COURSE PROGRAM

SYLLABUS

1. General information on the course

Full course name	Modern Methods of Genetic Diagnostics
Full official name of a higher education institution	Sumy State University
Full name of a structural unit	Academic and Research Medical Institute. Кафедра педіатрії
Author(s)	Petrashenko Viktoriia Oleksandrivna
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	5 ECTS, 150 hours. For full-time course 36 hours are working hours with the lecturer (36 hours of seminars), 114 hours of the individual study.
Language(s)	English

2. Place in the study programme

Relation to curriculum	Elective course available for study programme "Medicine"
Prerequisites	There are no specific pre-requisites
Additional requirements	There are no specific requirements
Restrictions	There are no specific restrictions

3. Aims of the course

The purpose of the discipline is to achieve students' modern knowledge and professional skills in the methods of genetic diagnosis based on the study of risk groups for hereditary diseases; algorithms of examination of patients with high genetic risk, analysis and interpretation of the results of cytogenetic, molecular genetic, biochemical examinations and determination of the fetal development

4. Contents

Module 1. Syndromological analysis

Topic 1 Methodology of examination of a patient with suspected hereditary pathology. Phenotypical analysis of probang and its family members Complaints and features of the history of proband and family of proband in hereditary pathology. Systematic evaluation of phenotypical features of the proband in accordance with the developed survey algorithm. Characteristics of congenital malformations and small developmental abnormalities as markers of hereditary pathology. Analysis of phenotypical features of proband. Recognition of phenotypical manifestations of hereditary pathology. Comparison of phenotypical features of a proband and his family members. Isolation of the leading clinical symptom complex.
Topic 2 Clinical-genealogical analysis Determination of the type of trait inheritance, pathological manifestation, disease and gene penetrance. Peculiarities of pedigree in autosomal dominant, autosomal recessive, X-linked dominant, X-linked recessive, Y-linked, mitochondrial inheritance. Genetic diseases with different types of inheritance.
Topic 3 Making of pedigree. Work with diagnostic catalogs. Risk calculation for different types of inheritance. Pedigree analysis. Pedigree rules. Symbols used in making of pedigree. Requirements to the pedigree legend. Establishment of hereditary character of a sign, pathological display, disease. Rules of work with diagnostic catalogs.
Topic 4 Syndromological analysis Definition of syndromological analysis. Methods of syndromological analysis in medical and genetic counseling.
Module 2. Cytogenetic methods of diagnosis of congenital and hereditary pathology
Topic 5 Cytogenetic methods of diagnosis in clinics Role of cytogenetic method in clinical practice: diagnosis of chromosomal diseases, diagnosis of a number of mendelian diseases associated with chromosomal instability, diagnosis of cancer and some forms of leukemia, assessment of mutagenic effects of drugs, monitoring of environmental damages. Indications for cytogenetic analysis. Methods of material collection for cytogenetic research. Methods of cytogenetic research. Methods of chromosome staining, their features. Variants of cytogenetic research methods. The essence of the methods. Modern technologies of chromosome research: promethase analysis, fluorescent in situ hybridization, autoradiographic research, chromosome-specific and region-specific molecular probes. Indications for molecular genetic research. Methods of molecular genetic research.
Topic 6 Chromosomal abnormalities (numerical, structural). Types of pathological changes in karyotype: violation of the number, structure, ploidy of chromosomes. Karyotype recording rules. Representation of microstructural rearrangements in chromosomes.
Topic 7 Chromosomal polymorphism, chromosomal instability, gonadal mosaicism, single parent disomy Interpretation of the concept of chromosomal polymorphism, gonadal mosaicism, single parent disomy. Representation of types of chromosomal instability.
Module 3. Biochemical methods of diagnosis of congenital and hereditary pathology

Topic 8 Diagnosis of hereditary metabolic diseases

Types of metabolism. Classification of hereditary metabolic diseases. General characteristics of hereditary metabolic diseases. Indications for screening. Techniques, possibilities of methods. Biochemical methods in the early diagnosis of hereditary metabolic diseases.

Topic 9 Mass screening in the early diagnosis of hereditary pathology.

Indications and conditions for conducting mass screening programs. Mass screening for phenylketonuria. Mass screening for congenital hypothyroidism. The value of mass screening programs in the early diagnosis of phenylketonuria and congenital hypothyroidism.

Topic 10 Selective screening programs in diagnosis of hereditary metabolic disorders.

Indications for selective screening programs. Methods used in selective biochemical screening (general metabolic screening tests of urine, thin layer chromatography and others). Selective screening for amino acids disorders. Selective screening for carbohydrate storage disorders. Selective screening for connective tissue disorders. Selective screening for organic aciduria. Selective screening for disorder of purines and pyrimidines. Selective screening for disorders of metals. Selective screening for cystic fibrosis. Biochemical methods of diagnosis in neuromuscular pathology. Biochemical methods of diagnosis in mitochondropathies. Biochemical methods of diagnosis of disorders of fat metabolism.

Module 4. Molecular genetic methods of diagnosis of hereditary pathology

Topic 11 Modern methods of DNA diagnosis of hereditary pathology.

Methods of DNA diagnosis of hereditary pathology. Indications for these methods. The latest technologies in molecular diagnostics. Mitochondrial genome.

Topic 12 DNA diagnosis of monogenic and infectious diseases.

Population studies of mitochondrial DNA. Direct methods of mutation diagnosis: Southern blot hybridization method, PCR analysis. Multiplex PCR, a method of analysis of conformational polymorphism of single-stranded DNA (SSCP- analysis), heteroduplex analysis of DNA fragments. Indirect (indirect) methods for diagnosing mutations

Module 5. Prenatal diagnosis of congenital and hereditary pathology

Topic 13 Methods of prenatal diagnosis.

History of prenatal diagnostics. Prenatal diagnosis as a method of prevention. General indications for prenatal diagnosis. Screening methods of prenatal diagnosis. Organization of medical and genetic care for pregnant women with high genetic risk (ultrasound screening, biochemical screening, invasive prenatal diagnosis).

Topic 14 Prenatal ultrasound diagnosis of congenital malformations

Non-invasive methods of prenatal diagnosis. Ultrasound examination, principles, indications, timing, effectiveness of diagnosis of various diseases of the fetus, assessment of the condition of the placenta, amniotic sac. Deontological and ethical issues that arise during prenatal diagnosis. Strategy of ultrasound prenatal diagnostics. Levels of examination of pregnant women (first, second, third). The amount of examinations performed on each wound. Terms of ultrasound screening Indications for referring pregnant women to the second and third level of examination. Somatogenetic examination of the fetus with syndromic analysis. Modern possibilities of prenatal ultrasound diagnosis of congenital malformations. Optimal timing for the diagnosis of congenital malformations. Use of Doppler. Indications for pregnancy elimination.

Topic 15 Biochemical screening programs Biochemical markers of congenital malformations (chorionic gonadotropin, alpha-fetoprotein, estriol) at different stages of pregnancy. Their diagnostic value, median levels of these indicators.
Topic 16 Invasive methods of prenatal diagnosis. General characteristics. indications and contraindications Methods of invasive prenatal diagnosis, terms of their carrying out. Indications and contraindications for invasive prenatal diagnosis, possible complications due to invasive diagnosis. Conditions for invasive diagnosis.
Topic 17 Methodology of conducting invasive prenatal research methods Methods of chorion biopsy, cordocentesis, placentocentesis, amniocentesis. Study of chorionic villi cells, placenta (direct method, cultivation). Cultivation of amniocytes. Analysis of fetal umbilical cord blood.

5. Intended learning outcomes of the course

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

LO1	Analyze, interpret and use knowledge in practice current state of affairs and achievements in the field of medical genetics, basic concepts, theories, hypotheses on the problems of hereditary pathology.
LO2	Choose and use modern research methods in the field of medical genetics (cytogenetic, methods of genetic and cell engineering, prenatal diagnosis) in accordance with the set goals, objectives and criteria for achieving the expected results in the study of hereditary and congenital diseases.
LO3	Interpret, analyze and summarize data on chromosomal, genetic problems and multifactorial diseases, to determine their place in the system of existing knowledge
LO4	Evaluate and use information on the causes of genetic, chromosomal and congenital malformations, have prognostic algorithms calculations of the development of genetic pathology
LO5	Use professional vocabulary in practice.

7. Soft Skills

8. Teaching and learning activities

Topic 1. Methodology of examination of a patient with suspected hereditary pathology. Phenotypical analysis of probang and its family members

pr.tr.1 "Methodology of examination of a patient with suspected hereditary pathology. Phenotypical analysis of probang and its family members" (full-time course)

Complaints and features of the history of proband and family of proband in hereditary pathology. Systematic evaluation of phenotypical features of the proband in accordance with the developed survey algorithm. Characteristics of congenital malformations and small developmental abnormalities as markers of hereditary pathology. Analysis of phenotypical features of proband. Recognition of phenotypical manifestations of hereditary pathology. Comparison of phenotypical features of a proband and his family members. Isolation of the leading clinical symptom complex.

Topic 2. Clinical-genealogical analysis

pr.tr.2 "Clinical-genealogical analysis" (full-time course)

Determination of the type of trait inheritance, pathological manifestation, disease and gene penetrance. Peculiarities of pedigree in autosomal dominant, autosomal recessive, X-linked dominant, X-linked recessive, Y-linked, mitochondrial inheritance. Genetic diseases with different types of inheritance.

Topic 3. Making of pedigree. Work with diagnostic catalogs.

pr.tr.3 "Making of pedigree. Work with diagnostic catalogs." (full-time course)

Risk calculation for different types of inheritance. Pedigree analysis. Pedigree rules. Symbols used in making of pedigree. Requirements to the pedigree legend. Establishment of hereditary character of a sign, pathological display, disease. Rules of work with diagnostic catalogs.

Topic 4. Syndromological analysis

pr.tr.4 "Syndromological analysis" (full-time course)

Definition of syndromological analysis. Methods of syndromological analysis in medical and genetic counseling.

Topic 5. Cytogenetic methods of diagnosis in clinics

pr.tr.5 "Cytogenetic methods of diagnosis in clinics" (full-time course)

Role of cytogenetic method in clinical practice: diagnosis of chromosomal diseases, diagnosis of a number of mendelian diseases associated with chromosomal instability, diagnosis of cancer and some forms of leukemia, assessment of mutagenic effects of drugs, monitoring of environmental damages. Indications for cytogenetic analysis. Methods of material collection for cytogenetic research. Methods of cytogenetic research. Methods of chromosome staining, their features. Variants of cytogenetic research methods. The essence of the methods. Modern technologies of chromosome research: promethase analysis, fluorescent in situ hybridization, autoradiographic research, chromosome-specific and region-specific molecular probes. Indications for molecular genetic research. Methods of molecular genetic research.

Topic 6. Chromosomal abnormalities (numerical, structural).

pr.tr.6 "Chromosomal abnormalities (numerical, structural)." (full-time course)

TTypes of pathological changes in karyotype: violation of the number, structure, ploidy of chromosomes. Karyotype recording rules. Representation of microstructural rearrangements in chromosomes.

Topic 7. Chromosomal polymorphism, chromosomal instability, gonadal mosaicism, single parent disomy

pr.tr.7 "Chromosomal polymorphism, chromosomal instability, gonadal mosaicism, single parent disomy" (full-time course)

Interpretation of the concept of chromosomal polymorphism, gonadal mosaicism, single parent disomy. Representation of types of chromosomal instability.

Topic 8. Diagnosis of hereditary metabolic diseases

pr.tr.8 "Diagnosis of hereditary metabolic diseases" (full-time course)

Types of metabolism. Classification of hereditary metabolic diseases. General characteristics of hereditary metabolic diseases. Indications for screening. Techniques, possibilities of methods. Biochemical methods in the early diagnosis of hereditary metabolic diseases.

Topic 9. Mass screening in the early diagnosis of hereditary pathology.

pr.tr.9 "Mass screening in the early diagnosis of hereditary pathology." (full-time course)

Indications and conditions for conducting mass screening programs. Mass screening for phenylketonuria. Mass screening for congenital hypothyroidism. The value of mass screening programs in the early diagnosis of phenylketonuria and congenital hypothyroidism.

Topic 10. Selective screening programs in diagnosis of hereditary metabolic disorders.

pr.tr.10 "Selective screening programs in diagnosis of hereditary metabolic disorders." (full-time course)

Indications for selective screening programs. Methods used in selective biochemical screening (general metabolic screening tests of urine, thin layer chromatography and others). Selective screening for amino acids disorders. Selective screening for carbohydrate storage disorders. Selective screening for connective tissue disorders. Selective screening for organic aciduria. Selective screening for disorder of purines and pyrimidines. Selective screening for disorders of metals. Selective screening for cystic fibrosis. Biochemical methods of diagnosis in neuromuscular pathology. Biochemical methods of diagnosis in mitochondropathies. Biochemical methods of diagnosis of disorders of fat metabolism.

Topic 11. Modern methods of DNA diagnosis of hereditary pathology.

pr.tr.11 "Modern methods of DNA diagnosis of hereditary pathology." (full-time course)

Methods of DNA diagnosis of hereditary pathology. Indications for these methods. The latest technologies in molecular diagnostics. Mitochondrial genome.

Topic 12. DNA diagnosis of monogenic and infectious diseases.

pr.tr.12 "DNA diagnosis of monogenic and infectious diseases." (full-time course)

Population studies of mitochondrial DNA. Direct methods of mutation diagnosis: Southern blot hybridization method, PCR analysis. Multiplex PCR, a method of analysis of conformational polymorphism of single-stranded DNA (SSCP- analysis), heteroduplex analysis of DNA fragments. Indirect (indirect) methods for diagnosing mutations

Topic 13. Methods of prenatal diagnosis.

pr.tr.13 "Methods of prenatal diagnosis." (full-time course) History of prenatal diagnostics. Prenatal diagnosis as a method of prevention. General indications for prenatal diagnosis. Screening methods of prenatal diagnosis. Organization of medical and genetic care for pregnant women with high genetic risk (ultrasound screening, biochemical screening, invasive prenatal diagnosis).
Topic 14. Prenatal ultrasound diagnosis of congenital malformations
pr.tr.14 "Prenatal ultrasound diagnosis of congenital malformations" (full-time course) Non-invasive methods of prenatal diagnosis. Ultrasound examination, principles, indications, timing, effectiveness of diagnosis of various diseases of the fetus, assessment of the condition of the placenta, amniotic sac. Deontological and ethical issues that arise during prenatal diagnosis. Strategy of ultrasound prenatal diagnostics. Levels of examination of pregnant women (first, second, third). The amount of examinations performed on each wound. Terms of ultrasound screening Indications for referring pregnant women to the second and third level of examination. Somatogenetic examination of the fetus with syndromic analysis. Modern possibilities of prenatal ultrasound diagnosis of congenital malformations. Optimal timing for the diagnosis of congenital malformations. Use of Doppler. Indications for pregnancy elimination.
Topic 15. Biochemical screening programs
pr.tr.15 "Biochemical screening programs" (full-time course) Biochemical markers of congenital malformations (chorionic gonadotropin, alpha-fetoprotein, estriol) at different stages of pregnancy. Their diagnostic value, median levels of these indicators.
Topic 16. Invasive methods of prenatal diagnosis. General characteristics. indications and contraindications
pr.tr.16 "Invasive methods of prenatal diagnosis. General characteristics. indications and contraindications" (full-time course) Methods of invasive prenatal diagnosis, terms of their carrying out. Indications and contraindications for invasive prenatal diagnosis, possible complications due to invasive diagnosis. Conditions for invasive diagnosis.
Topic 17. Methodology of conducting invasive prenatal research methods
pr.tr.17 "Methodology of conducting invasive prenatal research methods" (full-time course) Methods of chorion biopsy, cordocentesis, placentocentesis, amniocentesis. Study of chorionic villi cells, placenta (direct method, cultivation). Cultivation of amniocytes. Analysis of fetal umbilical cord blood.
pr.tr.18 "Final module" (full-time course) Final module

9. Teaching methods

9.1 Teaching methods

Course involves learning through:

TM1	Case-based learning

TM2	Team Based Learning
TM3	Research Based Learning
TM4	Gamified learning
TM5	Electronic learning
TM6	Practical training

Practical classes allow students to plan a scheme of examination of the patient and interpret the results of studies of patients with genetic pathology. Analysis of specific situations will determine the tactics of examination of patients. Practice-oriented learning will develop students' skills of independent learning, synthesis and analytical thinking

The study of the discipline develops the ability of students to think abstractly, analyze and synthesis; ability to learn, master modern knowledge and apply them in practical situations, the ability to use information and communication technologies; creativity

9.2 Learning activities

LA1	Preparation for practical classes
LA2	E-learning in systems (Zoom, MIX.sumdu.edu.ua, OCW.sumdu.edu.ua)
LA3	Case-study
LA4	Preparation for current and final control
LA5	Individual research project (preparation of multimedia presentations)
LA6	Self-education
LA7	Watching educational films
LA8	Work with textbooks and relevant information sources
LA9	Interpretation of karyograms, work with diagnostic catalogs

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)	$140 \leq RD < 169$
Fair but with significant shortcomings	3 (Satisfactory)	$120 \leq RD < 139$
Fail – some more work required before the credit can be awarded	2 (Fail)	$0 \leq RD < 119$

10.2 Formative assessment

	Description	**Deadline, weeks**	**Feedback**
FA1 Computer tests	During semester	During semester	-

FA2 Interviews and oral comments of the teacher on his results	During semester	During semester	-
FA3 Checking and evaluating of written assignments	During semester	During semester	-
FA4 Peer assessment	During semester	During semester	-
FA5 Defence of presentation	Final class	Final class	-
FA6 Making clinical cases	During semester	During semester	-

10.3 Summative assessment

	Description	**Deadline, weeks**	**Feedback**
SA1 Evaluation of written works, surveys, solving a clinical case	During semester	During semester	-
SA2 Computer tests	During semester	During semester	-
SA3 Defence of presentation	Last class	Final class	-
SA4 Complex written module control	Final class	Final class	-

Form of assessment:

		Points	Можливість перескладання з метою підвищення оцінки
The first semester of teaching		**200 scores**	
SA1. Evaluation of written works, surveys, solving a clinical case		**100**	
		100	No

SA2. Computer tests		**10**	
		10	No
SA3. Defence of presentation		**10**	
		10	No
SA4. Complex written module control		**80**	
		80	No

The mark of the discipline is defined as the addition of points for current educational activities (not less 72) and points for the final module control (not less than 48). Number of points for the current activity is calculated by the formula 100x arithmetic mean of student performance in 4 scoring system / 5. For diagnostic testing the student receives a maximum of 10 points. The minimum number of points that a student must receive is 6 points. For protection presentations the student receives a maximum of 10 points, a minimum of -6. Maximum number points for the current educational activity of the student - 120. The student is admitted to the test for conditions for fulfilling the requirements of the curriculum and if for current educational activities he scored at least 72 points: 60 points during practical classes, 6 points for defense presentations and 6 points for testing The final module control is carried out at the end of the academic semester in the form of a written test, with a grade of "5" corresponds to 80 points, "4" - 64 points, "3" - 48 points, "2" - 0 points. In case of unsatisfactory result for the final modular control, the student has the right to retake the test. Students who fail to take the test without a good reason are considered to have received it unsatisfactory assessment. Refusal of the student to perform the final modular task certified as an unsatisfactory answer.

11. Learning resources

11.1 Material and technical support

MTS1	Library funds, archive of karyograms, genealogical cards, results of biochemical screening tests of blood.
MTS2	Computers, computer systems and networks
MTS3	Non-commercial Enterprise of Sumy Regional Council «Regional Children Clinical Hospital»
MTS4	Multimedia, video and sound reproduction, projection equipment (camcorders, projectors, laptop screens)
MTS5	Software (to support distance learning)

11.2 Information and methodical support

Essential Reading	
2	USMLE Step 1: Biochemistry and Medical Genetics [Текст] : Lecture Notes / Editors S. Turco, R. Lane, R.M. Harden. — New York : Kaplan, 2019. — 409 p.
Supplemental Reading	
1	Modern methods of genetic diagnosis / V.E. Markevich, V.O. Petrashenko, O.K. Redko [et.al.] // Sumy: Sumy state University, 2016. - 214 p.

2	Nelson Texbook of Pediatrics, 20th edition / Robert M. Kliegman, Bonita F. Stanton, Ninaa F. Schor [et al.] // London: Elsevier, 2016. - 3880 p.
3	Medical genetics / V..O. Petrashenko, A.M. Loboda, S.M. Kasian // Sumy: Sumy state University, 2018. - 139 p.
Web-based and electronic resources	
1	https://ocw.sumdu.edu.ua/content/796

COURSE DESCRIPTOR

№	Course Bescriptor	Total hours	Classroom work, hours				Independent work of students, hours								
			Total hours	Lectures	Workshops (seminars)	Labs	Total hours	Self-study of the material	Preparation for workshops (seminars)	Preparation for labs	Preparation for assesment	Independent extracurricular tasks			
1	2		3	4	5	6	7	8	9	10	11	12	13		
full-time course															
Module 1. Syndromological analysis															
1	Methodology of examination of a patient with suspected hereditary pathology. Phenotypical analysis of probang and its family members	2.5	2	0	2	0	0.5	0	0.5	0	0	0			
2	Clinical-genealogical analysis	2.5	2	0	2	0	0.5	0	0.5	0	0	0			
3	Making of pedigree. Work with diagnostic catalogs.	2.5	2	0	2	0	0.5	0	0.5	0	0	0			
4	Syndromological analysis	2.5	2	0	2	0	0.5	0	0.5	0	0	0			
Module 2. Cytogenetic methods of diagnosis of congenital and hereditary pathology															
1	Cytogenetic methods of diagnosis in clinics	2.5	2	0	2	0	0.5	0	0.5	0	0	0			
2	Chromosomal abnormalities (numerical, structural).	2.5	2	0	2	0	0.5	0	0.5	0	0	0			
3	Chromosomal polymorphism, chromosomal instability, gonadal mosaicism, single parent disomy	2.5	2	0	2	0	0.5	0	0.5	0	0	0			
Module 3. Biochemical methods of diagnosis of congenital and hereditary pathology															
1	Diagnosis of hereditary metabolic diseases	2.5	2	0	2	0	0.5	0	0.5	0	0	0			
2	Mass screening in the early diagnosis of hereditary pathology.	2.5	2	0	2	0	0.5	0	0.5	0	0	0			
3	Selective screening programs in diagnosis of hereditary metabolic disorders.	2.5	2	0	2	0	0.5	0	0.5	0	0	0			
Module 4. Molecular genetic methods of diagnosis of hereditary pathology															
1	Modern methods of DNA diagnosis of hereditary pathology.	2.5	2	0	2	0	0.5	0	0.5	0	0	0			

1	2	3	4	5	6	7	8	9	10	11	12	13
2	DNA diagnosis of monogenic and infectious diseases.	2.5	2	0	2	0	0.5	0	0.5	0	0	0
Module 5. Prenatal diagnosis of congenital and hereditary pathology												
1	Methods of prenatal diagnosis.	2.5	2	0	2	0	0.5	0	0.5	0	0	0
2	Prenatal ultrasound diagnosis of congenital malformations	2.5	2	0	2	0	0.5	0	0.5	0	0	0
3	Biochemical screening programs	2.5	2	0	2	0	0.5	0	0.5	0	0	0
4	Invasive methods of prenatal diagnosis. General characteristics. indications and contraindications	2.5	2	0	2	0	0.5	0	0.5	0	0	0
5	Methodology of conducting invasive prenatal research methods	5	4	0	4	0	1	0	1	0	0	0
Assesment												
1	Graded Credit	6	0	0	0	0	6	0	0	0	6	0
Independent extracurricular tasks												
1	extracurricular tasks	99	0	0	0	0	99	0	0	0	0	99
Total (full-time course)		*150*	*36*	*0*	*36*	*0*	*114*	*0*	*9*	*0*	*6*	*99*