DESCRIPTION OF COURSE UNIT FOR DOCTORAL STUDIES AT VILNIUS UNIVERSITY

Scientific Area/eas, Field/ds of Science	Medical and Health Sciences (M 000): Medicine (M 001)			
Faculty, Institute, Department/Clinic	Faculty of Medicine, Institute of Biomedical Sciences, Department of Human and Medical Genetics			
Course unit title (ECTS credits, hours)	**Human Genetics** 10 credits (270 hours)			
Study method	**Lectures**	**Seminars**	**Consultations**	**Self-study**
Number of ECTS credits	-	-	1	9
Method of the assessment (in 10 point system)	Written and oral exams. Three open-ended/problem-based questions.			

PURPOSE OF THE COURSE UNIT

To master the fundamental patterns, theories, principles, and issues of the most important aspects of human genetics. In this field of science, it is particularly necessary to have an understanding of genetic testing methods, their diversity, advantages and disadvantages. To give knowledge of the trends and tendencies in genetic research, and an understanding of its application in medicine.

THE MAIN TOPICS OF COURSE UNIT

The history of the science of human genetics and its most important discoveries. The Human Genome Project. Evolution, tasks and main results of the human genome research projects (HapMap, 1000 Genomes, ENCODE, LITGEN and other projects).
Structure of the human genome: nuclear and mitochondrial genome. Mitochondrial gene expression and inheritance. Diseases caused by changes in mitochondrial DNA. Human chromosomes, their structure, human karyotype. Heterochromatin and euchromatin. Epigenetic marks and their functions. Chromosome condensation: structure, formation mechanisms and function of histones, centromeres, kinetochores, telomeres. Chromosomal theory of inheritance and its principles. Mitosis and meiosis. Chromosomal changes during mitotic and meiotic division. The biological role of meiosis in the stability and intergenerational transfer of genetic information. Genetic recombination. X-chromosome inactivation as a mechanism for gene dosage compensation. Karyotype and clinical chromosomal syndromes. Increased chromosomal instability and its mechanism of occurrence. Mechanisms of chromosomal structural rearrangements. Autosomal aneuploidies. Sex chromosome aneuploidies. Human chromosomal diseases, indications for karyotyping, application of molecular cytogenetic methods.
Human gene structure. Gene families and clusters. Regulation of gene experssion. RNA genes. Practical application of methods for the study of human genes (PCR, DNA sequencing, hybridisation, etc.).
G. Mendelian patterns of inheritance. Autosomal dominant. Autosomal recessive. X-linked recessive and dominant. Y-linked. Modifier genes. Di-genic, triallelic, polygenic inheritance. Multifactorial inheritance: gene-gene, gene-environment interaction. Factors disrupting Mendelian patterns of inheritance. Polyallelism. Anticipation. Codomination. Superdominance. Pleiotropy. Peculiarities of inheritance of quantitative traits. Determination of inheritance type, estimation of segregation frequency for rare traits.
Genetic and physical mapping. Linkage analysis of diseases and traits, genealogical approach and mapping of the human genome. Transmission disequilibrium test.

Genome-wide association studies. Significance and application of the results of GWAS.
Genome variability. Genomic variation diversity and classification systems. Single nucleotide polymorphisms/variants, short repeated sequences, short deletions and insertions (delins), copy number changes, structural variants, inversions, conversions. Causes, mechanisms and consequences of genetic variation. Spontaneous variation. Induced variation. Mosaicism and chimerism. DNA repair: mechanisms and consequences of disruption. Effects of genetic variants on gene expression.
Developmental genetics of the human organism. Gene activity in the early stages of embryonic development. Mutagens and teratogens, their mechanisms of action and consequences.
Genetics of cancer. Cancer genes: oncogenes and cancer suppression genes, DNA repair genes. Mechanisms and theories of cancer development. The cancer genome.
Immunogenetics. Genes involved in the immune response, their rearrangement and control. Genetics in transplantation.
Objects and directions of human population genetics. Factors altering population structure: genetic drift, migration, inbreeding, recombination, natural selection. Hardy and Weinberg equilibrium and its application to human population genetics. Coalescence theory and its applications. Causes of changes in allele frequencies. Assortative/non-assortative mating and related genetic phenomena.
Human origins and evolution. Genetic mechanisms of evolution. Chromosomal evolution. Evolution of proteins. Methods and applications of comparative genomics. Studies of different population groups.
Pharmacogenetics: purpose, methods and applications.
Human behavioural genetics. Directions, principles and methods of behavioural genetics. Genetic diseases and behavioural disorders.
Animal and other models in human genetics. Transgenic organisms. Cell models. Alternative modelling systems.
Genetic counselling: principles and tools. Newborn screening programmes.
Genetic engineering in human genetics. Genome editing. Gene therapy, principles, strategies, applications, examples.
Bioethics and legal aspects in human genetics. Regulation of research and manipulation of the human genome and bioethical, social and legal issues.

RECOMMENDED LITERATURE SOURCES

1. Tom Strachan, Andrew Read, Human Molecular Genetics, 5th. ed., 2019.
2. Daniel L. Hartl. A Primer of Population Genetics and Genomics. Oxford Scholarship Online, 2020.
3. Jobling M., Hollox E., Hurles M., Kivisild T., Tyler-Smith C. Human Evolutionary Genetics (2nd edition). 670p., Garland Science, New York/London, 2014.
4. Guy Bradley-Smith, Sally Hope, Helen V.Firth, Jane A.Hurst, Oxford Handbook of Genetics, (Oxford Handbooks Series), Oxford university press, 2009.
5. Speicher, Michael; Antonarakis, Stylianos E.; Motulsky, Arno G.(Eds.).Vogel and Motulsky's Human Genetics. Problems and Approaches,4th. ed., Springer,2010.
6. William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino. Concepts of Genetics, 11th Edition, Mylab and Mastering, 2015.
7. Robert Brooker. Genetics: Analysis and Principles 5th Edition, McGraw-Hill Education, 2014.
8. R. J. McKinlay Gardner and Grant R. Sutherland. Chromosome Abnormalities and Genetic Counseling. 4rd ed. Oxford university Press, 2011.
9. http://varnomen.hgvs.org/
10. https://genome.ucsc.edu/
11. http://ensmebl.org/

CONSULTING LECTURERS
1. Coordinating lecteurer: Ingrida Domarkienė (Assist. Prof. Dr.).
2. Vaidutis Kučinskas (Acad. Prof. Habil. Dr.)
3. Laima Ambrozaitytė (Assoc. Prof. Dr.).
APPROVED:
By Council of Doctoral School of Medicine and Health Sciences at Vilnius University: 29th of September 2022
Chairperson of the Board: Prof. Janina Tutkuvienė