

SYLLABUS

1. General information on the course

Full course name	Fundamentals of scientific research in medicine
Full official name of a higher education institution	Sumy State University
Full name of a structural unit	Academic and Research Medical Institute. Кафедра патологічної анатомії
Author(s)	Moskalenko Roman Andriiovych
Cycle/higher education level	The Second Level Of Higher Education, National Qualifications Framework Of Ukraine – The 7th Level, QF-LLL – The 7th Level, FQ-EHEA – The Second Cycle
Duration	one semester
Workload	3 ECTS, 90 hours. For full-time course 36 hours are working hours with the lecturer (36 hours of seminars), 54 hours of the individual study.
Language(s)	English

2. Place in the study programme

Relation to curriculum	Compulsory course available for study programme "Medicine"
Prerequisites	Krok-1, Internal medicine, incl. medical genetics, endocrinology, dermatology, venereology, clinical pharmacology, clinical immunology and allergology, phthisiology, Obstetrics and gynecology, Pediatrics incl. children's infectious diseases, Surgery, incl. pediatric surgery, neurosurgery; traumatology and orthopedics; emergency/urgent medical care; oncology, Infectious diseases. Epidemiology and principles of evidence-based medicine
Additional requirements	There are no specific requirements
Restrictions	There are no specific restrictions

3. Aims of the course

The goal of the educational discipline is for the learner to achieve constructive, fundamental thinking and obtain modern knowledge and professional skills in formulating a scientific hypothesis, the goal and task of scientific research, and the development of a design and plan of scientific research.

4. Contents

Topic 1 History and essence of scientific knowledge Science: concepts and functions. The history of scientific research during the development of civilization. Stages of development of scientific knowledge. Basic categories of science. The essence and features of the process of scientific knowledge. Concept of scientific idea, hypothesis, fundamental and applied sciences, applied developments.
Topic 2 The structure of scientific research Elements of scientific research. Formation of the goal of scientific research. Object and subject of scientific research as a category of scientific knowledge. The main approaches to conducting scientific research are disciplinary, interdisciplinary, multidisciplinary, and transdisciplinary.
Topic 3 Methods of scientific research Selection of research methods for hypothesis testing. Experimental and clinical research methods. Use of special research methods in experimental works and clinical studies. Peculiarities of the formation of research groups.
Topic 4 Criteria for evaluating the methodological quality of research. Types of scientific data and methods of their calculation. Concepts of evaluating the results of scientific activity. Basic principles: perspective, relevance, and consistency with the priority development directions (in science and technology, innovative activity), scientific novelty and innovative orientation, practical value, and global integration. Sequence processing, image analysis, relationship modeling, probabilistic modeling, process modeling, and graphical data.
Topic 5 Ethics of scientific medical research and academic integrity Bioethical aspects of a scientist's scientific activity. Ethical norms when working with various biological objects (cell cultures, microorganisms, animals) and patients. Violation of academic integrity in the performance of scientific research, types and fight against plagiarism. Tools for monitoring compliance with academic integrity. Provisions of "Recommendations on the status of scientific workers". Code of ethics of a Ukrainian scientist, doctor.
Topic 6 Scientific research in clinical practice. Peculiarities of involving children in clinical research, informed consent of parents (guardians). Basic principles of collecting information and clinical data in pediatric practice, ensuring confidentiality.
Topic 7 Basics of biosafety of scientific research. Biosafety rules in laboratories and rules for handling biological diagnostic material of patients. Management of laboratory waste, "green laboratories", rules for disposal of scientific research waste.
Topic 8 Basics of microscopy Types of microscopic studies: light-optical, electronic, fluorescent, new methods of high resolution. Rules for handling a light microscope. Principles of photo documentation in microscopy.
Topic 9 Basic methods of biological tissue research: histology Rules for preparing samples for research. Methodology and technique of conducting histological research. The importance of histological examination for the diagnostic process.

Topic 10 Basic methods of biological tissue research: histochemistry Rules for preparing samples for research. Peculiarities of the use of histochemical techniques in the diagnostic process. Practical demonstration of one of the histochemical methods.
Topic 11 Basic methods of biological tissue research: immunohistochemistry. Rules for preparing samples for research. Correct fixation of samples. Production of slices. Deparaffinization and unmasking of antigens. Blockade of tissue peroxidase activity. Blockade of excess antigens. Incubation with primary and secondary antibodies. Results visualization methods. Production of an immunohistochemical micropreparation. Evaluation of reaction results.
Topic 12 Basic methods of researching biological samples: cytology. Rules for preparing samples for research. Methodology and technique of conducting cytological research, necessary equipment and reagents. Diagnostic value of cytological methods. Methods and techniques of immunocytochemical research. Peculiarities of using immunocytochemical techniques in the diagnostic process.
Topic 13 General ideas about molecular biological research methods. The principle of the polymerase chain reaction method. The principle of the in situ hybridization method. Indications for conducting molecular cytogenetic studies.
Topic 14 Statistical methods in scientific research. The concept of correct and incorrect distribution of data in the studied samples. Ways to check data distribution. Parametric and non-parametric methods of statistics.
Topic 15 Publication of scientific results Types of publication of scientific data. Rules for preparation of theses of scientific research. Rules for preparation of review and research articles.
Topic 16 Funding of scientific research Search for grant and financial support. Peculiarities of preparing requests for funding of scientific research. The structure of the request for participation in the grant competition: general information.
Topic 17 Scientific career in Ukraine and the world. The system of academic degrees and titles in Ukraine and abroad. Useful tips for early stages researchers
Topic 18 Module Report on an individual scientific project.

5. Intended learning outcomes of the course

After successful study of the course, the student will be able to:

LO1	Be able to solve medical problems in new or unfamiliar environments given incomplete or limited information, taking into account aspects of social and ethical responsibility.
LO2	Be able to develop and implement scientific and applied healthcare projects.

LO3	Be able to solve medical problems in new or unfamiliar environments given incomplete or limited information, taking into account aspects of social and ethical responsibility.
LO4	Be able to develop and implement scientific and applied healthcare projects.

6. Role of the course in the achievement of programme learning outcomes

Programme learning outcomes achieved by the course.

For 222 Medicine:

PO22	To communicate one's knowledge, conclusions, and arguments on health issues and related concerns clearly and unambiguously to professionals and non-specialists, in particular to students.
PO23	To manage healthcare workflows that are complex, unpredictable and require new strategic approaches; to organize conditions for work and professional development of staff.
PO24	To communicate freely in state and foreign languages orally and in writing in order to discuss professional and research activities.
PO25	To make effective healthcare decisions assessing resources and considering social, economic, and ethical implications.

7. Soft Skills

SS1	Ability to abstract thinking, analysis and synthesis.
SS2	Ability to learn, master modern knowledge and apply it in practical situations.
SS3	Knowledge and understanding of the subject area and professional activity comprehension.
SS4	Ability to make reasoned decisions; teamwork ability; interpersonal skills.
SS5	Ability to use information and communication technologies.
SS6	Determination and persistence on the tasks and commitments undertaken.
SS7	Ability to maintain and multiply moral, cultural, scientific values and achievements of society based on understanding the history and development patterns of the subject area, its place in the general system of knowledge about nature and society and in the development of society, techniques and technologies using different types and forms of physical activity for active recreation and a healthy lifestyle.

8. Teaching and learning activities

Topic 1. History and essence of scientific knowledge

pr.tr.1 "Historical stages and definitions of scientific research" (full-time course) The essence and features of the process of scientific knowledge. Structural elements of science: principles (postulates), simple abstraction (concepts, definitions), categories, axioms, regularities, laws. Scientific hypothesis. Methods empirical research, methods of theoretical knowledge and general logical methods and research techniques. Basic concepts of analysis and synthesis of information, methods of abstraction, idealization, generalization and systematic approach. The general structure of the research work: 1) formation of the topic of scientific research; 2) goal formation and research tasks; 3) theoretical studies; 4) experimental or empirical research; 5) analysis and design of scientific research; 6) implementation and effectiveness of scientific research. The use of general logical methods in medical and biological research.
Topic 2. The structure of scientific research
pr.tr.2 "The structure of scientific research" (full-time course) Elements of scientific research. Formation of the goal of scientific research. Object and subject of scientific research as a category of scientific knowledge. The main approaches to conducting scientific research: disciplinary, interdisciplinary, multidisciplinary, transdisciplinary.
Topic 3. Methods of scientific research
pr.tr.3 "Methods of scientific research" (full-time course) Selection of research methods for hypothesis testing. Experimental and clinical research methods. Use of special research methods in experimental works and clinical studies. Peculiarities of the formation of research groups.
Topic 4. Criteria for evaluating the methodological quality of research.
pr.tr.4 "Criteria for evaluating the methodological quality of research." (full-time course) Types of scientific data and methods of their calculation. Concepts of evaluating the results of scientific activity. The main principles: perspective, relevance and consistency with the priority directions of development (in the field of science and technology, innovative activity), scientific novelty and innovative orientation, practical value, global integration. Sequence processing, image analysis, relationship modeling, probabilistic modeling, process modeling, and graphical data.
Topic 5. Ethics of scientific medical research and academic integrity
pr.tr.5 "Ethics of scientific medical research and academic integrity" (full-time course) Bioethical aspects of a scientist's scientific activity. Ethical norms when working with various biological objects (cell cultures, microorganisms, animals) and patients. Violation of academic integrity in the performance of scientific research, types and fight against plagiarism. Tools for monitoring compliance with academic integrity. Provisions of "Recommendations on the status of scientific workers". Code of ethics of a Ukrainian scientist, doctor.
Topic 6. Scientific research in clinical practice.

pr.tr.6 "Scientific research in clinical practice." (full-time course) Peculiarities of involving patients in clinical research informed consent (including guardians). Basic principles of collecting information and clinical data in pediatric practice, ensuring confidentiality.
Topic 7. Basics of biosafety of scientific research.
pr.tr.7 "Basics of biosafety of scientific research." (full-time course) Biosafety rules in laboratories and rules for handling biological diagnostic material of patients. Management of laboratory waste, "green laboratories", rules for disposal of scientific research waste.
Topic 8. Basics of microscopy
pr.tr.8 "Basics of microscopy" (full-time course) Types of microscopic studies: light-optical, electronic, fluorescent, new methods of high resolution. Rules for handling a light microscope. Principles of photo documentation in microscopy.
Topic 9. Basic methods of biological tissue research: histology
pr.tr.9 "Basic methods of biological tissue research: histology" (full-time course) Rules for preparing samples for research. Methodology and technique of conducting histological research. The importance of histological examination for the diagnostic process.
Topic 10. Basic methods of biological tissue research: histochemistry
pr.tr.10 "Basic methods of biological tissue research: histochemistry" (full-time course) Rules for preparing samples for research. Peculiarities of the use of histochemical techniques in the diagnostic process. Practical demonstration of one of the histochemical methods.
Topic 11. Basic methods of biological tissue research: immunohistochemistry.
pr.tr.11 "Basic methods of biological tissue research: immunohistochemistry." (full-time course) Rules for preparing samples for research. Correct fixation of samples. Production of slices. Deparaffinization and unmasking of antigens. Blockade of tissue peroxidase activity. Blockade of excess antigens. Incubation with primary and secondary antibodies. Results visualization methods. Production of an immunohistochemical micropreparation. Evaluation of reaction results.
Topic 12. Basic methods of researching biological samples: cytology.
pr.tr.12 "Basic methods of researching biological samples: cytology." (full-time course) Rules for preparing samples for research. Methodology and technique of conducting cytological research, necessary equipment and reagents. Diagnostic value of cytological methods. Methods and techniques of immunocytochemical research. Peculiarities of using immunocytochemical techniques in the diagnostic process.
Topic 13. General ideas about molecular biological research methods.

pr.tr.13 "General ideas about molecular biological research methods." (full-time course) The principle of the polymerase chain reaction method. The principle of the in situ hybridization method. Indications for conducting molecular cytogenetic studies. Sample preparation for molecular biological methods.
Topic 14. Statistical methods in scientific research.
pr.tr.14 "Statistical methods in scientific research." (full-time course) The concept of correct and incorrect distribution of data in the studied samples. Ways to check data distribution. Parametric and non-parametric methods of statistics.
Topic 15. Publication of scientific results
pr.tr.15 "Publication of scientific results" (full-time course) Types of publication of scientific data. Rules for the preparation of theses of scientific research. Rules for preparation of review and research articles.
Topic 16. Funding of scientific research
pr.tr.16 "Funding of scientific research" (full-time course) Search for grant and financial support. Peculiarities of preparing requests for funding of scientific research. The structure of the request for participation in the grant competition: general information.
Topic 17. Scientific career in Ukraine and the world.
pr.tr.17 "Scientific career in Ukraine and the world." (full-time course) The system of academic degrees and titles in Ukraine and abroad. Useful tips for early-stage researchers.
Topic 18. Module
pr.tr.18 "Module" (full-time course) Report on an individual scientific project.

9. Teaching methods

9.1 Teaching methods

Course involves learning through:

TM1	Practical training
TM2	Team Based Learning
TM3	Research Based Learning
TM4	Self-study
TM5	Project training

Practice-oriented training is focused on the formation of deep conceptual knowledge in pediatrics and the border of subject areas, as well as research skills sufficient for conducting scientific and

applied research at the level of world achievements (RN 1). Research-based education is aimed at the formation of new knowledge and skills, and the ability to use the acquired knowledge in practical activities (RN 2,3). Team-oriented training is aimed at solving specific tasks and stimulates the skills of critical thinking and solving problems in a limited time (RN 2,3). Project training is a method of active problem-situational analysis aimed at developing the skills of forming practical solutions and algorithms for solving a given task (RN 4,5). Self-study in remote systems develops the skills to organize a search, independent selection, and high-quality processing of information from various sources (RN 2,3,4).

During practical classes, graduate students acquire the skills to set and achieve set goals, approach problem solving in a project-based manner, and manage time; communication skills, leadership, the ability to work in a team, the ability to think logically and systematically; skills of academic thinking and displaying information in various forms. Preparation of presentations on the topic of scientific work by the winners will help them develop and implement the skills of critical thinking, self-evaluation, synthesis and analysis of information, expression of opinions in written, graphic and oral form. Project tasks develop the skills of self-study, quick critical thinking, and production of new ideas in the applicants, activating theoretical knowledge on individual research and practical skills to freely and reasonably express opinions on scientific issues, using appropriate vocabulary in Ukrainian and foreign languages.

9.2 Learning activities

LA1	Preparation for practical classes
LA2	Performing a group practical task
LA3	Individual research project
LA4	Preparation for current control
LA5	Research-based learning

10. Methods and criteria for assessment

10.1. Assessment criteria

Definition	National scale	Rating scale
Outstanding performance without errors	5 (Excellent)	$170 \leq RD \leq 200$
Above the average standard but with minor errors	4 (Good)	$164 \leq RD < 169$
	4 (Good)	$140 \leq RD < 163$
Fair but with significant shortcomings	3 (Satisfactory)	$127 \leq RD < 139$
	3 (Satisfactory)	$120 \leq RD < 126$
Fail – some more work required before the credit can be awarded	2 (Fail)	$70 \leq RD < 119$
	2 (Fail)	$0 \leq RD < 69$

10.2 Formative assessment

	Description	Deadline, weeks	Feedback
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FA1 Diagnostic testing	The introduction of the test as a tool for measuring the educational achievements of students and the effectiveness of the educational process is aimed at identifying gaps in the knowledge, abilities, and/or skills of students and ensuring that they eliminate the corresponding deficiencies in their training. Implementation of the test as a tool for measuring applicants' educational achievements and the educational process's effectiveness.	Writing during the cycle in accordance with the calendar and thematic plan.	The maximum number of points for the test is 10 points, provided that 100% of the answers are correct. The minimum score for successfully passing the tests is 6 points (60% of correct answers).
FA2 Survey and teacher's oral comments based on his results.	Makes it possible to find out the state of educational experience acquired by students in accordance with the set goals, to find out prerequisites of the state of formation of the obtained results, reasons occurrence of difficulties, adjust the learning process, track the dynamics of the formation of learning outcomes and predict their development.	During the entire period of studying the discipline.	According to the obtained data on the results of training, on the basis of their analysis, it is proposed to determine the evaluation as an indicator of the achievements of the students' educational activities.
FA3 Review and evaluation of written assignments.	Assessment of practical work considers independence, compliance with the algorithm, correctness, completeness, and awareness.	Writing during the cycle in accordance with the calendar and thematic plan	Feedback is aimed at supporting the independent work of applicants, identifying shortcomings and assessing the level of acquired theoretical knowledge.

FA4 Peer assessment	Evaluation of each other's work results by applicants. Partnership interaction is aimed at improving the results of educational activity by comparing one's current level of success with previous indicators. Provides an opportunity to analyze one's educational activities.	During the entire period of studying the discipline.	Adjustment together with the students of learning approaches, taking into account the results of the assessment.
FA5 Providing feedback on the results of checking the performance of individual tasks by the acquirer.	Assessment of practical work taking into account independence, compliance with the algorithm, correctness, completeness, awareness.	During the cycle in accordance with the calendar and thematic plan.	Feedback is aimed at supporting the independent work of applicants, identifying shortcomings and assessing the level of acquired theoretical knowledge.

10.3 Summative assessment

	Description	Deadline, weeks	Feedback
SA1 Performing situational exercises (preparation, presentation, defense)	Assessment of correct and logical thinking, skill development observe and analyze problems arising from certain professional activity.	During of course	A student can get a maximum of 10 points. The minimum number of points for a successful defense is 6 points.
SA2 Execution of a practical case (preparation, presentation, defense)	The acquirer's ability to analyze the received information, synthesize the assessment of established knowledge, implementation, and formation of skills is determined and skill in a specific situation, modeled by verbal description or other teaching aids, and facilitates the process knowledge through observation and perception and generate ideas for solving problems based on available theoretical and practical knowledge and skills.	According to the calendar and thematic plan	The winner can get a maximum of 10 points. The minimum number of points for a successful defense is 6 points

SA3 Carrying out a research task (preparation, presentation, defense)	Consolidation of theoretical knowledge and practical skills with of this educational course and the development of students' skills a practical solution to specific tasks. students, are involved in research activities and have the opportunity to present the results of own research.	According to the calendar and thematic plan	A student can get a maximum of 15 points. The minimum number of points for a successful defense is 8 points
SA4 Differentiated assessment	Differentiated assessment	At the end of studying the discipline	A student can get a maximum of 80 points. The minimum number of points for a successful defense is 48 points

Form of assessment:

		Points	Можливість перескладання з метою підвищення оцінки
The first semester of teaching		200 scores	
SA1. Performing situational exercises (preparation, presentation, defense)		60	
	3x20	60	Yes
SA2. Execution of a practical case (preparation, presentation, defense)		40	
		40	Yes
SA3. Carrying out a research task (preparation, presentation, defense)		20	
		20	Yes
SA4. Differentiated assessment		80	
		80	Yes

The grade for the discipline is defined as the sum of points for the current educational activity (at least 36) and points for the final module control (at least 24). The number of points for the current activity is calculated according to the formula $60 \times \frac{\text{the arithmetic average of the student's success in 4 point system of evaluation}}{5}$. The final module control is conducted at the end of the academic semester in the form of a credit, while the grade "5" corresponds to 40 points, "4" - 32 points, "3" - 24 points, "2" - 0 points. In case of an unsatisfactory result for the final module control, the acquirer has the right to readjust the balance. Applicants who did not appear for the assessment without a good reason are considered to have received an unsatisfactory grade. The applicant's refusal to complete the final module task is certified as an unsatisfactory response.

11. Learning resources

11.1 Material and technical support

MTS1	Library funds
MTS2	Laboratory equipment (chemical, physical, medical, materials and preparations, etc.)
MTS3	Computers, computer systems and networks
MTS4	Multimedia, video and sound reproduction, projection equipment (projectors, screens, smart boards)
MTS5	Medical buildings/premises and equipment (Center for collective use of scientific equipment of the Medical Institute "Center for Biomedical Research", University Clinic of Sumy State University, Center for collective use of scientific equipment "Laboratory of materials science of helio-energy, sensor and nanoelectronic systems")

11.2 Information and methodical support

Essential Reading	
1	Andrew Blann. Fundamentals of Biomedical Science. 2024. pp.752 University of Liverpool. ISBN: 9780198834236
2	Aguinis, H. (2025). Research methodology: Best practices for rigorous, credible, and impactful research. Sage Publications.
Supplemental Reading	
1	Topical Issues of Biosafety and Biosecurity [Електронний ресурс] : lecture course for stud. of spec. 222 “Medicine”, 221 “Dentistry”, 229 “Public health” of full-time course of studies / V. M. Holubnycha. — Sumy : Sumy State University, 2023. — 76 p.
2	Tran, P., Mishra, P., Williams, L. G., Moskalenko, R., Sharma, S., Nilsson, A. K., Watt, D. L., Andersson, P., Bergh, A., Pursell, Z. F., & Chabes, A. (2024). Altered dNTP pools accelerate tumor formation in mice. Nucleic acids research, Vol. 52, Issue 20, 11 November 2024, Pages 12475–12486, https://doi.org/10.1093/nar/gkae843
3	R. Chyzhma, A. Piddubnyi, A. Romaniuk, R. Moskalenko, Case report: Metastasis of Merkel cell carcinoma in the small intestine. Pathology - Research and Practice. 248 (2023) 154594. https://doi.org/10.1016/j.prp.2023.154594
4	Savchenko T, Lakhtaryna R, Denysenko A, Dovbysh A, Coupland SE, Moskalenko R. An Information-Extreme Algorithm for Universal Nuclear Feature-Driven Automated Classification of Breast Cancer Cells. Diagnostics. 2025; 15(11):1389. https://doi.org/10.3390/diagnostics15111389

5	Kurochkin A, Moskalenko R. Diagnostic value of lymph node calcification in thyroid cancer. Theoretical and practical aspects of the development of modern scientific research: monograph / ed. Anita Jankovska. Riga : Izdevniecība "Baltija Publishing", 2022. P. 194–212. DOI: https://doi.org/10.30525/978-9934-26-195-4-23
Web-based and electronic resources	
1	https://www.abcam.com/tag/ihc%20protocols
2	https://www.sigmaaldrich.com/technical-documents/protocols/biology/immunohistochemistry-protocol.htm
3	http://www.philsci.univ.kiev.ua/biblio/Phil-science.pdf
4	https://www.youtube.com/watch?v=uthcFBJxfFw&list=PLFSkmosYxTD7M2kSoH-kLlywV09Yu7ybN