In the name of God

Tehran University

Institute of Biochemistry & Biophysics

Course Descriptions
Courses: Masters and Ph.D.
Field: Biophysics

Course title: Biophysical Chemistry
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☑ Ph.D. ☑ MSc & Ph.D. ☐

Course Objectives:

The aim of this course understands of protein ligand binding from theory to experimental actions. This course expresses the biomacromolecular interactions and discusses extensively different binding isotherms for protein binding sites analysis. In this course discuss vastly concerning different methods of protein denaturation.

Headlines:

- Characterization of biomacromolecules
- Understanding the inter and intra-molecular forces for biomacromolecules
- Protein structure function relationship
- The importance of Protein denaturation
- Description on all forms of protein denaturations
- Protein ligands binding
- Theoretical insights into protein–ligand binding
- Identification of Protein–Ligand Binding Sites
- Protein–Ligand Binding linkages
- Protein usual and unusual binding isotherms and various analysis by Scatchard and Hill plots
- The philosophy and mechanism for Protein cooperative and non-cooperative binding sites
- Hemoglobin and myoglobin oxygen binding affinity and analysis by binding isotherms and Hill plots
- The applications of binding isotherms for diagnostic tests

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
10%	_____	Written Test: 90%	__ _____
		Practical: -	

References:

1. J. Wyman and S.J. Gill, "Binding and linkage", University Science Book, California, 1990.
2. R. Chang, "Physical chemistry with application to Biological system", MacMillan publishing Co., New York, 1981.
3. G.U. Nienhaus, "Protein-Ligand Interaction" Humana Press, New Jersey, 2005.
4. D. Freifelder, "Physical Biochemistry, Applications to Biochemistry and Molecular Biology, Publisher: W. H. Freeman, 2nd edition , 1983
5. A.A. Moosavi–Movahedi and et al. " Protein Structure", University of Tehran Press, In Persian, 2004

Course title: Radiation Biophysics
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☑ Ph.D. ☑ MSc & Ph.D. ☐

Course Objectives:

The goal of this course is to familiarize students with physical and mathematical foundations of radiation, including particle rays and electromagnetic radiation, and the way energy is transmitted by these beams and their interaction with their surroundings.

Headlines:

- Introduction to radiation
- Electromagnetic waves
  - Electrical and magnetic fields and their effects on biomaterials
  - Electromagnetic waves and their effects on biomaterials
  - X radiation: Sources and effects on biomaterials
- Atomic structure and isotopes
  - Atomic structure
  - Nuclear structure
  - Radioactivity
  - Particle radiation
- Matter – Photon interaction
  - Photo electric
  - Compton effect
  - Pair production
- Matter - Particle radiation interaction
  - Energy transfer
  - Heavy particles – environment interaction
- Radiation detection
- Dosimetry
- Radiation protection

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
10%	_____	Written Test: 90% Practical: -	__ _____

References:

1. Helmut Wiedemann, ed. “Electron-Photon Interaction in Dense Media” Kluwer Academic Publisher (2002).
2. E. L. Alpen, "Radiation Biophysics," Academic Press (1998).
3. J. Turner, Atoms, Radiation, and Radiation Protection, 2nd Ed., John Wiley&Sons, Inc. (1995).
4. D.W. Anderson, “absorption of Ionizing Radiation”, Universtiy Park Press (1984).

Course title: Membrane Biophysics
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☑ Ph.D. ☑ MSc & Ph.D. ☐

Course Objectives:

Considering the biological membranes acting as the first barrier and center for the processing of the incoming information and triggering signals, the current course has tailored to address the fact by discussing structure and function of the biological membranes, and defining corresponding electronic elements and systems for further quantitative modeling and evaluation purposes. In this course, different physical, electrical, mechanical and chemical characteristics as well as techniques to study the membrane and constituted proteins are discussed. Understanding the mentioned aspects provides the basis to learn different mechanisms involved and assists one to monitor and manipulate the malfunctioning ones in different related diseases and also to apply them for design of biosensors.

Headlines:

- Water and biological buffers
  - Structures and dynamics of water molecules
  - Polarity, dielectrics, spatial and temporal charge distributions
  - Viscosity, density, molecular phases, Kosmotrope and Chaotropes
  - Thermodynamics, energy transfer and heat capacity
  - Conductivity, transmittance, compressibility, electron hopping, electron wire
  - Hydration
- Lipids
  - Hydrophilicity and hydrophobicity
  - Structures and dynamics
  - Distributions in different part of membranes and cells
  - Micelles, CMC, surfactants, Hysteresis, Kraft point
  - Conductivity, turbidity, surface tension
  - Heat, pressure, water ratio and ionic strength effects
  - Phases (L, H, Q), polymorphisms
- Biological and artificial lipid membranes
  - Structure and dynamics
  - Lipid and protein distributions, rafts, micro-domains

- Lateral, rotational, translational diffusion, flip flop
- Fluidity, thickness, order, packing
- Protein translocation, folding, protein-lipid interaction,

- Interfaces, means of diffusion and transportation
  - Diffusion and electro-transference and permeation
  - Osmosis, electro-osmosis, hydrostatic permeation
  - Ion channels, carriers, pumps, pores
  - Selectivity, specificity, flux rate
- Bio-electric and biomechanics of lipid membranes
  - Capacitance, conductance, dielectric, surface charge density, breakage voltage
  - Potential layers (Stern, Helmholtz, Deby-Huckle)
  - Membrane potentials (Donnan, Nernst, Zeta, Goldman-Hodgkin-Katz)
  - Effects of electric, magnetic, electromagnetic and ultrasonic fields
- Theoretical and practical techniques
  - Artificial planar bilayer, supported bilayer, liposomes,
  - Liposome Swelling Assay (LSA), Langmuir, Electroporation
  - Fluorescent Recovery after Photobleaching (FRAP)
  - AFM, STM, ssNMR,
  - Patch clamp, Voltage clamp, Pat, Electophysilogic data acquisition
  - MatLab, MD, HOLE, CHARMM, Hydropathy, RasMol, Protein Explorer
- Applications of the discussed subjects
  - Drug and gene delivery (Packaging, smart and targeted delivery and release)
  - Tissue engineering and cell membrane fusion, repair (Wound healing, SCI, …)
  - Complimentary medicine (Biophysical application of Laser, electric, magnetic, electromagnetic, IR and plasma for pain relief, drug delivery, surgery, and monitoring of targeted cell and organ)
  - Immunotherapy (Allergy and Ab-Ag interactions, kits, monitoring, treatments)
  - Biosensors design and fabrication (Based on membrane and reconstituted proteins)

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
60%	_____	Written Test: 40%	__ _____
		Practical: -	

References:

1. Jones, M.N. and Chapman, D. (1995), Micelles, Monolayers. And Biomembranes
2. Tien, T.H. (2000) Membrane Biophysics
3. Kotyk A. Jemacek (1996) Biophysical Chemistry of Membrane Functions

4. Hoppe W. (1983) Biophysics
5. Aidley, D.J. and Stanfield, P.R. (1996) Ion Channels, Molecules in Action
6. Silver, B.L. (1985) The Physical Chemistry of Membranes
7. Weiss T.F. (1996) Cellular Biophysics: Vol I, MIT Press

Course title: Molecular Biophysics
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☑ Ph.D. ☑ MSc & Ph.D. ☐

Course Objectives:

The purpose of this course is to familiarize students with the principles governing the formation and structure of biological macromolecules. In this course, in addition to familiarity with the topic of interactions between atoms and molecules, familiarity with the experimental methods of determining the structure of macromolecules is also introduced.

Headlines:

- Introduction: Biophysical definitions
- Chemical and physical links:
  - Covalent and ion bond
  - Types of inter-molecular forces
  - Special water structure
  - Hydrophobic interactions and their role in molecular self-healing
- Physics of biomercromycles
- The structure of the first type of proteins
- Physical methods of determining the structure
- The structure of the second type of proteins
- The structure of the third type of proteins
- The structure of nucleic acids
- The first structure in DNA and RNA
- Second and third structures in DNA and RNA

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
10%	_____	Written Test: 90% Practical: -	__ _____

References:

1. Jackson, M.B., Molecular and Cellular Biophysics, Cambridge University Press, 2006
2. Volekenstein, MV, Molecular Biophysics, Academic Press, New York, 1977.

Course title: Methods of Biophysics
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☑ Ph.D. ☑ MSc & Ph.D. ☐

Course Objectives:

The aim of this course is that the students could become familiar with those physical methods which are applicable in separation, and identification of bio-macro-molecules specially proteins and enzymes. In this course in addition to the theoretical base of each method, their limitation and potential for studding the bio-macro-molecules is taught.

Headlines:

- Chapter I: chromatography
  - Thin layer chromatography: The method for preparation of thin layers, sample preparation and replacement on thin layer, localization and detection of the ingredients beside the examples for separation of lipids, amino acids and natural substances
  - Column chromatography: Classification based on the phases and mechanism of action, linear chromatography and their deviations, theory of chromatography (theory of theoretical plates, theory of speed) column efficiency and the related factors, resolution, Van Dimter Equation and factors contributing to the widening the peaks, Scale up of column chromatography
  - Liquid chromatography and high performance liquid chromatography: System components including pumps and solvent gradient, stationary phase, the factors affecting on the separation yield such as grain and functional group
  - Application of liquid chromatography in protein separation:
    - Ion exchange chromatography, Ion exchange polymers, factors affecting on protein separation such as ionic strength, pH and pI
    - Focusing chromatography, chromatography based on hydrophobic interactions, covalent binding chromatography, affinity chromatography, supercritical fluid chromatography
  - Detectors for LC & HPLC: UV-Vis, electrochemical and Mass
  - Gas chromatography: System components, the open column and their functions, the error caused by injection, narrowing of the bands by split and splitless injections, solvent trappings, detector for GC (FID, TCD, ECD), advantages and limitations
- Chapter II: Electrophoresis for proteins and nucleic acids separation:

- The factors affecting on the electrophoresis performance such as electrophoretic mobility, field, charge, time and temperature
- Operation of electrophoresis: Buffer systems (continuous and batch), band sharpening (Stacking), the medium for electrophoresis (buffer, paper, starch, polyacrylamide and agar)
- Methods of electrophoresis: PAGE for separation of proteins in natural structure, SDS-PAGE for determination of molecular weight, gradient gel electrophoresis, isoelectric focusing, two-dimensional electrophoresis, capillary electrophoresis, pulsed field gel electrophoresis for separation of nucleic acids, blotting for transmission of bands

- Chapter III: Mass Spectrometry
  - Mass as a detector for LC, HPLC, GC and electrophoresis
  - Mass techniques: (a) magnetic sector, (b) chemical ionization, (c) time of flight spectrometry, (d) quadrupole Mass: the principles of separation and detection, patterns to identify the molecular ions and other molecular components, examples of applications
- Chapter IV: UV-Vis spectroscopy for amino acids and proteins
  - Electron excitation in UV-Vis wavelength, the Bear low and its applications and limitations, types of chromophores in organic compounds, proteins and nucleic acids, the instrumentation of single-beam, dual-beam and Diode Array
  - Determination of protein concentration and studying the factors affecting the UV-Vis absorption such as solvent, temperature, molecular orientation, pH and ligand
- Chapter V: Fluorescence spectroscopy
  - The theory of fluorescence: The excitation, relaxation and fluorescence processes, resonance bands and Stokes shift, quantum yield, relationship between the excitation and fluorescence spectra, the correlation between fluorescence and structure of aromatic compounds, the relationship between concentration and fluorescence intensity,
  - Application of fluorescence for studying the protein conformation, comparing the fluorescence and UV-Vis instrumentation, Intrinsic fluorescence of amino acids and proteins, examples
- Chapter VI: Circular Dichroism (CD) spectroscopy
  - Physical basis of circular dichroism, plain and circularly polarized light, optical activity
  - Instrumentation of CD
  - Studies of protein structure: CD of the far UV (peptide bond), the near UV (aromatic amino acids), visible and near UV (cofactor and ligand), the study of the process of protein folding and unfolding
- Chapter VII: Surface Plasmon Resonance
  - Physical principle
  - Application in the analyzing the following bio-macromolecules interactions:
    - Protein-Ligand
    - Protein-Protein
    - Protein-DNA

- Protein-Membrane
- Antibody-Antigen

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
10%	_____	Written Test: 90%	__ _____
		Practical: -	

References:

1. Daniel C. Harris, Quantitative Chemical Analysis, 7th Edition, W H Freeman & Co (2006) - ISBN 0716761254
2. Douglas A. Skoog, F. James Holler, Stanley R. Crouch, Principles of instrumental analysis - Thomson Brooks/Cole (2007), 1039 pages - ISBN 0495012017
3. Bengt Nolting, Method in Modern Biophysics, (2003) Springer.

Course title: Enzymes Kinetics
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☑ Ph.D. ☑ MSc & Ph.D. ☐

Course Objectives:

To familiar students by kinetics of enzymatic simple and complex reactions; Ligand binding of metal ions and small molecules to an enzyme and their effects on the catalytic activity of the enzyme; Design and study of inhibitors for enzyme.

Headlines:

- Chapter 1: Kinetics of enzymatic simple reactions
  - Kinetics of enzymatic reaction by one active site
  - Rapid equilibrium and steady state methods
  - The initial rate and the Michaelis-Menton equation
  - limitations of the Michaelis-Menton equation
  - Enzymatic assays
  - Graphical methods to determine the enzymatic kinetic constants
  - Dixon method to determine the enzymatic kinetic constants
  - Michaelis constants for substrates and products and the overall speed of reaction
  - Enzymes dimorphism (active and passive)
- Chapter 2: Kinetics of enzymatic reactions by several active sites
  - Kinetics of enzymatic reactions by several identical and noncooperative active sites
  - Kinetics of enzymatic reactions by several identical and cooperative active sites: Hill equation
  - Kinetics of enzymatic reactions with two substrates (Random and ordered mechanism)
  - Kinetics of enzymatic reactions with two substrates (Ping pong mechanism)
- Chapter 3: Kinetics reactions of enzyme inhibition
  - Reversible and irreversible inhibitors
  - Partial and complete inhibitors
  - Competitive, noncompetitive, uncompetitive and mixed type inhibitors
  - The General Theory of inhibitory
  - The degree of inhibition and activity of an enzyme
  - Substrate and product inhibition of the enzyme
  - competition between two different inhibitor and substrate

- Enzyme inhibition by different binding sites
- Application of isothermal titration calorimetry in studies of enzyme inhibition

- Chapter 4: Kinetics of enzyme reactions by activator
  - Essential and nonessential activators for an enzyme
  - Substrate activators
  - Competition of activation by inhibitor in enzymatic reactions
  - The General Theory of enzyme inhibition and activation
- Chapter 5: Effects of temperature and pH on kinetics of enzymatic reactions
  - The effect of temperature on the enzyme activity
  - The activation energy and Arrhenius equation.
  - Effects of buffer and acidity (pH) environment on the enzyme activity
  - Kinetics of inactivation of the enzyme by affected of pH
  - Logarithmic plots of Dixon - Web
  - The effect of pH on the acid and base groups effective on the enzyme activity
  - inhibition of the enzymatic reaction by changing the pH

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
10%	_____	Written Test: 90%	__ _____
		Practical: -	

References:

1. Enzyme Kinetics, I. H. Segel, John Wiley & Sons, New York, 1993.
2. Enzyme Kinetics: Principles and Methods, H. Bisswanger (Translated by L. Bubenheim), Wiley, Weinheim: Germany, 2002.
3. Enzyme Kinetics, V. Leskovac, Plenum Pub., New York, 2003.
4. Enzymes & Their Inhibitory: Drug Development, H. J. Smith and C. Simons, CRC Press, Boca Raton, 2005.
5. Enzyme Kinetics, Ali Akbar Saboury and Ali Akbar Moosavi-Movahedi, University of Tehran Press, 2006 (Persian Book)
6. Articles published during recent 10 years in the subject of enzyme kinetics.

Course title: Glycolipobiology
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☐ Ph.D. ☑ MSc & Ph.D. ☐

Course Objectives:

Familiarity with the Structure and Importance of Glycoproteins and Proteolipids in Biology and Major Applications in Biology of Glycans and Lipoproteins

Headlines:

- Introduction: Biological role of Glycan
- The diversity and common structural features of glycoproteins and glycolipids
- Cell position(s) of Glycosylation of proteins in different physiological conditions
- Enzymes involved in glycosylation of proteins
- Glycans detecting proteins, their categorization and their diagnostic principles
- The most modern methods of structural analysis of glycoproteins and glycolipids
- Glycans involvement in bacterial, viral and other human diseases, especially cancer and metastases
- The position of Glycans in the pharmaceutical industry
- The position of biotechnology in the production of Glycans

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
20%	_____	Written Test: 80%	__ _____
		Practical: -	

References:

1. Susan A. Brooks et al., Functional and molecular Glycobiology, Bios scientific publishers, 2002.
2. Ajit Varki, et al., Essential of Glycobiology, 2nd Ed, Cold Spring Harbor, 2009.

Course title: Advanced Biochemistry of Proteins and Nucleic acids
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☐ Ph.D. ☑ MSc & Ph.D. ☐

Course Objectives:

Study of chemical changes in proteins by binding small molecules and macromolecules and interacting proteins with nucleic acids

Headlines:

- Introduction to protein and nucleic acids structure and function, structural and functional motifs.
- Proteins modifications through binding of small molecules, methyl, acetyl….
- Modifications of proteins through glycosylation, acylation, ADP-ribosylation., Ubiquitination, motifs, structure and function.
- Interaction of proteins with nucleic acids at amino acids and nucleotides level.
- Structural motifs SPK, HMG-box…..
- Interaction of regulatory proteins with DNA, HTH, HLH, Zinc finger, Leu-zipper and other motifs
- Interaction of proteins with RNAs, RRM, KH and …. Motifs.
- Seminars

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
20%	_____	Written Test: 80%	__ _____
		Practical: -	

References:

1. Branden & Tooze (latest edition) Introduction to protein structure, Garland Pub.
2. Walsh CT (2006) Post translation modification of proteins, RC Pub.
3. Rice PA, Correl CC (2008) Protein-Nucleic acid interactions, Structural biology, RSC Pub.

Course title: Mechanism of enzyme action
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☐ Ph.D. ☑ MSc & Ph.D. ☐

Course Objectives:

Familiarity with the required techniques and the way of study the mechanism of action of enzymes and interpreting the results of the studies with several examples with the aim of capability in the design of drugs, insecticides and other materials of industrial value.

Headlines:

- The importance of studying the mechanism of action of enzymes
- Different and general methods of Chemistry of enzymes:
  - Catalysis by approximation
  - Catalysis by covalent modification
  - Acid/base catalysis
  - Strain catalysis
- Important methods for determining the mechanism of action of enzymes:
  - Kinetic tools
  - Use of labeled materials
  - Use of inhibitors
  - Use of various Spectroscopic Techniques
  - Use of Space Chemistry
- A comprehensive review of the mechanisms of action of the enzymes from the following groups:
  - Isomerization reactions
  - Molecular displacement reaction
  - Exclusion and elimination reactions
  - Carboxylation and dicarboxylation reactions
  - Oxidation and resuscitation reactions

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
30%	_____	Written Test: 70%	__ _____
		Practical: -	

References:

1. Christopher Walsh, Enzymatic reaction mechanisms; Freeman and Co., N. Y., 1979.
2. Perry A. Frey and Adrian D. Hegeman, Enzyme Reaction Mechanism, Oxford university press, 2007.

Course title: Advanced Bioinformatics
Number of units: 3
The number of hours: 64
Unit type: 2 Theoretical and 1 Practical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☑ doesn't have ☐ Scientific journey ☐ Workshop ☐ Laboratory ☑ Seminar☑
Degree: MSc ☐ Ph.D. ☑ MSc & Ph.D. ☐

Course Objectives:

The aim of this course is to make the students familiar with new hot topics in the field of bioinformatics. After completing the course, students have an overview of the most important bioinformatics techniques. Students will be familiarized with the cutting edge subjects, after surveying scientific papers weekly.

Headlines:

- Introduction and bioinformatics history
  - Review on gathering and storing bioinformatics sequences, biological databases, sequence alignment, multiple sequence alignment, searching and finding similar sequences (homology and BLAST), phylogenetic prediction
- Secondary biological databases
- Knowledge bases
- Protein-Protein interaction networks data
- Signaling networks data
- Cancer networks data
- Regulatory networks data
- Genome structure determination and next generation sequencing
- RNA-Seq data analysis
- Microarray and related data analysis
- Introduction to biological networks
- Introduction to systems biology
- Introduction to synthetic biology
- Introduction to Brain Networks
- Weekly review and survey of new bioinformatics papers and project

Evaluation Method

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
20%	20%	Written Test: 30%	30%
		Practical: 0	

References:

1. Bioinformatics and Functional Genomics, 3nd Edition, Jonathan Pevsner, 2015, Wiley-Blackwell, USA
2. Bioinformatics for Biologists, Pavel Pevzner, Ron Shamir, 2014, Cambridge University Press, UK
3. Bioinformatics: An Introduction, Jeremy Ramsden,2015, Springer, USA
4. Essential Bioinformatics, Jin Xiong, 2006, Cambridge University Press, UK

Course title: Algorithms in Bioinformatics
Number of units: 3
The number of hours: 48
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☑ doesn't have ☐ Scientific journey ☐ Workshop ☐ Laboratory ☑ Seminar☑
Degree: MSc ☐ Ph.D. ☑ MSc & Ph.D. ☐

Course Objectives:

In this course, students will be familiarized with various methods of natural sequence generation and processing. State of the art algorithms for high-throughput sequencing data analysis will be introduced. Learning Graph-based algorithms for better biological networks understanding and preparation of students for effective and novel algorithm design are the other important aims of this course. After completing the course, students will be ready to solve a variety of problems, using existing algorithms or design a new one.

Headlines:

- Course introduction and introductory concepts
- Processing and analyzing biological sequences including applications of dynamic programming, alignment, and multiple alignments, Markov chains, hidden Markov models and its applications in biological sequences, different methods of searching in sequence databases, motif finding, …
- Introduction to next-generation sequencing methods in genome, transcriptome, metagenome, metatranscriptome
- De novo assembly algorithms, mapping assembly for different sequencing data
- Applications of Graph and tree based algorithms in bioinformatics, creating and interpreting trees and phylogenetic relationships.
- Different biological networks algorithms e.g. link prediction, motif finding, finding modules, node clustering, …

Evaluation Method

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
20%	20%	Written Test: 30%	30%
		Practical: 0	

References:

1. Algorithms in Computational Molecular Biology, M. Elloumi, A. Y. Zomaya, Wiley, 2011.

2. An Introduction to Bioinformatics Algorithms (Computational Molecular Biology), N. C. Jones and P. A. Pevzner, MIT Press, 2004.
3. Algorithmic Aspects of Bioinformatics, Hans-Joachim Bockenhauer and D. Bongartz, Springer, 2007.
4. http://bioinformatics.msu.edu/ngs-summer-course-2014
5. Algorithms on Strings, Trees and Sequences: Computer Science and Computational Biology, D. Gusfield, Cambridge University Press, 1997.
6. Biological sequence analysisProbabilistic models of proteins and nucleic acids, R. Durbin, S. R. Eddy, A. Krogh, G. Mitchison, Cambridge University Press, 1998.

Course title: Biological Databases
Number of units: 3
The number of hours: 64
Unit type: 2 Theoretical and 1 Practical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☑ doesn't have ☐ Scientific journey ☐ Workshop ☐ Laboratory ☑ Seminar☑
Degree: MSc ☐ Ph.D. ☑ MSc & Ph.D. ☐

Course Objectives:

One of the aims is to make the students familiar with different biological databases, methods for accessing stored data and biological data integration. So, students should learn ways of creating databases for efficient biological data storage. The ability to design and implementation of proper graphical user interfaces for storing and retrieving data from different databases are other objectives of this course.

Headlines:

- Course introduction and basic concepts of databases
- Database architecture, introduction to database models e.g. flat, hierarchical, network, relational, object-oriented, semi-structured.
- Database management systems, relational databases design, and ER model, normalization, and optimization
- Heterogeneous database integration
- Introduction to genome databases and genetic sequence e.g. GenBank, Ensemble, …. Explorers, standard file formats, protein databases
- Introduction to transcriptome databases, biological pathways, gene regulation, protein interaction databases
- Introduction to metagenome and metatranscriptome databases
- Introduction to particular phenotype and disease databases for human and other species
- Introduction to creating and programming biological databases
- Introduction to biological databases API and their usage
- Introductory and Advanced SQL (MySQL, SQLite)
- Connecting to database using programming languages
- NoSQL Databases
- Big Data storage and management, introduction to big data processing approaches e.g. MapReduce
- Introduction to cloud computing, data storage, and management in cloud space.

Evaluation Method

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
20%	20%	Written Test: 30%	30%
		Practical: 0	

References:

1. Marketa Zvelebil, Jeremy O. Baum, “Understanding Bioinformatics”, Garland Science, 2008.
2. Peter Revesz, “Introduction to Databases: From Biological to Spatio-Temporal”, Springer London, 2012.
3. Abraham Silberschatz, Henry F. Korth, S. Sudarsham, “Database System Concepts”, 6th h ed., McGraw-Hill, 2011.
4. Baoying Wang, Ruowang Li, William Perrizo, “Big Data Analytics in Bioinformatics and Healthcare”, Medical information science, 2015.
5. Jake Chen and Amandeep S. Sidhu, “Biological Database Modeling”, Artech House, 2007.
6. Remez Elmasri and Shamkant B. Navathe, “Fundamentals of Database Systems”, Addison Wesley, 5th ed., 2003.
7. John V. Carlis, Joseph Maguire, “Mastering Data Modeling: A User-Driven Approach”, Addison Wesley, 2000.
8. C.J. Date, “Relational Database”, Writings 1994-1997, Addison Wesley, 1998.

Course title: Cellular Biophysics
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☐ Ph.D. ☐ MSc & Ph.D. ☑

Course Objectives:

In this course, based on the physics of the membrane, cytoplasm and organelles constituent molecules and according to the laws of electricity, magnetism, and mechanics, temporal and spatial forces and fields that define the structure and function of the cells are discussed. Further to the intrinsic fields and forces, their possible susceptibility to the extrinsic fields is elaborated and possible consequent effects on the intracellular traffic, dynamics, motility, migration and living status of the cells are evaluated. Understanding the physics of the cells at atomic and molecular levels, students will be able to tailor novel monitoring and manipulative means for pharmaceutical, environmental as well as clinical diagnostic and treatment purposes.

Headlines:

- Water and biological buffers
  - Structures and dynamics of water molecules
  - Polarity, dielectrics, spatial and temporal charge distributions
  - Viscosity, density, molecular phases, Kosmotrope and Chaotropes
  - Thermodynamics, energy transfer and heat capacity
  - Conductivity, transmittance, compressibility, electron hopping, electron wire
  - Hydration
- Lipids
  - Hydrophilicity and hydrophobicity
  - Structures and dynamics
  - Distributions in different part of membranes and cells
  - Micelles, CMC, surfactants, Hysteresis, Kraft point
  - Conductivity, turbidity, surface tension
  - Heat, pressure, water ratio and ionic strength effects
  - Phases (L, H, Q), polymorphisms
- Biological and artificial lipid membranes
  - Structure and dynamics
  - Lipid and protein distributions, rafts, micro-domains
  - Lateral, rotational, translational diffusion, flip flop
  - Fluidity, thickness, order, packing

- Protein translocation, folding, protein-lipid interaction,
- Interfaces, means of diffusion and transportation
  - Diffusion and electro-transference and permeation
  - Osmosis, electro-osmosis, hydrostatic permeation
  - Ion channels, carriers, pumps, pores
  - Selectivity, specificity, flux rate
- Bio-electric and biomechanics of lipid membranes
  - Capacitance, conductance, dielectric, surface charge density, breakage voltage
  - Potential layers (Stern, Helmholtz, Deby-Huckle)
  - Membrane potentials (Donan, Nernst, Zeta, Goldman-Hodgkin-Katz)
  - Effects of electric, magnetic, electromagnetic and ultrasonic fields
- Theoretical and practical techniques
  - Artificial planar bilayer, supported bilayer, liposomes,
  - Liposome Swelling Assay (LSA), Langmuir, Electroporation
  - Fluorescent Recovery after Photobleaching (FRAP)
  - AFM, STM, ssNMR,
  - Patch clamp, Voltage clamp, Pat, Electophysilogic data acquisition
  - MatLab, MD, HOLE, CHARMM, Hydropathy, RasMol, Protein Explorer
- Applications of the discussed subjects
  - Drug and gene delivery (Packaging, smart and targeted delivery and release)
  - Tissue engineering and cell membrane fusion, repair (Wound healing, SCI, …)
  - Complimentary medicine (Biophysical application of Laser, electric, magnetic, electromagnetic, IR and plasma for pain relief, drug delivery, surgery, and monitoring of targeted cell and organ)
  - Immunotherapy (Allergy and Ab-Ag interactions, kits, monitoring, treatments)
  - Biosensors design and fabrication (Based on membrane and reconstituted proteins)

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
60%	_____	Written Test: 40%	__ _____
		Practical: -	

References:

1. Hoppe W. (1983) Biophysics
2. Weiss T.F. (1996) Cellular Biophysics: Vol I" MIT Press
3. Raicu, V. and Popescu, A. (2008) Integrated Molecular and Cellular Biophysics, Springer Science
4. Merighi, A. and Carmignoto, G. (2002) Cellular and Molecular Methods in Neuroscience Research, Springer-Verlag New York,
5. Meyer, B. Jackson (2006) Molecular and Cellular Biophysics, Cambridge University Press

6. Nelson, P. (2006) Biological Physics
7. Philips, R. (2009) Physical Biology of the cell

Course title: Biosensors
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☐ Ph.D. ☐ MSc & Ph.D. ☑

Course Objectives:

The aim of this course is that the students become familiar with the fundamentals of chemical sensing in living organisms and the methods for mimicking them in such a way that leads to the construction of bio-sensors. Learning the variety of physical transducers to convert biological function of receptor to electrical signals and studying the techniques for developing the biosensors are of the other objectives of this course.

Headlines:

- Chapter I: 1. Definition, principal and the classifications of biosensors, 2. Signaling in living organisms, 3. Designing the mimetic biosensors
- Chapter II: Applications of biosensors in various fields including medical diagnosis, industrial sample analysis, automation of industrial processes, environmental control and military purposes
- Chapter III: Examples of biosensors: Biosensor for detection of Blood glucose, Biosensor for detection of Warfare agents, Biosensors for detection of viruses, Biosensors for on line applications
- Chapter IV: Biological receptors: 1. enzymes, antibodies, nucleic acids and receptors, 2. plant or animal tissues, micro-organisms, cell components (mitochondria)
- Chapter V: Immobilization of biological components (techniques of making biosensors): 1. physical methods: adsorption, microencapsulation, entrapment, 2. Chemical methods: crosslinking and covalent binding, 3. Different supports for protein immobilizations, 4. The methods for surface modifications, 5. Nanoparticles and nanocomposites as supports for protein immobilizations
- Chapter VI: Physical transducers: 1. Electrochemical methods: potentiometry, voltammetry, conductometry, and field effect transistors, 2. Optical methods: spectroscopic approaches, fiber optic biosensors, and surface plasmon resonance (SPR), 3. Piezoelectric transducers including EQCM, QCM, SAW and BAW, 4. Thermal biosensors
- Chapter VII: Factors affecting on the performance of biosensors: Selectivity, linear range, detection limit, calibration curve, reproducibility, repeatability, response time and life time, operational and storage stability

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
10%	30%	Written Test: 60%	__ _____
		Practical: -	

References:

1. Brian R. Eggins, Biosensors: an Introduction, Springer, 1996.
2. J. Cooper, T. Cass, Biosensors, Oxford University Press, 2004.
3. D. M. Fraser, Biosensors in the Body, John Wiley & Sons 1997.

Course title: Mathematical Models in Biological Issues
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☐ Ph.D. ☐ MSc & Ph.D. ☑

Course Objectives:

This lesson focuses on mathematical modeling of biological processes based on population growth and dynamics models.

Headlines:

Syllabus:

- Introduction to mathematical methods
  - Ordinary and partial differential equations
  - Linear algebra
  - Game theory
- Evolutionary dynamics: deterministic methods
  - Growth dynamics
  - Introduction to evolution
  - Evolutionary dynamics
  - Evolutionary games
- Evolutionary dynamics: Stochastic models
  - Moran process
  - Agent Based Modeling
  - Cellular Automata
- Dynamical models for cancer
  - Tumor growth models
  - Angiogenesis
  - Metastasis
- Dynamical models for infection

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
20%	30%	Written Test: 50%	__ _____
		Practical: -	

References:

1. Evolutionary Dynamics, Nowak, President and Fellows of Harvard College (2006)
2. Dynamics of Cancer, Wodarz and Komarova, World Scientific (2014)

Course title: Methods and Research Logic
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☐ Ph.D. ☐ MSc & Ph.D. ☑

Course Objectives:

This course aims to familiarize students with research methods and methodology, define research projects, rights and values involved in group activities, intellectual property, methods of searching for articles and scientific data and scientific publications, collections and stories writing research papers at international level, is taught.

Headlines:

- Methods and research methodology
- Defined principles, writing proposal
- Intellectual property
- Principles of group activities
- Introduce scientific and literary ethics violations and plagiarism
- Principles of data collection and compilation thesis
- Methods of compiling progress reports
- Principles of participation in scientific conferences and writing reports and poster
- The rules and regulation of the research paper for journal submission, thesis, scholarly book chapters, articles and abstracts extension or the full proceeding for presentation at scientific conferences
- Writing scientific articles for international publications
- Software resources and scientific texts
- Introducing the prestigious international issues and evaluation criteria and indexing journals
- Familiarity with Digital Library of University of Tehran
- Introduction to the position of papers citation and documentation and new approaches in the analysis of them
- Basic understanding of Web of Science citation and other websites and its application in research and scientific publications

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
50%	_____	Written Test: 50%	__ _____
		Practical: -	

References:

1. Martyn Shuttleworth "How to Write a Research Paper", Experiment-Resources Publisher, 2010
2. A.A.Saboury, A.A. Moosavi-Movahedi and et al. “Handbook: A Practical Guide to International Journal” University of Tehran Press (2008)

Course title: Biothermodynamics
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☐ Ph.D. ☐ MSc & Ph.D. ☑

Course Objectives:

The aim of this study was to determine protein stability, protein thermal denaturation via various methods such Differential Scanning Calorimetry, Isothermal Titration Calorimetry, thermal spectroscopy

Headlines:

- Cold and thermal protein denaturation
- Theoretical and experimental thermodynamic study on Cold and thermal protein denaturation
- The analysis of protein thermal profiles
- Comparative states of intermediates for protein thermal denaturation
- Comparative study on thermodynamic and non-thermodynamic parameters for protein structure
- Protein Calorimetry: Isothermal Titration Calorimetry and Differential Scanning Calorimetry study for protein –ligand interaction, protein structure deconvolution, measurement of energetic domains for protein, study the reversibility and irreversibility states for protein denaturation
- Protein stability measurements by different methods

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
10%	_____	Written Test: 90%	__ _____
		Practical: -	

References:

1. J.T. Edsall and H. Gutfrund, "Biothermodynamics", John Wiley, New York, 1983.
2. J.E. Ladbury and M.L. Doyle, "Biocalorimetry", John Wiley, New York, 2004.
3. M.N. Jones, "Biochemical Thermodynamics", Elsevier, 1984.

4. J. Chamani and A.A. Moosavi-Movahedi “Biothermodynamics “University of Tehran Press, 2009

Course title: Physical Chemistry of Proteins
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☐ Ph.D. ☐ MSc & Ph.D. ☑

Course Objectives:

The aim of this course is the understanding of the pathways and intermediates of protein folding/unfolding and relation with protein structure and function is taught

Headlines:

- Protein folding and its stages
- The role of intermediates in protein folding
- The role of molten globule in protein folding
- The role of disulfide bond in protein folding
- The role of temperature in protein folding
- The role of ionic strength, pH, solvent, pressure, temperature, salts in protein folding
- The role of conformational states in protein folding
- The role of domain assembly in protein folding
- The kinetic pathways in protein folding
- Forecast and prediction in protein folding

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
10%	_____	Written Test: 90%	__ _____
		Practical: -	

References:

1. R.H. Pain, "Mechanisms of protein folding", IRL Press, Oxford, 1994.
2. B.A. Shirley, "Protein stability and folding", Humana Press, New Jersey, 1995
3. A.A. Moosavi–Movahedi and et al. " Protein Structure", University of Tehran Press, In Persian, 2004

Course title: Topics in Biophysics
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☐ Ph.D. ☐ MSc & Ph.D. ☑

Course Objectives:

The purpose of this course is to review the latest biophysical papers and achievements. In this class, students will discuss their research topics with other students.

Headlines:

- Course categories each time the lesson is presented, the resources and articles and the various topics that have been considered in the past years will be examined. Presenting the results of the students' work is to provide written reports and oral presentations.

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
10%	_____	Written Test: 90%	__ _____
		Practical: -	

References:

1. Protein Stability and Folding: Theory and Practice (Methods in Molecular Biology) by Bret A. Shirley, 1995, Springer

Course title: Biospectroscopy
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☐ Ph.D. ☐ MSc & Ph.D. ☑

Course Objectives:

Teaching Different Spectrometry Techniques and Its Applications in Biological Sciences

Headlines:

- Chapter 1: Principles of Spectroscopy
  - Quantum view of the interaction between light and matter, Atomic and molecular spectroscopy, Different parts of spectroscopy devices, using computer in spectroscopy
- Chapter 2: UV-Visible Spectroscopy
  - Device principles, Principles of quantitative and qualitative analysis, Quantitative and qualitative assays in biomacromolecules, Biomacromolecule ligand interaction and ligand binding in different systems, Protein stability measurements, Enzyme assays
- Chapter 3: Infrared and Raman Spectroscopy
  - Device principles, principles of quantitative analysis and identification of functional groups, Determine of secondary structure of proteins, Structural studies of biological macromolecules by Raman and Infrared spectroscopies
- Chapter 4: Mass Spectrometry
  - Device principles, principles of fragmentation of molecules and identify quantitatively, Roles of isotopes in identifying qualitatively, Different biological applications
- Chapter 5: Circular Dichroism Spectroscopy
  - Device principles, Study of proteins secondary structures, Study of proteins tertiary structure, Application in structural studies of nucleic acids
- Chapter 6: Fluorescence Spectroscopy
  - Device Principles, intrinsic and extrensic fluorescence, Protein stability and tertiary structure, Protein folding and unfolding, Thermodynamic studies of ligand binding to biomacromolecules, other biological applications
- Chapter 7: Nuclear Magnetic Resonance (NMR) Spectroscopy
  - Device Principles, Nuclear Magnetic Resonance of different elements, Chemical shift and analysis qualitatively, Principles of interpretation of spectra to identify materials, Study of protein structure, Ligand- biomacromolecule interaction, Different biological applications

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
Short student lecture	_____	Written Test: ✓ Practical: -	Persistent questioning

References:

1. Biological Applications of Infrared Spectroscopy, B. H. Stuart, John Wiley, 1997.
2. Spectroscopy for the Biological Sciences, Gordon G. Hammes, Wiley, New York, 2005
3. Principles and Applications Fluorescence Spectroscopy, J. Albani (Translated by A.A. Saboury and M. Saeidifar), University of Tehran Press, 2013
4. Different published articles during last 10 years on the biospectroscopy subjects.

Course title: Ligand Protein Interaction
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☐ Ph.D. ☐ MSc & Ph.D. ☑

Course Objectives:

Education of various ligand transplantation theories and its empirical methods

Headlines:

- Chapter One: The linkage of the ligand to the biomacromolecule
  - Ligand transplantation to a transplantation site, ligand transplantation to a linkage site, Scachrard, Clouds and Hill equations, and their relationship, ligand transplantation to multiple linkage sites, a variety of equilibrium constants in the study of multiple equilibria, competition in the conjugation of two simultaneous ligands
- Chapter Two: Abnormal Biomacromolecule
  - Abnormalities with heat and cold, abnormalities with surfactants, abnormalities with chemicals, abnormalities under environmental factors
- Chapter Three: Determination of Biomacromolecule Stability
  - Definition of stability, thermodynamic stability and kinetic stability, determination of thermodynamic stability, determination of kinetic stability, concept and determination of thermal stability of biomacromolecules, differential calorimetry scanning, use of rotary exponential doping in determining the structure and stability of biomacromolecules
- Chapter Four: Determination of ligand transplantation parameters
  - Equilibrium Dialysis, Spectrophotometry, Homogeneous Titration Thermometer, Thermodynamic Parameters of Transplantation

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
Continuous questions	_____	Written Test: *	Provide short student presentations
		Practical: -	

References:

1. Protein-Ligand Interactions, First Edition, Holger Gohlke, Wiley, New York, 2012.
2. Protein–Ligand Interactions, G. Ulrich Nienhaus, Humana Press, New Jersey, 2005.

Course title: Pharmaceutical Biophysics
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☐ Ph.D. ☐ MSc & Ph.D. ☑

Course Objectives:

Considering the extensive development of nanotechnology, in this course different aspects such as identification of structure, migration and interactions between drug-polymeric carrier, drug-membrane, drug-cell, and drug-serum molecule complexes, and corresponding half-life in the physiological condition of the cell and body as well as shelf time will be discussed. Accordingly, tracing of the drug in body and tissue as well as different parts of target cells will be evaluated based on the physical and electronic remote sensing to tailor efficient proscription with minimum dose, fastest effects, precise targeting and minimal side effects. The approaches presented at atomic and molecular levels, together with novel practical considerations, will provide students with some basis to design, produce, monitor, track and have more efficient drugs.

Headlines:

- Biophysics of water (Structures, dynamics, dielectrics)
- Membrane biophysics (structure, dynamics, lipid diversity, electrical characteristics)
- Cellular biophysics (Bio-electrics, bio-impedance, biomechanics)
- Chemico-physical status of biological fluids
- Drug carriers (Inorganic, polymeric, metal-based, composites, biological)
- Fundamentals and techniques in drug encapsulation and packaging (CMC, Lipid phases, Order parameter, Packing parameter, Polarity)
- Stability, release, half-life, dose, solubility
- Targeted drugs (destination factors, carrier elements)
- Smart drug delivery (Nanoparticle based, controlled rate, concentration release rate)
- Practical biophysical techniques in pharmaceutics
    - Modern techniques in drug delivery (Electrical, Thermal, ultrasonic, electromagnetic, IR, UV, Magnetic)
    - Modern techniques for drug tracking (MRI, PET, Electrophysiological impedance-metery, Gama counter, Fluorescent base, Bio-resonance)
    - Microfluidic, Lab-on-chip،Cell-on-chip, Organ-on-chip for drug effect analysis
    - Confocal Fluorescent Microscope and its application in time-lapse intracellular traffic monitoring

- Thermodynamic analysis of interactions, structural and dynamics of the drug effects on nucleic acids, soluble and membrane proteins
- Theoretical methods
  - Modeling of drug release, diffusion and interaction
  - Simulation of the drug targets on the target molecules (Auto dock)
- Application of discussed subjects
  - Design and production of drug packages with efficient targeting and release rate
  - Proposing novel optimum methods of drug tracking in body and cell
  - Tailoring novel and more efficient means of drug administration

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
60%	_____	Written Test: 40%	__ _____
		Practical: -	

References:

1. Seetharama D. Sat yanarayanajois. Drug Design and Discovery Methods and Protocols, Springer Science+Business Media, LLC, 2011.
2. Li, X., Jasti, BR. Design of Controlled Release Drug Delivery Systems, The McGraw-Hill Companies, Inc., 2006.
3. W. Mark Saltzman, DRU G DELIVERY, Engineering Principles for Drug Therapy, Oxford University Press, Inc., 2001.
4. AJAY K.BANGA, Electrically Assisted Transdermal and Topical Drug Delivery, Taylor & Francis e-Library, 2003.
5. Betageri, GV, Jenkins, SA, Parson, DL. Liposome Drug Delivery Systems, Tectonic publishing Company, 2003.
6. Hans Schreier, Drug Targeting Technology, Physical, Chemical and Biological Methods, Marcel Dekker, Inc., 2001.
7. Beard, DA, Qian, H, CHEMICAL BIOPHYSICS, Quantitative Analysis of Cellular Systems Cambridge University Press, 2008
8. Oren M., Becker, Alexander, D. MacKerell, Jr. Benoi, Roux, Masakatsu Watanabe. Computational Biochemistry and Biophysics, Marcel Dekker, Inc. UK, 2001.

Course title: Bio-electromagnetics
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☐ Ph.D. ☐ MSc & Ph.D. ☑

Course Objectives:

The optimum function of biological systems is achieved by unique structural and dynamics of their constituent molecules in the polar and dynamic water medium and in the presence of charged and radical elements. This situation causes intrinsic electric, magnetic and electromagnetic fields in the biological system in first place and makes them susceptible to the extrinsic ones in return. Exposure of the biological molecules to the fields, changes their atomic orientation, conformation, binding constant of ligands, channel conductivity, enzyme activity and ultimate function of tissue, organ, and whole body. In this course, the bioelectric and bioelectronics nature of biological molecules will be discussed and the consequent effects of the intrinsic and extrinsic fields on the structure and function of the host system at atomic, molecular, cellular and tissue levels will be elaborated.

Headlines:

- Biophysics of water (Structures, dynamics, dielectrics, EM absorption)
- Life definition based on stochastic and deterministic events at molecular and atomic levels
- Sources and characteristics of electric, magnetic and electromagnetic fields
- Structure and dynamics of biological macromolecules and intracellular polyelectrolytes
- Dielectrics and charge distribution in living cell and constituent organelles and consequent electric, magnetic and electromagnetic fields
- Spatial and temporal electromagnetic polarization in cells at different stages of cell cycle
- Bio-resonance of molecules, cells and tissues, basics and susceptibilities
- Quantum biology and means of non-thermal field effects at low KbT
- Bone piezoelectric at atomic, molecular and cellular levels
- Magneto-proteins, and magneto-susceptibility of bio-macromolecules
- Molecular oscillators and source of electric and electromagnetic fields in the cells
- Effects of extrinsic fields on the living status, division, orientation, formation of podia and migration of cells
- Practical techniques
    - Identification of the interaction between external and intracellular sources of electric, magnetic and electromagnetic fields (real time analysis of morphology, differentiation, orientation and migration)

- Real time recording of the effects of the extrinsic magnetic and electromagnetic fields on the activity of single ion channel (Patch clamp, Voltage clamp, Fluorescent Recovery After Photobleaching)

- Theoretical approaches
  - Simulation of electromagnetic bio-fields caused by the ion channel activities
  - Computational methods in determination of the electric and magnetic fields caused by ionic motion and diffusions
- Application of the discussed subjects
  - Identification of environmental effects of the fields caused by telecommunication, cell phones, satellites and electric and electronic systems
  - Development of diagnostics and therapeutics application of bio-resonance, energy medicine, AURA, Telepathy and so on.

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
60%	_____	Written Test: 40%	__ _____
		Practical: -	

References:

1. Cynthia Furse, Douglas A. Christensen, Carl H. Durney, Basic Introduction to Bioelectromagnetics, CRC Press, Taylor & Francis Group LLC 2009.
2. Thomas F. Valone, BIOELECTROMAGNETIC HEALING, A RATIONALE FOR ITS USE A nonprofit 501(c) 3 organization Washington DC USA 2007.
3. Paul J. Rosch, Marko S. Markov, Bioelectromagnetic Medicine, Taylor & Francis e-Library, 2005.
4. An Introduction to Environmental Biophysics. Springer Verlag, N.Y., 1998.
5. Ben Greenebaum, Frank S. Barnes, Bioengineering and Biophysical Aspects of Electromagnetic Fields 2006
6. Oren M., Becker, Alexander, D. MacKerell, Jr. Benoi, Roux, Masakatsu Watanabe. Computational Biochemistry and Biophysics, Marcel Dekker, Inc., UK, 2001.
7. Edward L. Alpen, Radiation Biophysics, Second Edition, ACADEMIC PRESS, 1998.

Course title: Biophysics and Tissue Engineering
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☐ Ph.D. ☐ MSc & Ph.D. ☑

Course Objectives:

Cell is a complex system which continuously interacts with the physico-chemical conditions of its media that should be considered in tissue engineering based on the structural, electrical, and functional means of cells at atomic, molecular and cellular levels. In this course, following discussion on the electrical and mechanical characteristics of cells and neighboring medium and scaffolds, roles of physico-chemical condition of the electrolyte substrate on the attraction of migrating cells and their settlement to form a graft is elaborated. Learning this aspects not only provides students with the evaluation of cell-media interactions at molecular level needed for cell culture, tissue engineering and graft formation, familiarizes them with the possibility of real-time monitoring of cell activities inside and outside of host body, and helps them to define noninvasive biophysical approaches for clinical treatment purposes.

Headlines:

- Biophysics of water
- Membrane Biophysics (Bioelectric, mechanics, permeability, surface tension)
- Biophysics of biological cells and tissues
- Physical chemistry of the biological electrolytes
- Cell and tissue culture (slice culture, whole organ culture)
- Polymeric scaffolds, fabrication, mechanical and electrostatic interaction (Electrospinning, Hydrogel, Self-casting polymer)
- Bio-composites, structure, stability, porosity, mechanical strength, surface change
- Biophysical approaches to create grafts inside host body, biocompatibility, biodegradability of polymer scaffolds, bio-metals, bio-ceramics
- Practical methods
    - Microscopic monitoring and real time identification of density, migration growth and confluency
    - Electronic and impedance based indirect means of monitoring and documentation of cell activities inside and outside of the host body
    - Microfluidic systems, natural and artificial ones, in tissue engineering
    - Application and tailoring of Lab-on–Chip, Cell-on-Chip systems in tissue engineering
    - Precise and ultrasensitive online bioreactors, as a pilots for cell culture and tissue factories

- Scan and 3D print of scaffolds and cells for creation of cellular grafts
- Theoretical approaches
  - Modeling and calculation methods of tissue and organs
  - Application of the biological cells data banks in tissue engineering
- Application of the discussed subjects
  - Design, approaches and construction of bioreactors and real time monitoring for mass tissue production purposes
  - Engineering and monitoring of new tissues in the host bodies

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
60%	10%	Written Test: 30%	__ _____
		Practical: -	

References:

1. Park, JB, Bronzino, JD. Biomaterials PRINCIPLES and APPLICATIONS, CRC Press LLC, 2003.
2. Bin He. Modeling and Imaging of Bioelectrical Activity, Principles and Applications. Kluwer Academic/Plenum Publishers, New York, USA 2004.
3. Artmann, GM, Chien, S. Bioengineering in Cell and Tissue Research, Springer-Verlag Berlin Heidelberg, 2008.
4. Beard, DA, Qian, H, CHEMICAL BIOPHYSICS, Quantitative Analysis of Cellular Systems Cambridge University Press, 2008
5. Robin Leatherbarrow, R H TemplerCampbell G.S., J.M. Norman. Biophysical Chemistry

a. Biophysical Chemistry Group,

6. Chaudhuri, J., Al-Rubaei, M. BIOREACTORS FOR TISSUE ENGINEERING, Springer 2005.
7. Ma, PX., Eleesseff, J. Scaffolding in Tissue Engineering, Taylor & Francis Group, LLC. 2006.

Course title: Environmental Biophysics
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☐ Ph.D. ☐ MSc & Ph.D. ☑

Course Objectives:

Significant industrial progress in the living environment of human being and increasing presence of physical, electrical, electromagnetics, sonic, and radiation polluting sources has endangered susceptible molecules and systems in human and other living systems. In this course considering physico-chemical, electrochemical and electronic nature of the polluting sources, possible targets and incurred changes in the structure and function of target molecules, cells and eventually tissues and organs that have already been manifested by genetic, metabolic and behavior deviation will be discussed. The involved mechanism of most of these events has still remained unknown and as no specific expertise has yet defined to address the fact at molecular and cellular levels, biophysical approaches can play critical roles. Having the advanced high-tech facilities and approaches together with novel molecular atomic and nano techniques, has practically made it possible to reveal the involved mechanisms through practical and theoretical approaches.

Headlines:

- Biophysics of living systems activity in the natural condition
- Biophysics of Earth gravity and magnetic field
- Earthquake biophysics and the way some living creatures detect it
- Magnetic navigation of birds and distorting effects
- Biophysics of ionized atmosphere and charged clouds
- Sound biophysics, effects of sound pollution and plant based control and challenges
- Biophysics of radioactive radiations (possibility of safe living at high doses, Ramsar)
- Biophysics of non-ionizing , electric, magnetic and electromagnetic radiations
- Biophysics of traveling dusts (settlement, sedimentation and filtration approaches)
- Biophysics of air polluting hydrocarbon, Pb, and other facile fuel burned side products
- Biophysics of magnetic water, formation, stability and effects
- Biophysics of greenhouse effect and increased temperature
- Practical methods
    - Molecular, cellular, tissue and whole body analysis of the effects of the gravity, electric, magnetic and electromagnetic fields
    - Monitoring, recording and analysis means of global monitoring and data collection (satellites)

- Recording and analysis of the living patterns at different geographical locations and forming data banks
- Theoretical methods
  - Modeling of electrical and magnetic fields and analysis of their effects on the conformation and dynamics of targeted molecule
  - Bioinformatics and computational biophysics of correlations between living patterns and status of their correlated area
- Application of the discussed subjects
  - Defining the standard safety and environmental conditions for living creatures across globe
  - Identification of the means to tackle with the side effects where the situation is inevitable

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
60%	_____	Written Test: 40%	__ _____
		Practical: -	

References:

1. Campbell G.S., J.M. Norman. An Introduction to Environmental Biophysics. Springer Verlag, N.Y., 1998
2. Cancer and the Environment, Research, and Medicine. Roundtable on Environment Health Sciences, NATIONAL ACADEMY PRESS Washington, D.C. 2002
3. Friedl, A.A. Rühm, W. Radiation and Environmental Biophysics
4. Oren M., Becker, Alexander, D. MacKerell, Jr. Benoi, Roux, Masakatsu Watanabe. Computational Biochemistry and Biophysics, Marcel Dekker, Inc. , UK, 2001
5. Waigh T. Applied Biophysics - Molecular Approach for Physical Scientists, John Wiley & Sons Ltd, TheWest Sussex PO19 8SQ, England, 2007
6. Edward L. Alpen, Radiation Biophysics, Second Edition, ACADEMIC PRESS, 1998.
7. Roland Glaser, Biophysics, Gustav Fischer Verlag, Jena Germany 1999

Course title: Topics in radiation Biology
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: Radiation Biophysics
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☐ Ph.D. ☐ MSc & Ph.D. ☑

Course Objectives:

The purpose of this course is to review the latest scientific papers and achievements in the field of Biophysics of Beams and Biology of Radiation. In this class, students will discuss their research topics with other students.

Headlines:

- Introduction
- An overview of the biophysics of the beams
- Radiation chemistry
- Survival Curves: Models and Experiences
- Repair of radiation damage
- Changes in beam effects
- Biodegradation of normal body tissues
- Biodegradable tumors
- Immediate effects of the beams
- Long-term effects of beams
- Hyperthermia

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
10%	_____	Written Test: 90%	__ _____
		Practical: -	

References:

1. Radiobiology for the Radiologist, Hall, E.J. 5th ed. LIPPINCOTT WILLIAMS & WILKINS, Philadelphia, 2000.
2. Radiation Biophysics, Alpen, E.L., 2nd ed. Academic Press, Boston 1998.
3. Perez and Brady's Principles and practice of Radiation Oncology, 5th ed. Halperin, E.C., Perez, C.A., and Brady, L.W., Lippincott Williams & Wilkins, New York 2008.

Course title: Computational Biophysics
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☐ Ph.D. ☐ MSc & Ph.D. ☑

Course Objectives:

The purpose of this course is to familiarize students with theoretical foundations and common approaches to computational biophysics. In this lesson, students will be introduced to the use of static and dynamic mechanics and other simulation and modeling techniques with the broad application of these methods in modeling biological structures.

Headlines:

- Introduction to computational biophysics
- Atomic models and force fields
- Monte Carlo
- Molecular Dynamics
- Long range force fields
- Implicit solvent models for molecular simulations
- Normal state calculations
- Free energy calculations
- Quantum Mechanics/ Molecular Mechanics Methods
- Other computational methods

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
10%	_____	Written Test: 90%	__ _____
		Practical: -	

References:

1. Becker, CM., Mackerell, Jr. AD, Roux, B., Watanabe, M. Computational Biochemistry and Biophysics, Marcell Dekker, New York, 2001.
2. Jensen, F. Introduction to computational chemistry. 2ed edition, John Wiley & Sons, Chichester, 2007.

Course title: Topics in the Philosophy of Biology
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☐ Ph.D. ☐ MSc & Ph.D. ☑

Course Objectives:

The purpose of this course is to study different views on the philosophy of science in general, and in particular the philosophy of life sciences.

Headlines:

- The course syllabus will be explored every time the lesson is presented, resources and articles and various topics that are considered in the fields of logic and philosophy of science, and some philosophical schools and philosophy of biological sciences. Presenting the results of the students' work is to provide written reports and oral presentations.

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
10%	_____	Written Test: 90%	__ _____
		Practical: -	

References:

1. Ayala, FJ, and Arp, R. eds. contemporary debates in Philosophy of Biology, Wiley-Blackwell, 2010.

Course title: X-Ray scattering from Biological Macromolecule
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☐ Ph.D. ☐ MSc & Ph.D. ☑

Course Objectives:

The purpose of this course is to familiarize students with theoretical foundations and the theory of X-ray diffraction from biological macromolecules.

Headlines:

- Overview of Protein Crystalography
- Protein Crystals, Characteristics and Procedures
- X-rays and special features necessary for use in diffraction from biological macromolecules
- Problem of diffraction and interference of waves
- Collect the diffraction data
- From diffraction to electron density
- The issue of phase
- Preparation and evaluation of molecular models
- Other diffraction methods

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
10%	_____	Written Test: 90%	__ _____
		Practical: -	

References:

1. Crystallography Made Crystal Clear, Third Edition: A Guide for Users of Macromolecular Models. Rhodes, G. Academic Press, NY, 2002.
2. X-Ray Crystallography of Biomacromolecules: A Practical Guide. Messerschmidt, A. Wiley-VCH, 2007. Weinheim, Germany.
3. Biophysical Chemistry, Part 2: Techniques for the Study of Biological Structure and Function. Cantor, C.R. and Schimmel. P.R. W. H. Freeman and Company; 1st edition, 1980. San Francisco, USA.
4. Selected papers on the subject.

Course title: Bioelectrochemistry of proteins and nucleic acids
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☐ Ph.D. ☐ MSc & Ph.D. ☑

Course Objectives:

In this lesson, students will find useful information on how to use these methods in the study of biological molecules, including proteins and nucleic acids, while familiarizing them with the principles and types of electrochemical methods.

Headlines:

- Introduction to Electrochemical: Electrochemical Tubules, Conductivity in Solutions, Types of Electrodes.
- Electrochemical methods: Potentiometry, voltammetry, impedance, capacitance, and field effect transistors.
- Correction of electrode surfaces for direct electrochemical studies of proteins and nucleic acids using a variety of functional groups and a range of nanoparticles.
- Electrochemistry of free and stabilized proteins.
- Electrochemistry NAD (P) + / NAD (P) H
- Electron Transfer in Proteins: Direct Transfer and Transmission via Intermediate Materials.
- Kinetics of electron transfer in redox proteins.
- Study of nucleic acid by electrochemical methods.
- Single cell electrochemistry, Membrane electrochemistry.
- Scanning Electrochemical Microscopy.
- Bioelectronics
- Commercialization of bio-electrochemical instruments based on potentiometric, voltammetric, capacitive, impedance methods and field effect transistors.

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
10%	30%	Written Test: 60%	__ _____
		Practical: -	

References:

1. George S. Wilson Bioelectrochemistry, Volume 9; in Allen J. Bard and Martin Stratmann, (Editor) Encyclopedia of Electrochemistry, Wiley-VCH, Weinheim, 2002.
2. Itamar Wilner and Eugenii Katz, Bioelectronics from theory to applications, Wiley-VCH, Weinheim, 2005.

Course title: Biophysics of ion channels
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☐ Ph.D. ☐ MSc & Ph.D. ☑

Course Objectives:

Ion channels with known atomic structure provide the basis to study the molecular dynamics and activity of single biological nano-molecules in real time in the presence and absence of different physical and chemical effectors. The aim of this course is to familiarize students with the practical and theoretical aspects of ion channels, their structure, dynamics and functions as controllable influx and efflux molecular gates that control the traffic of different ions and molecules across the membrane. The provided information can transfer the capability of channel application in the design, fabrication of biosensors and molecular switches, control and challenge with pathogenic viruses and bacteria as well as treatment of diseases caused by the malfunction of channels in a non-chemical manner.

Headlines:

- Biological membranes (Composition, structure, thickness, fluidity, surface charge)
- Membrane proteins (channels, receptors, carriers, pumps)
- Ion channels (structure, distribution)
- Identification, extraction, purification and structure definition of ion channels
- Mechanisms of gating in channels (ligand, pH, potential difference, pressure)
- Role of channels as oscillators in the establishment of direct and alternative fields
- Ion channels and biological electrical resonance (bioresonance)
- Application of channels as controllable nano-valves (electrical, chemicals, mechanicals)
- Means of mounting and reconstitution of ion channels on supported bilayers for biosensor activity
- Application of ion channels in next generation nucleotide sequencing
- Ion channels as unique targets to overcome failure caused in certain diseases
- Ion channels as a means for targeted drug delivery and tackle with pathogenic microorganisms
- Practical methods
    - Patch clamp, Voltage clamp, AFM, STM, FRAP, Single-Unit, LSA
    - Application of (Macro Electro-Mechanical Systems), MEMS, NEMS
- Theoretical methods
    - Simulation and modeling of channel activities based on current traces

- Application of HOLE, CHARMM, AMBER, PAT softwares
- Application of the discussed subjects
  - Biophysical targeting and manipulation of channels as substitute for chemical and pharmaceutical treatments
  - Application of channels as bio-transistors to identify the positive and negative biological effects of electric, magnetics and electromagnetic fields at molecular levels in real time

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
60%	_____	Written Test: 40% Practical: -	__ _____

References:

1. Aidley, D.J. and Stanfield, P.R. (1996) Ion Channels, Molecules in Action
2. Tien, T.H. (2000) Membrane Biophysics
3. Hoppe W. (1983) Biophysics
4. Molleman A. (2003) Patch clamping (An Int. to Patch Clamp Electrophysiology)
5. Molnar P. and Hichman, JJ (2007) Patch clamp methods and protocols
6. Luchtag HR (2008) Voltage-sensitive ion channels (Biophysics of Molecular Excitability)

Course title: Enzymology
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☐ Ph.D. ☐ MSc & Ph.D. ☑

Course Objectives:

Students familiarity with the mechanism of action of enzymes and their qualitative and quantitative comparison with chemical catalysts, the role and importance of enzymes in industrial production and the necessity of their engineering in this regard

Headlines:

- Introduction: Illustrating the impact of enzymology on our lives through some examples from medical and biotechnological industries
- Enzyme nomenclature
- Understanding the mechanisms used by enzymes to increase reaction rate through examples from simple chemical reactions
- Mechanistic basis of chemical reactions catalyzed by cofactors
- Chemical nature of enzymatic reactions catalyzed by serine proteases, cysteine proteases, metalloproteases, aspartic proteases, ribonucleases, glycosidases
- Mechanisms of enzyme inhibitors
- Michaelis–Menten equations, Lineweaver–Burk plot, Eadie–Hofstee diagram
- Site directed mutagenesis of enzymes and its role in deciphering the mechanism of enzyme action
- Application of Recombinant DNA technology to enzyme engineering

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
30%	_____	Written Test: 70%	__ _____
		Practical: -	

References:

1. An Introduction to Enzyme and Coenzyme Chemistry, by T. Bugg, John Wiley 2012
2. Athel Cornish – Bowden, Fundamentals of Enzyme Kinetics, Portland press, 2004.

Course title: Advanced Molecular Biology
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☐ Ph.D. ☐ MSc & Ph.D. ☑

Course Objectives:

Promotion of students' knowledge on the field of molecular biology. In this course students will get familiar with the history and the experiments which led to the discovery of discussed biological phenomena. At the end they will be able to compare molecular mechanisms of replication, transcription and translation in the prokaryotic and eukaryotic system.

Headlines:

- History and philosophy of molecular biology; The concept of the gene; Forward and reverse genetics
- Genome and its organization in prokaryotes and eukaryotes; introducing of the epigenetic modifications in eukaryotic systems.
- DNA replication and its regulation in prokaryotes and eukaryotes with emphasis on the fate of chromatin modifications after DNA replication
- Mutations and DNA damage and repair in prokaryotes and eukaryotes; Genome elimination and its biological implications; Molecular mechanisms of genome instability
- Transcription and its regulation in prokaryotes
- Transcription and its regulation in eukaryotes (Chromatin structure and its effects on transcription, post-transcriptional events including RNA processing and post-transcriptional control of gene expression) and introducing of different DNA binding proteins
- Translation and its regulation in prokaryotes and eukaryotes
- Brief description of main molecular methods which have been used in the study of central dogma discussed in each session.

Evaluation method:

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
20%	_____	Written Test: 80%	__ _____
		Practical: -	

References:

1. Robert F. Weaver, Molecular Biology, latest edition, McGraw Hill; (currently 5th ed. 2012).
2. Brue Alberts, Molecular Biology of the Cell, latest edition, Garland Science; (currently 6th ed. 2015.

Course title: Bioinformatics
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar ☐
Degree: MSc ☐ Ph.D. ☐ MSc & Ph.D. ☑

Course Objectives:

Familiarizing students with data, data bases and methods of storage, extraction and analysis of biological data, biological algorithms, and computer methods for the proper examination and utilization of molecular biology data.

Headlines:

- Introduction
- An overview of network structure
- Database on bioinformatics and search on them
- Dual matching of sequences
- Multiple sequence matching
- Second type databases and search them
- Phylogenetic predictions
- Genome structure and analysis of DNA sequences and gene prediction
- Analysis of RNA structure and predict its structure
- Database of protein structures and display and analysis the structures
- Methods of prediction the Protein Structures and Structural Modeling

Evaluation Method

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
40%	30%	Written Test: 30%	0%
		Practical: -	

References:

1. Mount, D. Bioinformatics, Sequence and Genome Analysis. Cold Spring Harbor Lab., New York, 2001.
2. Baldi, P., Brunak, S., Bioinformatics, The machine learning approach, MIT Press, Cambridge, 2001.

Course title: Molecular Modeling
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☐ doesn't have ☑ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☐
Degree: MSc ☐ Ph.D. ☐ MSc & Ph.D. ☑

Course Objectives:

To make the students familiar with basic topics in molecular modeling with emphasis on biological systems.

Headlines:

- Historical introduction to the development of methods and issues in molecular modeling.
- The mathematical expression of molecular structures, coordinate systems for describing molecular movements, coordinate and internal variables.
- Introduction to quantum approaches in molecular modeling e.g. Hartree-Fock, density function, and semi-empirical methods.
- Concepts related to potential energy surface of simple and complex molecules, minimum and saddle points.
- Energy minimization methods and algorithms, and structure optimization e.g. steepest descent, and conjugate gradient methods.
- Molecular mechanic approaches and force fields.
- Force fields for biological systems e.g. CHARMM, and AMBER.
- Methods and algorithms of analysis and searching conformations e.g. simulated annealing, and evolutionary algorithms.
- Elements of molecular dynamics simulation
- Concepts and methods of molecular structure analysis, structural similarity measurement, structural superposition, coarse-grained coordinate calculation e.g. radius of gyration, RMSD, number of atom contacts, accessible surface area, …
- Methods for the description of the solvent and its effects on molecular modeling, including implicit and explicit solvent models, generalized Born model and multicenter models
- Methods of analysis and prediction of protein-ligand binding e.g. molecular docking.

Evaluation Method

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
40%	30%	Written Test: 30%	0%
		Practical: -	

References:

1. Molecular Modeling Principles and Applications, Andrew R. Leach, Pearson Education, 2001.
2. Molecular Modeling of Proteins, Andreas Kukol, Springer (Humana Press), 2008.
3. New Algorithms for Macromolecular Simulation, T. J. Barth, M. Griebel, D. E. Keyes, R. M. Nieminen, D. Roose, T. Schlick, Springer, 2006.

Course title: Modeling of Biological Systems
Number of units: 2
The number of hours: 32
Unit type: Theoretical
Course type: Specialized-Optional
Prerequisite: -
Practical training: has it ☐ doesn't have ☐ Scientific journey ☐ Workshop ☐ Laboratory ☐ Seminar☑
Degree: MSc ☐ Ph.D. ☐ MSc & Ph.D. ☑

Course Objectives:

In this course at first various standard methods and tools for modeling physiological systems will be introduced, and then novel approaches of modeling complex biological systems will be proposed.

Headlines:

- Introduction: needs, concepts, importance and applications, and various modeling approaches
- Modeling biological systems process
- Modeling biological systems, methods, and applications
- Methods of model identification: parametric and nonparametric models
- Model validation
- Case studies: cell, neurological system, blood flow, respiration, muscle
- Methods and novel concepts in modeling biological systems: computational intelligence-based methods, cellular automata, expert systems, and modular structures.

Evaluation Method

Continuous evaluation (To be specified in percentage)	midterm (To be specified in percentage)	Final Test (To be specified in percentage)	Project (To be specified in percentage)
20%	-	Written Test: 50%	30%
		Practical: -	

References:

1. C. Cobelli, E. Carson, Introduction to Modeling in Physiology and Medicine, Academic Press (Elsevier), 2008.
2. J. Keener, J. Sneyd, Mathematical Physiology, Springer, 2009.
3. J. Haefner, Modeling of Biological System: Principles and Application, Springer, 2005.
4. U. Alon, An Introduction to Systems Biology: Design Principles of Biological Circuits, Chapman & Hall/CRC, 2006.
5. MCK Khoo, Physiological Control Systems: Analysis, Simulation and Estimation, Willey-Black Well, 1999.