Program SPECIFICATION FOR PhD Degree in Medical Biophysics Code: 800

University: Alexandria **Faculty:** Medical Research Institute

Program Specification

A- Basic information

1- Program title : Master Degree in Medical Biophysics

2- Program type: single [√] **double** [ ] **multiple** [ ]

3- Department(s) : Medical Biophysics

4- Coordinator : Prof/ Yousef Seliem Yousef

5- External evaluator(s):

Prof/ Abdelsataar Mohamed Morsy

6- Last date of program specification approval: 8/1/2017

B- Professional Information

1- Program aims to provide students knowledge on :

1. biophysics of membranes and membrane proteins, Thermodynamics and function of artificial and biological membranes, Theoretical analysis of lipid dynamics and phase transitions, Electrostatics of charged bilayers, and Membrane proteins, structure, and function

2. A specialized area of tissue engineering.New biomaterials designed for tissue engineering. Traditional and computer aided design for biomaterials.

3. Models of nonlinear biological and physiological systems, Analysis and synthesis of dynamic models, Pressure-flow Model, Cardiac and circulation dynamics, Lung mechanics, Cardiovascular system, Respiratory system, Mass transport through diffusion and fluid flow, Multiple Model, Renal system, Membrane resting and action potential (Nernst equation), Cable conduction model, Electrical conduction and Signal propagation in the nervous system, and Finite difference Model.

4. Absorption of the energy of ionizing radiation, Dependence of the biological effect on absorbed dose, Direct and indirect actions of ionizing radiation, Response of the cell to the action of ionizing radiation, Biological effects of low doses of ionizing radiation and long term consequences.

5. Medical instruments such as: Electrocardiogram, Blood pressure sensors, Heart sound sensors, Blood flow meters, Pacemakers and defibrillators, Cardiac assist devices. Clinical laboratory measurements, Radiography, MRI, Ultrasonic imaging, the electroshock hazards, and electroshock protection.

6. Dynamics of muscle and tendon, Models of muscle contraction, Kinematics and dynamics of the human body, Methods for generating equations of motion, Analysis of human movement, including gait, running, and balance, Computer simulations, and Discussion of experimental measurement techniques.

7. The Physiological fluid dynamics, Respiratory flow patterns, Blood flow and pulse propagation, and blood flow in the micro circulation. Laws for bio-viscoelastic fluids, solids and mixtures. Mechanical properties of blood vessels, ligaments, muscle, bone, and cartilage, Nonlinear continuum, and Multiphasic models of tissues.

8. Mathematical methods useful in theoretical molecular biophysics, Quantum mechanical description of molecules, Computational approaches to calculate properties of molecules of biological interest. Fundamental concepts of electrostatics for describing microscopic and macroscopic representations of the dielectric effects of solvating environments, Importance of solvation in biological processes, Molecular mechanical representation of systems and ensembles, Force field and energy expression.

9. The biophysical principles and experimental approaches in the following areas: fluorescence techniques and application in biology, nuclear magnetic resonance structure and spectroscopy in biology, and X-ray Diffraction analysis of structure and function of macromolecules

10. topics on linear algebra like vectors, matrices, vector spaces, determinants, eigen values and linear transformations. advanced calculus such as double and triple integrals, Fourier transforms, infinite series, improper integrals, Gamma and Beta functions and functions of complex variables, ordinary and partial differential equations.

11. Advanced signal processing techniques.Pattern recognition/classification,Spectral estimation, including classical and modern, Time-frequency and time-scale.Nonlinear filtering, including rank order filtering,Random processes are an important component of the methods.

12. Introduction to proteomics, from experimental procedures to data organization and analysis, Sample preparation and separations, Database search analysis, Characterizing post translational modifications, Protein-protein interactions and Protein microarrays.

13. Chemical, physical, and biological properties of synthetic polymer, metal, and ceramic biomaterials,Relationship between the structure of biomaterials and their interaction with soft, and hard tissue,Mechanical properties, fabrication, and degradation mechanisms, and performance testing of materials in biomedical use

14. Nanotechnology Scaling laws, Micro- and nanomaterials, Micro- and nanofabrication techniques, Biochemical and biomedical applications, Non-traditional fabrication techniques.

15. Biocompatibility of soluble and insoluble polymers, Biocompatibility of biomaterials used as implants, blood substitutes, and carriers of bioactive molecules, Bio recognition of synthetic macromolecules on cellular and subcellular levels, Biodegradability and immunogenicity of biomaterials.

16. The molecular and cellular neuroscience and theoretical analysis of brain function,The biophysical and molecular concepts relating to membrane excitability, action potential generation and propagation. The molecular basis of chemical signaling at synapses, Mechanisms and models of synaptic integration and plasticity with emphasis on how molecular changes translate into altered synaptic strength and gene expression programs.

17. Standard methods of preparing research experimental design, Writing and criticizing scientific research papers and thesis, Presenting a recent journal article in the area of biophysics, physiology, biomedical engineering, or structural biology, the methodologies used and whether these were appropriate for the experiments carried out.

2- Intended learning outcomes (ILOS)

a- knowledge and understanding:

a1. Discuss the bilayer structure of biological membranes, the fundamental physico-chemical properties of the biological membrane, thermodynamics of lipid aggregation using spectroscopic method, the function of cell membrane and its role in signal transduction.

a2. Discuss tissue engineering, essential biomaterials in tissue engineering, the role of nanotechnology in tissue engineering, the nanofibers as a scaffold for tissue engineering

a3. Explain Models of nonlinear biological and physiological systems , Analysis and synthesis of dynamic models, Pressure-flow Model, Cardiac and circulation dynamics, Lung mechanics, Cardiovascular system, Respiratory system, Mass transport through diffusion and fluid flow, Multiple Model, Renal system, Membrane resting and action potential (Nernst equation), Cable conduction model, Electrical conduction and Signal propagation in the nervous system, and Finite difference Model.

a4. Discuss the types of radiations, methods and units used for radiation measurement, the effect of ionizing radiation on biological tissues the medical applications of ionizing radiation.

a5. Discuss the principles of medical instrumentation, the brain and muscle potentials, the medical sensors used in measurements of blood pressure and heart sound, the principals of imaging using ultrasound and MRI

a7. Recall Dynamics of muscle and tendon, Models of muscle contraction, Kinematics and dynamics of the human body Methods for generating equations of motion Analysis of human movement, including gait, running, and balance, Computer simulations, and Discussion of experimental measurement techniques.

a8. Discuss the physiological fluid dynamics and respiratory flow patterns, mechanical properties of blood vessels and bone, the laws for bio- viscoelastic fluids, solids and mixtures, the Blood flow in the microcirculation and pulse propagation.

a9. Recall the mathematical methods used in theoretical molecular biophysics, the quantum mechanical description of molecules, computational approaches to calculate properties of molecules of biological interest, the microscopic and macroscopic representations of the dielectric effects of solvating environments

a10. Discuss the biophysical principles of macromolecular structure and function, the Nuclear Magnetic Resonance Spectroscopy, Fluorescence Techniques in macromolecule identification, the X-ray Diffraction Analysis for macromolecular structure.

a11. Discuss topics on linear algebra like vectors, matrices, vector spaces, determinants, eigen values and linear transformations, advanced calculus such as double and triple integrals, Fourier transforms, infinite series, improper integrals, Gamma and Beta functions and functions of complex variables, ordinary and partial differential equations.

a12. Discuss general orthonormal bases, the advanced signal processing technique, Spectral estimation method, the nonlinear filtering, including rank order filtering,

a13. State the basics of proteome informatics.different methods for sample preparation and separation,protein-protein interactions, protein microarray

a14. Discuss the Chemical, physical, mechanical and biological properties of synthetic biomaterial.State the relation between structure and function of biomaterials, fabrication and degradation mechanisms of biomaterials, the interaction between biomaterial and biological tissues, biomaterials applications

a15. Discuss the scaling laws, micro- and nanotechnology, micro- and nanofabrication techniques, the biomedical applications of micro and nanotechnology.

a16. Recall the Biocompatibility, biodegradability and immunogenicity of biomaterials, the biomaterials used as implants, blood substitutes and carriers of bioactive molecules.bio recognition of synthetic macromolecules on cellular and subcellular levels, the indications, sterilization and preparation of biocompatible biomaterials.

a17. Recall the biophysical concepts of membrane excitability, action potential generation and propagation, the molecular and cellular neuroscience and theoretical analysis of brain function, the molecular basis of chemical signaling at synapses and models of synaptic integration, the molecular changes on the synaptic strength and health of the brain

a18. Recall the standard methods of preparing experimental research design, the basics of scientific writing, elementary statistical analysis methods of experimental data, the ethics of scientific research, publishing and copyrights.

b- Intellectual skills:

b1-Compare between different spectroscopic methods used to study membrane biophysics

b2- Examine the cell culture conditions.

b3-Develop mathematical models for nonlinear biological systems.

b4-Compare between different radio diagnostic and therapeutic tools

b5- Examine medical equipment testing and calibration.

b6- Judge the heart health from electrocardiogram graph.

b7- Analyze the nonlinear continuum and Multiphasic models of tissues.

b8- Create a molecular mechanical representation and energy expression for biological systems

b9- Analyze Structure of Macromolecules using Fluorescence Technique, X-ray Diffraction and Nuclear Magnetic Resonance analysis

b10- Construct a computer algorithm to solve determinants a solve integrals, determinants, matrices and differential equations.

b11- Compare between different advanced signal processing techniques

b12-Compare between different database search methodologies to analyze proteome informatics.

b13- Judge the biocompatibility of biomaterials.

b14- Compare between different methods of micro- and nanomaterials fabrication.

b15- Examine the characterization of biomaterials and their application.

b16- Analyze physical parameters related to action potentials generation and propagation using mathematical equations and models

b17- Differentiate between different methodologies used to carry out a scientific research.

c- professional and practical skills:

c1- Prepare tissues samples to be studied by electron microscopes.

c2-Illustrate the structure of membrane using electron microscopes.

c3- Apply biophysical equations which describe membrane functions.

c4- Demonstrate the electrospinning device for production of nanofibers.

c5- Prepare and characterize polymer solutions to be spun.

c6- Prepare and characterize nanofibers by using electrospinning technique.

C7-Apply mathematical equations to calculate the mass transport through diffusion, membrane resting and action potential and Signal propagation in the nervous system

C8- Apply mathematical equations to calculate the radiation dose.

C9- Use the radiation dosimeters to estimate the radiation hazards

c10- Demonstrate the working procedures of medical ultrasonograph, electrocardiography and the structure and function of some optical sensors.

c11– Apply the Computer simulations for experimental measurement techniques for human movement.

C12- Use mathematical equations of motion to explain Kinematics and dynamics of the human body.

c13- Use mathematical models for measuring the stress and strain of hard tissues and soft tissues and for measuring the bio-viscoelastic fluids, solids and mixtures.

c14- Practice the measuring of dielectric properties of biological tissues.

c15- Apply computational and mathematical methods to calculate physical properties of molecules of biological cell.

c16- Prepare materials to be analyzed by X-ray Diffraction

c17-Illustrate the X-ray Diffraction pattern.

c18-Interpret the macromolecular structure from the X-ray diffraction pattern

c19- Use computer programming languages like FORTRAN and C++ to test algorithms and validate mathematical models.

c20- Interpret signal spectrum obtained by different techniques.

c21- Use different algorithms for signal processing

c22- Use computer programming language to run the signal processing algorithms

c23-. Demonstrate the mass spectroscopy as a separation technique

c24-Use different data mining techniques to explore proteome data base

c25- Use supercomputers to process the proteome data.

c26-Prepare some of biomaterials in laboratory

c27- Employ mathematical equations to calculate some of biomaterials physical properties in laboratory.

c28 -Use computer simulation software to represent structure of biomaterials

c29- Prepare and characterize micro- and nanomaterials.

c30- Apply micro- and nanomaterials in biomedical application.

c31- Demonstrate using the biomaterials as implants, as blood substitutes and as matrix carriers for bioactive molecules.

c32- Use LCR dielectric Bridge to measure the dielectric properties of brain tissues.

c33- Use computational methods to simulate the way by which the brain functioning like artificial neural network and its application

c34-Practice the measuring of stress and strain of brain tissues

c35-Use the appropriate research methodology to conduct a research .

c36-Apply statistical methods to analyze experimental data .

c37-Use the principal of scientific writing to avoid literal mistakes and misrepresentations.

d- General and transferable skills:

d1- Develop skills in reading.

d2- Develop team work

d3- Use information technology

d4- Increase written and oral skills

3- Academic standards

3a External references for standards (Benchmarks)

Generic Academic Reference Standards if the National Authority for Quality Assurance and Accreditation of Education (NAQAAE)

3b Comparison of provision to selected external references

Generic Academic Standards	ARS of PhD in Medical Biophysics
A1-Basic facts, theories, of the specialty and related subjects/ fields	a1- Recognize the principals of theoretical and experimental biophysical methods used in study macromolecules a2- Discuss advanced topics on tissue engineering a3- Recognize the fundamentals of neuroscience a4- Discuss the mechanics of soft , hard tissues and human movement a5- Recognize the different research methodologies, statistical analyses and ethical considerations
A2-Mutual relation between professional practice and effects on environment	b3-Evaluate many biophysical parameters used in nuclear medicine and radiotherapy b4-Assess the efficiency of medical instruments involved in monitoring, diagnosis and therapy.
A3- Recent advances in the field of practice	c4- Prepare and characterize different types of nanomaterials b2- Judge the biocompatibility of biomaterials, micro and nanomaterials
A4-Details of ethical & legal practice	Recognize ethical and legal considerations in laboratory practice through thesis work a5- Recognize the different research methodologies, statistical analyses and ethical considerations
A5 -Quality standards of the practice	Ensure the quality of practice through experimental quizzes and practical exams
A6- Design, conduction & publishing of scientific research	- Design, conduct & publish scientific research through thesis work a5- Recognize the different research methodologies, statistical analyses and ethical considerations

A7-Ethical considerations in different types of scientific research	Recognize ethical and legal considerations in different scientific research through thesis work a5- Recognize the different research methodologies, statistical analyses and ethical considerations
B1- Analyze, deduce, extrapolate & evaluation of information	b1-Construct mathematical methods to represent some physiological systems b2- Judge the biocompatibility of biomaterials, micro and nanomaterials b3-Evaluate many biophysical parameters used in nuclear medicine and radiotherapy
B2- Solve the majority of problems in the specialty according to the available data (complete or incomplete)	b1-Construct mathematical methods to represent some physiological systems b3-Evaluate many biophysical parameters used in nuclear medicine and radiotherapy b4- Assess the efficiency of medical instruments involved in monitoring, diagnosis and therapy.
B3- Conduct research studies that add to the existing specialty knowledge	Conduct scientific research through thesis work a5- Recognize the different research methodologies, statistical analyses and ethical considerations
B4- Publish scientific articles/papers (in indexed journals)	Publish scientific research through thesis work a5- Recognize the different research methodologies, statistical analyses and ethical considerations
B5- Plan and implement (or supervise implementation of) enhancement & Improvement approaches to practice	Plan an enhancement of experimental skills and presentation skills through group project and seminars
B6- Take decisions in various professional situations (including dilemmas & controversial issues)	b2- Judge the biocompatibility of biomaterials, micro and nanomaterials b4-Assess the efficiency of medical instruments involved in monitoring, diagnosis and therapy.
B7- Add to the specialty field through creativity & innovation	Add to the specialty field through creativity & innovation through thesis work
B8- Manage discussions on basis of evidence and proofs	d2- Develop team,communication skills and disussion groups

C1- Competent in all basic and all required advanced professional skills (to be determined according to the specialty board/ department)	c1-Practice different spectroscopic and microscopic techniques used to study the biological systems characteristics. c2- Use computer software to handle proteome informatics database and process images and signals harvested by different medical instrumentations c3- Use computer software to test mathematical models represent some physiological systems. c4- Prepare and characterize different types of nanomaterials
C2- Write and appraise reports	Write and appraise reports on the experimental work through thesis
C3-Evaluate *and improve* methods and tools used in specialty	c3- Use computer software to test mathematical models represent some physiological systems. b1-Construct mathematical methods to represent some physiological systems
C4- Use technology to advance practice	d3- Use information technology.
C5- Plan professional development courses to improve practice and enhance performance of juniors	Plan professional development courses to improve practice and enhance performance of juniors through assignments and seminars d1-Develop skills in reading. d4- Increase written and oral skills.
D1- Communicate effectively using all methods	d2- Develop team,communication skills and disussion groups
D2- Use information technology to improve his/her professional practice	d3- Use information technology.
D3- Teach and evaluate others	Teach and evaluate others through assignments and seminars
D4- Perform self appraisal & seek continuous learning	Perform self appraisal & seek continuous learning through thesis and seminars
D5- Use different sources of information to obtain data	Use different sources of information to obtain data

	through thesis
D6- Work in teams as well as a member in larger teams	d1- Develop team work skills and ability to communicate with others in scientific meetings and group
D7- Manage scientific meetings and appropriately utilize time	Manage scientific meetings and appropriately utilize time through seminars

4- curriculum structure and contents

4.a program duration:

4.b program structure :**from 3 to 7 years**

4.b.i- No. of hours per week in each year/semester: 12 hours per week/ semester

Semester	**Number of hours**
First semester	**6 credit hours**
Second semester	**6 credit hours**
Third semester	**6 credit hours**
Fourth semester	**6 credit hours**
Thesis	**24 credit hours after finishing 12 credit hours at least**

4.b.ii- No. of credit hours **Lectures** **16** **Practical** **8** **Total** **24**

Compulsory **18** **Elective** **6** **Optional** **0**

4.b.iii- No. of credit hours of basic science courses **No.** **24** **%** **100**

4.b.iv- No. of credit hours of courses of social sciences and humanities. **No.** **0** **%** **0**

4.b.v- No. of credit hours of specialized courses	**No.**	**18**	**%**	**75**
4.b.vi- No. of credit hours of other courses	**No.**	**0**	**%**	**0**
4.b.vii- Practical/Field Training	**Yes**	**0**	**No**	√

4.b.viii- Program levels (in credit-hours system)

Student is required to pass at least 12 credit hours with CGPA not less than C+ before submitting a thesis proposal.

5- Program Courses

5.1- Compulsory (add no. of hours)

Code No.	Course Title	No. of credit hours	No. of hours /week	
			Lecture	Practical
1712801	Biophysics of membranes and membrane proteins	3	2	2
1712802	Advanced topics in tissue engineering	3	2	2
1712803	Modeling of physiological systems	3	2	2
1712804	Radiobiology and radionuclides	3	2	2
1712805	Medical instrumentation	3	2	2
1712806	Mechanics of human movement	3	2	2

5.2- Elective I (add no. of hours)

Code No.	Course Title	No. of credit hours	No. of hours /week	
			Lecture	Practical
1712807	Biosolid and biofluid mechanics	3	2	2
1712808	Introduction to theoretical molecular biophysics	3	2	2
1712809	Methods in molecular and cellular biophysics	3	2	2
1712810	Mathematical methods II	3	2	2
1712811	Advanced signal processing	3	2	2
1712812	Advances in vascular imaging techniques	3	2	2
1712813	Introduction to modern biomaterials	3	2	2
1712814	Biological micro and nanotechnology	3	2	2

1712815	**biocompatibility**	**3**	**2**	**2**
1712816	**Fundamental neuroscience**	**3**	**2**	**2**
1712817	**Journal club in medical biophysicsII**	**3**	**2**	**2**

5.4- Optional – (none)

6- Program admission requirements

Postgraduate students with a MSc or an equivalent degree in medical biophysics after passing the pre-requisite courses

7- Regulations for progression and program completion

For the progression and completion of the program to obtain the degree of PhD in medical biophysics, the student must complete 48 credit hours with CGPA of at least C+ and submit a thesis validity report.

8- Evaluation of program intended learning outcomes

Evaluator	**tool**	**Sample**
1- Senior students	Questionnaire	All the students
2- Alumni	NA	NA
3- Stakeholders (Employers)	NA	NA
4- External Evaluator(S) External Examiner (s)	NA	NA
5- Other	NA	NA

Dates of previous editions/revisions

Editions/revisions number	**Date**
Edition no 1	**2009**
Edition no 2	**2011**
Edition no 3	**5/6/2014**
Edition no 3, revision no 1	**12/2014**
Edition no 3, revision no 2	**10/2016**
Edition no 3, revision no 3	**6/9/2017**

Program coordinator :

Name: Prof/ Yousef Seliem Yousef

Signature ……. Date …………

Program Courses vs teaching and learning methods Matrix

	801	*802*	*803*	*804*	*805*	*806*	*807*	*808*	*809*	*810*	*811*	*812*	*813*	*814*	*815*	*816*	*817*	*820*
Lectures	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Practical sessions	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Seminars	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
group discussion	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
self learning	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
brain storming	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√

Program Courses vs Program ILO's Matrix

Course code	Course title	a1	a2	a3	a4	a5	a6	a7	a8	a9	a10	a11	a12	a13	a14	a15	a16	a17
1712801	Biophysics of membranes and membrane proteins	√																
1712802	Advanced topics in tissue engineering		√															
1712803	Modeling of physiological systems			√														
1712804	Radiobiology and radionuclides				√													
1712805	Medical instrumentation					√												
1712806	Mechanics of human movement						√											
1712807	Biosolid and biofluid mechanics							√										
1712808	Introduction to theoretical molecular biophysics								√									
1712809	Methods im molecular and cellular biophysics									√								
1712810	Mathematical methods II										√							
1712811	Advanced signal processing											√						
1712812	Advances in vascular imaging techniques												√					
1712813	Introduction to modern biomaterials													√				

1712814	Biological micro and nanotechnology														√			
1712815	biocompatibility															√		
1712816	Fundamental neuroscience																√	
1712817	Journal club in medical biophysicsII																	√

Course code	Course title	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15	b16	b17
1712801	Biophysics of membranes and membrane proteins	√																
1712802	Advanced topics in tissue engineering		√															
1712803	Modeling of physiological systems			√														
1712804	Radiobiology and radionuclides				√													
1712805	Medical instrumentation					√												
1712806	Mechanics of human movement						√											
1712807	Biosolid and biofluid mechanics							√										
1712808	Introduction to theoretical molecular biophysics								√									
1712809	Methods im molecular and cellular biophysics									v								

1712810	Mathematical methods II										√							
1712811	Advanced signal processing											√						
1712812	Advances in vascular imaging techniques												√					
1712813	Introduction to modern biomaterials													√				
1712814	Biological micro and nanotechnology														√			
1712815	biocompatibility															√		
1712816	Fundamental neuroscience																√	
1712817	Journal club in medical biophysicsII																	√

Course code	Course title	c 1	c2	c3	c4	c5	c6	c7	c8	c9	c10	c11	c12	c13	C 14	C 15	C 16	c1 7
1712801	Biophysics of membranes and membrane proteins	√	√	√														
1712802	Advanced topics in tissue engineering				√	√	√											
1712803	Modeling of physiological systems							√										
1712804	Radiobiology and radionuclides								√	√								
1712805	Medical instrumentation										√							

1712806	Mechanics of human movement											√	√					
1712807	Biosolid and biofluid mechanics													√	√			
1712808	Introduction to theoretical molecular biophysics															√		
1712809	Methods im molecular and cellular biophysics																√	√

Course code	Course title	c18	c19	c20	c21	c22	c23	c24	c25	c26	c27	c28	c29	c30	c31	c32	c33	c34	c35	c36	c37
1712809	Methods im molecular and cellular biophysics	√																			
1712810	Mathematical methods II		√																		
1712811	Advanced signal processing			√	√	√															
1712812	Advances in vascular imaging techniques						√	√	√												
1712813	Introduction to modern biomaterials									√	√	√									
1712814	Biological micro and nanotechnology												√	√							
1712815	biocompatibility														√						
1712816	Fundamental neuroscience															√	√	√			
1712817	Journal club in medical																		√	√	√

	biophysicsII																			

Course code	Course title	d1	d2	d3	d4
1712801	Biophysics of membranes and membrane proteins	√	√	√	√
1712802	Advanced topics in tissue engineering	√	√	√	√
1712803	Modeling of physiological systems	√	√	√	√
1712804	Radiobiology and radionuclides	√	√	√	√
1712805	Medical instrumentation	√	√	√	√
1712806	Mechanics of human movement	√	√	√	√
1712807	Biosolid and biofluid mechanics	√	√	√	√
1712808	Introduction to theoretical molecular biophysics	√	√	√	√
1712809	Methods im molecular and cellular biophysics	√	√	√	√
1712810	Mathematical methods II	√	√	√	√
1712811	Advanced signal processing	√	√	√	√
1712812	Advances in vascular imaging techniques	√	√	√	√

1712813	Introduction to modern biomaterials	√	√	√	√
1712814	Biological micro and nanotechnology	√	√	√	√
1712815	biocompatibility	√	√	√	√
1712816	Fundamental neuroscience	√	√	√	√
1712817	Journal club in medical biophysicsII	√	√	√	√

Program Aims vs Program ILO's Matrix

No.	Aim	a1	a2	a3	a4	a5	a6	a7	a8	a9	a10	a11	a12	a13	a14	a15	a16	a17
1	biophysics of membranes and membrane proteins, Thermodynamics and function of artificial and biological membranes, Theoretical analysis of lipid dynamics and phase transitions, Electrostatics of charged bilayers, and Membrane proteins, structure, and function	√																
2	A specialized area of tissue engineering.New biomaterials designed for tissue engineering. Traditional and computer aided design for biomaterials.		√															
3	Models of nonlinear biological and physiological systems, Analysis and synthesis of dynamic models, Pressure-flow Model, Cardiac and circulation dynamics, Lung mechanics, Cardiovascular system, Respiratory system, Mass transport through diffusion and fluid flow, Multiple Model, Renal system, Membrane resting and action potential (Nernst equation), Cable conduction model, Electrical conduction and Signal propagation in the nervous system, and Finite difference Model.			√														
4	Absorption of the energy of ionizing radiation, Dependence of the biological effect on absorbed dose, Direct and indirect actions of ionizing radiation, Response of the cell to the action of ionizing radiation, Biological effects of low doses of ionizing radiation and long term consequences.				√													

5	Medical instruments such as: Electrocardiogram, Blood pressure sensors, Heart sound sensors, Blood flow meters, Pacemakers and defibrillators, Cardiac assist devices. Clinical laboratory measurements, Radiography, MRI, Ultrasonic imaging, the electroshock hazards, and electroshock protection.					√												
6	Dynamics of muscle and tendon, Models of muscle contraction, Kinematics and dynamics of the human body, Methods for generating equations of motion, Analysis of human movement, including gait, running, and balance, Computer simulations, and Discussion of experimental measurement techniques.						√											
7	The Physiological fluid dynamics, Respiratory flow patterns, Blood flow and pulse propagation, and blood flow in the micro circulation. Laws for bio-viscoelastic fluids, solids and mixtures. Mechanical properties of blood vessels, ligaments, muscle, bone, and cartilage, Nonlinear continuum, and Multiphasic models of tissues.																	
8	Mathematical methods useful in theoretical molecular biophysics, Quantum mechanical description of molecules, Computational approaches to calculate properties of molecules of biological interest. Fundamental concepts of electrostatics for describing microscopic and macroscopic representations of the dielectric effects of solvating environments, Importance of solvation in biological processes, Molecular mechanical representation of systems and ensembles, Force field and energy expression.							√										

9	The biophysical principles and experimental approaches in the following areas: fluorescence techniques and application in biology, nuclear magnetic resonance structure and spectroscopy in biology, and X-ray Diffraction analysis of structure and function of macromolecules								√									
10	topics on linear algebra like vectors, matrices, vector spaces, determinants, eigen values and linear transformations. advanced calculus such as double and triple integrals, Fourier transforms, infinite series, improper integrals, Gamma and Beta functions and functions of complex variables, ordinary and partial differential equations.									√								
11	Advanced signal processing techniques.Pattern recognition/classification,Spectral estimation, including classical and modern, Time-frequency and time-scale.Nonlinear filtering, including rank order filtering,Random processes are an important component of the methods.										√							
12	Introduction to proteomics, from experimental procedures to data organization and analysis, Sample preparation and separations, Database search analysis, Characterizing post translational modifications, Protein-protein interactions and Protein microarrays.											√						
13	Chemical, physical, and biological properties of synthetic polymer, metal, and ceramic biomaterials,Relationship between the structure of biomaterials and their interaction with soft, and hard tissue,Mechanical properties, fabrication, and degradation mechanisms, and performance testing of materials in biomedical use													√				
14	Nanotechnology Scaling laws, Micro- and nanomaterials, Micro- and nanofabrication techniques, Biochemical and biomedical applications, Non-traditional fabrication techniques.														√			

15	Biocompatibility of soluble and insoluble polymers, Biocompatibility of biomaterials used as implants, blood substitutes, and carriers of bioactive molecules, Bio recognition of synthetic macromolecules on cellular and subcellular levels, Biodegradability and immunogenicity of biomaterials.															√		
16	The molecular and cellular neuroscience and theoretical analysis of brain function,The biophysical and molecular concepts relating to membrane excitability, action potential generation and propagation. The molecular basis of chemical signaling at synapses, Mechanisms and models of synaptic integration and plasticity with emphasis on how molecular changes translate into altered synaptic strength and gene expression programs.																√	
17	Standard methods of preparing research experimental design, Writing and criticizing scientific research papers and thesis, Presenting a recent journal article in the area of biophysics, physiology, biomedical engineering, or structural biology, the methodologies used and whether these were appropriate for the experiments carried out.																	√

No.	**Aim**	**b1**	**b2**	**b3**	**b4**	**b5**	**b6**	**b7**	**b8**	**b9**	**b10**	**b11**	**b12**	**b13**	**b14**	**b15**	**b16**	**b17**

1	biophysics of membranes and membrane proteins, Thermodynamics and function of artificial and biological membranes, Theoretical analysis of lipid dynamics and phase transitions, Electrostatics of charged bilayers, and Membrane proteins, structure, and function	√																
2	A specialized area of tissue engineering.New biomaterials designed for tissue engineering. Traditional and computer aided design for biomaterials.		√															
3	Models of nonlinear biological and physiological systems, Analysis and synthesis of dynamic models, Pressure-flow Model, Cardiac and circulation dynamics, Lung mechanics, Cardiovascular system, Respiratory system, Mass transport through diffusion and fluid flow, Multiple Model, Renal system, Membrane resting and action potential (Nernst equation), Cable conduction model, Electrical conduction and Signal propagation in the nervous system, and Finite difference Model.			√														
4	Absorption of the energy of ionizing radiation, Dependence of the biological effect on absorbed dose, Direct and indirect actions of ionizing radiation, Response of the cell to the action of ionizing radiation, Biological effects of low doses of ionizing radiation and long term consequences.				√													
5	Medical instruments such as: Electrocardiogram, Blood pressure sensors, Heart sound sensors, Blood flow meters, Pacemakers and defibrillators, Cardiac assist devices. Clinical laboratory measurements, Radiography, MRI, Ultrasonic imaging, the electroshock hazards, and electroshock protection.					√												

6	Dynamics of muscle and tendon, Models of muscle contraction, Kinematics and dynamics of the human body, Methods for generating equations of motion, Analysis of human movement, including gait, running, and balance, Computer simulations, and Discussion of experimental measurement techniques.						√											
7	The Physiological fluid dynamics, Respiratory flow patterns, Blood flow and pulse propagation, and blood flow in the micro circulation. Laws for bio-viscoelastic fluids, solids and mixtures. Mechanical properties of blood vessels, ligaments, muscle, bone, and cartilage, Nonlinear continuum, and Multiphasic models of tissues.																	
8	Mathematical methods useful in theoretical molecular biophysics, Quantum mechanical description of molecules, Computational approaches to calculate properties of molecules of biological interest. Fundamental concepts of electrostatics for describing microscopic and macroscopic representations of the dielectric effects of solvating environments, Importance of solvation in biological processes, Molecular mechanical representation of systems and ensembles, Force field and energy expression.							√										
9	The biophysical principles and experimental approaches in the following areas: fluorescence techniques and application in biology, nuclear magnetic resonance structure and spectroscopy in biology, and X-ray Diffraction analysis of structure and function of macromolecules								√									
10	topics on linear algebra like vectors, matrices, vector spaces, determinants, eigen values and linear transformations. advanced calculus such as double									√								

	and triple integrals, Fourier transforms, infinite series, improper integrals, Gamma and Beta functions and functions of complex variables, ordinary and partial differential equations.																	
11	Advanced signal processing techniques.Pattern recognition/classification,Spectral estimation, including classical and modern, Time-frequency and time-scale.Nonlinear filtering, including rank order filtering,Random processes are an important component of the methods.									√								
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13	Chemical, physical, and biological properties of synthetic polymer, metal, and ceramic biomaterials,Relationship between the structure of biomaterials and their interaction with soft, and hard tissue,Mechanical properties, fabrication, and degradation mechanisms, and performance testing of materials in biomedical use												√					
14	Nanotechnology Scaling laws, Micro- and nanomaterials, Micro- and nanofabrication techniques, Biochemical and biomedical applications, Non-traditional fabrication techniques.													√				
15	Biocompatibility of soluble and insoluble polymers, Biocompatibility of biomaterials used as implants, blood substitutes, and carriers of bioactive molecules, Bio recognition of synthetic macromolecules on cellular and subcellular levels, Biodegradability and immunogenicity of biomaterials.														√			

16	The molecular and cellular neuroscience and theoretical analysis of brain function,The biophysical and molecular concepts relating to membrane excitability, action potential generation and propagation. The molecular basis of chemical signaling at synapses, Mechanisms and models of synaptic integration and plasticity with emphasis on how molecular changes translate into altered synaptic strength and gene expression programs.																√	
17	Standard methods of preparing research experimental design, Writing and criticizing scientific research papers and thesis, Presenting a recent journal article in the area of biophysics, physiology, biomedical engineering, or structural biology, the methodologies used and whether these were appropriate for the experiments carried out.																	√

No.	Aim	c1	c2	c3	c4	c5	c6	c7	c8	c9	c10	c11	c12	c13	c14	c15	c16	c17
1	biophysics of membranes and membrane proteins, Thermodynamics and function of artificial and biological membranes, Theoretical analysis of lipid dynamics and phase transitions, Electrostatics of charged bilayers, and Membrane proteins, structure, and function	√	√	√														
2	A specialized area of tissue engineering.New biomaterials designed for tissue engineering. Traditional and computer				√	√	√											

	aided design for biomaterials.																	
3	Models of nonlinear biological and physiological systems, Analysis and synthesis of dynamic models, Pressure-flow Model, Cardiac and circulation dynamics, Lung mechanics, Cardiovascular system, Respiratory system, Mass transport through diffusion and fluid flow, Multiple Model, Renal system, Membrane resting and action potential (Nernst equation), Cable conduction model, Electrical conduction and Signal propagation in the nervous system, and Finite difference Model.							√										
4	Absorption of the energy of ionizing radiation, Dependence of the biological effect on absorbed dose, Direct and indirect actions of ionizing radiation, Response of the cell to the action of ionizing radiation, Biological effects of low doses of ionizing radiation and long term consequences.								√	√								
5	Medical instruments such as: Electrocardiogram, Blood pressure sensors, Heart sound sensors, Blood flow meters, Pacemakers and defibrillators, Cardiac assist devices. Clinical laboratory measurements, Radiography, MRI, Ultrasonic imaging, the electroshock hazards, and electroshock protection.										√							
6	Dynamics of muscle and tendon, Models of muscle contraction, Kinematics and dynamics of the human body, Methods for generating equations of motion, Analysis of human movement, including gait, running, and balance, Computer simulations, and Discussion of experimental measurement techniques.											√	√					

7	The Physiological fluid dynamics, Respiratory flow patterns, Blood flow and pulse propagation, and blood flow in the micro circulation. Laws for bio-viscoelastic fluids, solids and mixtures. Mechanical properties of blood vessels, ligaments, muscle, bone, and cartilage, Nonlinear continuum, and Multiphasic models of tissues.													√	√			
8	Mathematical methods useful in theoretical molecular biophysics, Quantum mechanical description of molecules, Computational approaches to calculate properties of molecules of biological interest. Fundamental concepts of electrostatics for describing microscopic and macroscopic representations of the dielectric effects of solvating environments, Importance of solvation in biological processes, Molecular mechanical representation of systems and ensembles, Force field and energy expression.															√		
9	The biophysical principles and experimental approaches in the following areas: fluorescence techniques and application in biology, nuclear magnetic resonance structure and spectroscopy in biology, and X-ray Diffraction analysis of structure and function of macromolecules																√	√

No.	Aim	c18	c19	c20	c21	c22	c23	c24	c25	c26	c27	c28	c29	c30	c31	c32	c33	c34	c35	c36	c37
9	The biophysical principles and experimental approaches in the following areas: fluorescence techniques and application in biology, nuclear magnetic resonance structure and spectroscopy in biology, and X-ray Diffraction analysis of structure and function of macromolecules	√																			
10	topics on linear algebra like vectors, matrices, vector spaces, determinants, eigen values and linear transformations. advanced calculus such as double and triple integrals, Fourier transforms, infinite series, improper integrals, Gamma and Beta functions and functions of complex variables, ordinary and partial differential equations		√																		
11	Advanced signal processing techniques.Pattern recognition/classification,Spectral estimation, including classical and modern, Time-frequency and time-scale.Nonlinear filtering, including rank order filtering,Random processes are an important component of the methods.			√	√	√															
12	Introduction to proteomics, from experimental procedures to data organization and analysis, Sample preparation and separations, Database search analysis, Characterizing post translational modifications, Protein-protein interactions and Protein microarrays.						√	√	√												
13	Chemical, physical, and biological properties of synthetic polymer, metal, and ceramic biomaterials,Relationship between the structure of biomaterials and their interaction with soft, and hard tissue,Mechanical properties, fabrication, and degradation mechanisms, and performance testing of materials in biomedical use									√	√	√									

14	Nanotechnology Scaling laws, Micro- and nanomaterials, Micro- and nanofabrication techniques, Biochemical and biomedical applications, Non-traditional fabrication techniques.												√	√							
15	Biocompatibility of soluble and insoluble polymers, Biocompatibility of biomaterials used as implants, blood substitutes, and carriers of bioactive molecules, Bio recognition of synthetic macromolecules on cellular and subcellular levels, Biodegradability and immunogenicity of biomaterials.														√						
16	The molecular and cellular neuroscience and theoretical analysis of brain function,The biophysical and molecular concepts relating to membrane excitability, action potential generation and propagation. The molecular basis of chemical signaling at synapses, Mechanisms and models of synaptic integration and plasticity with emphasis on how molecular changes translate into altered synaptic strength and gene expression programs.															√	√	√			
17	Standard methods of preparing research experimental design, Writing and criticizing scientific research papers and thesis, Presenting a recent journal article in the area of biophysics, physiology, biomedical engineering, or structural biology, the methodologies used and whether these were appropriate for the experiments carried out.																		√	√	√

No.	Aim	d1	d2	d3	d4
1	biophysics of membranes and membrane proteins, Thermodynamics and function of artificial and biological membranes, Theoretical analysis of lipid dynamics and phase transitions, Electrostatics of charged bilayers, and Membrane proteins, structure, and function	√	√	√	√
2	A specialized area of tissue engineering.New biomaterials designed for tissue engineering. Traditional and computer aided design for biomaterials.	√	√	√	√
3	Models of nonlinear biological and physiological systems, Analysis and synthesis of dynamic models, Pressure-flow Model, Cardiac and circulation dynamics, Lung mechanics, Cardiovascular system, Respiratory system, Mass transport through diffusion and fluid flow, Multiple Model, Renal system, Membrane resting and action potential (Nernst equation), Cable conduction model, Electrical conduction and Signal propagation in the nervous system, and Finite difference Model.	√	√	√	√
4	Absorption of the energy of ionizing radiation, Dependence of the biological effect on absorbed dose, Direct and indirect actions of ionizing radiation, Response of the cell to the action of ionizing radiation, Biological effects of low doses of ionizing radiation and long	√	√	√	√

	term consequences.				
5	Medical instruments such as: Electrocardiogram, Blood pressure sensors, Heart sound sensors, Blood flow meters, Pacemakers and defibrillators, Cardiac assist devices. Clinical laboratory measurements, Radiography, MRI, Ultrasonic imaging, the electroshock hazards, and electroshock protection.	√	√	√	√
6	Dynamics of muscle and tendon, Models of muscle contraction, Kinematics and dynamics of the human body, Methods for generating equations of motion, Analysis of human movement, including gait, running, and balance, Computer simulations, and Discussion of experimental measurement techniques.	√	√	√	√
7	The Physiological fluid dynamics, Respiratory flow patterns, Blood flow and pulse propagation, and blood flow in the micro circulation. Laws for bio-viscoelastic fluids, solids and mixtures. Mechanical properties of blood vessels, ligaments, muscle, bone, and cartilage, Nonlinear continuum, and Multiphasic models of tissues.	√	√	√	√
8	Mathematical methods useful in theoretical molecular biophysics, Quantum mechanical description of molecules, Computational approaches to calculate properties of molecules of biological interest. Fundamental concepts of electrostatics for describing microscopic and macroscopic representations of the dielectric effects of solvating environments, Importance of solvation in biological processes, Molecular mechanical representation of systems and ensembles, Force field and energy expression.	√	√	√	√
9	The biophysical principles and experimental approaches in the following areas: fluorescence techniques and application in biology, nuclear magnetic resonance structure and spectroscopy in biology, and X-ray Diffraction analysis of structure and function of macromolecules	√	√	√	√
10	topics on linear algebra like vectors, matrices, vector spaces, determinants, eigen values and linear transformations. advanced calculus such as double and triple integrals, Fourier transforms, infinite series, improper integrals, Gamma and Beta functions and functions of	√	√	√	√

	complex variables, ordinary and partial differential equations.				
11	Advanced signal processing techniques.Pattern recognition/classification,Spectral estimation, including classical and modern, Time-frequency and time-scale.Nonlinear filtering, including rank order filtering,Random processes are an important component of the methods.	√	√	√	√
12	Introduction to proteomics, from experimental procedures to data organization and analysis, Sample preparation and separations, Database search analysis, Characterizing post translational modifications, Protein-protein interactions and Protein microarrays.	√	√	√	√
13	Chemical, physical, and biological properties of synthetic polymer, metal, and ceramic biomaterials,Relationship between the structure of biomaterials and their interaction with soft, and hard tissue,Mechanical properties, fabrication, and degradation mechanisms, and performance testing of materials in biomedical use	√	√	√	√
14	Nanotechnology Scaling laws, Micro- and nanomaterials, Micro- and nanofabrication techniques, Biochemical and biomedical applications, Non-traditional fabrication techniques.	√	√	√	√
15	Biocompatibility of soluble and insoluble polymers, Biocompatibility of biomaterials used as implants, blood substitutes, and carriers of bioactive molecules, Bio recognition of synthetic macromolecules on cellular and subcellular levels, Biodegradability and immunogenicity of biomaterials.	√	√	√	√
16	The molecular and cellular neuroscience and theoretical analysis of brain function,The biophysical and molecular concepts relating to membrane excitability, action potential generation and propagation. The molecular basis of chemical signaling at synapses, Mechanisms and models of synaptic integration and plasticity with emphasis on how molecular changes translate into altered synaptic strength and gene expression programs.	√	√	√	√
17	Standard methods of preparing research experimental design, Writing and criticizing scientific research papers and thesis, Presenting a recent journal article in the area of biophysics, physiology, biomedical engineering, or structural biology, the methodologies used and	√	√	√	√

	whether these were appropriate for the experiments carried out.				