NON-PROFIT JOINT-STOCK COMPANY
«AL-FARABI KAZAKH NATIONAL UNIVERSITY»

MODULE HANDBOOK

EDUCATION PROGRAMME

8D05109- NEUROSCIENCE

CLUSTER A

Content

Purpose of education programme

To train highly qualified, competitive scientific personnel on the international labor market in the field of neuroscience, possessing universal and subject-specialized competencies that meet the demands of the global labor market, carrying out research, practical, expert-analytical activities in integrative neuroscience, development and safety of neurotechnologies in the fields of science, economics, health care, state security and education based on the modern methodology of an interdisciplinary approach; capable of organizing original research, making a significant contribution to the development of the world neuroscience, integrating into the international scientific community bearing moral and ethical responsibility for scientific research, contributing to technological progress and socio-cultural development of society.

Learning outcomes

ON1. Evaluate scientific concepts and methodologies of experimentation in neuroscience in order to form new topical scientific studies in accordance with the ethical norms of conducting scientific research with human resources and living objects;

ON2. Generalize the experience of ongoing world scientific projects in the field of neuroscience with the aim of implementing and adapting research methods into the proper scientific projects in local conditions;

ON3. Implement their own original scientific and scientific-practical projects in the international scientific market with the involvement of international funds through the submission of grant applications;

ON4. Predict the socio-economic consequences and results of scientific research in neuroscience and be responsible for them by adhering to international ethical standards in conducting research;

ON5. Develop patentable neurotechnologies with the potential to acquire intellectual property copyrights;

ON6. Organize and conduct an examination of the validity and safety of innovative developments and technologies in the field of neuroscience used in various spheres of human social life;

ON7. Solve applied issues in the field of health care, education, the socio-economic sphere and state security based on the principles of integrative neuroscience;

ON8. Implement modern achievements of neuroscience into educational programs, integrated courses and educational technologies including digital educational resources in order to increase the effectiveness of training for various target groups;

ON9. Develop valid reliable neurotechnologies aimed at solving tasks of optimizing work activity in various spheres of life;

ON10. Demonstrate publishing activity in highly ranked scientific journals and publications in the field of neuroscience and the ability to review scientific articles in accordance with international standards;

ON11. Establish and maintain a constructive relationship with the international scientific community in order to implement a fruitful exchange of advances in neuroscience;

ON12. Commercialize scientific ideas and achievements in neuroscience, attracting interested consumers from various sectors of the economy and business.

Learning Objectives-Module Matrix

Module	Learning outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
Instruments of scientific researches	+	+	+	+	+	+		+	+	+	+	
Advanced Neuroscience			+	+	+	+	+	+	+		+	+
Neuroscience			+	+	+	+	+	+	+	+	+	+

Course structure

RESEARCH			CORE DISCIPLINES *(Базовые дисциплины)*		MAJOR DISCIPLINES *(Профильные дисциплины)*	
UNIV. COMP.	RESEARCH SEMINAR	DOCTORAL THESIS	UNIVERSITY COMPONENT	ELECTIVE COMPONENT	UNIVERSITY COMPONENT	ELECTIVE COMPONENT
31	33	59	15	5	20	5
123			20		25	

TERM

1	Instruments of scientific researches 5 ECTS	Elective component **(1 of 4)** 5 ECTS	Advanced Neuroscience 10 ECTS	Neuroscience **(1 of 6)** 5 ECTS	Res. Sem. 3 ECTS	Doc. Thes. 2 ECTS	30
2	Teaching intership 10 ECTS	Research Seminar 8 ECTS	Doctoral Thesis 12 ECTS				30
3	Research practice 5 ECTS	Research Seminar 8 ECTS	Doctoral Thesis 14 ECTS	Sci. Conf. 3 ECTS			30
4	Research practice 5 ECTS	Research Seminar 10 ECTS	Doctoral Thesis 15 ECTS				30
5	Res. Sem. 3 ECTS	Doctoral Thesis 14 ECTS	Scientific conferences (Participation) Scientific Internship 13 ECTS				30
6	RS 1	DT 2	Publication of the main scientific results of the dissertation in scientific journals 15 ECTS	FINAL ATTESTATION 12 ECTS			30

List of modules

Workload HPW (Hours per week) according – Teaching methods as lecture, seminar, lab works and others (lesson, project, etc.)

Module/Disciplines	ECTS	Workload HPW				Term
		lec.	sem.	lab.	other	
Instruments of scientific researches	**20**					
Academic Writing	2	0	2			1
Methods of scientific researches	3	1	1			1
Elective component						
Brain Signals Processing	5	1	2			1
Developmental neuroscience and brain plasticity	5	1	2			1
Methods of Artificial intelligence in Neuroscience	5	1	2			1
Molecular and Cellular Neuroscience	5	1	2			1
TEACHING INTERSHIP	10					2
Advanced Neuroscience	**25**					
Neuroscience	5	1	2			1
Consciousness theories: from philosophy to neurocybernetics	5	1	2			1
Neurosciecne	**5**					
Neural Plasticity, Learning and Memory	5	1	2			1
Behavioral Neuroscience	5	1	2			1
Connectivity and Big DATA	5	1	2			1
Human-Computer Interaction	5	1	2			1
Neuropathology	5	1	2			1
Brain and Aging	5	1	2			1
REASEARCH PRACTICE	10					
RESEARCH WORK	**123**					
Research Seminar	26				26	1-6
The implementation of a Doctoral Thesis	41				41	1-6
Publication in the Proceedings of International Conferences	17				17	2-5
Publication in journals recommended by CCSES or indexed be Web of Science, Scopus Databases	31				31	2-6
Scientific Internship	8				8	5-6
FINAL ATTESTATION					12	6

CORE DISCIPLINES

University component

Instruments of scientific researches

Module Objectives. Doctoral students will be able to:
1. Understand and present scientific information in neuroscience;
2. Apply ethical standards in experimental research in neuroscience;
3. Critically analyze methodological approaches in the study of brain functions using modern approaches to processing its signals in Neuroscience;
4. Synthesize complex approaches in the study of brain neurobiology and the development of artificial intelligence in the context of methodological, theoretical, practical issues in neuroscience;
5. Design and design experimental research in an interdisciplinary approach in neuroscience;
6. Master the skills of self-structuring and transformation of scientific knowledge in neuroscience;
7. Form the skills of presenting a scientific text in publications for high-ranking scientific journals and publications;
8. Develop research products in the field of neuroscience following international standards.

Discipline designation	*Academic Writing*
Credit points	*2*
Semester(s) in which the discipline is taught	*1*
Relation to curriculum	*CORE DISCIPLINES* *Instruments of scientific researches*
Teaching methods	Seminar
Workload (incl. contact hours, self-study hours)	**15 weeks,** **3 hours per week for Seminar, total 45 Contact hours.** **Independent work of a doctoral student - 15**
Person responsible for the discipline	**Terleckaya N.V.** Candidate of biological science, Associate Professor Department of biodiversity and bioresources **Kamaznova A.T.** PhD, Associate Professor* Department of Biophysics, Biomedicine and Neuroscience
Language	*English*
Discipline objectives/intended learning outcomes	The purpose of the discipline is the formation of professional communicative competence associated with analytical textual activity. The course contributes to the formation of linguistic and pragmatic thinking, forms the ability of PhD doctoral students to analyze the expressive units of the language and competently select the desired unit depending on the goals and conditions of oral and written scientific communication. Know: understand main structure of research paper effectively summarize and analyze various texts in Neurosciecne by identifying and highlighting their main ideas and messages To be able to: apply skills necessary for the accomplishment

	of a writing project Competences: evaluate different writing style of research paper, critically analyze plagiarism and acceptable paraphrasing Own: constructively critique their own and others' writing in Neuroscience
Content	1. The writing process. Intentions for Academic Writing 2. Styles of Academic Writing 3. Review of writing paragraphs. Process comparison and contrast. Opinion paragraphs. 4. Review of writing essays - descriptive essays, process essays 5. Review of writing essays - classification essays. Comparison-contrast essays 6. Review of writing essays. Cause-effect essays. Argumentative essays. 7. Data commentary 8. Writing summaries and paraphrases 9. Writing critiques 10. Transforming the notes into a rough draft 11. Online resources 12. The thesis and the outline 13. Revision Skills: Emphasis, Clarity, Concision, Completeness, Structural Cohesion 14. Using sources: quotation, paraphrasing, plagiarism, summarizing 15. Improving of style and syntax in academic writing
Examination forms	Written examination: problem solving questions. Base question amount 10-30: questions on the application of knowledge regardless of the number of students, regardless of loans for any level of education; exam –2-3 questions, time of preparation for the answer – 10-20 minutes
Reading list	1. Sheehy M., Wray C. Academic writing handbook for learners. FET, 2019. P. 100 2. Newman A. How write a great research paper, and get it accepted by a good journal: Life Sciences Department, Senior Publisher, Elsevier, 2018. P. 487 3. Bailey S. Academic writing: A Handbook for International Students, Fifth edition, 2018, P.663 4. Lebrun J.-L., Lebrun J. Scientific Writing 3.0: A reader and writer's guide. 2022, P. 316. 5. Swales J.M. (2020) Academic Writing for Graduate Students: Essential Tasks and Skills Kindle Edition 6. Nigel A. Caplan (2019) Grammar Choices for Graduate and Professional Writers, Second Edition 7. Bailey, S. (2018). Academic writing: A Handbook for International Students. Routledge 8. Winkler A.,C., & Metherell, J.R. (2012). Writing the Research Paper: A Handbook, Cengage Learning.

	the United States of America 9. Hairston, et al. The Scott, Foresman Handbook for Writers (San Francisco: Longman 2010 or latest edition) 10. Bullock R. (2013) The Norton Field Guide to Writing . W.W. Norton 11. Peat, J., Elliott, E., Baur, L., Keena, V. (2002) Scientifc Writing - Easy when you know how. BMJ Books, London

Discipline designation	*Methods of scientific researches*
Credit points	*3*
Semester(s) in which the discipline is taught	*1*
Relation to curriculum	*CORE DISCIPLINES* *Instruments of scientific researches*
Teaching methods	lecture, seminar
Workload (incl. contact hours, self-study hours)	**15 weeks,** **1 hour per week for Lecture, total 15 Contact hours.** **1 hours per week for Seminar, total 15 Contact hours.** **Independent work of a doctoral student - 60**
Person responsible for the discipline	**Terleckaya N.V.** Candidate of biological science, Associate Professor Department of biodiversity and bioresources
Language	*English*
Discipline objectives/intended learning outcomes	The purpose of the discipline is the formation of knowledge about the methodology of scientific research, planning and conducting effective scientific activities in neuroscience. The course is designed to promote the development of ways and methods of scientific research. The consistent use of scientific research methodology contributes to a comprehensive increase in the level of scientific research of the future scientist in the field of neuroscience. Know: essential components of the scientific method with respect to experimentation in the Biological Sciences and discuss the need to perform experiments in replicates, account for likely sources of error, appropriate safety and ethical considerations etc. to be able: skills relating to the process of conducting scientific research and the scientific method including experimental design, hypothesis testing, data collection, data analysis, data interpretation and writing research proposals. Competences: set up a research study.Critically analyze and synthesize recent published research in primary scientific literature. Own: critically assess different research designs.
Content	1. Research Methodology: An Introduction

	2. Definition of the research problem 3. Literature review 4. Constructing Hypotheses 5. Hypothesis testing 6. Study Design 7. Methods of Data Collection 8. Sampling for research 9. Establishing the validity and reliability of the research instrument 10. Processing and Analysis of Data 11. Data display 12. Ethical Issues in Data Collection 13. Researcher intellectual property 14. How to write a research project (proposal) 15. Interpretation and Report Writing
Examination forms	Oral examination: problem solving questions. Base question amount 10-30: questions on the application of knowledge regardless of the number of students, regardless of loans for any level of education; exam –2-3 questions, time of preparation for the answer – 10-20 minutes
Reading list	1. Robert Coe, Michael Waring, Larry V Hedges, Laura Day Ashley. Research Methods and Methodologies in Education. 3rd edition.: Sage , 2021. 480p. 2. Dr. Alok Gupta, Nitin Gupta. Research Methodology by Dr. Alok Gupta, Nitin Gupta. SBPD Publications, 2022. 247p. 3.Chawla, D. & Sodhi, N. (2011) "Research Methodology: Concepts and Cases" Vikas Publishing House PVT Ltd 4. Kumar R. Research Methodology a step-by-step guide for beginners. 3rd edition. 2011. SAGE Publications Ltd 5. Layman E., Watzlaf V.J Health informatics research methods: principles and practice. Chicago, Ill.: American Health Information Management Association, 2009. - xiii, 439 p. 6. Denscombe M. The good research guide [Elektronisk resurs]: for small-scale social research projects. 4th ed.: Maidenhead: Open University Press, cop.2012. - 373 p. 7. Glasman-Deal H. Science research writing for non-native speakers of English. London: Imperial College Press, cop. 2011 - xiii, 257 p. 1.https://elibrary.ru 2.https: //link.springer.com - Springerlink international abstract database of scientific publications (open access resources) 3.https: //zbmath.org - International abstract database of scientific publications zbMATH (open access resources) 4.http://window.edu.ru - Information system "Single window of access to educational resources"

Elective component

Module Objectives. Doctoral students will be able to: 1. Understand and present scientific information in neuroscience; 2. Apply ethical standards in experimental research in neuroscience; 3. Critically analyze methodological approaches in the study of brain functions using modern approaches to processing its signals in neuroscience; 4. Synthesize complex approaches in the study of brain neurobiology and the development of artificial intelligence in the context of methodological, theoretical, practical issues in neuroscience; 5. Design and design experimental research in an interdisciplinary approach in neuroscience; 6. Master the skills of self-structuring and transformation of scientific knowledge in neuroscience; 7. Form the skills of presenting a scientific text in publications for high-ranking scientific journals and publications; 8. Develop research products in the field of neuroscience following international standards.

Discipline designation	*Brain Signals Processing*
Credit points	5
Semester(s) in which the module is taught	1
Relation to curriculum	Elective component Instruments of scientific researches
Teaching methods	lecture, seminar
Workload (incl. contact hours, self-study hours)	**15 weeks,** **1 hour per week for Lecture, total 15 Contact hours.** **2 hours per week for Seminar, total 30 Contact hours.** **Independent work of a doctoral student - 105.**
Person responsible for the module	***Kusutbayeva A.M.*** *PhD, Professor Department of Biophysics, Biomedicine and Neuroscience* ***Melnikov M.*** *Federal Research Center of Fundamental and Translational Medicine, Russia*
Language	English
Discipline objectives/intended learning outcomes	The purpose of the discipline is to study the basic physical and mathematical provisions of the nature of brain signals, methods and approaches for processing brain signals in neuroscience. The course will allow you to form the ability to choose the right strategy for selecting the appropriate mathematical and statistical analysis for solving a research problem using modern applied computer programs for analyzing various types of brain signals. Know: To be able to: Own: - to argue the main approaches and aspects of brain signal processing, to navigate in modern computer applications used for brain signal processing; - to compare different approaches to brain signal processing in a reasoned and evidence-based manner, and to build a theoretically

	and methodologically correct algorithm for digital brain signal processing; - to compare the main approaches to signal processing in the scientific literature with the subsequent possibility of their implementation in practice when working with their own scientific data; - to evaluate the problems of developing scripts in the processing of brain signals in the context of a scientific hypothesis with the subsequent possibility of writing them independently.
Content	1. Brain signals. Types of brain signals on different levels 2. Neuronal activity. Action Potential. 3. Synaps. Nerve impulse and transduction 4. Electrocorticogramm (Ecog) 5. Electroencephalogramm (EEG), its origin and characteristics. EEG recording. EEG design: block design and Event Related Potential/ERP design. 6. Preprocessing of EEG signal: EEGLAB, SPM, Neurosoft. 7. Statistical analysis of the EEG data. 8. Linear and nonlinear analysis 9. Structural MRI. Data acquisition. Quantification of sMRI data: parcellation and 10. Basics of Functional MRI. BOLD signal. 11. Preprocessing of fMRI data. 12. Resting state fMRI technics 13. Sattistical analysis of fMRI data: AFNI, SPM, FSL. 14. Connectivity methods for EEG and fMRI data. 15. Block design and ER-fMRI, PPI with fMRI
Examination forms	Oral examination: Base question amount 10-30: questions on the application of knowledge regardless of the number of students, regardless of loans for any level of education; exam –2-3 questions, time of preparation for the answer – 10-20 minutes
Reading list	1. Ashburner J., Barnes G., Chen C.-C., et al. SPM12 Manual. 2021. 2. Nieto-Castanon A. CONN toolbox manual. 2022. 3. Group ICA/IVA of fMRI Toolbox (GIFT) Manual. 2020. 4. eeglab.org [electronic resourse] 5. https://labeling.ucsd.edu/tutorial [electronic resourse] 6. https://sccn.ucsd.edu/wiki/Makoto's_ preprocessing_pipeline [electronic resourse] 7. Kropotov J. Quantitative EEG, Event-Related Potentials and Neurotherapy. Academic Press, 2008. 8. Khanna A., Pascual-Leone A., Michel C.M., Farzan F. Microstates in resting-state EEG: current status and future directions. Neuroscience and Biobehavioral Reviews. 2015. 49:105-13. 9. Pascual-Marqui R.D., Esslen M., Kochi K., Lehmann D. Functional imaging with low-resolution brain electromagnetic tomography (LORETA): a review. Methods and Findings in Experimental and Clinical Pharmacology. 2002. 24S:91-95. 10. Robbins K.A., Touryan J., Mullen T., et al. How Sensitive Are EEG Results to Preprocessing Methods: A

	Benchmarking Study. IEEE Transactions on Neural System and Rehabilitation Engineering. 2020. 28(5):1081-1090. 11. EEG-fMRI: Physiological Basis, Technique, and Applications. C. Mulert, L. Lemieux (Eds.). Springer, 2010. 12. Glasser M.F., Sotiropoulos S.N., Wilson J.A., et al. The minimal preprocessing pipelines for the Human Connectome Project. Neuroimage. 2013. 80:105-124.

Discipline designation	*Developmental neuroscience and brain plasticity*
Credit points	5
Semester(s) in which the module is taught	1
Relation to curriculum	Elective component Instruments of scientific researches
Teaching methods	lecture, seminar
Workload (incl. contact hours, self-study hours)	**15 weeks,** **1 hour per week for Lecture, total 15 Contact hours.** **2 hours per week for Seminar, total 30 Contact hours.** **I ndependent work of a doctoral student - 105.**
Person responsible for the module	**Kamaznova A.T.** PhD, Associate Professor* Department of Biophysics, Biomedicine and Neuroscience
Language	English
Discipline objectives/intended learning outcomes	The goal of the discipline is to determine the basic patterns of brain development, its plasticity in the dynamics of age-related changes, as well as compensatory mechanisms of abnormal development. The course acquaints doctoral students with modern research in the field of neuroscience of brain plasticity, which will allow to analyze the state of studying the formation of the brain in the "organism-environment" system to develop new research in solving problems of this branch of science. Know: identifies main theories and the historical foundations of Developmental Neuroscience, understanding of the neuroscience tools and methods that can be used to answer current developmental questions on brain plasticity To be able to: criticaly think by constructing hypotheses and opinions and learn to find empirical support for hypotheses in Developmental Neuroscience Competence: apply developmental neuroscience concepts, theories, and research findings to Neuroscience issues in everyday life Own: Identify appropriate applications of developmental neuroscience knowledge in health, service, education, or business professions.
Content	1. Introduction to Developmental Neuroscience and brain plasticity 2. Biological Foundations of Developmental Neuroscience

	3. Connectivity driving development and plasticity 4. The Genesis of Neurons and plasticity 5. Synaptogenesis in the Neocortex of the Newborn 6. Myelination in the Developing Human Brain 7. Early brain injury, intervention, and plasticity 8. Adolescent Brain Development 9. Adult Brain Development and Critical Periods 10. Behavior and Plasticity 11. Early brain damage and developmental plasticity 12. Development, Plasticity, and Learning 13. Neurodegeneration and brain plasticity: current researches 14. Ethical Issues in Developmental Neuroscience 15. Applied Research of Brain plasticity: ethics and perspectives
Examination forms	Oral examination: problem solving questions. Base question amount 10-30: questions on the application of knowledge regardless of the number of students, regardless of loans for any level of education; exam –2-3 questions, time of preparation for the answer – 10-20 minutes.
Reading list	1. The Oxford Handbook of Developmental Cognitive Neuroscience. Kathrin Cohen Kadosh (ed.) 2020 2. Developmental Cognitive Neuroscience, 4 th Edition Mark H. Johnson & Michelle de Haan, 2015. 3. Handbook of developmental cognitive neuroscience / edited by Charles A. Nelson 4. and Monica Luciana, 2008. 5. Kandel E., Schwartz J., Jessell T.M. Principles of neuronal science. International edition, 2000. 6. Understanding Other Minds Perspectives from Developmental Social Neuroscience. Edited by Simon Baron-Cohen Helen Tager-Flusberg, Michael V. Lombardo, Oxford University Press 2013 7. Gazzaniga M.&Mangun G. The Cognitive Neurosciences. 2014

Discipline designation	*Methods of Artificial intelligence in Neuroscience*
Credit points	5
Semester(s) in which the module is taught	1
Relation to curriculum	Elective component Instruments of scientific researches
Teaching methods	lecture, seminar
Workload (incl. contact hours, self-study hours)	**15 weeks,** **1 hour per week for Lecture, total 15 Contact hours.** **2 hours per week for Seminar, total 30 Contact hours.** **I ndependent work of a doctoral student - 105.**
Person responsible for the module	**Mansurova M.E.** Candidate of Physic-Mathematical Sciences, Associate Professor

Language	English
Discipline objectives/intended learning outcomes	The goal of the discipline is to develop the ability to use artificial intelligence to understand the work of the brain, to develop mathematical models of brain functions in simulations based on the analysis of brain work at the cellular, network and system levels, to apply experimental approaches to analyze brain function. The course introduces the methods of finding solutions used in artificial intelligence systems. Students acquire practical skills: - develop mathematical models of brain functions; - use mathematical models of brain functions in simulations based on the analysis of the brain at the cellular, network and system level; - use experimental approaches to measure and analyze brain function; - analyze the main models, methods, tools and programming language used in the development of artificial intelligence systems in neuroscience.
Content	1. fMRI Basics. fMRI, data acquisition and reconstruction. 2. fMRI signal, experimental design and pre-processing. Spatial and Temporal Resolution of Bold. 3. fMRI Analysis. General Linear Model (GLM). Applying GLM to fMRI Data. 4. Linear Basis Sets. Filtering & Nuisance Covariates. 5. GLM Estimation. Noise Models - AR Models. 6. Inference - Contrasts and T-tests. 7. Multiple Comparison Problem in fMRI. 8. fMRI and Machine Learning. 9. fNIRS Analysis. 10. Brain-machine interface, data processing, real-time imaging. 11. Building Predictive Models of Emotion with Functional Near-Infrared Spectroscopy. 12. Review of Brain Measurement Techniques. 13. Machine Learning challenges for Brain Data. 14. Machine Learning Classifiers on fNIRS data. 15. Functional Connectivity.
Examination forms	Combined1: Project work. Develop mathematical models of brain functions in simulations
Reading list	1. Mark R. Bear, Barry W. Connors, Michael A. Paradiso, Lippincott Williams and Wilkins. Neuroscience Exploring the Brain. Fourth Edition, 2016. 2. Fabrice Jotterand, Marcello Ienca. Artificial Intelligence in Brain and Mental Health: Philosophical, Ethical & Policy Issues (Advances in Neuroethics). Springer. 2022. 283 p. 3. Wen, D., Wei, Z., Zhou, Y., Li, G., Zhang, X., & Han, W. Deep Learning Methods to Process fMRI Data and Their Application in the Diagnosis of Cognitive Impairment: A Brief Overview and Our Opinion. Frontiers in Neuroinformatics, 12, 23. 2018.

	4. Daeyeol Lee. Birth of Intelligence: From RNA to Artificial Intelligence. Oxford University Press. 2022. 232 p. 5. Sasikumar Gurumoorthy, Bangole Narendra Kumar Rao, Xiao-Zhi Gao. Cognitive Science and Artificial Intelligence: Advances and Applications (SpringerBriefs in Applied Sciences and Technology). 2018. Springer. 120 p. 6. Dr Khalil Isaac Mathai MCh. Neuroscience Paradigms and Artificial Intelligence - Reflections of a Neurosurgeon. 2020. 274 p. 7. Peter Robin Hiesinger. The Self-Assembling Brain: How Neural Networks Grow Smarter. Princeton University Press. 2022. 384 p. 8. van Baar, J. M., Chang, L. J., & Sanfey, A. G. (2019). The computational and neural substrates of moral strategies in social decision-making. Nature Communications, 10(1), 1483.

Discipline designation	*Molecular and Cellular Neuroscience*
Credit points	5
Semester(s) in which the module is taught	1
Relation to curriculum	Elective component Instruments of scientific researches
Teaching methods	lecture, seminar
Workload (incl. contact hours, self-study hours)	**15 weeks,** **1 hour per week for Lecture, total 15 Contact hours.** **2 hours per week for Seminar, total 30 Contact hours.** **I ndependent work of a doctoral student - 105.**
Person responsible for the module	***Davletov B.*** *PhD, professor, Department of Biomedical Science, University of Sheffield, Sheffield, England*
Language	English
Discipline objectives/intended learning outcomes	The purpose of the discipline is to form a critical analysis of modern literature on the molecular and cellular mechanisms underlying the functional units of the brain among doctoral students. The course includes the study of the molecular and cellular levels of organization of nerve cells and nervous tissue, morphology, molecular identity and physiological characteristics of neurons, mechanisms of signal processing by neurons. Know: - modern approaches in the study of cellular neurophysiology; - molecular mechanisms of neurotransmitter release; To be able to: - analyze scientific literature on the main thematic areas of molecular and cellular neurobiology; - critically analyze current research in the field of neurogenomics and the formation of the nervous system; Own: - to carry out a comparative analysis of modern research in the field of molecular and cellular neuroscience; - to formulate, plan and conduct relevant research on the main topics of molecular and cellular neuroscience.
Content	1. Neurotherapeutics for treatment of neurological diseases. Part 1. 2. Neurotherapeutics for treatment of neurological diseases. Part 2. 3. Applications of antibodies in neurosciences. 4. Molecular approaches to investigations of nervous system. 5. Stimulating neurotoxins as tools in neuroscience. 6. Inhibiting neurotoxins in neuromedicine. 7. Synaptic biology: general structure. 8. Role of SNARE proteins in synaptic biology.

	9. Regulators of SNARE function. 10. Role of lipids in synaptic biology. 11. Molecular basis of neurological disorders. Part 1. 12. Molecular basis of neurological disorders. Part 2. 13. Molecular approaches in drug development. 14. Bioethics: reduction, reuse and replacement of animals in neuroscience. 15. Revision of neuroscience topics.
Examination forms	Essay - written examination. Give own opinion on 3 topics related of molecular and cellular neuroscience (700 words essay)
Reading list	1) Bear, Mark, Barry Connors, and Michael A. Paradiso. Neuroscience: Exploring the Brain, Enhanced Edition: Exploring the Brain. Jones & Bartlett Learning. 2020. 1016 p. 2) Mangione, A.S., Obara, I., Maiarú, M., Geranton, S.M., Tassorelli, C., Ferrari, E., Leese, C., Davletov, B. and Hunt, S.P. Nonparalytic botulinum molecules for the control of pain. Pain. V. 157(5). 2016. P.e1045. 3) Mavlyutov, T. A., Duellman, T., Kim, H. T., Epstein, M. L., Leese, C., Davletov, B. A., & Yang, J. Sigma-1 receptor expression in the dorsal root ganglion: Reexamination using a highly specific antibody. Neuroscience. V.331. 2016. P. 148-157. 4) Andreou, Anna P., et al. Double-binding botulinum molecule with reduced muscle paralysis: evaluation in in vitro and in vivo models of migraine. Neurotherapeutics. V.18. 2021. P. 556-568.

MAJOR DISCIPLINES

University component

Advanced Neuroscience

Module Objectives. Doctoral students will be able to:
1. Explain modern theoretical and practical problems in the study of brain plasticity in health and disease by synthesizing interdisciplinary approaches in the field of neuroscience; 2. Critically analyze the main problems of human-computer interaction in the study of brain connectivity in development; 3. Analyze and prove complex ideas and hypotheses about brain functions using BigDATA; 4. Critically analyze the current trends in the development of brain research in health and disease; 5. Develop and substantiate your scientific hypothesis in the study of cognitive processes and brain plasticity; 6. Determine the priority areas of research in the field of brain connectivity in health and disease through the study of new approaches and methods in neuroscience; 7. Draw up the design of modern experimental studies in behavioral neuroscience concerning the methodological analysis of modern interdisciplinary concepts; 8. Develop new methodological, theoretical, practical issues in the field of brain plasticity by synthesizing various scientific approaches and research in the field of neuroscience.

Discipline designation	*Neuroscience*
Credit points	5
Semester(s) in which the module is taught	1
Relation to curriculum	Unversity component Advanced Neuroscience
Teaching methods	lecture, seminar
Workload (incl. contact hours, self-study hours)	**15 weeks,** **1 hour per week for Lecture, total 15 Contact hours.** **2 hours per week for Seminar, total 30 Contact hours.** **Independent work of a doctoral student - 105.**
Person responsible for the module	***Kusutbayeva A.M.*** *PhD, Professor Department of Biophysics, Biomedicine and Neuroscience* ***Kamaznova A.T.*** *PhD, Associate Professor* Department of Biophysics, Biomedicine and Neuroscience (seminar)*
Language	English
Discipline objectives/intended learning outcomes	The goal of the discipline is the formation of integrative thinking about the problems of neuroscience as a synthesis of scientific directions, united to understand the functions of the brain at different levels, from the molecular to the systemic levels. The course examines modern interdisciplinary research in the field of neuroscience, develops a critical approach to the analysis of recent publications and a creative approach in finding solutions to scientific problems.

	Know: to analyze the study of the development of the nervous system and the mechanisms of integration of neural pathways; critically evaluate studies of the neural processes underlying learning, the formation of memory and behavior; Competence: formulate research hypotheses taking into account the principles of neuroscience; To be able to: to determine the ethical side of ongoing research in neuroscience; Own: to carry out experimental research in the field of neuroscience that meets international standards.
Content	1. Introduction to Neuroscience. Brain and mind. Techniques of Neuroscience. 2. Introduction to Cellular Neuroanatomy. Neurons. Synapses. Ion Channels. Membrane Potential. The Action Potential. 3. Histology of the Cerebral Cortex. Columnar Organization. 4. The anatomical and functional organization of perception and movement. Integration of Sensory and Motor Function. From nerve cells to cognition. 5. Perception. Coding of sensory information. Vision. Visual perception 6. Auditory system. Hearing. The Bodily Senses. Touch. Pain. Smell and Taste. 7. Motor cortex. Control of movement. Cerebellum. Basal ganglia. Voluntary movement. Motor systems hierarchical organization 8. Arousal, Emotion, and behavioral Homeostasis. Limbic system. Amygdala. Hypothalamus. Thalamus. Theories of emotion. Emotion regulation. Theories of emotional intelligence. 9. The Development of the Nervous System. The Generation and Survival of Nerve Cells. The Formation and Regeneration of Synapses. Aging of the Brain and Dementia. 10. Neuroanatomy of Memory system. Inmplicit and Explicit Memory. Memory theories. Temporal lobe. Hippocampus. 11. Motivation and reward. Hypothalamus. Basal Ganglia. Reinforcement learning. Learning. Habituation. Sensitization. Classical Conditioning. 12. Executive control. Frontal Cortex. Cingulate cortex. Attention Networks and Orienting. Parietal lobe. Multiple demanding (MD) brain areas. 13. Language and the Aphasias. Broca and Wernicke areas. Beyond the Classical Language Areas. Alexia, Dyslexia, Agraphia. 14. Biological Basic of Thought. Brain-computer interfaces. Artificial Intelligence. Disorders of Thought and Volition. Schizophrenia. 15. Biological Basic of Individuality. Neurogenetics.

	Genes and Behavior.
Examination forms	Oral examination: problem solving questions. Base question amount 10-30: questions on the application of knowledge regardless of the number of students, regardless of loans for any level of education; exam –2-3 questions, time of preparation for the answer – 10-20 minutes
Reading list	1. Kandel E., Schwartz J., Jessell T.M. Principles of neuronal science. Sixth edition, 2021. 2. Kustubayeva A.M. Cognitive processes and Brain. Qazak University, 2020, -134 p. 3. Purves D., Augustine G., Fitzpatrick D., et al. Neuroscience 6th edition, 2017. 4. Gazzaniga M.&Mangun G. The Cognitive Neurosciences. 2014. 5. FMRI: From Nuclear Spins to Brain Functions. Uludag K., Ugurbil K., Berliner L. 6. McRae K, Gross JJ. Emotion regulation. Emotion. 2020 Feb;20(1):1-9. doi: 10.1037/emo0000703. PMID: 31961170. 7. Jones DT, Graff-Radford J. Executive Dysfunction and the Prefrontal Cortex. Continuum (Minneap Minn). 2021 Dec 1;27(6):1586-1601. doi: 10.1212/CON.0000000000001009. PMID: 34881727. 8. Ma S, Dubin AE, Zhang Y, Mousavi SAR, Wang Y, Coombs AM, Loud M, Andolfo I, Patapoutian A. A role of PIEZO1 in iron metabolism in mice and humans. Cell. 2021 Feb 18;184(4):969-982.e13. doi: 10.1016/j.cell.2021.01.024. Epub 2021 Feb 10. PMID: 33571427; PMCID: PMC7927959. 9. Voss JL, Bridge DJ, Cohen NJ, Walker JA. A Closer Look at the Hippocampus and Memory. Trends Cogn Sci. 2017 Aug;21(8):577-588. doi: 10.1016/j.tics.2017.05.008. Epub 2017 Jun 15. PMID: 28625353; PMCID: PMC5659202. 10. Posner J, Polanczyk GV, Sonuga-Barke E. Attention-deficit hyperactivity disorder. Lancet. 2020 Feb 8;395(10222):450-462. doi: 10.1016/S0140-6736(19)33004-1. Epub 2020 Jan 23. PMID: 31982036; PMCID: PMC7880081.

Discipline designation	*Consciousness theories: from philosophy to neurocybernetics*
Credit points	5
Semester(s) in which the module is taught	1
Relation to curriculum	University component

	Advanced Neuroscience
Teaching methods	lecture, seminar
Workload (incl. contact hours, self-study hours)	**15 weeks,** **1 hour per week for Lecture, total 15 Contact hours.** **2 hours per week for Seminar, total 30 Contact hours.** **Independent work of a doctoral student - 105.**
Person responsible for the module	***Kusutbayeva A.M.*** *PhD, Professor Department of Biophysics, Biomedicine and Neuroscience* ***Kamaznova A.T.*** *PhD, Associate Professor* Department of Biophysics, Biomedicine and Neuroscience*
Language	English
Discipline objectives/intended learning outcomes	The goal of the discipline is to develop the ability to critically analyze historical and modern theories of consciousness, starting with a philosophical understanding of consciousness, which determines the scientific methodology of neurobiological and mathematical research of consciousness. The course is aimed at developing creative thinking for the formation of their own worldview approaches to the problem of consciousness and ways of research. Know: evaluate a range of theories and perspectives on consciousness including neurobiological, evolutionary, neuropsychological, philosophical approaches. To be able to: analyze the neural mechanisms underpinning conscious awareness, explore manifestations of consciousness as subjective experience through the Neuroscience Competence: masters in the discussion on brain-mind-body problem, masters the tools of evaluation of strength and weakness of different theories of consciousness Critique the major theories about human consciousness Own: conduct a theoretical substantiation of the results of the study of consciousness through the prism of science, philosophy and culture, conduct scientific research in the field of neurocybernetics and consciousness
Content	1. Introduction to Consciousness Science. From Rene Descartes to David Chalmer. 2. A Biological theory of consciousness by Gerald Edelman 3. Split-brain studies of Sperry and Michael Gazzaniga and contribution to understanding consciousness 4. Global Workspace Theory of consciousness: toward a cognitive neuroscience of human experience 5. Francis Crick and Christof Koch. Dynamic Coalitions Theory of consciousness 6. Sensory system and mental representations. Internal

	Cortical Representations and consciousness 7. Integrated information theory 8. Damasio's theory of consciousness 9. A higher-order theory of emotional consciousness (LeDoux&Brown). 10. Aleksandrov's theory of consciousness. Anochin's theory of consciousness. 11. Learning and consciousness 12. Consciousness in the universe A review of the 'Orch OR' theory. Stuart Hameroff & Roger Penrose 13. FMRI and EEG studies on levels of Consciousness. Metacognition and thinking. 14. Artificial Intelligence Consciousness 15. Consciousness, Aging, and Pathology
Examination forms	Oral examination: problem solving questions. Base question amount 10-30: questions on the application of knowledge regardless of the number of students, regardless of loans for any level of education; exam –2-3 questions, time of preparation for the answer – 10-20 minutes
Reading list	1. Dehaene S. (2014) Consciousness and the Brain: Deciphering How the Brain Codes Our Thoughts. 2. Tononi G, Boly M, Massimini M, Koch C. Integrated information theory: from consciousness to its physical substrate. Nature Reviews Neuroscience. 2016; 17(7):450–461. https://doi.org/10.1038/nrn.2016. 44 PMID: 27225071 3. Friston KJ (2009) The free-energy principle: A rough guide to the brain? Trends in Cognitive Sciences 13(7): 293–301. 4. Baars B.J., Cage N.M. Cognition, Brain, and Consciousness: Introduction to Cognitive Neuroscience. 2010. 5. Dehaene, S., Lau, H., and Kouider, S. (2017). What is consciousness, and could machines have it? Science 358, 486–492. doi: 10.1126/science.aan8871 6. Hameroff, S. (2012). How quantum brain biology can rescue conscious free will. Front. Integr. Neurosci. 6:93. doi: 10.3389/fnint.2012.00093 7. Hameroff, S., and Penrose, R. (2014). Consciousness in the universe: a review of the 'Orch OR' theory. Phys. Life Rev. 11, 39–78. doi: 10.1016/j.plrev.2013.08.002 8. Hameroff, S., and Penrose, R. (2014). Consciousness in the universe: a review of the 'Orch OR' theory. Phys. Life Rev. 11, 39–78. doi: 10.1016/j.plrev.2013.08.002 9. Koch, C., Massimini, M., Boly, M., and Tononi, G.

	(2016). Neural correlates of consciousness: progress and problems. Nat. Rev. Neurosci. 17, 307–321. doi: 10.1038/nrn.2016.22 10. LeDoux, J. E., and Brown, R. (2017). A higher-order theory of emotional consciousness. Proc. Natl. Acad. Sci. U.S.A. 114, E2016–E2025. doi: 10.1073/pnas.1619316114Crick, F., and Koch, C. (2003). A framework for consciousness. Nat. Neurosci. 6, 119–126.

Elective Component

Neuroscience

Module Objectives. Doctoral students will be able to:
1. Explain modern theoretical and practical problems in the study of brain plasticity in health and disease by synthesizing interdisciplinary approaches in the field of neuroscience;
2. Critically analyze the main problems of human-computer interaction in the study of brain connectivity in development;
3. Analyze and prove complex ideas and hypotheses about brain functions using BigDATA;
4. Critically analyze the current trends in the development of brain research in health and disease;
5. Develop and substantiate your scientific hypothesis in the study of cognitive processes and brain plasticity;
6. Determine the priority areas of research in the field of brain connectivity in health and disease through the study of new approaches and methods in neuroscience;
7. Draw up the design of modern experimental studies in behavioral neuroscience concerning the methodological analysis of modern interdisciplinary concepts;
8. Develop new methodological, theoretical, practical issues in the field of brain plasticity by synthesizing various scientific approaches and research in the field of neuroscience.

Discipline designation	*Neural Plasticity, Learning and Memory*
Credit points	5
Semester(s) in which the module is taught	1
Relation to curriculum	Elective component Advanced Neuroscience
Teaching methods	lecture, seminar
Workload (incl. contact hours, self-study hours)	**15 weeks,** **1 hour per week for Lecture, total 15 Contact hours.** **2 hours per week for Seminar, total 30 Contact hours.** **Independent work of a doctoral student - 105.**
Person responsible for the module	***Kamaznova A.T.*** *PhD, Associate Professor* Department of Biophysics, Biomedicine and Neuroscience*
Language	English
Discipline objectives/intended learning outcomes	The goal of the discipline is to form a modern understanding of the theories of learning and memory, the role of neuroplasticity in the mechanisms of learning and memory. The course presents a historical perspective of classical studies of learning and memory mechanisms along with modern achievements of interdisciplinary research of this problem, which will allow you to independently organize research in this direction. Know: scientifically substantiate methodological approaches in the study of brain plasticity, memory processes and their role in learning; To be able to: critically analyze studies of the mechanisms of brain plasticity and learning processes; discuss in scientific discussions the experimental and clinical methods

	used to assess the plasticity of the brain in improving memory processes Own: to identify and apply the methods used in the study of brain function and cognitive processes involved in the learning process: to conduct scientific research in the field of neuroplasticity, learning and memory.
Content	1. Neural Plasticity, Learning and Memory: introduction, Basic Concepts, Historical Background 2. Large scale neural plasticity: is neural reorganization possible? 3. Synaptogenesis: the integration and modification of new synapses 4. Cognitive and behavioral plasticity 5. Plasticity in learning and memory 6. Main aspects of learning and its underlying plastic mechanisms: developmental, non-synaptic and sensory plasticity 7. Memory, neurogenesis and the hippocampus 8. Learned behavior, basal ganglia, and memory 9. Human memory and the Prefrontal Cortex 10. Adult neurogenesis and learning 11. Critical components of plasticity, myelination, and neurotransmitters for the learning brain 12. Aging and memory 13. Stress, Neuronal Plasticity, Learning and Memory 14. Plasticity, Sleep and Memory 15. Technology, multi-tasking, and working memory
Examination forms	Oral examination: problem solving questions. Base question amount 10-30: questions on the application of knowledge regardless of the number of students, regardless of loans for any level of education; exam –2-3 questions, time of preparation for the answer – 10-20 minutes.
Reading list	1. Learning and Memory. Mark A. Gluck; Eduardo Mercado; Catherine E. Myers (3rd or 4th Edition)S 2019 2. Gluck M.A., Eduardo Mercado, Catherine E. Myers Learning and Memory Third Edition. 2016 3. McLeod, S. A. (2013, August 05). Stages of memory – encoding storage and retrieval. Simply Psychology. 4. Rasch B, Born J (2013) About sleep's role in memory. Physiology Reviews, 93; 681-766. 5. Tononi G, Cirelli C (2014) Sleep and the price of plasticity: from synaptic and cellular homeostasis to memory consolidation and integration. Neuron, 81:12-34 6. McEwen BS. Plasticity of the hippocampus: adaptation to chronic stress and allostatic load. Annals of the New York Academy of Sciences, 2001.

	7. Herman JP, Flak J, Jankord R. Chronic stress plasticity in the hypothalamic paraventricular nucleus. Progress in Brain Research, 2008 8. Joëls M, Pu Z, Wiegert O, Oitzl MS, Krugers HJ. Learning under stress: how does it work? Trends in Cognitive Sciences, 2006. 9. Roozendaal B, McEwen BS, Chattarji S. Stress, memory, and the amygdala. Nature Reviews Neuroscience, 2009.

Discipline designation	*Behavioral Neuroscience*
Credit points	5
Semester(s) in which the module is taught	1
Relation to curriculum	Elective component Advanced Neuroscience
Teaching methods	lecture, seminar
Workload (incl. contact hours, self-study hours)	**15 weeks,** **1 hour per week for Lecture, total 15 Contact hours.** **2 hours per week for Seminar, total 30 Contact hours.** **Independent work of a doctoral student - 105.**
Person responsible for the module	***Kamaznova A.T.*** *PhD, Associate Professor* Department of Biophysics, Biomedicine and Neuroscience*
Language	English
Discipline objectives/intended learning outcomes	The purpose of the discipline is to form the ability to synthesize evolutionary neurobiology, evolutionary psychology for understanding the neurophysiological foundations of human and animal behavior. The course mainly involves the study of the neural foundations of human behavior processes, as well as the role of the environment in the formation of subjective experience. Know: Describe the importance of an multi-disciplinary approach in behavioral neuroscience to understanding neural foundations of human behavior processes To be able to: obtain a basic understanding of the neuroscience tools and methods that can be used to answer current questions of Behavioral Neuroscience; critically analyze the problems of the neurobiological foundations of behavior; develop experimental plans in the study of behavior in neuroscience; analyze research in the field of behavioral neuroscience. Competences: criticaly thinking skills by constructing hypotheses and opinions and learn to find empirical support for hypotheses in Behavioral Neuroscience, apply critical analysis, research methods and statistical data processing procedures in research in the field of behavioral neuroscience. Own: apply Behavioral Neuroscience concepts, theories,

	and research findings to issues in different area of science; apply contribution of Behavioral Neuroscience to an understanding of brain/behavior relationships; effectively apply interdisciplinary databases and search engines to clarify research questions in the field of behavioral neuroscience.
Content	1. Mind-brain relations: Behavioral history. Historical background of Behavioral Neuroscience 2. Communication Within the Nervous System 3. Evolution of the Brain and Behavior 4. Biological basis of human and animal behavior 5. The Body Senses and Movement 6. Animal Learning and Behavior 7. Human Learning and Behavior 8. Motivational systems of the brain and behavior 9. Anger, Aggression and the brain 10. Motivation, reward and addiction. 11. Pain and behavior 12. Appetite and the brain 13. The brain, emotion, and social behavior 14. An organizing framework for social cognition 15. Ethical issues in Behavioral Neuroscience. Ethics of Human Research in Behavioral Neuroscience
Examination forms	Oral examination: problem solving questions. Base question amount 10-30: questions on the application of knowledge regardless of the number of students, regardless of loans for any level of education; exam –2-3 questions, time of preparation for the answer – 10-20 minutes.
Reading list	1. Laura A. Freberg. Discovering Behavioral Neuroscience: An Introduction to Biological Psychology. 2018. 2. Bob Garrett & Gerald Hough. Brain & Behavior: An Introduction to Behavioral Neuroscience. 2018 3. Neuroscience Exploring the Brain. Mark R. Bear, Barry W. Connors, Michael A. Paradiso, Lippincott Williams and Wilkins, Fourth Edition, 2016 4. Behavioral Neuroscience. Eight edition, 2011. 5. Gazzaniga M.&Mangun G. The Cognitive Neurosciences. 2014 6. Hudspeth, A. J., Jessell, T. M., Kandel, E. R., Schwartz, J. H., & Siegelbaum, S. A. (Eds.). (2013). Principles of neural science.

Discipline designation	*Connectivity and Big DATA*
Credit points	5
Semester(s) in which the module is taught	1
Relation to curriculum	Elective component Advanced Neuroscience
Teaching methods	lecture, seminar
Workload (incl. contact hours, self-study hours)	**15 weeks,** **1 hour per week for Lecture, total 15 Contact hours.** **2 hours per week for Seminar, total 30 Contact hours.** **Independent work of a doctoral student - 105.**
Person responsible for the module	***Kustubayeva A.M.*** *PhD, Professor Department of Biophysics, Biomedicine and Neuroscience*
Language	English
Discipline objectives/intended learning outcomes	The goal of the discipline is to develop the ability to analyze modern literature based on the theory of connectivity with application to the analysis of brain signals. The course integrates complex mathematical approaches to brain signals at different levels and modalities, includes measuring the segregation and integration of the brain, identifying the causality of dynamic brain activation. Know: how to collect data for neuroimaging of a large number of subjects; To be able to: study the work of the brain using new technologies that significantly increase the resolution of the studied images; Competences: arry out statistical analysis of big data of neuroimaging; Own: develop fast, scalable, reliable and accurate neuroimaging models and approaches.
Content	1. Theory of Connectivity and its application to Neuroscience. Big Data and brain connectivity. 2. Richard Semon and Donald Hebb: cell assembly. 3. Functional connectivity motif (FCM) computition. 4. Connectivity, dynamics, information 5. Structural connectivity 6. Functional connectivity 7. Effective connectivity 8. Human Connectome project 9. Connectivity studies with resting state fMRI data. 10. Connectivity studies with source localization of EEG data. 11. Multimodal Imaging 12. Evolution and energy of brain networks 13. Brain networks in neurodegenerative deasease 14. Connectivity and Brain networks for psychiatry. 15. Complexity of the brain.
Examination forms	Oral examination: problem solving questions. Base question

	amount 10-30: questions on the application of knowledge regardless of the number of students, regardless of loans for any level of education; exam –2-3 questions, time of preparation for the answer – 10-20 minutes.
Reading list	1. Olaf Sporns. The complex brain: connectivity, dynamics, information. Trends in Cognitive Sciences, December 2022, Vol. 26, No. 12 2. Sporns. Networks of the Brain, MIT Press, 2011 3. Sporns, G Tononi, GM Edelman Theoretical neuroanatomy: relating anatomical and functional connectivity in graphs and cortical connection matrices. Cerebral cortex, 2000 2012201320142015201620172018201920202021 2022 4. E Bullmore, O Sporns. The economy of brain network organization. Nature reviews neuroscience, 2012 5. Li M, Liu J, Tsien JZ. Theory of Connectivity: Nature and Nurture of Cell Assemblies and Cognitive Computation. Front Neural Circuits. 2016 Apr 29;10:34. doi: 10.3389/fncir.2016.00034. PMID: 27199674; PMCID: PMC4850152. 6. Landhuis, E. Neuroscience: Big brain, big data. Nature 541, 559–561 (2017). https://doi.org/10.1038/541559a 7. Cao J, Zhao Y, Shan X, Wei HL, Guo Y, Chen L, Erkoyuncu JA, Sarrigiannis PG. Brain functional and effective connectivity based on electroencephalography recordings: A review. Hum Brain Mapp. 2022 Feb 1;43(2):860-879. doi: 10.1002/hbm.25683. Epub 2021 Oct 20. PMID: 34668603; PMCID: PMC8720201. 8. Senk J, Kriener B, Djurfeldt M, Voges N, Jiang HJ, Schüttler L, Gramelsberger G, Diesmann M, Plesser HE, van Albada SJ. Connectivity concepts in neuronal network modeling. PLoS Comput Biol. 2022 Sep 8;18(9):e1010086. doi: 10.1371/journal.pcbi.1010086. PMID: 36074778; PMCID: PMC9455883.

Discipline designation	*Human-Computer Interaction*
Credit points	5
Semester(s) in which the module is taught	1
Relation to curriculum	Elective component Advanced Neuroscience
Teaching methods	lecture, seminar
Workload (incl. contact	**15 weeks,**

hours, self-study hours)	**1 hour per week for Lecture, total 15 Contact hours. 2 hours per week for Seminar, total 30 Contact hours. Independent work of a doctoral student - 105.**
Person responsible for the module	***Kustubayeva A.M.*** *PhD, Professor Department of Biophysics, Biomedicine and Neuroscience* ***Melnikov M.*** *Federal Research Center of Fundamental and Translational Medicine, Russia*
Language	English
Discipline objectives/intended learning outcomes	The goal of the discipline is to develop the ability to analyze and scientifically apply the principles of human-computer interaction based on the latest achievements in the field of neurotechnology, describe the methods of human-computer interaction using brain activity, apply neurotechnology applications of human-computer interaction. The course allows you to form an idea of the achievements of human-computer interaction for solving applied problems in neuroscience. Know: describe the ways of human-computer interaction using brain activity, neurocomputer interfaces; To be able to: apply methods and applications of neurotechnologies of human-computer interaction; Competences: apply the achievements of human-computer interaction and neurotechnologies to solve applied problems, such as design, analysis of interfaces for neurorehabilitation, improvement of cognitive functions; Own: evaluate the effectiveness of human-computer interaction based on the cognitive and emotional reactions of the brain.
Content	1. The overview of the problem of human-computer interaction 2. Interacting with hard peripheral devices 3. Interacting with computer applications 4. Computer games-related experiences 5. Immersiveness in user experience 6. Peculiarities of application-mediated communication 7. Social network-mediated behavior 8. Application-mediated consumer behavior 9. Interaction with an artificial partner, e.g. chat bot 10. Human-robot interaction 11. Human identity features recognition 12. Human-generated messages recognition 13. Preferences recognition and recommendation systems 14. Brain-machine interfaces 15. Impact of the HCI on the healthcare
Examination forms	Oral examination: discussion. Base question amount 10-30: questions on the application of knowledge regardless of the number of students, regardless of loans for any level of education; exam –2-3 questions, time of preparation for the

	answer – 10-20 minutes
Reading list	1. Human Computer Interaction Handbook: Fundamentals, Evolving Technologies, and Emerging Applications, Third Edition (Human Factors and Ergonomics) 3rd ed. J.A. Jacko (Ed.). CRC Press, 2013. 2. *Human Computer Interaction* journal, https://www.tandfonline.com/journals/hhci20 3. Brain-Computer Interfaces: Applying our Minds to Human-Computer Interaction. Tan D.S., Nijholt A. (Eds.). Springer-Verlag London Limited, 2010. 4. Khan M.M., Sherazi H.I., Quain R. Tongue-Supported Human-Computer Interaction systems: a review. Annual International Conference of IEEE Engineering in Medicine and Biology Society. 2014. 1410-1415. 5. Bonarini A. Communication in Human-Robot Interaction. Current Robotics Report. 2020. 1(4):279-285. 6. Gao X., Wang Y., Chen X., Gao S. Interface, interaction, and intelligence in generalized brain-computer interfaces. Trends in Cognitive Sciences. 2021. 25(8):671-684. 7. Al-Faris M., Chiverton J., Ndzi D., Ahmed A.I. A Review on Computer Vision-Based Methods for Human Action Recognition. Journal of Imaging. 2020. 6(6):46. 8. Oertel C., Castellano G., Chetouani M., et al. Engagement in Human-Agent Interaction: An Overview. Frontiers in Robotics and AI. 2020. 7:92. 9. Viaud-Delmon I., Gaggioli A., Ferscha A., Dunne S. Human computer confluence applied in healthcare and rehabilitation. Studies in Health and Technology and Informatics. 2012. 181:42-5. 10. Spezialetti M., Placidi G., Rossi S. Emotion Recognition for Human-Robot Interaction: Recent Advances and Future Perspectives. Frontiers in Robotics and AI. 2020. 7:532279.

Discipline designation	*Neuropathology*
Credit points	5
Semester(s) in which the module is taught	1
Relation to curriculum	Elective component Advanced Neuroscience
Teaching methods	lecture, seminar
Workload (incl. contact hours, self-study hours)	**15 weeks,** **1 hour per week for Lecture, total 15 Contact hours.** **2 hours per week for Seminar, total 30 Contact hours.** **Independent work of a doctoral student - 105.**

Person responsible for the module	**Giniatullin R.** *PhD, professor University of Eastern Finland*
Language	English
Discipline objectives/intended learning outcomes	To form the ability to rationally find key information and critically analyze modern studies of diseases of the nervous system based on interdisciplinary synthesis. To form an integrative understanding of pathologies of the central nervous system, such as migraine and epilepsy, depression, neurodegenerative and vascular diseases of the brain, CNS infections in order to further study pathological processes from the perspective of related fields of neuroscience. Know: understand the cellular and molecular mechanisms of nociception. Know the neurobiology of migraine and epilepsy based on basic neurophysiological principles; understand how a clinician can apply this knowledge in the diagnosis of migraine and epilepsy. To be able: explain the cellular and molecular mechanisms of electrogenesis and nociception and interpret the mechanisms of migraine and epilepsy on the basis of this knowledge: rationally argue the appointment of medicines for migraine and epilepsy, depending on the forms of diseases. Competences: possess modern ideas about the neurotoxicity of the glutamate transmitter in the nervous system and the basic mechanisms of neurodegeneration, about Alzheimer's and Parkinson's disease, amyotrophic lateral sclerosis; possess modern knowledge about neurotoxicity and neurodegeneration. Own: classify and interpret the main neurodegenerative diseases based on their pathophysiology; apply the functions of different types of neuroglia, neuroinflammation and the role of the immune system in CNS diseases; master the functions of different types of neuroglia, neuroinflammation in diseases of the central nervous system; analyze and interpret the interactions of the immune and nervous systems; evaluate the importance of oxidative stress mechanisms, sources, forms of ROS and main targets in the nervous system; possess the necessary information to interpret the mechanisms of oxidative stress; indicate the main sources, forms of ROS and their molecular targets in the nervous system; understand the principles of the organization of blood flow and lymph flow in the brain and their disorders; to understand the mechanisms and forms of stroke; apply the principles and organization of blood flow and lymph flow in the central nervous system; analyze and interpret different forms of stroke.
Content	1. Basic mechanisms of pain-1. Definition and biological significance of pain. Peripheral mechanisms of pain. Types of nociceptive fibers. Somatic and autonomous nociceptive innervation. 2. Basic mechanisms of pain-2. Spinal mechanisms and cortical pain centers. Chronic pain and neuronal

	sensitization. 3. Anesthesia and analgesia. 4. Neurobiology of migraine-1. Nociceptive system of the trigeminal nerve and trigeminal pain. Primary and secondary headaches. Meningeal the trigeminovascular system and its role in generating a specific pain signal. 5. Neurobiology of migraine-2. Aura, clinical picture and neurophysiological mechanisms. Spreading cortical depression (CSD). Hyper-excitability of the cerebral cortex in migraine and epilepsy. Familial forms of migraine. Migraine treatment. 6. Neuronal hyperexcitability of mechanisms of epilepsy. 7. Neuromuscular system. Neuromuscular diseases: muscle diseases, peripheral nerve diseases, neuromuscular junction diseases and motor neuron diseases. Myasthenia gravis, amyotrophic lateral sclerosis. 8. Oxidative stress. Signaling of reactive oxygen species (ROS). Sources of ROS, cellular and molecular targets of ROS in the central nervous system. 9. Brain plasticity and memory. The role of the hippocampus. 10 Fundamentals of neurodegeneration. Neurotoxic effect of glutamate (glutamate excitotoxicity). 11 Alzheimer's disease: biomarkers and treatments. Application of CRISPR-Cas systems in neuroscience. 12 Blood flow in the brain. The blood-brain barrier, its disorders and its role in neurotherapy. Stroke, its types, methods of early correction and rehabilitation. 13 The role of lymph flow in clearing the brain of metabolites: the clio lymphatic system and the opening of the meningeal lymph flow. The role of these systems in sleep mechanisms and in brain pathology. 14 Neuromodulation as a promising non-drug approach in the treatment of brain diseases: electric and magnetic therapy, ultrasound. Invasive and non-invasive methods. 15 Cellular, molecular and gene therapy of CNS diseases: neurotrophins, gene correction, stem cells, microRNAs. Extracellular vesicles: microvesicles and exosomes as carriers of endogenous modulators.
Examination forms	Written examination Essay. Essay - written examination. Give own opinion on 3 topics related to Neuropathology (700 words essay)
Reading list	1. Nicholls, J. et al. From neuron to brain / translated from English. Ed. PM Balaban and RA Giniatullina. Moscow: Publishing house LKI. 2003. 684 p. 2. Bear, Mark, Barry Connors, and Michael A. Paradiso. Neuroscience: Exploring the Brain, Enhanced Edition: Exploring the Brain. Jones & Bartlett Learning. 2020. 1016 p. 3. Thematic reviews Internet resources: 1)https://elibrary.kaznu.kz/ru/

	2)https://www.ncbi.nlm.nih.gov/ 3)https://www.frontiersin.org/ 4)https://www.jpain.org/content/journalclub

Discipline designation	*Brain and aging*
Credit points	5
Semester(s) in which the module is taught	1
Relation to curriculum	Elective component Advanced Neuroscience
Teaching methods	lecture, seminar
Workload (incl. contact hours, self-study hours)	**15 weeks,** **1 hour per week for Lecture, total 15 Contact hours.** **2 hours per week for Seminar, total 30 Contact hours.** **Independent work of a doctoral student - 105.**
Person responsible for the module	**Datkhabayeva G.K.** *Candidate of Biological Sciences, Associate Professor of the Department of Biophysics, Biomedicine and Neuroscience*
Language	English
Discipline objectives/intended learning outcomes	The goal of the discipline is to develop the ability to critically analyze scientific research in the field of age-related changes in the brain associated with aging processes. The course reveals the mechanisms of the effect of aging on brain function, behavior, age-related decrease in the efficiency of the functioning of cognitive processes from the point of view of various neurobiological theories of aging. Know: identify and investigate symptoms of cognitive decline; To be able to: critically analyze the role of age-related changes in the brain in the functioning of cognitive processes; Competences: apply the methods of modern research of age-related neurobiological changes in emotional and cognitive processes; Own: apply methodological and theoretical approaches in understanding the mechanisms of brain aging in the interpretation of scientific data.
Content	1. Anatomic and Histological Changes of the Aging Brain. 2. Cellular and Molecular Mechanisms for Age-Related Cognitive Decline. Gene associated with brain aging. 3. Changes in Visuospatial, Visuoperceptual, and Navigational Ability in Aging 4. Chemosensory Function during Neurologically Healthy Aging 5. Aging-Related Alterations in Language 6. Changes in Emotions and Mood with Aging 7. Aging and Attention. Brain Aging and Creativity

	8. Changes in Motor Programming with Aging 9. Alterations in Executive Functions with Aging 10. Attractor Network Dynamics, Transmitters, and Memory and Cognitive Changes in Aging 11. Mechanisms of Aging-Related Cognitive Decline 12. The Influence of Physical Exercise on Cognitive Aging 13. Pharmacological Cosmetic Neurology 14. Cognitive Rehabilitation in Healthy Aging 15. Preventing Cognitive Decline and Dementia
Examination forms	Oral examination: discussion and defence of performed assignments. Base question amount 10-30: questions on the application of knowledge regardless of the number of students, regardless of loans for any level of education; exam –2-3 questions, time of preparation for the answer – 10-20 minutes.
Reading list	1. S. Marc Breedlove, Neil V. Watson. Behavioral Neuroscience. Ninth Edition. NY: Oxford University Press. 2020. 840 p. 2. Brain Aging: Models, Methods, and Mechanisms \ Edited by David R. Riddle. NC Boca Raton (FL): CRC Press/Taylor & Francis; 2007. 384 pp. 3. Blinkouskaya Y, Caçoilo A, Gollamudi T, Jalalian S, Weickenmeier J. Brain aging mechanisms with mechanical manifestations. Mech Ageing Dev. V.200. 2021. P. 111575. 4. Feng T, Lacrampe A, Hu F. Physiological and pathological functions of TMEM106B: a gene associated with brain aging and multiple brain disorders. Acta Neuropathol. 2021 Mar;141(3):327-339. doi: 10.1007/s00401-020-02246-3.

REASEARCH WORK

Module Objectives. Students will be able to:
1. to organize a plan of a research practice acording to topic of own PhD degree dissertation;
2. analyze scientific articles according to the PhD thesis;
3. be able to obtain research data of thesis;
4. present the scientific results of own thesis research at an International Conference in Neuroscience.
5. publish a scientific article in journals recommended by CCSES or indexed be Web of Science, Scopus Databases.

Discipline designation	**REASEARCH WORK**
Credit points	123
Semester(s) in which the module is taught	1-6
Relation to curriculum	University Component M-2 Pathological physiology. Oncoimmunology
Teaching methods	lecture, seminar
Workload (incl. contact hours, self-study hours)	**90 weeks,** **scientific work, publications, conferences and more** **Research Seminar** 1-26 **The implementation of a Doctoral Thesis** 2-41 **Publication in the Proceedings of International Conferences** 3-17 **Publication in journals recommended by CCSES or indexed be Web of Science, Scopus Databases** 4 -31 **Scientific Internship** 5 - 8
Person responsible for the module	***Kustubayeva A.M.*** *PhD, Professor Department of Biophysics, Biomedicine and Neuroscience* ***Kamaznova A.T.*** *PhD, Associate Professor* Department of Biophysics, Biomedicine and Neuroscience*
Language	English
Required and recommended prerequisites for joining the module	publications, conferences and more
Discipline objectives/intended learning outcomes	The purpose of research practice: the study of theoretical, methodological achievements of modern neuroscience, the consolidation of practical skills using modern methods of scientific research, processing the interpretation of empirical data in the dissertation research. Learning outcomes: - acquisition of practical work skills at all stages of research in neuroscience; - the development of doctoral students' skills of conducting independent scientific work in accordance with international

	standards and requirements; - expansion and consolidation of professional theoretical knowledge; - consolidation of practical skills for developing a program of research in neuroscience; - the acquisition of the skills of organizing research at the international level; - gaining analytical experience with data in neuroscience; - work with data processing programs MATLAB, EEGLab, R-statistics, SPSS, etc. - collecting materials on the topic of a doctoral thesis; - formation of skills for the preparation of reporting documentation for activities during the period of research practice; - writing analytical results of psychological research, report in accordance with existing requirements
Content	1. Modern methods and methodologies of scientific research in a doctoral dissertation 2. methodologies of scientific research 3. Curent modern experimental approaches in scientific research 4. Stages and principles of planning a scientific experiment 5. Experiments in Neurosciecne 6. Experimental approaches in Neuroscientific researches 7. Specifics of a computer experiment in scientific research 8. Ethical rules for experiments in Neurosciecne 9. Experimantal ata processing and interpretation.
Examination forms	Oral examination and publications Practical/laboratory exercises, SIW should be independent, creative. Plagiarism, forgery, the use of cheat sheets, cheating at all stages of control are unacceptable.
Reading list	1. Kandel E., Schwartz J., Jessell T.M. Principles of neuronal science. Sixth edition, 2021. 2. Kustubayeva A.M. Cognitive processes and Brain. Qazak University, 2020, -134 p. 3. Purves D., Augustine G., Fitzpatrick D., et al. Neuroscience 6th edition, 2017. 4. Gazzaniga M.&Mangun G. The Cognitive Neurosciences. 2014. 5. FMRI: From Nuclear Spins to Brain Functions. Uludag K., Ugurbil K., Berliner L. 6. McRae K, Gross JJ. Emotion regulation. Emotion. 2020 Feb;20(1):1-9. doi: 10.1037/emo0000703. PMID: 31961170. 7. Dr. Alok Gupta, Nitin Gupta. Research Methodology by Dr. Alok Gupta, Nitin Gupta. SBPD Publications, 2022. 247p. 8. Chawla, D. & Sodhi, N. (2011) “Research Methodology: Concepts and Cases” Vikas Publishing House PVT Ltd

FINAL EXAMINATION

Module Objectives. Students will be able to:
1. critically evaluate strategies for conducting scientific research of own PhD thesis;
2. independently conduct research of own PhD thesis;
3. analyze of research results and write PhD thesis;
4. publish scientific papers on the topic of a doctoral dissertation;
5. do public defence the PhD thesis.

Discipline designation	PhD THESIS WRITING AND DEFENCE
Credit points	12 ECTS
Semester(s) in which the module is taught	6
Relation to curriculum	-
Teaching methods	seminar
Workload (incl. contact hours, self-study hours)	**1 weeks, 12 ECTS**
Person responsible for the module	***Kustubayeva A.M.*** *PhD, Professor Department of Biophysics, Biomedicine and Neuroscience* ***Kamaznova A.T.*** *PhD, Associate Professor* Department of Biophysics, Biomedicine and Neuroscience*
Language	English
Discipline objectives/intended learning outcomes	The final certification of doctoral students is carried out in the form of writing and defending a doctoral dissertation. Students who have fully completed the educational process in accordance with the requirements of the working and individual curriculum and working curricula, and who have received admission to the defense by the supervisor, are allowed to the final certification. The defense of a doctoral dissertation is carried out at a meeting of the dissertation council. On the topic of a doctoral dissertation, at least seven scientific papers must be published. Before defending doctoral dissertations, they undergo a mandatory check for plagiarism. A student who has mastered the educational programme of doctoral studies and defended a doctoral dissertation, with a positive decision of the dissertation council based on the results of the examination, is awarded the degree of PhD / Doctor of Philosophy and is issued a diploma with an application (transcript) free of charge. In cases of early mastering of the educational programme of doctoral studies and successful defense of the dissertation, the doctoral candidate is awarded the degree of Doctor of Philosophy (PhD) or Doctor of the profile, regardless of the period of study. A doctoral candidate who has mastered the full course of theoretical training of the doctoral educational programme, completed the scientific component, but did not defend a doctoral dissertation, is awarded learning outcomes and academic credits

	and is given the opportunity to defend a dissertation in subsequent years on a paid basis in the amount of 4 academic credits.
Content	Theoretical part of a PhD thesis Experimental design of an experiment in Neuroscience Research methods in Neuroscience Ethical ussues of an experiments in Neurosciecne Data processing in Neurosciecne Data discussion in Neurosciecne Conferences in Neurosciecne Publishing research results in Neurosciecne
Examination forms	Public defence
Reading list	1. Gazzaniga M.&Mangun G. The Cognitive Neurosciences. 2014. 2. Kustubayeva A.M. Cognitive processes and Brain. Qazak University, 2020, -134 p. 3. Kandel E., Schwartz J., Jessell T.M. Principles of neuronal science. Sixth edition, 2021. 4. Posner J, Polanczyk GV, Sonuga-Barke E. Attention-deficit hyperactivity disorder. Lancet. 2020 Feb 8;395(10222):450-462. doi: 10.1016/S0140-6736(19)33004-1. Epub 2020 Jan 23. PMID: 31982036; PMCID: PMC7880081. 5. McRae K, Gross JJ. Emotion regulation. Emotion. 2020 Feb;20(1):1-9. doi: 10.1037/emo0000703. PMID: 31961170. 6. Voss JL, Bridge DJ, Cohen NJ, Walker JA. A Closer Look at the Hippocampus and Memory. Trends Cogn Sci. 2017 Aug;21(8):577-588. doi: 10.1016/j.tics.2017.05.008. Epub 2017 Jun 15. PMID: 28625353; PMCID: PMC5659202.