Department of Medical Genetics and Molecular Medicine
Mashhad University of Medical Sciences

Semester Program
Course Syllabus
Exam Schedule

Mashhad University of Medical Sciences
Department of Medical Genetics and Molecular Medicine

✓ Bachelor's (B.Sc.)
✓ Professional Doctorate
✓ Master's (M.Sc.)
✓ Specialized Doctorate (Ph.D.)

First Semester
2024-2025

Course Syllabus, Semester Program
First Semester 2024-2025: Ph.D. and M.Sc. (Department of Medical Genetics and Molecular Medicine)

Greetings and respect to our esteemed colleagues and dear students,

The comprehensive academic program of the Department of Medical Genetics and Molecular Medicine for the first semester of the academic year 2024-2025 is presented. Please note the following points:

- The new academic semester will begin in person on September 22, 2024.
- The curriculum is presented separately for each semester, level, and field of study.
- The provided schedule will be adhered to as much as possible.
- Coordination with the respective instructor is required one week before the class time.
- M.Sc. and Ph.D. students from the 4th semester onwards must select their thesis unit and submit a progress report at the end of each semester.
- Graduate students are required to follow up on their research affairs until the approval of their thesis at the university. In case of any disruption in the approval process, they should follow up on the matter. Due to the requirement of a 6-month interval for M.Sc. students and a one-year interval for Ph.D. students from the time of thesis approval in the graduate council of the faculty until the defense, it is necessary to follow up on the status of the thesis.
- Final exams are scheduled on the dates proposed by the faculty's education department. Any potential changes will be announced one month before the end of the semester. In case of coordination for any midterm exam or class project (with the elimination of the corresponding topic from the final exam), the department must be informed.
- The proposed topics by esteemed professors for the M.Sc. student seminar course will be announced subsequently.

Course Syllabus, Semester Program
First Semester 2024-2025: Ph.D. and M.Sc. (Department of Medical Genetics and Molecular Medicine)

Ph.D. in Medical Genetics - Semester 2 - Fall 2023 Intake
Advanced Medical Genetics (2 theoretical credits)
Course Coordinator: Dr. Hamzehloei

Overall Goal: In-depth teaching of the most advanced and strategic topics in medical genetics in the fields of comprehensive diagnosis and prevention, with an emphasis on the most common and important genetic diseases in the country.

Course Description: This course covers new developments in the genetic diagnosis of diseases, congenital anomalies, genetic screening, and topics such as the genetics of complex diseases, the genetics of aging, and microarrays. It also includes some of the most important diagnostic techniques and some of the most important and common genetic diseases in the country and in medical genetics. These topics will help students gain a deep understanding of the diagnosis, prevention, and treatment of genetic diseases.

Theoretical Topics (34 hours):

1. Importance and status of advanced medical genetics in Iran and the world
2. Congenital anomalies (dysmorphology)
3. Genetic diseases caused by trinucleotide repeat expansions
4. Adult-onset genetics (Parkinson's, Alzheimer's, cardiovascular diseases, etc.)
5. Genetics in the prevention, diagnosis, and treatment of eye diseases
6. Genetics in the prevention, diagnosis, and treatment of common heart diseases
7. Genetics in the prevention, diagnosis, and treatment of hemoglobinopathies and bleeding disorders
8. Genetics in the prevention, diagnosis, and treatment of mental-psychological disorders
9. Genetics in the prevention, diagnosis, and treatment of neuromuscular disorders
10. Genetics in the prevention, diagnosis, and treatment of ear, nose, and throat diseases (deafness and related syndromes)
11. Genetics in the prevention, diagnosis, and treatment of mitochondrial diseases
12. Gene-nutrition interaction, importance, and applications
13. Pharmacogenetics
14. Common monogenic and metabolic diseases in Iran

Instructor	Number of Sessions	The items to be involved
Dr. Abbas Zadegan	7	(4,5,6,8,9,10,11)
Dr. Hamzeh Loei	7	(1,2,3,7,12,13,14)

Course Syllabus, Semester Program
First Semester 2024-2025: Ph.D. and M.Sc. (Department of Medical Genetics and Molecular Medicine)

Advanced Immuno- and Cancer Genetics (2 theoretical credits)
Course Coordinator: Dr. Abbas Zadegan

Course Description and Topics (34 hours, theoretical):
The last decade has witnessed unprecedented progress globally and nationally in the field of stem cell transplantation for the treatment of various diseases, to the extent that global standards for stem cell transplantation are changing and improving annually. Since our country holds the top position in the Middle East and a favorable rank globally in stem cell transplantation, familiarity with the new mechanisms and hypotheses of immune diversity, standards and updated methods for HLA typing, selection of the best related and unrelated donors, the role of national and international banks (cord blood and adult), and Iran's position in the field of transplantation and stem cell banking in the international arena are essential topics for study. Furthermore, considering the remarkable and growing progress in cancer genetics, teaching topics such as changes in stem cells and cancer, different sets of gene classes involved in the complex event of cancer, new and growing strategic technologies in the field of molecular cancer genetics, along with important topics such as metastasis, apoptosis, and personalized medicine are among the subjects covered in the cancer section.

1. **Syllabus:**
2. Immunoglobulin diversity (recombination mechanisms and antibody engineering)
3. Immunoglobulin diversity (mechanisms and new findings in class switching and somatic hypermutation)
4. TCR genes (gene structure, function, and mechanisms of diversity and related diseases)
5. MHC gene region (gene structure, classes, distribution, function, and related diseases)
6. New findings in the genetics of autoimmune diseases
7. Standards for HLA typing (new methods, protocols, and guidelines)
8. Global standards and new findings in related and unrelated stem cell transplantation
9. The role of global and national donor banks (cord blood and adult banks)
10. Application of new techniques in identifying HLA gene diversity
11. Mechanisms of metastasis (angiogenesis and invasion) and apoptosis in cancer
12. Induced pluripotent stem cells in the treatment of cancers and animal models
13. Pharmacogenetics of cancer stem cells (importance and applications)
14. The role of various RNAs in the genesis, diagnosis, and treatment of cancer
15. The concept of epithelial-mesenchymal transition (EMT) in the cancer process
16. Personalized medicine and its strategies in the diagnosis and treatment of cancer
17. Application of new techniques in the diagnosis and treatment of hereditary cancers

18. Application of new techniques in identifying somatic mutations

Instructor	Number of Sessions	The items to be involved
Dr. Avan	6	(1,2,3,4,5,6)
Dr. Abbas Zadegan	6	(7,8,9,10,11,12)
Dr. Sabouri	6	(13,14,15,16,17,18)

Course Syllabus, Semester Program
First Semester 2024-2025: Ph.D. and M.Sc. (Department of Medical Genetics and Molecular Medicine)

Behavioral Genetics (2 theoretical credits)

Course Coordinator: Dr. Hamzehloei

- **Course Name:** Behavioral Genetics
- **Prerequisite/Corequisite:** None
- **Credits:** 2
- **Type:** Theoretical
- **Course Code:** 24

Overall Goal: To introduce the important aspects of behavioral genetics and explain the biological basis of its similarities and differences in human species and compare it with other organisms, with an emphasis on some behavioral diseases.

Course Description: Familiarity with behavioral genetics (both normal and abnormal behaviors) in humans and its similarities and differences with other organisms, especially other mammals. Study of family and population behaviors and the role of genetics and environment in shaping them. Therefore, given the prevalence and diversity of behavioral diseases and personality disorders, students, in addition to being familiar with the related concepts, will gain knowledge about new genetic findings in these diseases.

Topics (34 hours, theoretical):

1. Introduction, definition of aspects and complexities of studies
2. Nature and nurture
3. Research methods in behavioral genetics (family, twin, adoption, animal model studies)
4. Psychology and psychiatry
5. The genetics and behavior gap
6. Mental retardation and impairment of intelligence and cognition
7. Personality and its diseases
8. Antisocial behavior / crime
9. Genetics of anxiety and depression
10. Genetics of bipolar disorder (BPD)
11. Genetics of Alzheimer's
12. Genetics of schizophrenia
13. Genetics of psychosis
14. Genetics of autism
15. Genetics of addiction
16. Genetics of suicide
17. Ethical and legal principles related to behaviors

Instructor	Number of Sessions	The items to be involved
Dr. Hamzehloei	9	(9,10,11,12,13,14,15,16,17)
Dr. Sadr Nabavi	8	(1,2,3,4,5,6,7,8)

Course Syllabus, Semester Program
First Semester 2024-2025: Ph.D. and M.Sc. (Department of Medical Genetics and Molecular Medicine)

Medical Bioinformatics (2 credits; 1 theoretical + 1 practical)
Course Coordinator: Dr. Sabouri

Course Description: It is expected that at the end of this course, students will be familiar with various types of omics data in studies related to medical sciences. They should know the new methods of high-throughput data generation and their relative advantages and disadvantages. They should know the difference between array and sequencing methods and their relative pros and cons. They should be familiar with the various stages of omics data analysis. They should understand the general concepts of population genetics and Genome-Wide Association Studies (GWAS) and be able to use its information sources. They should know the main stages of a GWAS study. They should be able to analyze the results of a GWAS study. They should be familiar with influential projects in the field of genomics such as HapMap and 1000 Genomes and ENCODE. They should know about post-GWAS studies and be able to design a limited post-GWAS study. They should be familiar with the challenges and statistical considerations in omics data analysis and be able to provide a suitable solution for each problem.

Theoretical Topics (17 hours):

1. Heritability study
2. Twin, pedigree, and polygenic study methods
3. Population genetics, haplotype, and linkage disequilibrium
4. High-throughput genotyping methods and linkage analysis
5. Introduction to Genome-Wide Association Studies (GWAS)
6. Expression Quantitative Trait Loci (eQTLs) studies
7. Introduction to WES and WGS data analysis
8. Transcriptome studies from RNA Sequencing and Microarray and their data analysis
9. Studies related to regulatory elements in the genome, such as DNA seq, Hi-C, ChIP-Seq, etc., and data analysis
10. Access to data available in databases
11. Encyclopedia of DNA Elements, ENCODE Project
12. Bioinformatics for proteomics
13. CRISPR-Cas bioinformatics
14. Statistical considerations in omics data analysis, meta-analysis, multiple testing

Practical Topics (34 hours):

1. Linkage analysis
2. GWAS analysis
3. Familiarity with the Linux environment
4. WES/WGS analysis

5. Familiarity with R
6. Transcriptome data analysis
7. Familiarity with ENCODE and accessing transcriptome, ChIP, etc. data and using this data in databases
8. Practical project in CRISPR-Cas bioinformatics
9. Familiarity with software for statistical analysis of omics data and meta-analysis

Instructor	**Number of Sessions**
Dr. Sabouri	4 (theory) + 2 (practical)
Dr. Pasdar	5 (theory) + 3 (practical)
Dr. Gholoubi	5 (theory) + 4 (practical)

Course Syllabus, Semester Program
First Semester 2024-2025: Ph.D. and M.Sc. (Department of Medical Genetics and Molecular Medicine)

M.Sc. in Medical Genetics - Semester 1 - Fall 2024 Intake
Principles of Computer, Internet, and Applications (2 credits; 1.5 theoretical, 0.5 practical)
Course Coordinator: Dr. Sabouri

Topics: 23 hours (26 hours theoretical - 17 hours practical)

Row	Syllabus
1	Introduction, history, and definitions
2	Familiarity with computer architecture, including: chips, CPU, memory, disk, and other computer components
3	Windows operating system
4	Other operating systems
5	Familiarity with basic computer software
6	Familiarity with specialized software in life sciences
7	Familiarity with the main applications of computers and the internet in life sciences
8	How the internet works and concepts such as ip address, routing, ethernet, wi-fi
9	How to design a website
10	Security on the computer and internet, viruses, and other malicious and threatening factors
11	How to deal with factors and threats on the computer and internet
12	Introduction to reputable websites for use in biological research and evaluation of internet sources in terms of Authority, Accuracy, Relevance
13	Principles of e-learning and online education
14	Introduction to the principles of bioinformatics
15	Important applications of bioinformatics in life sciences
16	Familiarity with the principles and method of citing sources from journals, books, and sources taken from the internet
17	Ethical issues in the use of computers, the internet, and citing internet sources

Instructor	Proposed Topic
Dr. Gholoobi	Genetic Database (2)
Dr. Gholoobi	Vector Design (1)
Dr. Gholoobi	SNP/Mutation Submission (1)

Dr. Avan	Primer Design (2)
Dr. Avan	Mutation Effect prediction (1)
Dr. Pasdar	Sg-sh RNA design (1)
Dr. Pasdar	NGS Database (2)
Dr. Sabouri	RealTime PCR software (2)
Dr. Sabouri	Flowcytometry Software (1)

Course Syllabus, Semester Program
First Semester 2024-2025: Ph.D. and M.Sc. (Department of Medical Genetics and Molecular Medicine)

Molecular Genetics (3 credits; 2 theoretical, 1 practical)
Course Coordinator: Dr. Gholoubi

Course Description:
A) (2 theoretical credits, 34 hours) Molecular genetics is the advanced knowledge of biological systems and strategic molecules, their structure, function, and regulation of DNA, RNA, transcription, and repair. In this course, the diversity of DNA structure, molecular basis of replication and gene expression, and its control mechanisms are discussed. Also, the basis of genetic diversity, DNA repair mechanisms, and disease creation due to mutation or epigenetic changes will be explained.
B) (1 practical credit, 34 hours) - In this course, the student should be able to extract nucleic acids and quantify and qualify them. Also, they should be familiar with the principles of gene amplification and analysis of point mutations or repeat sequences.

Theoretical Topics (34 hours):

Row	Syllabus (Topics)	Number of Sessions (2 hours each)
1	Introduction, history, importance	1
2	Important and common definitions and terms	1
3	Replication, transcription of the DNA molecule, and translation in eukaryotes	2
4	Genetic code, recombination (definitions, types, and consequences)	1
5	Mutation, mutability, and molecular mechanisms of mutation	1
6	Molecular mechanisms of DNA repair	1
7	Details of transcription regulation systems I: gene promoters, silencers, enhancers	1
8	Details of transcription regulation systems II: transcription factors and types of transcription control	1
9	Details of RNA processing (RNA splicing) and the translation process	2
10	Epigenetic inheritance, DNA methylation	
11	Histone modification and long non-coding RNAs (general)	
12	Epigenetics: small RNAs, transcriptome, and proteome, ENCODE, modENCODE	
13	Repetitive DNA and transposable genetic elements	2

Total	**17**

Practical Topics (34 hours):

Row	Syllabus (Topics)	Number of Sessions (2 hours each)
1	DNA extraction methods, quantitative and qualitative DNA control	2
2	RNA extraction methods, quantitative and qualitative RNA control	2
3	Performing PCR / RFLP experiment	2
4	Analysis of repeat sequences using PCR	2
5	cDNA synthesis and performing RT-PCR	2

Instructor	Number of Sessions
Dr. Avan	2 theory + 4 practical
Dr. Hamzeh Louei	10 theory
Dr. Gholoubi	4 theory + 13 practical

Course Syllabus, Semester Program
First Semester 2024-2025: Ph.D. and M.Sc. (Department of Medical Genetics and Molecular Medicine)

Cytogenetics (3 credits; 2 theoretical, 1 practical)
Course Coordinator: Dr. Sadr Nabavi

Instructor	**Number of Sessions**
Dr. Sadr	(1-9)theory + 17 practical
Dr. Abbaszadegan	(10-17)theory

Topics (34 hours theoretical - 34 hours practical):

Row	**Theoretical Syllabus (Topics)**	**Number of Sessions (2 hours each)**
1	Introduction, history	1
2	Human chromosome structure, normal variations in chromosome structure	1
3	Differentiation between chromosomes based on banding patterns, human chromosome nomenclature	1
4	Cell divisions, gametogenesis in humans, causes of aneuploidy in humans	1
5	Theoretical basis of lymphocyte culture, metaphase chromosome preparation, banding staining methods, mechanism, and their applications in postnatal diagnosis of chromosomal abnormalities	1
6	Theoretical basis of bone marrow cell culture, metaphase chromosome preparation, banding staining methods, mechanism, and their applications in the diagnosis of chromosomal abnormalities in leukemias and lymphomas	1
7	Theoretical basis of amniocyte and chorionic villus cell culture, metaphase chromosome preparation, banding staining methods, mechanism, and their applications in prenatal diagnosis of chromosomal abnormalities	1
8	Theoretical basis and mechanism of Sister Chromatid Differentiation (SCD) methods and cell culture in the presence of clastogenic agents and their applications	1
9	Fluorescence In Situ Hybridization (FISH) methods and their applications	1
10	QF-PCR and MLPA methods and their application in diagnosing	1

	chromosomal abnormalities	
11	New methods in medical cytogenetics including Array CGH, CGH, Spectral Fish, M-FISH and their applications	1
12	Numerical abnormalities of autosomes, mechanisms of origin, screening and prevention methods	1
13	Structural abnormalities of autosomes, mechanisms of origin, diagnosis and prevention methods	1
14	Sex chromosomes in humans, molecular mechanism of X chromosome inactivation in humans	1
15	Numerical and structural abnormalities of sex chromosomes in humans	1
16	Syndromes related to microdeletions and chromosomal instability in humans	1
17	Genetic counseling and ethical aspects in human cytogenetics	1

Course Syllabus, Semester Program
First Semester 2024-2025: Ph.D. and M.Sc. (Department of Medical Genetics and Molecular Medicine)

Practical Topics (34 hours):

Row	Practical Syllabus (Topics)	Number of Sessions (2 hours each)
1	Preparation of mitotic metaphase chromosomes from peripheral blood samples (lymphocyte culture, harvesting, slide preparation, staining with solid and banding methods). (Minimum of three repetitions under the supervision of the respective instructor)	3
2	Training in chromosome identification with banding patterns under a microscope and karyotyping. (Continuous practice by students throughout the semester under the supervision of the senior cytogenetics lab technician)	2
3	Preparation of mitotic metaphase chromosomes from peripheral blood samples for high-resolution banding. (Minimum of three repetitions under the supervision of the respective instructor)	2
4	Preparation of metaphase chromosomes from bone marrow and peripheral blood samples of patients with hematologic malignancies and their karyotyping. (Minimum of three repetitions under the supervision of the respective instructor)	3
5	Preparation of mitotic metaphase chromosomes from amniotic fluid samples including amniocyte culture, harvesting, and slide preparation, staining with banding methods, chromosome identification, and karyotyping. (Minimum of three repetitions under the supervision of the respective instructor)	3
6	How to work with automatic karyotyping software. (Practice throughout the semester under the supervision of the senior lab technician)	1
7	Application of lymphocyte culture method in the presence of stress-inducing agents (clastogens) and Sister Chromatid Differentiation (SCD) method for diagnosing chromosomal breakage syndromes and training in the analysis of results from these tests. (Minimum of three repetitions under the supervision of the respective instructor)	2

Course Syllabus, Semester Program
First Semester 2024-2025: Ph.D. and M.Sc. (Department of Medical Genetics and Molecular Medicine)

Genetic Engineering (2 theoretical credits)
Course Coordinator: Dr. Hamzehloei

Overall Goal: Familiarity with the macro concepts and important methods in genetic engineering related to medical sciences.

Course Description:
Explaining the history and strategic position of the science and art of genetic engineering and its implementation stages, along with introducing important tools for performing these operations and the strategic applications of these highly efficient techniques in molecular and applied genetic studies in the fields of medicine, human, food and drug industries, and transgenic organisms (GMOs) and their medical applications are among the topics that students are expected to understand and comprehend by the end of the course.

Theoretical Topics (34 hours):

Row	Syllabus (Topics)	Number of Sessions (2 hours each)
1	History of origin, importance, position, and applications of genetic engineering	1
2	Cloning vectors in prokaryotes	1
3	Cloning vectors in eukaryotes	1
4	Manipulation of purified DNA and introduction and use of important enzymes	1
5	Extraction and purification of DNA molecules from living cells	1
6	Introduction and entry of DNA molecules into living cells	1
7	How to obtain a clone of a pure gene	1
8	Study of the location and structure of a cloned gene	1
9	Study of the expression and application of a cloned gene	1
10	Production of protein from cloned genes	1
11	Differential display techniques and their applications	1
12	DNA blotting and its medical applications	1
13	Polymorphism and DNA analysis in forensic medicine and archaeology	1

14	Random and directed mutagenesis and its medical applications	1
15	Transgenic plants and their applications	1
16	Transgenic animals and their applications	1
17	Genetic engineering in medicine, food and drug industries	1

Instructor	**Number of Sessions**	**The items to be involved**
Dr. Hamzehloei	14	(1-14)
Dr. Mozaffari	3	(15,16,17)

Course Syllabus, Semester Program
First Semester 2024-2025: Ph.D. and M.Sc. (Department of Medical Genetics and Molecular Medicine)

M.Sc. in Medical Genetics - Semester 3 - Fall 2023 Intake
Bioinformatics (1 practical credit)
Course Coordinator: Dr. Sabouri

Practical Topics (34 hours):

Row	Syllabus (Topics)	Number of Sessions (1 hour each)
1	The role of bioinformatics in modern biology	1
2	Searching databases of articles and patents	1
3	Citing sources in the text	1
4	Nucleic acid sequences (GeneBank, UniGene, Gene, EST)	2
5	Genome structure and description (dbSNP, UCSC Genome Browser, Ensembl Genome Browser)	2
6	Polymorphism and its bioinformatic analysis	1
7	Basic concepts in GWAS	2
8	Protein sequence and structure (UniProt, NCBI Protein, ExPASY, InterPro, Pfam, PDB)	1
9	Homology search concepts and tools: Local Alignment (BLAST), Multiple Alignment (Clustal, Mega, Homologene)	2
10	Project A1 and A2	4
11	Primer design with GeneRunner	1
12	Primer design with Primer 3, Allele ID	1
13	Gene cloning tools (Clone Manager, Plasm, GeneRunner)	2
14	Project B1, B2, B3, B4, B5	4
15	Excel software and its application in bioinformatics	1
16	R software and its application in bioinformatics	2
17	Linux and its application in bioinformatics	2
18	Project C1, C2, C3	4

Instructor	Proposed Topic	Number of Sessions (theory/practical)*
Dr. Rahimi	1 to 5	7 (+4)
Dr. Gholoubi	6,7,11,12	4 (+2)
Dr. Sabouri	8 and 9	3 (+2)
Presentation Hub	**15, 16, and 17**	**5**

* Due to the project-oriented nature of the course (items 10, 14, and 18), a total of 12 project-based sessions are divided among all topics.
** These topics will be taught with the participation of Ph.D. students.

Course Syllabus, Semester Program
First Semester 2024-2025: Ph.D. and M.Sc. (Department of Medical Genetics and Molecular Medicine)

Cancer Genetics (2 theoretical credits)

Course Coordinator: Dr. Hamzehloei

Overall Goal: Familiarity with the most up-to-date fundamental principles of cancer genetics and understanding the different aspects of cancer development with an emphasis on the important role of genetics.

Course Description: Explaining the history, the position of cancer genetics, features of cancer cells, the relationship between mutagenesis and carcinogenesis, the main classes of genes involved in cancer, as well as the relationship between the cell cycle and cancer, and genetic stability and instability in tumors, and teaching the major details of genes involved in cancer, the application of molecular methods and markers in cancer diagnosis, and gene therapy and immunotherapy of cancers.

Theoretical Topics (34 hours):

Row	Syllabus (Topics)	Number of Sessions (2 hours each)
1	History, position, definition, and basics of cancer genetics	1
2	The cancer cell and its features	1
3	The processes of mutagenesis and carcinogenesis and their relationship	1
4	Metastasis and the mechanisms of angiogenesis and invasion	1
5	Control of the cell cycle, regulation of growth, and developmental and oncogenes	1
6	Genetic instability and chromosomal and centromeric abnormalities in cancer	1
7	Structure and function of viral and cellular oncogenes	1
8	Structure and function of tumor suppressor genes	1
9	Signal transduction pathways in cancer	1
10	Telomerase and its inhibition in cancer	1
11	Techniques and molecular markers in cancer diagnosis	1
12	Epigenetics and cancer	1
13	Genetics of familial cancer syndromes	1
14	Mitochondrial genetics and cancer	1

15	Causes of predisposition to cancer in childhood and adulthood	1
16	Conventional cancer treatment methods with new genetic methods	1
17	Immunotherapy in cancer	1

Instructor	**The items to be involved**
Dr. Abbas Zadegan	(15,16)
Dr. Hamzeh Louei	(1-14)

Course Syllabus, Semester Program
First Semester 2024-2025: Ph.D. and M.Sc. (Department of Medical Genetics and Molecular Medicine)

Ethics and Biosafety (2 theoretical credits)
Course Coordinator: Dr. Hamzehloei

Overall Goal:
To familiarize students more than ever with the strategic role and importance of ethics and legal issues, as well as biosafety in molecular biotechnology and genetic engineering research in the field of medical sciences, especially human and medical genetics.

Course Description:
Today, experimental sciences, especially genetics, are progressing at a surprising speed, and scientists are making amazing discoveries every day through laboratory research. In such a situation, even when they achieve very new and important treatments, we must also answer very important ethical and legal questions. In this course, students, in addition to getting acquainted with the concepts of ethics and biosafety and their relationship with new molecular and cellular issues and techniques, will focus on ethical and safety approaches towards the patient, family, clinical sample, and research in medical genetics.

Syllabus and Topics (34 hours, theoretical):

Row	Topics	Number of Sessions (2 hours each)
1	Definition of ethics and medical ethics - importance, history, position	1
2	Biosafety - legal and ethical aspects	1
3	Ethical, social, and legal aspects of biotechnology and genetics	1
4	Transgenic animals and safety and ethical considerations	1
5	Ethical aspects of genetic engineering, gene transfer, and gene therapy	1
6	Ethical aspects of prenatal genetic diagnosis (PND), preimplantation genetic diagnosis (PGD), and pre-conception sex selection	1
7	Ethical aspects of forensic medicine and genetics, human genome diversity	1
8	Ethical aspects of changing the genome of organisms and legal rights	1
9	Ethical and legal aspects of NGS	1
10	Ethical, legal, and social aspects of stem cells and	1

	human cloning	
11	Consent form and maintaining the confidentiality of genetic information	1
12	EUGENICS & GENETIC DOPING	1
13	Ethical aspects of genetic testing of asymptomatic individuals and children	1
14	Ethical issues related to therapeutic abortion	1
15	Ethical issues related to scientific articles	1
16	Environment, ethics, and applied research in genetic engineering and molecular biotechnology	1
17	National and international protocols and guidelines for ethics and biosafety	1

Instructor	**The items to be involved**
Dr. Gholoobi	(10-17)
Dr. Hamzeh Louei	(1-9)

Course Syllabus, Semester Program
First Semester 2024-2025: Ph.D. and M.Sc. (Department of Medical Genetics and Molecular Medicine)

Cell and Tissue Culture (2 credits; 1 theoretical, 1 practical)
Course Coordinator: Dr. Sabouri

Theoretical Topics (17 hours):

Row	Syllabus (Topics)	Number of Sessions (2 hours each)
1	Basic principles in the selection of equipment and consumable and non-consumable supplies and materials needed for culture and substrates	1.5
2	Familiarity with the causes and points to consider in selecting defined culture media and supplements and how to prepare them	1
3	Providing various preparation and sterilization methods usable for cell and tissue culture	1
4	Providing important principles in freezing and storing cells	1
5	Basic principles of classifying types of cell and tissue culture methods and also methods of mass cell culture in the laboratory and bioreactor	1
6	Contamination in cell culture and methods of identification and dealing with various types of contamination	1
7	Familiarity with methods and tests for identifying living cells (viability tests)	1
8	Various methods for producing immortal cell lines	1
Total		**8.5**

Practical Topics (34 hours):

Row	Syllabus (Topics)	Number of Sessions (2 hours each)
1	Ways to familiarize students with working in a cell culture laboratory environment and observing safety points and laboratory equipment, how to work and maintain it	2
2	Familiarity with different culture media and their specialized use for different cells and their sterilization	2
3	Familiarity and how to use light, phase-contrast, and fluorescent microscopes and their maintenance	1

4	Suspension cell culture methods such as myeloma and hybridoma cells	1
5	Adherent cell culture methods (mono-layer) such as adherent cell lines and familiarity with their morphological characteristics	1
6	Methods of taking cells out of freeze and re-culturing and passaging	1
7	Storing and maintaining cells with freezing methods of cultured cells and methods of trypsinizing cells	2
8	Cell synchronization methods using different substances (thymidine, methotrexate, 5-fluorouracil) and cell counting and growth curve	2
9	Methods of preparing a tissue for culture	2
10	Primary cell culture methods such as peripheral blood lymphocytes, bone marrow cells, and tissues	2
11	Methods of identifying contamination in cultured cells	1
12	Methods of dealing with contamination	1
Total		**17**

Instructor	**Number of Sessions**
Dr. Sabouri	7 theory sessions + 17 practical sessions

Course Syllabus, Semester Program
First Semester 2024-2025: Ph.D. and M.Sc. (Department of Medical Genetics and Molecular Medicine)

Seminar 2 (1 credit, presentation-based)
Course Coordinator Dr. Avan **(with the collaboration of department professors)**

Overall Goal:
Theoretical research and gathering and processing library information about a very important and especially scientific-applied topic under the supervision of a professor or professors whose proposed topic or topics should be different from the course topics of the students of this level, selected by the students.

Syllabus:
The student is required to select and present their seminar units in the second to third academic semesters according to the specified topic from among the latest important and advanced topics in human and medical genetics with the help of the seminar supervisor. The topic selected for each seminar will be chosen to complement the topics and subjects presented in the compulsory courses and should not be the student's thesis topic. Active participation of all students along with the supervisor and course coordinator in the seminar presentation sessions is mandatory.

Student Evaluation Method:
Formative evaluation with the evaluation of the written seminar report, seminar evaluation, and quantitative evaluation (comprehensive final written exam):

1. Seminar preparation: 40% (evaluated by the supervisor)
2. Seminar presentation: 30% (evaluated by the supervisor and course coordinator)
3. Final exam on the summary of the collection of seminars presented by the students: 30%

Course Syllabus, Semester Program
First Semester 2024-2025: Ph.D. and M.Sc. (Department of Medical Genetics and Molecular Medicine)

Ph.D. in Molecular Medicine - Semester 2 - Spring 2024 Intake
Cellular Signaling and Systems Biology (2 theoretical credits)
Course Coordinator: Dr. Gholoobi

- **Course Name:** Cellular Signaling and Systems Biology
- **Credits:** 2
- **Type:** 2 theoretical credits
- **Prerequisite/Corequisite:** None
- **Course Code:** 18

Overall Course Goal: Learning the principles and fundamentals of cellular signaling and systems biology, including identifying signaling pathways, systematic pathway communication, structure, dynamic nature, and modeling of systems and their application in molecular medicine.

Syllabus: (34 hours, theoretical)

1. New topics and developments in receptors
2. G protein-coupled cellular signaling and their receptors
3. Serine-threonine kinase cellular signaling and cell growth pathways
4. Receptor Binding
5. Adenosine, serotonin, and their receptor signaling
6. Steroid hormone signaling
7. Cell cycle and its regulatory mechanisms
8. Insulin and molecular basis of insulin resistance
9. Molecular basis of cancer chemotherapy
10. Regulation of cell death and its role in disease treatment
11. Introduction, history, goals, and applications in systems biology
12. Identification of gene networks and biochemical pathways
13. Methods of dynamic analysis, variability, and adaptable systems
14. System control mechanisms, optimization, and evolution
15. Gene expression models, modeling tools
16. System design and modeling, embedding and model matching
17. Examples of systems biology projects
18. Databases

Instructor	**Number of Sessions**	**Topics**
Dr. Rahimi	5 sessions	Topics 1-4
Dr. Sabouri	6 sessions	Topics 6-12
Dr Gholoobi	7 session	Topics 13-18

Course Syllabus, Semester Program
First Semester 2024-2025: Ph.D. and M.Sc. (Department of Medical Genetics and Molecular Medicine)

Molecular Basis of Diseases (3 theoretical credits)

Course Coordinator: Dr. Gholoobi

Syllabus: (51 hours, theoretical)
In this course, molecular changes that occur at the cellular and receptor level and lead to organ dysfunction are studied.

Introduction:
Genetic message and genetic content of the open reading frame, structure of a gene, genetic screening of individuals for hereditary diseases, and risk factor determination.

Endocrine and Metabolic Diseases:
Cellular signaling and genetic activity of human growth factor receptors, molecular basis and specific indicators of insulin activity, type 2 diabetes, thyroid hormone receptors, regulation and function of steroid receptors, model animals for studying glands, etc.

Urological Diseases:
Molecular basis of prostate cancer metastasis, genetic susceptibility of individuals to prostate cancer, mechanism of prostate cancer progression, genetic changes and risk of prostate cancer, role of steroid receptors and vitamin D deficiency in prostate cancer, autocrine and paracrine mechanisms in prostate cancer development, etc. Squamous cell carcinoma of the urinary tract, Burkitt's lymphoma, etc.

Women's Diseases:
Molecular basis of common diseases in women, pregnancy, and infertility.

Rheumatoid and Autoimmune Diseases:
Molecular basis of rheumatoid diseases (viruses, apoptosis, etc.), bioactive lipids, costimulatory molecules, lupus, vasculitis, osteoarthritis, malignancies of connective tissue, etc.

Instructor	Topics	
Dr. Rahimi	Introduction, Cardiovascular diseases	5 sessions
Dr. Pasdar	Lung diseases, Urological diseases	5 sessions
Dr. Sabouri	Blood diseases, Neurological diseases, Rheumatoid and Autoimmune diseases	7 sessions
Dr. Gholoubi	Women's diseases, Endocrine and metabolic diseases, Gastrointestinal diseases	9 sessions

Course Syllabus, Semester Program
First Semester 2024-2025: Ph.D. and M.Sc. (Department of Medical Genetics and Molecular Medicine)

Genetic Engineering and Molecular Biotechnology (2 credits; 1 theoretical + 1 practical)
Course Coordinator: Dr. Mozaffari

Syllabus: (17 hours theoretical - 34 hours practical)
A: Theoretical Topics

1. History, importance, applications, and future prospects
2. New developments in gene cloning vectors and their development
3. New developments in enzymes used in gene cloning
4. New developments in hosts used in gene cloning and their development
5. Study of the location and structure of cloned genes
6. Study of the expression of cloned genes
7. Study of recombinant proteins (genetically engineered), protein engineering
8. Gene cloning (genomic DNA and cDNA)
9. Cloning or simulation of organisms and its ethical considerations
10. Applications of genetic engineering and molecular biotechnology in the achievements of the international human genome project and its future prospects
11. Model animals and transgenic animals
12. The role of transgenic plants in producing biological products
13. Stem cells, their medical applications, and future prospects
14. Applications of the principles of genetic engineering and molecular biotechnology in molecular medicine and summary

B: Practical Topics

1. Extraction of DNA, RNA, and protein from various sources
2. Blotting of DNA, RNA, and protein
3. Basic and fundamental operations of genetic engineering, cell and suitable host culture, use of specific enzymes, ligation of vector and foreign DNA, transfer of recombinant vector to a suitable host, identification and analysis of recombinants

Instructor	Topics	Proposed Date and Time
Dr. Gholoubi	5 theoretical + 9 practical	To be scheduled with the course coordinator (in coordination with collaborating professors).
Dr. Mozaffari	3 theoretical + 9 practical	

Course Syllabus, Semester Program
First Semester 2024-2025: Ph.D. and M.Sc. (Department of Medical Genetics and Molecular Medicine)

Medical Nanotechnology (2 theoretical credits)
Course Coordinator: Dr. Gholoubi

Syllabus: (34 hours, theoretical)

1. An introduction to nanobiotechnology, including definitions and history
2. The relationship between nanobiotechnology and molecular medicine
3. Molecular motors and intracellular transport
4. Nanoparticles, nanoshells, and their application in drug and gene delivery, cancer tissue targeting, and imaging
5. Uptake of nanoparticles and nanocolloids by cells and their application
6. Cancer immunotherapy, tumor targeting
7. Pigmentation of nanoparticles for tissue and gene therapy grafting
8. Virus-like DNA nanoparticles and their application in gene therapy for tumors
9. Liposomes and heat-sensitive nanoparticles
10. Processes of nanolayer formation and its application in biosensor construction and for use in separation
11. Nanotubes and carbon fibers and their application as a new generation of antibiotic drugs and intracellular agents
12. Mechanical manipulation of a biological molecule
13. Micro- and nano-sized tools for manipulating cells and biomolecules
14. Future prospects of nanobiotechnology in the developments of medical biotechnology

Instructor	Number of Sessions Topics
Dr. Sabouri	4 theory
Dr. Gholoubi	7 theory
Dr. Rahimi	8 theory

Course Syllabus, Semester Program
First Semester 2024-2025: Ph.D. and M.Sc. (Department of Medical Genetics and Molecular Medicine)

Mechanism of Organ Repair and Tissue-Engineered Products (2 theoretical credits)

Course Coordinator: Dr. Rahimi

- **Course Name:** Mechanisms of Organ Repair and Tissue-Engineered Products
- **Credits:** 2
- **Type:** 2 theoretical credits
- **Prerequisite/Corequisite:** None
- **Course Code:** 28
  Overall Course Goal: Familiarity with the mechanisms of repair in the body's organs and tissue-engineered products.

Syllabus: (34 hours, theoretical)
Tissue-engineered products and their clinical applications, methods of construction, repair, and replacement of tissues: cardiovascular system, endocrine glands, gastrointestinal tract, hematopoietic system cells, kidney and urinary system, musculoskeletal system, nervous system, eye, ear, craniomaxillofacial and dental, respiratory system, skin, breast.
Tissue-engineered models for laboratory drug testing.
Familiarity with ethical issues in this course.

Student Evaluation Method:
Cumulative evaluation in each semester for each course will be conducted by the instructor(s) through a written exam. Questions will be in descriptive or multiple-choice format with the selection of the correct options. During the course sessions, instructors can evaluate students through midterm exams and seminar presentations, which will constitute a percentage of the final grades.

Instructor	Topics
Dr. Rahimi (9 sessions)	Cardiovascular, gastrointestinal, nervous, eye, and ear systems, kidney and urinary system, respiratory, and breast.
Dr. Sabouri (8 sessions)	Endocrine glands, hematopoietic, musculoskeletal system, skin, craniomaxillofacial, and dental.