

**MINISTRY OF SCIENCE AND HIGHER EDUCATION
RUSSIAN FEDERATION**

**FEDERAL STATE AUTONOMOUS EDUCATIONAL INSTITUTION OF
HIGHER EDUCATION
NORTH-CAUCASUS FEDERAL UNIVERSITY**

Methodological Guidelines
for Students on arranging and performing independent work
in the Discipline of Developmental biology, embryology
for Students majoring (Specialty) in 31.05.01 General Medicine

Methodological Recommendations for Studying Theoretical Material

When performing the independent study of theoretical material, the student must follow the rules as set below. The working curriculum of the respective academic discipline shall be recommended to be used as the basis for such activity. According to the schedule of classroom lessons and independent work, a different number of hours is to be allocated for studying individual topics. A significant portion of the student's independent work should be allocated to mastering the material on the covered topic, writing a summary (notes) on the specified theoretical blocks, and searching for additional literature based on the NCFU library and via the Internet system. The lecture material shall not cover all theoretical material; the greater part of it must be mastered through independent work. Given the above, working with the recommended literature is mandatory. Special attention must be paid to the content of the main provisions and conclusions, the explanation of phenomena and facts, and the understanding of the practical application of the theoretical issues under consideration. In the process of this work, the student should strive to understand and memorize the main provisions of the material being considered, the examples illustrating it, as well as to understand the illustrative material. Preparation should be completed by drawing up a plan (summary/notes) on the material (issue) being studied. This allows for the creation of a concentrated, concise representation of the issues being studied. First, studying the recommended literature is to be done. Special attention must be paid to the content of the main provisions and conclusions, the explanation of phenomena and facts, and the understanding of the practical application of the theoretical issues under consideration.

During this work, the student should strive to understand and memorize the main provisions of the material being considered, the examples illustrating it, as well as to understand the illustrative material. Preparation should be completed by drawing up a plan (summary/notes) on the material (issue) being studied. This allows for the creation of a concentrated, concise representation of the issues being studied. If necessary, one should seek (advice) consultation from the instructor. When going to a consultation, it is necessary to thoroughly think through the questions that require clarification. Keeping records contributes to turning reading into an active process, mobilizing motor memory along with visual memory. The following should be born in mind: a student who systematically keeps records creates their own individual stock of auxiliary materials for a quick review of what has been read and for the mobilization of accumulated knowledge. Records are especially important and useful when they reflect the thoughts that arose during independent work.

It is important to develop the students' capacity to compare sources and to think through the material being studied.

Improving note-taking skills among students is of great importance.

The instructor may recommend the following main forms of recording to students: a plan (simple and detailed), excerpts, and theses (abstracts).

The results of note-taking can be presented in various forms.

- A plan is an outline of the read material, a brief (or detailed) list of questions reflecting the structure and sequence of the material.
- A detailed plan fully replaces a summary.
- A summary (notes) is a systematized, logical presentation of the source material. Four types of summaries are distinguished:
 - Outline-summary (Plan-notes) – this is an expanded, detailed plan in which sufficiently detailed records are provided for those points of the plan that need explanation.
 - Textual summary – this is the reproduction of the most important provisions and facts of the source.
 - Free summary – these are clearly and briefly formulated (stated) main provisions resulting from a deep understanding of the material. It may contain excerpts, quotations, and theses; part of the material may be represented by a plan.

- Theme-based summary – this is compiled on the basis of studying a number of sources and gives a more or less exhaustive answer according to a certain scheme (issue).

Methodological Guidelines for the Preparation for Practical Activities

When preparing for practical activities, the recommendation implies studying the control questions for the given lesson and the theoretical material from one's own notes.

The main form of work during the lessons is an interview (discussion). Each student must be ready to speak on all issues raised in the plan and demonstrate maximum activity during their consideration.

The speech must be constructed freely, convincingly, and with arguments. The instructor ensures that the speech is not reduced to a reproductive level (simple reproduction of the text); simple reading of the summary is also not allowed.

It is necessary for the speaker to show their own attitude towards what they are talking about, express their personal opinion and understanding, substantiate it, and be able to draw the correct conclusions from what has been said. In doing so, the student may refer to the entries in the summary, directly to the primary sources, use knowledge of previously studied disciplines, etc. In addition, to obtain a grade at an advanced level, students solve situational tasks based on the results of the mastered topics.

During the execution of practical works, a defense of practical skills is provided, the full list of which is specified in the fund of assessment tools.

Methodological Recommendations for the Preparation of Presentations and Reports

The report must contain elements of novelty; along with the fundamental aspect, an analysis of the current state of the problem under study must be carried out, as well as inclusion in regional issues. The report must include an introduction, a theoretical part, a conclusion, a list of literature, and a presentation that reveals the essence of the topic in graphs, pictures, diagrams, and formulas.

The report is recommended to be submitted on 1 printed sheet. The text of the work must be printed with 1.5 line spacing on one side of a standard sheet (A4) of white paper.

The text and other printed elements of the work must be black, and the contours of letters and signs must be clear, without halos and shading. The font must be Times New Roman, size 14. The titles of chapters and paragraphs are highlighted in bold. The sheet with text must have margins: left – 30 mm, right – 10 mm, top – 20 mm, bottom – 20 mm.

Page numbering of the text is done in the lower right corner of the sheet. It is necessary to number pages starting from the page where the Introduction is printed, on which the number 3 is placed. After that, all pages, including appendices, are numbered.

A space equal to two intervals is placed between the title of the chapter and the title of the paragraph of this chapter, and the title of the paragraph must not be separated from the text of this paragraph by a space. The titles of paragraphs shall be separated from the text of the previous paragraph by a space equal to two intervals. Each chapter, as well as the introduction, conclusions, appendices, and the list of used literature, begin on a new page. The word Chapter is not to be written. Chapters have ordinal numbers within the entire work, designated by Arabic numerals (for example: 1, 2, 3), followed by a period.

The word **PARAGRAPH** or the paragraph symbol (§) is not placed in the title. Paragraphs have ordinal numbers within the chapters, designated by Arabic numerals (for example: 1.1. and 1.2.).

Headings of chapters and paragraphs in the text must be centered; a period shall not be placed at the end of the title of the chapter and paragraph. It is not allowed to hyphenate (transfer) a part of a word in a heading. 4.5. The numbering of tables and figures can be running (continuous) or relate to the number of the chapter and paragraph. For example, if a table or a figure is included in the text of the first paragraph of the second chapter, the numbering is as follows: Table 2.1.1., Fig. 2.1.1.

The last digit means the ordinal number of the table (or figure) in this paragraph.

The table is to be placed as the next page after the first mention of it in the text.

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Methodological guidelines
for completing laboratory work
in the discipline " DEVELOPMENTAL BIOLOGY, EMBRYOLOGY "
for students of the specialty 31.05.01 General Medicine

INTRODUCTION

The purpose of studying the discipline "Developmental Biology, Embryology" is to acquire knowledge of the basic patterns of individual development of organisms, intrauterine human development as a fundamental component of the main life processes, the influence of various factors on the reproduction and development of organisms, necessary for further training in other fundamental medical disciplines, as well as for clinical and preventive disciplines.

The main **objectives** of studying the discipline are:

- study the main stages of ontogenesis, phases of embryonic development and be able to outline and illustrate with schematic drawings the main processes of development in their real sequence and interrelationship;
- gain an understanding of the mechanisms of morphogenesis, cytodifferentiation and growth;
- to gain an understanding of the relationship between ontogenesis and evolution;
- know the main causes of developmental anomalies;
- master the skills of working with embryonic preparations, have an idea of the methods of obtaining and studying embryonic material.

As a result of studying the discipline, the student should know:

- features of the biological patterns of the emergence of multicellularity and the transition to sexual reproduction
- the main stages of ontogenesis, morphological, functional and biochemical changes during the development of embryonic cells

Must be able to:

- understand the mechanisms of growth, morphogenesis and differentiation, the causes of abnormalities in the development of cells and embryos
- apply practical skills in laboratory work with various objects, analysis and statistical processing of the obtained data, the ability to draw conclusions and generalizations
- independently conduct searches and analyses of information in the field of modern embryology and evolutionary theory for its use in the process of scientific and practical activities

Must possess:

- methods of working with microscopic equipment
- the skill of using reference anatomical literature, as well as Internet resources on developmental biology and embryology.

Introduction to Developmental Biology and Embryology. The subject and objectives of developmental biology. Methods of developmental biology. The medical significance of experimental data in developmental biology. Interdisciplinary connections.

The subject and objectives of the biology of individual development. Methods of the biology of individual development: descriptive, experimental-embryological, Cytological, cytochemical, molecular biological, biochemical, immunobiological, ecological, and genetic engineering. Medical significance of experimental data in developmental biology. Interdisciplinary connections.

The origin and development of new individuals in ancient times, the foundation of embryology as a science (Hippocrates, Aristotle). The development of embryology after the ancient era (Aldrovandi, Fabricius, Leeuwenhoek, Swammerdam, Malpighi, Haller, Leibniz). The discovery of parthenogenesis. Preformationism and its essence. Proclamation of epigenesis by W. Harvey: "all living things come from an egg". The development of embryology in the 18th - 19th centuries. Substantiation of epigenesis by K.F. Wolff. Supporters of epigenesis (I.F. Blumenbach, M. Rathke, H. Pander and K. Baer). The works of K. Baer - a new stage in embryology. Creation of prerequisites for comparative embryology.

Comparative animal embryology is the foundation of the principles of embryonic development in organisms. Ontogenesis and phylogenesis. The relationship between phylogenesis and ontogenesis.

Comparative embryology of animals is the basis for understanding the patterns of embryonic development of organisms. Ontogenesis and phylogenesis. Relationships between phylo- and ontogenesis. Muller-Haeckel's biogenetic law. The works of A. N. Severtsev, I. I. Schmalhausen, P. P. Ivanov. The role of experimental embryology in understanding the most important patterns in embryogenesis. Experimental embryology. The founders of experimental embryology are V. Roux, G. Spemann, D. P. Filatov, M. M. Zavadovsky. Comparative - experimental direction in embryology (D. P. Filatov). Biochemical embryology. Developmental genetics. Biology of individual development is a new stage in the study of the patterns of ontogenesis, which arose on the basis of the synthesis of the achievements of embryology, molecular biology, genetics, biochemistry, cytology.

Sexual and asexual reproduction.

Sexual and asexual reproduction. Morphological features of the reproductive organs of plants and animals. Differences between asexual and sexual reproduction of organisms. Features of germ cells. Gametogenesis. Spermatogenesis. Factors influencing spermatogenesis. Disorders of spermatogenesis. Infertility. Oogenesis and its features.

Fertilization. Evolution of fertilization methods. Fertilization methods in terrestrial and aquatic organisms. External, mixed, and internal fertilization.

Fertilization. Evolution of fertilization methods. Fertilization methods in terrestrial and aquatic organisms. External, mixed, and internal fertilization. Factors promoting and hindering fertilization. Meeting of gametes, attraction of sperm to the egg, gamones. Acrosomal reaction of sperm and its role in gamete union: physiological mono- and polyspermy. Egg activation. Two activation phases: activation impulse and cortical reaction. Formation of perivitelline space. Mechanism of egg protection from penetration of supernumerary sperm in physiologically monospermic animals. Syngamy. Changes in egg metabolism (respiration, DNA replication, protein synthesis). Physicochemical changes in the egg after fertilization. Features of the zygote in different organisms. Artificial insemination, its biological significance.

Stages and processes of individual development. The concept of the embryonic and postembryonic stages of ontogenesis. Cleavage.

The concept of the embryonic and postembryonic stages of ontogenesis. Cleavage. Types of cleavage, their dependence on the amount of yolk, its distribution in the cytoplasm (complete: uniform and uneven; partial: discoidal, superficial) and on the properties of the cytoplasm (radial, spiral, bisymmetric). Alternating holoblastic cleavage of mammals. Dependence of the cleavage type on the type of eggs. The structure of the blastula in animals with different types of cleavage and the formation of the blastula in mammals. Blastoderm and blastocoel. Parts of the blastoderm: roof, fundus, marginal zone. Embryoblast, trophoblast. The structure of the cell cycle during synchronous cleavage divisions. Desynchronization of nuclear division and restructuring of the cell cycle; asynchronous period of cleavage.

Gastrulation, the essence of the process. Primary embryonic induction.

Gastrulation: the essence of the process. Primary embryonic induction. The main modes of gastrulation are migration (emigration, immigration), invagination, delamination, and epiboly. The

primary mouth and, in connection with it, the division of animals into two branches: protostomes and deuterostomes. Formation of the mesoderm. The teloblastic and enterocoelic pathways of mesoderm formation. The two-layered embryo is the result of gastrulation in the lancelet. Gastrulation in reptiles, birds, and mammals.

Neurulation. The concept of neurulation. Segmentation of the mesoderm. Segmentation genes.

Primitive streak and Hensen's node; movement of material and formation of the chordomesodermal primordium. Features of gastrulation in mammals (formation of the primary cavity of the yolk sac, formation of the secondary cavity of the yolk sac).

Cell growth and differentiation in the rudiments of individual organs. Differentiation of germ layers.

Cell growth and differentiation in the rudiments of individual organs. Differentiation of the ectoderm and its derivatives. Differentiation of the endoderm and its derivatives. Differentiation of the foregut and development of the primary oral cavity, pharynx, esophagus, stomach, anterior half of the duodenum, lungs, liver, and part of the pancreas. Differentiation of the midgut and development of the duodenum. Methods for obtaining and examining embryonic material.

Processes of postembryonic individual development of organisms. Causes of anomalies. Biological age.

Processes of postembryonic individual development of organisms. Causes of anomalies. Biological age. Life cycles. Features of plant life cycles: alternation of gametophyte and sporophyte. Diversity of animal life cycles: free-living, parasitic, symbiotic, sedentary.

Current state of the problem of the biology of reproduction and development of organisms. Cloning. Genetic engineering.

Current state of the problem of the biology of reproduction and development of organisms. Cloning. Genetic engineering.

Human embryonic development. Current state of human embryology.

Periods of human development. Biological processes underlying embryonic development – induction, determination, cell division, cell migration, growth, differentiation, cell interactions, and cell death. Critical periods in human development.

General structure of the male and female gonads. Progenesis. The cytogenetic essence of gametogenesis.

The structure of the sperm and egg. Spermatogenesis. Oogenesis. Fertilization. The cytogenetic essence of gametogenesis. Distant and contact interactions of gametes. Capacitation, acrosomal reaction. Penetration of the sperm into the egg.

Fertilization. Ovarian-menstrual cycle.

The ovarian cycle, its phases, and hormonal regulation. The uterine cycle, its phases, and hormonal regulation. Fertilization and its phases. Zygote.

Formation of germ layers, extraembryonic organs. Differentiation of embryonic rudiments. Placentation. The "mother-placenta-fetus" system.

General characteristics of the cleavage process. Its biological significance.

Features of synthetic processes during cleavage. Moments of activation of maternal and paternal genes. Spatial organization of cleavage.

Mechanisms of blastulation . Blastula types and the relationship of their structure to cleavage morphology. Gastrulation and the formation of major organ primordia in vertebrates: description and results of experimental analysis.

Gastrulation modes: delamination, immigration, epiboly, invagination, and various combinations thereof. Types of gastrulae. Modes of mesoderm initiation. Axial mesoderm and its further differentiation: lateral plate. Differentiation of embryonic primordia. Placentation. The "mother-placenta-fetus" system and its functional significance. Features of this period. The advantage of hematotrophic nutrition over histiotrophic nutrition.

Mechanisms of interaction between the "mother" and "fetus" subsystems, their role in fetal development, maintaining pregnancy, and preparing the mother's body for childbirth. The theory of critical periods in embryogenesis. Critical periods in human ontogenesis.

Characteristics of human organogenesis as the final stage of embryonic development, the formation of organs and their systems

The main stages of human organogenesis.

Organogenesis, which consists of the formation of individual organs, constitutes the main content of the embryonic period.

Embryonic induction is the most important consequence of the interaction between germ layers.

Neurulation as the beginning of organogenesis.

Regulatory factors of embryogenesis. The influence of exogenous and endogenous factors on embryogenesis.

The influence of exogenous and endogenous factors on embryogenesis. Mutagenesis. Mutagenic factors.

Regulatory factors of embryogenesis.

Genetic level of regulation.

Intracellular level of regulation.

Epigenetic level of regulation.

Organismic level of regulation (nervous, endocrine, immune).

Clinical aspects.

Developmental defects and anomalies. Classification of developmental disorders.

Classification of congenital malformations – hereditary, exogenous (environmental) and multifactorial.

Developmental defects that are phylogenetically determined and not associated with previous phylogenesis, i.e., non-phylogenetic. Prevention of congenital malformations.

Teratogens and developmental disorders caused by them.

Teratogenesis. Teratogenic factors. Endogenous teratogens. Exogenous teratogens.

Consequences of exposure to teratogenic factors. Terminal teratogenic factor.

Recommended literature.

List of key literature:

1. Sadler, T. W. Langman's medical embryology. - 12th ed. -2012. -400 p.

List of additional literature:

1. Barresi M.J.F., Gilbert S.F. Developmental Biology. 12th ed, 2020. -1258 p.
2. Larry R. Cochard Netter's atlas of human embryology. Chicago, Illinois, 2012. -290 p.

Internet resources:

1. <http://rudocor.net/> - Medical Portal
2. <http://www.e-reading.club/> - Large Online Library
3. <http://www.pubmed.com/> - Database of full-text medical articles
4. <http://www.spravocnikpolekarstvam.ru/> - Free online pharmacological reference
5. <https://dic.academic.ru/> - Dictionaries and Encyclopedias
6. <https://www.rmj.ru/> - Russian Medical Journal