University of Tehran

College of Science

School of Biology

Description of program and course syllabi

Genetics

Master of Science

Table 1- Required courses

Major: Genetics Program: Master of Science

No.	Course name	Units			Hours			Prerequisite
		Theoretical	Practical	Total	Theoretical	Practical	Total	
1	Advanced molecular genetics	2	0	2	32	0	32	None
2	Developmental genetics	2	0	2	32	0	32	None
3	Advanced genetic engineering	2	0	2	32	0	32	None
4	Principles of molecular and cellular methods	2	0	2	32	0	32	None
5	Human molecular genetics	2	0	2	32	0	32	None
6	Systems biology	2	0	2	32	0	32	None
Total		12	0	12	192	0	192	-

Students must take all 12 units in this table.

Table 2- Elective courses

Major: Genetics Program: Master of Science

No.	Course name	Units			Hours			Prerequisite
		Theoretical	Practical	Total	Theoretical	Practical	Total	
1	Nano-biotechnology	2	0	2	32	0	32	None
2	Genetics of behavior	2	0	2	32	0	32	None
3	Advanced statistics	2	0	2	32	0	32	None
4	Animal cell and tissue culture	2	0	2	32	0	32	None
5	Chromatin biochemistry	2	0	2	32	0	32	None
6	Mutagens and mutagenesis	2	0	2	32	0	32	None
7	Bioethics	2	0	2	32	0	32	None
8	Molecular phylogenetics and evolution	2	0	2	32	0	32	None
9	Oncologic transcription factors	2	0	2	32	0	32	None
10	Mechanisms of cell growth and cell cycle control	2	0	2	32	0	32	None
11	Epigenetics in health and disease	2	0	2	32	0	32	None
12	Advanced population and quantitative genetics	2	0	2	32	0	32	None
13	Microscopy methods	2	0	2	32	0	32	None
14	Cellular and molecular mechanisms of cancer	2	0	2	32	0	32	None
Sum		28	0	28	448	0	448	-

Students must take 14 units of this table, chosen with approval of the department.

Prerequisites for Master of Science degree in Genetics.

The student’s supervisor requires the student to take up to 12 units of lower level courses.

Topics of required courses

Major: Genetics

Program: Master of Science

Course title: Advanced molecular genetics
No. of units: 2
No. of hours: 32
Unit type: theoretical
Course type: required
Prerequisites: none
Additional training: yes
Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes
The overall objectives of the course:
Understanding advanced topics in molecular biology of eukaryotes
Topics of the course:

1- Genome structure, pseudogenes, reterogenes, tandem repeat sequences, dispersed repeat sequences.
2- Transposable elements in eukaryotes, bacterial transposons, corn transposons, TY elements in yeast, P and Copia elements in drosophila, retrotransposons.
3- Advanced topics on replication, origins of replication in yeast and multicellular eukaryotes, time of replication in eukaryotic cells.
4- Replication of viral genomes: adenoviruses, adeno-associated viruses, baculoviruses, SV40, papovoviruses.
5- Replication of viral genomes: Pox viruses, herpes viruses, picornavirus and tiny viruses.
6- Levels of gene expression regulation in eukaryotes.
7- Types of regulatory sequences (enhancers, insulators, silencers) and their functions.
8- Various types of promoters, transcription factors and proteins involved in transcription.
9- Gene expression regulation at the RNA level, eukaryotic RNA-specific processing.
10- Roles of small RNAs in gene expression regulation.
11- Transcription vis ā vis genome organization in the nucleus, chromosome territories, transcription factories.
12- Complementary issues on eukaryotic translation: initiation, elongation and termination.

Table of assessment

Continuous evaluation	Midterm	Final exam	Project
10%	**-**	**70%- written**	**20%**

References:

- Weaver R. F. 2011. Molecular biology. 5th edition. Mc Graw Hill.
- Strachan T and Read A. 2010.Human Molecular Genetics. 4th edition. Garlans science.
- Clark D. P. 2012. Molecular biology. Academic press. 2nd edition.

Course title: Developmental genetics
No. of units: 2
No. of hours: 32
Unit type: theoretical
Course type: required
Prerequisites: none
Additional training: yes

Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes

The overall objectives of the course:

Understanding the roles of genes in control of different embryonic processes from fertilization to organogenesis, and familiarization with genetic approaches used in developmental studies.

Topics of the course:

1- Introduction: introduction to developmental genetics, signaling pathways, stages of development in animals.
2- Study of genes functions: a review on molecular techniques used in developmental biology studies, reasons for choosing and advantages of various animal models, mutagenesis, transgenic and knock out animal production, study of mutants, study of gene function based on their spatial-temporal expression in a cell or organism, *in vitro* study of gene functions.
3- Differential expression of genes (control of gene expression): control at the level of DNA, RNA, and protein.
4- Genetic control of development in drosophila (determination of polarity in embryos)
5- Genetic control of development in drosophila (sex determination)
6- Genetic control of development in C. elegans.
7- Genetic control of development in C. elegans (sex determination)
8- Molecular mechanisms for stem cell differentiation in vertebrates.
9- Genetic regulation of development of limbs in vertebrates.
10- Genetic control of differentiation of muscle cells in vertebrates.
11- Genetic control of differentiation of neural crest in vertebrates.
12- Understanding birth defects by study of model organisms

Table of assessment

Continuous evaluation	Midterm	Final exam	Project
10%	**-**	**70%- written**	**20%**

References:

- Gilbert, S. F. 2013. Development biology, 10th edition, Sinauer associates.
- Moody S.A. 2014. Principle of developmental genetics. 2nd edition. Academic press.
- Slack J. M. W. 2012. Essential developmental biology. 3rd edition. Blackwell publishing.

Course title: Advanced genetic engineering
No. of units: 2
No. of hours: 32
Unit type: theoretical
Course type: required
Prerequisites: none
Additional training: yes

Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes

The overall objectives of the course:

Understanding of applications of gene cloning in research and biotechnology.

Topics of the course:

1- A review on basic topics of genetic engineering.
2- Study of gene expression and function, and detection and sequencing of transcripts, analysis of transcripts by primer extension, analysis of transcripts by PCR.
3- Study of gene expression regulation, identification of protein binding regions on DNA, gel retardations assay, foot-printing by DNaseI, identification of regulatory sequences by analysis of deletions.
4- Identification and study of the cloned gene products, HRT and HART, protein analysis by *in vitro* mutagenesis.
5- Genome, transcriptome and proteome studies.
6- Protein production from cloned genes, various vectors use for foreign gene expression in *E.coli*, problems related to recombinant proteins production in *E.coli*.
7- Recombinant proteins production in eukaryotic cells.
8- Gene cloning and DNA analysis in medicine, recombinant drug production, identification of genes responsible for disease in human, gene therapy.
9- Gene cloning and DNA analysis in agriculture, genetic engineering in plants, gene destruction, and issues related to modified plants.
10- Gene cloning and DNA analysis in legality issues and archeology, DNA analysis in forensics, the study of kinship, sex determinations, archeology genetics.

Table of assessment

Continuous evaluation	Midterm	Final exam	Project
10%	**-**	**70%-written**	**20%**

References:

- Brown T. A. 2010. Gene cloning. 6th edition. Wiley-Blackwell.
- Primrose S. B and Twuman R. 2016. Principle of gene manipulation and genomics. 8th edition. Wiley-Blackwell.
- Nichol D. S. T. 2008. An introduction to genetic engineering. 3rd edition. Cambridge university press.

Course title: Principles of molecular and cellular methods
No. of units: 2
No. of hours: 32
Unit type: theoretical
Course type: required
Prerequisites: none
Additional training: yes
Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes
The overall objectives of the course:
Understanding of principles of cellular and molecular biology methodology and application to research designs.
Topics of the course:

1- Methods of electron microscopy including scanning (SEM) and transmission (TEM).
2- Confocal, fluorescence, magnetic force, and atomic force microscopy.
3- Chromatography methods: adsorption chromatography, gas chromatography, gel filtration, ion exchange chromatography, affinity chromatography, hydrophobic interaction chromatography, focusing chromatography, normal phase chromatography, invert phase chromatography.
4- Regular and iso-density centrifugation for molecular separation and determination of molecular weight and sedimentation constants.
5- Denaturing and non-denaturing electrophoretic methods for nucleic acids and proteins, including various forms of one or two dimensional protocols used for separation and determination of molecular weights, and gel staining and detecting methods.
6- Blotting methods including southern, northern, western, dot blot, reverse dot blot, and their applications.
7- PCR and RT-PCR.
8- New nucleic acid sequencing including Sanger sequencing, pyrosequencing, sequencing based on mass spectrometry, second generation sequencing protocols, and third generation sequencing protocols.
9- Microarrays.
10- Absorption, emission, and differential spectroscopy methods including visible, ultraviolet, infrared, fluorescence, and circular dichroism spectroscopy.
11- Immunologic methods.
12- Equilibrium dialysis and filtration.
13- Genome study methods.

Table of assessment

Continuous evaluation	Midterm	Final exam	Project
10%	**-**	**70%-written**	**20%**

References:

- Semwogerenot D and Weeks E. R. 2005. Confocal microscopy in encyclopedia of biomaterials and biomedical engineering. IRL press.
- Current protocols in molecular biology, 2000-2006.
- Practical approaches. 2000-2006. IRL press.
- Methods in enzymology. 2000-2006. Academic press.

Course title: Human molecular genetics
No. of units: 2
No. of hours: 32
Unit type: theoretical
Course type: required
Prerequisites: none
Additional training: yes
Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes

The overall objectives of the course:

To teach students the molecular biology of human genetics in a manner that will facilitate the application of powerful novel methodologies developed in the past two decades to design and performance of research projects.

Topics of the course:

1- Overview of human genome projects: achievements and prospects for application.
2- Categorizing human diseases based on their genetic criteria.
3- Molecular structure of the human nuclear and mitochondrial genomes.
4- Monogenic human diseases: grouping and study methods.
5- Cytogenetics: study of human chromosomes and chromosomal anomalies.
6- Hemoglobin damages and molecular basis of hereditary diseases caused by abnormal hemoglobin.
7- Principles of human gene expression – genetics and epigenetics.
8- Biochemical genetics –congenital metabolic diseases and molecular basis of human monogenic diseases.
9- Physical and genetic mapping of the human genome; use of various types of polymorphisms in the genome.
10- Identification of disease genes and factors that cause hereditary predisposition to disease.
11- Laboratory methods used in genetic studies: amplification and manipulation of DNA, transgenic organisms, gene targeting, gene silencing.
12- Pharmacogenetics and personalized medicine.
13- Genetic approaches for treatment of diseases: drugs, recombinant proteins, vaccines, cell therapy, RNA and oligonucleotide therapy.

Table of assessment

Continuous evaluation	Midterm	Final exam	Project
10%	**-**	**70%-written**	**20%**

References:

- Strachan T and Read A. 2013. Human molecular genetics, 4th edition. Garland science
- Lewis R. 2009. Human genetics: concepts and applications. 9th edition. McGraw Hill higher education.
- Nussbaum R. L. McInnes R.R, Willard H. F. 2015. Thompson & Thompson genetics in medicine. 8th edition. Elsevier.

Course title: Systems biology
No. of units: 2
No. of hours: 32
Unit type: theoretical
Course type: required
Prerequisites: none
Additional training: yes
Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes
The overall objectives of the course:
Familiarization with systems biology topics.
Topics of the course:

1- Introduction to systems biology.
2- Understanding dynamic modeling, basic aspects of dynamic mathematical models, and examples of dynamic behavior in cell molecular biology.
3- Modeling of metabolic networks, nature of biochemical reaction networks, open and closed biochemical systems, and numerical simulation of the behavior of the solutions of differential equations, related to chemical reaction networks.
4- Separation of time scales and simplification of models assuming fast and steady-state equilibrium.
5- The kinetics of chemical reaction, Michaelis–Menten kinetics, kinetics of two-substrate reactions, positive and negative regulation of enzymatic reactions, cooperative effect.
6- Modeling of exchange and diffusion in cells and cellular membranes.
7- Analysis of dynamic systems, phase page, stability, oscillatory behavior, bifurcation and sensibility.
8- Metabolic networks, the modeling of metabolic fluxes, metabolic pathways, reconstruction of models of metabolic networks.
9- Stoichiometric analysis of metabolic networks, calculation of metabolic pathways and modeling based metabolic fluxes.
10- Analysis of signaling networks, signal amplification, ultrasensitivity, adaptation, irreversible memory and decision making.
11- Analysis of gene expression regulation networks, modeling of gene expression by dynamic systems, genetic switches.
12- Oscillatory gene networks, modeling of cellular communications, calculation of nodes based on gene expression regulation networks.

Table of assessment

Continuous evaluation	Midterm	Final exam	Project
10%	**-**	**70%-written**	**20%**

References:

- Ingalls B.P. 2013. Mathematical modeling in system biology: an introduction. MIT press.
- Szallasi Z, Stelling J, Periwal V. 2010. System modeling in cellular biology: from concepts to nuts and bolts. The MIT press.
- Klipp E, Liebermeister W, Wierling C, Kowald A. 2009. System biology. Wiley-blackwell.

Topics of elective courses
Major: Genetics
Program: Master of Science

Course title: Nanobiotechnology
No. of units: 2
No. of hours: 32
Unit type: theoretical
Course type: elective
Prerequisites: none
Additional training: yes
Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes
The overall objectives of the course: Familiarization with the interdisciplinary topics in the field of nanobiotechnology
Topics of the course:
1-what is nanobiotechnology?
2- Quantum physics
3- Mesoscopic scale physics
4- Size-dependent properties
5- Properties associated with electron gap
6- Properties dependent on surface plasmon resonance
7- Allotropes of carbon
8- Non-carbon-based nanomaterials (metals, ceramics and etc.)
9- Nanobiomaterial
10- Observation methods in nanobiotechnology
11- Convection methods in nanobiotechnology
12- Production methods in nanobiotechnology
13- Applications of nanobiotechnology in diagnosis and disease treatment
14- Applications of nanobiotechnology in agriculture and food
15- Applications of nanobiotechnology in environmental issues and industry
16- Nano-bio-safety considerations

Table of assessment

Continuous evaluation	Midterm	Final exam	Project
10%	**-**	**70%- written**	**20%**

References:

- Mirkin C. A. 2013. Nanobiotechnology I, Wiley-VCH.
- Markin C. A, Niemeyer C. M. 2007. Nanobiotechnology II: more concepts and applications harcover. Wiley-VCH.
- Niemeyer C. M, Mirkin C. A. 2004. Nanobiotechnology: concepts, applications and perspectives. Harcover. Wiley-VCH.
- Shoseyov O, Levy I. 2008. NanoBioTechnology. Human press 1st edition.

Course title: Behavioral genetics
No. of units: 2
No. of hours: 32
Unit type: theoretical
Course type: elective
Prerequisites: none
Additional training: yes
Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes
The overall objectives of the course:
Behavioral genetics is a branch of science that connects genetics with psychology. The main purpose of this course is introduction to the basics of behavioral genetics.
Topics of the course:

1- Introduction to behavioral genetics; review of organization and function of the nervous system.
2- Review of Mendelian genetics, basics of genetics, phenotypic diversity, heritability, complex traits.
3- Measuring behavior, sources of diversity.
4- Genetics of olfactory systems.
5- Genetics of gustatory systems.
6- Neurogenetics of sleep and activity.
7- Genetics of social interactions, courtship, mating and aggression.
8- Genetics of learning and memory.
9- Cognitive phenotypes: language.
10- Genetic of addiction: drugs, alcohol, cigarettes.
11- Twin based studies of personality.
12- Schizophrenia and other mental diseases.
13- Autism and neurodevelopmental disorders.
14- Evolution of behavior

Table of assessment

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10%	**-**	**70%- written**	**20%**

References:

- Plomin R, Defries J.C, KnopikV.S, Neiderhiser J. M. 2012. Behhavioral genetics, 6th edition. Worth publishers.
- Anholt R. R. H and Mackay T.F. C. 2010. Principles of behavioral genetics. 1st Ed. Academic press.

Course title: Advanced statistics
No. of units: 2
No. of hours: 32
Unit type: theoretical
Course type: elective
Prerequisites: none
Additional training: yes
Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes

The overall objectives of the course:

Understanding topics of advanced statistics relevant to biology.

Topics of the course:

1- The importance of statistics in biological sciences, concepts of sampling and measurements.
2- Frequency and cumulative frequency tables, central indices: mean, median, mode and relationships between these.
3- Indices of dispersion: domain, standard deviation, variance, and coefficient of variation.
4- Presentation of data: scatter, linear, column, pie, and histogram presentation; distributions; introduction to probability; binominal distribution.
5- Distribution index, choice of distribution model, binominal model, Poisson model, negative binominal model, the probability of crises.
6- Normal distribution, standard normal distribution (one tail and two tails), small samples, t distribution, investigation of normality of the data and conversion of non-normal data to normal data.
7- Sampling error, distribution of sample means, standard error of the mean.
8- Confidence interval of sample mean, difference between two means, estimation of population number, estimation of diversity index.
9- Basics of statistical tests, experimental and statistical hypothesis, one tail and two tail statistical tests, type I and II errors, parametric and non-parametric statistics, the power of a test.
10- Parametric tests: t-student test, t-paired test, analysis of variance.
11- Non-parametric tests: U Mann-Whithney test, Wilcoxon signed-rank test, Kruskal–Wallis test, and Kolmogorov–Smirnov test.
12- Correlation test, correlation coefficient, coefficient of determination, and application of correlations.
13- Introduction to regression, models in regression, linear regression equation and testing of linear regretion.
14- Linear models, ANOVA, analysis of regression, correlation and analysis of covariance (ANCOVA), generalized linear models, mixed effect model.
15- Understanding and analysis of multivariate data.

Table of assessment

Continuous evaluation	Midterm	Final exam	Project
10%	**-**	**70%- written**	**20%**

References:

- Whitlock M and Schulter D. 2015. The analysis of biological data. Roberts and Co. 2nd edition.
- McDonald J. H. 2015. Hand book of biological statistics.
- Ekstrom C. T and Sorensen H. 2010. Introduction to statistical data analysis for the life sciences. CRC press.

Course title: Animal cell and tissue culture
No. of units: 2
No. of hours: 32
Unit type: theoretical
Course type: elective
Prerequisites: none
Additional training: yes
Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes

The overall objectives of the course:

Understanding animal cell and tissue culture principles and methodology.

Topics of the course:

1- Advantages and limitations of cell and tissue cultures, differences between *in vitro* and *in vivo* studies, different type of cultures.
2- Physical and chemical characteristics of culture media, salt solution media, complete media, supplements, serum and its components, serum types and choosing the right serum.
3- Serum-free medium, pros and cons of serum, replacement of serum and selection of serum-free medium.
4- Cell culture experiment design, introduction of characteristics of culture room, sterilization of media.
5- Primary culture and its various types, biopsy, primary culture techniques.
6- Cell line subculture, passage and proliferation, cellular selection, comparison of primary cell and cell line growth patterns (growth curve), cell freezing and number of passages.
7- Cell detachment, cell density, cell adhesion strength and its basis, adhesion molecules and antibody-based cell identifying techniques.
8- Cell morphology, chromosomal contents, cell line karyotypes, immortality and oncogenecity (transformation), transformation affecting agents (viruses and carcinogens).
9- Tumor cell culture and its challenges, determination of culture characteristics and types.
10- Cell culture contamination and its sources, detection of contamination type through changes in culture medium pH and acidity.

Table of assessment

Continuous evaluation	Midterm	Final exam	Project
10%	**-**	**70%- written**	**20%**

References:

- Masters, J. R. W. 2000. Animal cell culture. Oxford university press.
- Freshnney I. 2005. Animal cell culture. Wiley Liss pub.
- Khansari, N and Shamshiri M. 1995. Animal cell culture basic methods. National Institute of Genetic Engineering and Biotechnology. 1th edition.

Course title: Chromatin biochemistry
No. of units: 2
No. of hours: 32
Unit type: theoretical
Course type: elective
Prerequisites: none
Additional training: yes
Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes
The overall objectives of the course:
Learning chromatin structure and function from biochemical point of view.
Topics of the course:

1- Chromatin, chromosome, light chromatin, dense chromatin, chromatin constituents.
2- Histones: general features, classification, specific features, primary, secondary and tertiary level of structures.
3- Five main histone proteins: H1, H2A, H2B, H3, H4 conservation and Bradbury model.
4- Interactions with and influences of environmental factors on histone and chromatin structure, histone coding genes.
5- Histone modifications and citrullination.
6- Impacts of one histone modification on other histone modifications and on chromatin structure and function.
7- Non-histone proteins: Low mobility groups (LMGs).
8- Non-histone proteins: High mobility groups (HMGs).
9- Nucleosome structure, nucleosome remodeling and its effective factors.
10- Heterochromatin, euchromatin, chromatin structure and cell cycle.
11- Factors that affect Chromatin condensation and decondensation.
12- Role and importance of chromatin structure in gene regulation.
13- Changes in chromatin structure during cellular aging / telomers.
14- Histone like proteins and protamines.
15- Current topics about the biochemistry of chromatin.
16- Seminars.

Table of assessment

Continuous evaluation	Midterm	Final exam	Project
10%	**-**	**70%- written**	**20%**

References:
- Li H. J and Eckhardt R. 2012. Chromatin and chromosome structure. Academic Press.
- Turner B. M. 2001. Chromatin and gene regulatory mechanisms in epigenetics. Blackwell.
- Ballard T. D, Wolff J, Griffin J. B, Stanley J. S, Calcar S. V, Zempleni J. 2002. Biotidinase catalyses debiotinylation of histones. Eur. J. Nutr., 41:78-84.
- Healy S. H, Heightman L, Schriemer d, Gravel R. A. 2009. Nonenzymatic biotinylation of histone H2A. Protein Sci., 18(2): 314-328.
- Orgy B and Ebet E. 2006. Citrullination: A post-translational modification in health and disease.

Course title: Mutagens and mutagenesis
No. of units: 2
No. of hours: 32
Unit type: Theoretical
Course type: elective
Prerequisites: none
Additional training: yes
Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes
The overall objectives of the course:
Introduction to intracellular and extracellular materials that change the DNA sequence and safety observance in dealing with mutagens in biological researches.
Topics of the course:

1- Various types of genetic mutations and their effect on gene expression and function of gene products.
2- Mutation rates and calculation of mutation rates.
3- Physical mutagens.
4- Chemical mutagens (known chemical mutagens generated by industrial factories and environmental pollutants).
5- Review of DNA repair mechanisms and spontaneous mutations.
6- Translesion DNA synthesis, SOS system in *E.coli*, eukaryotic repair systems.
7- Genetic syndromes attributed to DNA repair systems.
8- Laboratory techniques for detection of genetic mutations.
9- Use of mutagens in cancer therapy.
10- Application of mutagens and mutagenesis experiments in biologic research.

Table of assessment

Continuous evaluation	Midterm	Final exam	Project
10%	**-**	**70%- written**	**20%**

References:
- Friedberg E. C, Walker G. C, Siede W, Wood R. D. 2005. DNA repair and mutagenesis. 2nd edition. American society for microbiology press.
- Collins H. 2011. Mutagenesis. Niantic Press. 2nd edition.

Course title: Bioethics
No. of units: 2
No. of hours: 32
Unit type: Theoretical
Course type: elective
Prerequisites: none
Additional training: yes
Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes
The overall objectives of the course:
Studying and explaining the ethical and legal considerations in biology.
Topics of the course:

1- History of ethics in biological sciences, medical ethics in Babel, Greece, and ancient Persia. Medical ethics in Islam and Islamic Iran.
2- Ethics and human biology, buying and selling of human biological samples, sending native biological samples abroad for research goals.
3- Testing (recombinant or non-recombinant) drugs in humans.
4- Human cloning and human stem cell cloning
5- In vitro fertilization and epigenetic diseases.
6- Legal issues in biology, dealing with patient information in biological research.
7- Registration of biological discoveries and live organisms generated by biological researches.
8- Ethics in plant biology, genetic manipulation of plants, production of effective materials of medicinal herbs and release of transgenic plants in ecosystems.
9- Ethics in animal biology, generation of genetically modified animals, animal cloning and release of transgenic animals in ecosystems.
10- Ethics in microbiology, use of microorganisms in ecosystems, consequences of manipulation of microorganisms and ethics, use of nanoparticles

Table of assessment

Continuous evaluation	Midterm	Final exam	Project
10%	**-**	**70%- written**	**20%**

References:
- Sanati M. H. 2002. Ethics in biotechnology. National Institute of Genetic Engineering and Biotechnology Press.
- The Cartagena Protocol on Biosafety to the Convention on Biological Diversity.
- Jafari Tabrizi M. T. 2011. The human genome project: including the declaration of the conference on survival in the 21th century. The Ostad Jafari Institute Corporation.
- Maienschein J, Michaeal R. 1999. Biology and the foundations of ethics. Cambridge studies in philosophy and biology.

Course title: Molecular phylogenetics and evolution
No. of units: 2
No. of hours: 32
Unit type: Theoretical
Course type: elective
Prerequisites: none
Additional training: yes
Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes

The overall objectives of the course:

The aim of this course is to familiarize students with basic methods in phylogenetic analysis and its application in fields such as comparative biology, systematics, and molecular evolution.

Topics of the course:

1- Introduction to phylogenetic analysis: trees, traits, cladistics, parsimony.
2- Parsimony: reconstruction of traits, size and other characteristics of trees, algorithms for construction of trees, homoplasia, weighted parsimony, consensus trees.
3- Distance based methods: Nucleotide and protein evolution models, UPGMA method, neighbor joining methods.
4- Sequence alignments, distances, gap coding, Clustal software, MALIGN software, POY software
5- The theory and methodology of maximum similarity, long branch attraction problem, phylogenetic methods, model selection and fitness.
6- Bayesian inference: MrBayes software, BEAST software.
7- Hypothesis testing: Comparison of trees and statistical tests, parametric bootstrap.
8- Heterogeneity of data, homogeneity testing, mixed models.
9- Gene trees, species trees, mixture.
10- Lineage sorting and multi-locus methods.
11- Evolutionary rates and divergence dates: Relative-rate tests, regulation of molecular clock.
12- Comparative analysis, concentrated changes test, independent comparison, ancestral reconstruction of continuous traits.
13- Phylogenomics, coevolution, cophylogeny.

Table of assessment

Continuous evaluation	Midterm	Final exam	Project
10%	**-**	**70%- written**	**20%**

References:

- Felsenstein J. 2003. Inferring phylogenies. Sinauer Associates.
- Nei M and Kumar S. 2000. Molecular evolution and phylogenetics. Oxford university press.
- Salemi M and Vandamme A. 2003. The phylogenetic handbook: A practical approach to DNA and protein phylogeny. Cambridge university press.

Course title: Cancerogenic transcription factors
No. of units: 2
No. of hours: 32
Unit type: Theoretical
Course type: elective
Prerequisites: none
Additional training: yes
Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes
The overall objectives of the course:
To familiarize students with roles of transcription factors in cell hemostasis and changes in their activities at the onset and during progression of carcinogenesis using cell lines, animal models, development models, and data from tissues from cancer patients.
Topics of the course:

1- Review of DNA transcription, regulatory elements and DNA binding motifs of transcription factors.
2- Laboratory assays for evaluation of transcription factors activities (cellular and cell free systems).
3- Steroid hormone receptors.
4- Homeodomain transcription factors.
5- E2F protein.
6- p53 protein.
7- Proteins of TCF/LEF family.
8- NF-kB protein.
9- STAT proteins
10- c-Myc protein.
11- c-Jun and c-Fos (AP1) proteins.
12- Transcription factors as good targets for clinical studies.
13- Seminars

Table of assessment

Continuous evaluation	Midterm	Final exam	Project
10%	**-**	**70%- written**	**20%**

References:
- Bruce A. 2014. Molecular Biology of the cell. 6th Edition. Garland Science. Chapters 7 and 8.
- Weaver R. F. 2011. Molecular Biology. 5th Edition. McGrow Hill. Chapters 10 and 13.
- Gilbert S. F. 2000. Developmental Biology. 6th Edition. Sinauer Associations. Chapter 4.
- Review articles about transcription factors.

Course title: Cell growth and cell cycle control
No. of units: 2
No. of hours: 32
Unit type: Theoretical
Course type: elective
Prerequisites: none
Additional training: yes
Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes

The overall objectives of the course:

Enhanced understanding of the mechanisms of cell growth and cell cycle control in eukaryotes.

Topics of the course:

1- Cell growth vs. cell proliferation.
2- Control of cell size in yeast.
3- Molecular mechanisms of cell growth and its control in plant and animal cells.
4- Signaling pathways (such as PI3kinase/AKT/mTOR), synthesis of nucleotides and ribosomes.
5- Role of GSK-3b enzyme in control of cell growth and glycogen metabolism.
6- History of identification of molecular mechanism of cell division in yeast.
7- The cell cycle in animal cells.
8- Mitogenic signaling pathways and checkpoint control.
9- G1/S transition control and G0 phase.
10- S phase control.
11- G2/M transition control.
12- Cellular aging (senescence).
13- Animal models of cell cycle.

Table of assessment

Continuous evaluation	Midterm	Final exam	Project
10%	**-**	**70%- written**	**20%**

References:

- Lodish H, Berk A, Kaiser C. A., Krieger M, Bretscher A, Ploegh H, Amon A, Scott M.P. 2012. Molecular Cell Biology. W. H. Freeman and Company. 7th Edition.

Course title: Epigenetics in health and disease
No. of units: 2
No. of hours: 32
Unit type: Theoretical
Course type: elective
Prerequisites: none
Additional training: yes
Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes
The overall objectives of the course:
Understanding the roles of epigenetics mechanisms in the etiology of human diseases.
Topics of the course:

1- Overview: the role of epigenetic mechanisms in regulation of genes expression (DNA methylation, histone modifications, histone variants, chromatin modifying enzymes, chromatin remodelers and non-coding RNAs, chromatin organization in the nucleus)
2- Nutrition, epigenome and gene expression regulation.
3- Stress, epigenome and gene expression regulation.
4- Xenobiotics and epigenetics modifications.
5- Transgenerational epigenetic inheritance.
6- Early life experiences, epigenetic modifications and behavior in adulthood
7- Epigenome of monozygotic and dizygotic twins.
8- Epigenetics and developing of sexual dimorphism in normal and abnormal brain structure and function.
9- Epigenetic mechanisms in learning and memory.
10- Epigenetic modifications and molecular targets in mental disorders and neurodegenerative diseases.
11- Seminars. Possible topics: Epigenetics of obesity and diabetes, epigenetics of cancer, genome imprinting defects and diseases, epigenetics of autoimmune diseases, epigenetics of cardiovascular diseases and epigenetics of renal diseases.

Table of assessment

Continuous evaluation	Midterm	Final exam	Project
10%	**-**	**70%- written**	**20%**

References:

- Armstrong L. 2014. Epigenetics, Garland Science.
- HO E and Domann F. 2015. Nutrition and Epigenetics. CRC press.
- Naumova A. K and Greenwood C. M. T. 2013. Epigenetics and complex traits. Springer.
- Petronis A and Mill J. 2011. Brain, Behavior, and epigenetics. Springer.
- Ballestar E. 2011. Epigenetic contribution in autoimmune disease. Springer.

Course title: Advanced population and quantitative genetics
No. of units: 2
No. of hours: 32
Unit type: Theoretical
Course type: elective
Prerequisites: none
Additional training: yes
Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes
The overall objectives of the course:
Understanding mechanisms involved in shaping intra-population and inter-population diversities. Recent developments in studying of whole human genomes relevant to population genetics.
Topics of the course:

1- Introduction: Phenotypic and genotypic diversities in natural populations, monogenic inheritance against polygenic inheritance (quantitative inheritance).
2- Sources of variations.
3- Contribution of sexual reproduction to population variation.
4- Selection (natural and artificial).
5- Hardy-Weinberg principles, required conditions for genetic equilibrium.
6- Gene linkage and linkage disequilibrium.
7- Genetic drift, stochastic changes in the gene frequencies
8- Inbreeding
9- Migration and gene flow
10- Molecular evolution
11- Quantitative traits and heritability
12- Quantitative trait loci mapping
13- Population genomics
14- Population genetics and human diseases

Table of assessment

Continuous evaluation	Midterm	Final exam	Project
10%	**-**	**70%- written**	**20%**

References:

- Hartl D. L and Clark A.G. 2006. Principles of population genetics. 4th edition. Sinauer Associates.
- Falconer D. S and Mackay T. F. C. 1996. Introduction to quantitative genetics. 3rd edition. Longman scientific and technical.
- Manjit S. K. 2002. Quantitative genetics, genomics and plant breeding. Oxford university press.
- Hamilton m. 2009. Population genetics. Chichester, Wiley-Blackwell.
- Gillespie G. H. 2004. Population genetics: A concise guide. 2nd edition. The Johns Hopkins university press.

Course title: Methods of microscopy
No. of units: 2
No. of hours: 32
Unit type: Theoretical
Course type: elective
Prerequisites: none
Additional training: yes
Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes
The overall objectives of the course:
Understanding the structure and applications of various types of microscopes and sample preparation methods
Topics of the course:

1- Basic physical principles of modern microscopy methods.
2- An introduction to optics.
3- The basics of image formation.
4- Optical microscopy methods.
5- The basics of fluorescence and digital imaging.
6- Transmission and scanning electron microscopy.
7- Wave emission, lens distortion and distortion correction.
8- Electron probes and probe fabrication, electron scattering and dynamic theory.
9- Electron optics and spectrometers.
10- The basics of confocal microscope and related techniques.

Table of assessment

Continuous evaluation	Midterm	Final exam	Project
10%	**-**	**70%- written**	**20%**

References:
- Rogers K. 2006. The Usborne complete book of the microscope.
- Williams D. B. 2009. Transmission electron microscopy: A textbook for materials science. Springer.
- Bhushan B. 2011. Scanning probe microscopy in nanoscience and nanotechnology.
- Pawley J. B. 2012. Handbook of biological confocal microscopy. Springer.

Course title: Cellular and molecular mechanisms of cancer.
No. of units: 2
No. of hours: 32
Unit type: Theoretical
Course type: elective
Prerequisites: none
Additional training: yes
Scientific expedition: no **Workshop:** no **Lab:** no **Seminar:** yes
The overall objectives of the course:
Understanding the cellular and molecular mechanisms of cancer
Topics of the course:

1- Introduction: Steps of transformation of a normal cell into a cancerous cell; molecular characteristics of cancerous colorectal tissue.
2- Molecular mechanisms of epithelial- mesenchymal transition (EMT).
3- Intercellular junctions and their relevance to cancer.
4- Deregulation of the G1/S phase transition in cancer
5- Deregulation of the G2/M phase transition in cancer
6- Senescence and cancer
7- Apoptosis and cancer.
8- Oncogenes and mechanisms of oncogene activation in human cancers.
9- Tumor suppressor genes and mechanisms of tumor suppressor gene inactivation in human cancers.
10- Major signal transduction pathways and mechanisms of their deregulation in human cancers.
11- Genetic instability in cancer.
12- Cellular and molecular mechanisms of angiogenesis in tumors.
13- Cellular and molecular mechanisms of metastasis.
14- New approaches in human cancer therapy.
15- Seminar

Table of assessment

Continuous evaluation	Midterm	Final exam	Project
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References:
-Volgelstein B and Kinzler K.W. 2002. The genetic basis of human cancer. McGraw Hill. 2nd edition.
- Research and review articles. (Nature reviews).