kidneys.
7. Evolution of the urogenital ducts.
8. Describe the methods of morpho-functional transformations of the genitourinary system.
9. List the main progressive trends in the evolution of the genitourinary system
10. Defects of the genitourinary system.

Guidelines for performing independent work

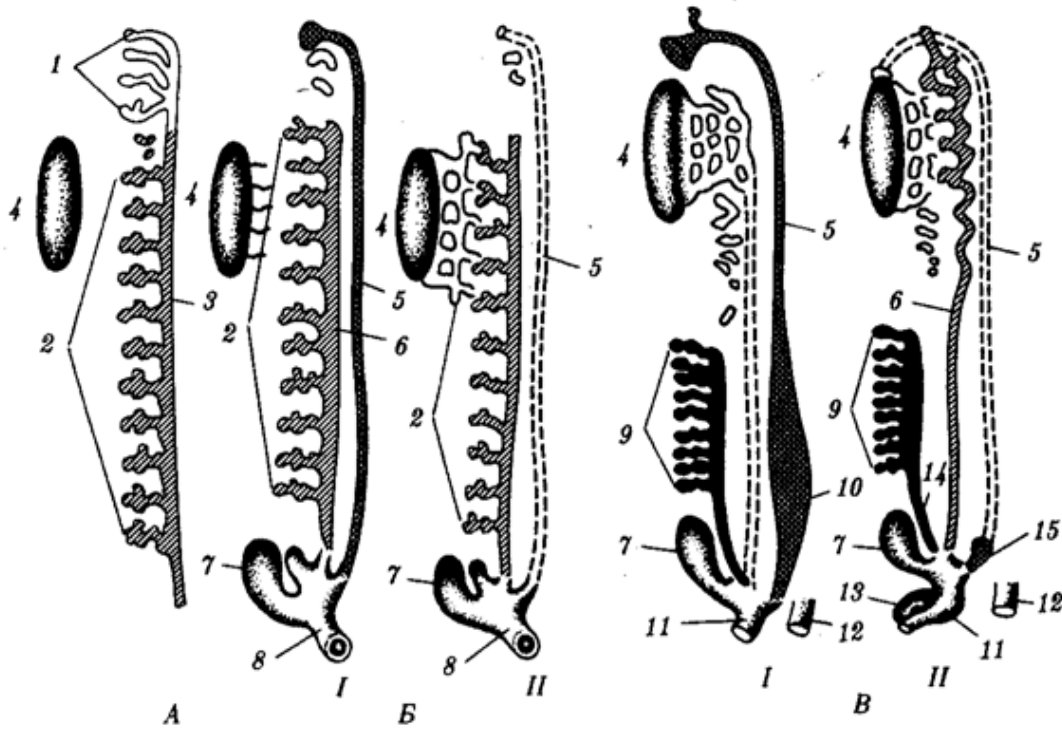
TASK 1 (theory)

In the embryogenesis of all vertebrates, during the development of the ventricle (pronephros) along the body, from the head end to the cloaca, a pronephric channel is laid through which the products of dissimilation from the nephrons enter the external environment.

During the development of the primary kidney(mesonephros), this channel either splits into two channels running parallel, or the second channel is formed in the longitudinal thickening of the wall of the first.This:

- Wolf channel - connects to the nephrons of the primary kidney.
- Muller's channel-fuses the front end with one of the nephrons of the pre-tube and forms an oviduct that opens in front of a wide funnel as a whole, and flows into the cloaca behind.

Regardless of gender, all vertebrates must form both wolf and Muller channels



A — a neutral embryonic state;

Б — anamnia;

B-amniotes:

I-females, II-males;

I-note,

2-primary kidney,

3-channel light bulbs,

4-sex gland,

5-Mueller channel,

6-wolf channel,

7-bladder

8-cloaca,

9-secondary kidney,

10—the womb,

11—the urogenital sinus,

12-posterior rectum,

13-penis,

14-secondary kidney ureter,

15—men's "dearest»

FISH.

In females, they perform the function:

- *Wolf canal of the ureter*
- *Muller canal is oviduct.*

In males

- *Mueller channel is reduced*
- *Wolf canal-performs both functions-sexual and excretory-performs. The seminal tubules in this case flow into the kidney, and the sperm during fertilization enter the water together with the urine.*

AMPHIBIA

In females, they perform the function:

- *wolf canal of the ureter*
- *Muller canal is oviduct.*

In males

- *Mueller channel is reduced*
- *Wolf canal performs both functions — sexual and excretory .The seminal tubules in this case flow into the kidney, and the sperm during fertilization enter the water together with the urine.*

REPTILES.

In females:

- *the Wolf canal -almost all of it is reduced,and the caudal part that performs the function of the ureter is preserved*
- *Muller channel-performs the function of the oviduct.*

In males

- *Mueller canal is reduced*
- *the Wolf canal: the caudal part forms a protrusion that performs the function of the ureter, and the canal itself performs the function of the ejaculatory canal.*

MAMMALS.

In females:

- *the Wolf canal almost all of it is reduced, and the caudal part that performs the function of the ureter is preserved*
- *Mueller canal differentiated into the oviduct, uterus, and vagina (in placental fused to form an unpaired vagina and uterus). The uterus can be either double, as in many rodents, or two-pronged, as in carnivores; or two-horned, as in insectivores and cetaceans, or simple, as in primates and humans.*

In males

- *Mueller canal is reduced*
- *the Wolf canal-the caudal part forms a protrusion that performs the function of the ureter, and the canal itself performs the function of the ejaculatory canal.*

TASK 2

List the main progressive directions of the circulatory system:

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TASK 3

List the main progressive directions of the urinary and sexual systems:

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TASK 4

Fill in the table "Evolution of vertebrate arterial gill arches".

ARTERIAL GILL ARCHES	FISH	AMPHIBIA	REPTILES	MAMMALS
I pair				
II pair				
III pair				
IV pair				
V pair				
VI pair				