# Program SPECIFICATION FOR PhD Degree in Medical Biophysics Code: 1712800

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

## Program Specification

### A- Basic information

**1- Program title: PhD Degree in Medical Biophysics**

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

**3- Department(s) : Medical Biophysics**

**4- Coordinator: ASS. Prof. Dr. Moustafa Hussein Moustafa**

**5- External evaluator(s): Prof/ Abdelsataar Mohamed Morsy**

**6- Last date of program specification approval: 5/6/2014**

### B- Professional Information

**1- Program aims to:**

1. Identify the terms of 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. Explore a specialized area of tissue engineering. New biomaterials designed for tissue engineering. Traditional and computer aided design for biomaterials.

3. Make 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. Identify the 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. Differentiate between 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. Analyze the 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. Examine dynamics of the Physiological fluid, 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. Explore useful mathematical methods 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. Explore 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. Recall 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. Examine 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. Explore the 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. Recall 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. Examine nanotechnology Scaling laws, Micro- and nanomaterials, Micro- and nanofabrication techniques, Biochemical and biomedical applications, Non-traditional fabrication techniques.

15. Analyze 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. Recognize the molecular and cellular neuroscience concepts and Examine the theoretical analysis of brain function, the biophysical and molecular concepts relating to membrane excitability, action potential generation and propagation. Recall 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. Explore the standard methods of preparing research of 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.

18. Use systematic approaches to design and conduct scientific research.

19. Conduct research studies that add to the existing specialty knowledge.

## 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.

a6. Examine 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.

a19- Design, conduction & explore publishing of scientific research.

## 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- Analyze 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- Examine 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.

b18- Prepare scientific articles/ papers to be published in the indexed journals.

## 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)

### Adopted at MRI council 12/2/2014 and re-adopted at 15/1/2023

### Last date of Academic Reference standards (ARS) approval by institute 15/1/2023 Council

### 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. Discuss the bilayer structure of biological membranes, their fundamental properties, and their role in signal transduction. It also discusses tissue engineering, essential biomaterials, and nanotechnology's role in tissue engineering. It also discusses models of nonlinear biological and physiological systems, including pressure-flow, cardiac, circulatory, and respiratory systems.<br><br>A2. Cover the radiation types, measurement methods, effects on biological tissues, medical applications, principles of medical instrumentation, brain and muscle potentials, and medical sensors for blood pressure and heart sound measurements.<br><br>A3. Examine ultrasound and MRI imaging principles, learn muscle and tendon dynamics, muscle contraction models, human body kinematics, motion equation generation, gait analysis, computer simulations, and experimental measurement techniques.<br><br>A4. Recall the physiological fluid dynamics, respiratory flow patterns, mechanical properties of blood vessels and bone, bio-viscoelastic fluid laws, blood flow in microcirculation, and pulse propagation, while also referencing mathematical methods and computational approaches. |
| **A2-Mutual relation between** | A5. Examine the macromolecular structure and |

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| **professional practice and effects on environment** | function, including biophysical principles, nuclear magnetic resonance spectroscopy, fluorescence techniques, and X-ray diffraction analysis, linear algebra, advanced calculus, and complex functions.<br><br>A6. Explore the orthonormal bases, advanced signal processing techniques, spectral estimation methods, nonlinear filtering, and rank order filtering, as well as the basics of proteome informatics and sample preparation and separation. |
| **A3- Recent advances in the field of practice** | A7. Explore the chemical, physical, mechanical, and biological properties of synthetic biomaterials, their structure-function relationship, fabrication and degradation mechanisms, interaction with biological tissues, and their biomedical applications. |
| **A4-Details of ethical & legal practice** | A9. Address the standard experimental research design methods, scientific writing basics, statistical analysis, ethics, publishing, and copyrights, as well as design, conduct, and explore publishing of scientific research. |
| **A5 -Quality standards of the practice** | A8. Recall principles of Biomaterials, used in implants, blood substitutes, and carriers of bioactive molecules, are biocompatible, biodegradable, and immunogenic. They recognize synthetic macromolecules, sterilize, and prepare biocompatible materials. Understanding molecular concepts and synaptic integration is crucial for brain function. |
| **A6- Design, conduction & publishing of scientific research** | A9. Address the standard experimental research design methods, scientific writing basics, statistical analysis, ethics, publishing, and copyrights, as well as design, conduct, and explore publishing of scientific research. |
| **A7-Ethical considerations in different types of scientific research** | A9. Address the standard experimental research design methods, scientific writing basics, statistical analysis, ethics, publishing, and copyrights, as well as design, conduct, and explore publishing of scientific research. |
| **B1- Analyze, deduce, extrapolate & evaluation of information** | B1. Compare various spectroscopic methods for studying membrane biophysics and examines cell culture conditions.<br><br>B2. Create mathematical models for nonlinear biological systems and comparing radio diagnostic and |

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| | therapeutic tools. |
| **B2- Solve the majority of problems in the specialty according to the available data ( complete or incomplete**) | B3.Examine medical equipment testing and calibration, as well as analyzing heart health from an electrocardiogram graph. |
| **B3- Conduct research studies that add to the existing specialty knowledge** | B9. Identify and Utilize various scientific research methodologies, as well as creating scientific articles or papers for publication in indexed journals. |
| **B4- Publish scientific articles/papers ( in indexed journals)** | B9. Identify and Utilize various scientific research methodologies, as well as creating scientific articles or papers for publication in indexed journals. |
| **B5- Plan and implement ( or supervise implementation of) enhancement & Improvement approaches to practice** | B4.Analyze nonlinear continuum and multiphasic tissue models, as well as creating molecular mechanical representations and energy expressions for biological systems. |
| **B6- Take decisions in various professional situations ( including dilemmas & controversial issues)** | B5. Examine macromolecule structure using fluorescence techniques, X-ray diffraction, and nuclear magnetic resonance analysis, and developing a computer algorithm for solving determinants, integrals, matrices, and differential equations. |
| **B7- Add to the specialty field through creativity & innovation** | B6. Compare various advanced signal processing techniques and database search methodologies for analyzing proteome informatics. |
| **B8- Manage discussions on basis of evidence and proofs** | B7.Explore the biocompatibility of biomaterials and compares various methods of fabrication for micro- and nanomaterials.<br><br>B8. Evaluate the characterization and application of biomaterials, while also analyzing physical parameters related to action potential generation and propagation using mathematical equations and models. |
| **C1- Competent in all basic and all required advanced professional skills ( to be determined according to the specialty board/ department**) | C1. Prepare tissue samples for electron microscope study, illustrating membrane structure, and applying biophysical equations to describe membrane functions.<br>C2. Demonstrate an electrospinning device for nanofiber production, preparing and characterizing |

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| | polymer solutions for spinning, and preparing and characterization of nanofibers using electrospinning technique.<br>C3. Calculate mass transport, radiation dose, and radiation hazards in the nervous system, using dosimeters to estimate hazards.<br>C4. Demonstrate medical ultrasonograph, electrocardiography, and optical sensor procedures, apply computer simulations for human movement measurements, and use mathematical equations to explain body kinematics and dynamics. |
| **C2- Write and appraise reports** | C5. Utilize mathematical models to measure stress, strain, and bio-viscoelastic fluids, practice dielectric properties of biological tissues, and apply computational and mathematical methods to calculate physical properties of biological cell molecules.<br>C.6 Prepare materials for X-ray diffraction analysis, illustrating the resulting pattern, and interpreting the macromolecular structure from the X-ray diffraction pattern. |
| **C3-Evaluate *and improve* methods and tools used in specialty** | C7. Utilize programming languages like FORTRAN and C++ for algorithm testing and mathematical model validation, interpret signal spectrum from various techniques, and employ various signal processing algorithms.<br>C8. Execute signal processing algorithms, demonstrating mass spectroscopy as a separation technique, and employing various data mining techniques to explore proteome databases. |
| **C4- Use technology to advance practice** | C9. Process proteome data, prepare biomaterials in the laboratory, and calculate their physical properties using mathematical equations.<br>C10. Outline the use of computer simulation software to represent biomaterial structure, prepare and characterize micro- and nanomaterials, and apply them |

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| | in biomedical applications. |
| **C5- Plan professional development courses to improve practice and enhance performance of juniors** | C11. Explore the biomaterials in implants, blood substitutes, and matrix carriers, as well as the use of LCR dielectric bridge for measuring brain tissue properties.<br><br>C12. Emphasize the importance of practicing stress and strain measurements on brain tissues and using the appropriate research methodology for conducting such studies.<br><br>C13. Utilize statistical methods for analyzing experimental data and adhere to the principles of scientific writing to prevent literal errors and misrepresentations. |
| **D1- Communicate effectively using all methods** | D1. Develop skills in reading.<br><br>D4. Increase written and oral skills |
| **D2- Use information technology to improve his/her professional practice** | D3. Use information technology |
| **D3- Teach and evaluate others** | D2. Develop team work |
| **D4- Perform self appraisal & seek continuous learning** | D4. Increase written and oral skills |
| **D5- Use different sources of information to obtain data** | D3. Use information technology |
| **D6- Work in teams as well as a member in larger teams** | D2. Develop team work |
| **D7- Manage scientific meetings and appropriately utilize time** | D1. Develop skills in reading.<br><br>D3. Use information technology |

# 4- Curriculum structure and contents

## 4. a program duration: from 3 to 5 years

***4.b program structure :***

### 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 | Thesis | 24 | Total | 48 |
|---|---|---|---|---|---|---|---|
| Compulsory | 18 | Elective | 6 | Optional | 0 | | |

**4.b.iii- No. of credit hours of specialized courses** No. 18 % 75

**4.b.iv- No. of credit hours of other courses** No. 6 % 25

## 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 (18 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 |
| **Total** | | **18** | **12** | **12** |

## 5.2- Elective I (6 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** | Proteome Informatics | **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 |
| **1701820** | Biochemistry | **3** | **2** | **2** |
| **1703820** | Physiology | **3** | **2** | **2** |
| **1704820** | Pharmacology | **3** | **2** | **2** |
| **1706820** | Bacteriology | **3** | **2** | **2** |
| **1707820** | Parasitology | **3** | **2** | **2** |
| **1709820** | Histochemisty and cell biology I | **3** | **2** | **2** |
| **1718820** | Radiodiagnosis | **3** | **2** | **2** |
| **1719820** | Nuclear Medicine | **3** | **2** | **2** |
| **1721820** | Medical statistics | **3** | **2** | **2** |

## 6- Program admission requirements

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

## 7- Teaching and learning methods

1. **Lectures**
2. **Practical sessions**
3. **Seminars**
4. **group discussion**
5. **self-learning**
6. **brain storming**

## 8- 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:

1- Complete 24 credit hours with CGPA of at least C+ through courses.

2- Complete 24 credit hours through thesis.

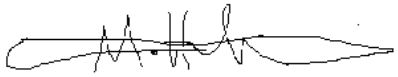
3- Submit a thesis validity report by an examination committee approved by the department council and their members include at least two external examiners.

## 9- Evaluation of program:

| **Evaluator** | **tool** | **Sample** |
|---|---|---|
| 1- Senior students | Questionnaire | All the students |
| 2- Alumni | Questionnaire | NA |
| 3- Stakeholders ( Employers ) | Meeting | NA |
| 4- External Evaluator(S)<br>External Examiner (s) | Report | **Prof/ Abdelsataar Mohamed Morsy** |
| 5- Other | NA | NA |

**Program coordinator:**

Name: ASS. Prof. Dr. Moustafa Hussein Moustafa

Signature: 

**Department Head:**

Name: Prof.Dr.Heba Said Ramadan

Signature: Heba Said

**Date of Department Council Approval: 29/8/2023**

## *Program Aims vs Graduate Attribute matrix*

| Generic Graduate Attributes of NAQAAE | Graduate Attributes of Doctor of Philosophy in medical biophysics<br>By the end of this program, Graduate of Doctor of Philosophy in *MEDICAL BIOPHYSICS , should be able to* | Program Aims |
|---|---|---|
| Master the basics and methodologies of scientific research. | • Physiological changes in biological membranes, physical equations, mechanical cell phenomena, electrical cell interconnection, signal propagation, mathematical modeling, nuclear radiation safety, and electromagnetic interaction in biological systems. | – Identify the terms of 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.<br>– Make 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.<br>– Identify the 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. |
| Work continuously to add to his/her | • The individual aims to develop teamwork, leadership, delegation, | – Use systematic approaches to |

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| knowledge in the field of specialty. | coordination, interpersonal skills, a positive attitude, and effective management abilities. | design and conduct scientific research. |
| Apply the analytical and critical approach to knowledge in the field of specialty and related fields. | • Enhance performance by focusing on specific traits in expertise, follow scientific guidelines and ethical rules, periodically update program specifications and contents, and follow peer-reviewed articles and online reviews. | – Explore the standard methods of preparing research of 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. |
| Integrate knowledge in the field of specialty with related knowledge, deduce and develop relationships between them. | • Possesses extensive knowledge and awareness about local construction, the ability to comprehend the big picture, the ability to finance projects, and professional and management skills. | – Explore a specialized area of tissue engineering. New biomaterials designed for tissue engineering. Traditional and computer aided design for biomaterials. |
| Demonstrate a deep awareness of current problems and modern theories in the field of specialty. | • The program aims to enhance critical thinking, decision-making, contingency management, problem-solving, analytical thinking, and in-depth analysis of action outcomes. | – Explore the 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. |
| Identify professional problems and find innovative solutions to solve them. | • The ability to efficiently research and analyze vast amounts of information, demonstrating a comprehensive understanding of the industry. | – Explore 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 |
| Master a wide range of professional skills in the field of specialty. | • The individual have excellent communication, interpersonal skills, self-confidence, negotiation, confidence/arrogance, people skills, and patience. | – Examine dynamics of the Physiological fluid, 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 |

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| | | blood vessels, ligaments, muscle, bone, and cartilage, nonlinear continuum, and Multiphasic models of tissues. |
| Develop new methods, tools and methods for professional practice. | • The ability to work independently and efficiently, as well as self-improvement, is a key aspect of individuality and independence. | – State the basics of proteome informatics. different methods for sample preparation and separation, protein-protein interactions, protein microarray |
| Use appropriate technological means to serve his professional practice. | • The individual acquires the ability to efficiently research and analyze vast amounts of information, demonstrating a deep understanding of general industry requirements. | – Conduct research studies that add to the existing specialty knowledge. |
| Communicate efficiently and lead work teams in various professional scenarios. | • Strong interpersonal skills, leadership, delegation, coordination, teamwork, and the capacity to lead and manage team members are all possessed by the individual. | – Recall 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 |
| Take Decision in light of available data. | • The capacity to collaborate with others in a group, Collaboration and leadership abilities within the team, including the capacity to inspire others, behavior characteristics. | – Analyze the 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. |
| Employ and develop available resources efficiently and work to find new resources. | • Creativity, inventiveness, and entrepreneurial skills Being capable of understand both what to accomplish and how to execute it successfully Self-assurance | – Differentiate between 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 |

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| | | imaging, the electroshock hazards, and electroshock protection. |
| Show awareness of his/her role in community development and environmental preservation | • Proficiency in communication, negotiation, Individual characteristics, such as humor, a concentration on the health issues, Knowing what and why the other parties are requesting | – Examine 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. |
| Act in a manner that reflects a commitment to integrity, credibility, and professionalism. | • Being able to communicate with clients and talk in public, abilities in communication, the capacity to communicate with others, confidence in oneself, abilities in negotiations, arrogance or confidence, be patient. | – Examine nanotechnology Scaling laws, Micro- and nanomaterials, Micro- and nanofabrication techniques, Biochemical and biomedical applications, Non-traditional fabrication techniques. |
| Commit to continuous self-development and transfer his/her knowledge and experiences to others. | • The power to oversee resources and time, The capacity for financial analysis and management, Skills in time management and leadership | – Recall 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. |

# *Program Aims vs ILO's Matrix*

| No. | ILOS / Aims | a1 | a2 | a3 | a4 | a5 | a6 | a7 | a8 | a9 | a10 | a11 | a12 | a13 | a14 | a15 | a16 | a17 | a18 | a19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Identify the terms of 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 | Explore a specialized area of tissue engineering.New biomaterials designed for tissue engineering. Traditional and computer aided design for biomaterials. | | √ | | | | | | | | | | | | | | | | | |
| 3 | Make 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 | Identify the 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 | Differentiate between the 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 | | | | | √ | | | | | | | | | | | | | | |

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| | electroshock protection. | | | | | | | | | | | | | | | | | | | |
| **6** | Analyze the 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** | Examine dynamics of the Physiological fluid , 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** | Explore useful Mathematical methods 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** | Explore 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** | Recall 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 | | | | | | | | | | √ | | | | | | | | | |

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| | variables, ordinary and partial differential equations. | | | | | | | | | | | | | | | | | | | |
| **11** | Examine 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** | Explore the 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** | Recall 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** | Examine nanotechnology Scaling laws, Micro- and nanomaterials, Micro- and nanofabrication techniques, Biochemical and biomedical applications, Non-traditional fabrication techniques. | | | | | | | | | | | | | | √ | | | | | |
| **15** | Analyze 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** | Recognize the molecular and cellular neuroscience concepts and Examine the theoretical analysis of brain function, the biophysical and molecular concepts relating to membrane excitability, action potential generation | | | | | | | | | | | | | | | | √ | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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** | Explore the standard methods of preparing research of 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. | | | | | | | | | | | | | | | | √ | | |
| **18** | Use systematic approaches to design and conduct scientific research. | | | | | | | | | | | | | | | | | √ | |
| **19** | Conduct research studies that add to the existing specialty knowledge. | | | | | | | | | | | | | | | | | | √ |

| **No.** | **ILOS**<br>**Aims** | **b1** | **b2** | **b3** | **b4** | **b5** | **b6** | **b7** | **b8** | **b9** | **b10** | **b11** | **b12** | **b13** | **b14** | **b15** | **b16** | **b17** | **b18** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | Identify the terms of 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** | Explore a specialized area of tissue engineering.New biomaterials designed for tissue engineering. Traditional and computer aided design for biomaterials. | | √ | | | | | | | | | | | | | | | | |
| **3** | Make Models of nonlinear biological and physiological systems, Analysis and synthesis of dynamic models, Pressure-flow Model, Cardiac and | | | √ | | | | | | | | | | | | | | | |

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| | 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** | Identify the 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** | Differentiate between the 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** | Analyze the 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** | Examine dynamics of the Physiological fluid , 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** | Explore useful Mathematical methods 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 | | | | | | | | √ | | | | | | | | | | |

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| | biological processes, Molecular mechanical representation of systems and ensembles, Force field and energy expression. | | | | | | | | | | | | | | | | | | |
| **9** | Explore 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** | Recall 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** | Explore the 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** | Recall 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** | Examine nanotechnology Scaling laws, Micro- and nanomaterials, Micro- and nanofabrication techniques, Biochemical and biomedical applications, Non-traditional fabrication techniques. | | | | | | | | | | | | | √ | | | | | |

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| **15** | Analyze 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** | Recognize the molecular and cellular neuroscience concepts and Examine the 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** | Explore the standard methods of preparing research of 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. | | | | | | | | | | | | | | | | | √ | |
| **18** | Use systematic approaches to design and conduct scientific research. | | | | | | | | | | | | | | | | | | √ |
| **19** | Conduct research studies that add to the existing specialty knowledge. | | | | | | | | | | | | | | | | | | √ |

| No. | ILOS<br>Aims | c1 | c2 | c3 | c4 | c5 | c6 | c7 | c8 | c9 | c10 | c11 | c12 | c13 | c14 | c15 | c16 | c17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Identify the terms of 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 | Explore a specialized area of tissue engineering.New biomaterials designed for tissue engineering. Traditional and computer aided design for biomaterials. | | | | √ | √ | √ | | | | | | | | | | | |
| 3 | Make 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 | Identify the 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 | Differentiate between the 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. | | | | | | | | | | √ | | | | | | | |

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| **6** | Analyze the 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** | Examine dynamics of the Physiological fluid , 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** | Explore useful Mathematical methods 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** | Explore 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.** | **ILOS**<br>**Aims** | **c18** | **c19** | **c20** | **c21** | **c22** | **c23** | **c24** | **c25** | **c26** | **c27** | **c28** | **c29** | **c30** | **c31** | **c32** | **c33** | **c34** | **c35** | **c36** | **c37** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **9** | Explore 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 | √ | | | | | | | | | | | | | | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10** | Recall 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** | Explore the 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** | Recall 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** | Examine nanotechnology Scaling laws, Micro- and nanomaterials, Micro- and nanofabrication techniques, Biochemical and biomedical applications, Non-traditional fabrication techniques. | | | | | | | | | | | | √ | √ | | | | | | | |
| **15** | Analyze 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. | | | | | | | | | | | | | | √ | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **16** | Recognize the molecular and cellular neuroscience concepts and Examine the 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** | Explore the standard methods of preparing research of 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. | | | | | | | | | | | | | | | | | | √ | √ | √ |
| **18** | Use systematic approaches to design and conduct scientific research. | | | | | | | | | | | | | | | | | | | √ | √ |
| **19** | Conduct research studies that add to the existing specialty knowledge. | | | | | | | | | | | | | | | | | | | √ | √ |

| **No.** | **ILOS**<br>**Aims** | **d1** | **d2** | **d3** | **d4** |
|---|---|---|---|---|---|
| **1** | Identify the terms of 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** | Explore a specialized area of tissue engineering.New biomaterials designed for tissue engineering. Traditional and computer aided design for biomaterials. | √ | √ | √ | √ |
| **3** | Make 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. | √ | √ | √ | √ |

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|---|---|---|---|---|---|
| **4** | Identify the 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** | Differentiate between the 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** | Analyze the 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** | Examine dynamics of the Physiological fluid , 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** | Explore useful Mathematical methods 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** | Explore 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** | Recall 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** | Explore the 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** | Recall 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** | Examine nanotechnology Scaling laws, Micro- and nanomaterials, Micro- and nanofabrication techniques, Biochemical and biomedical applications, Non-traditional fabrication techniques. | √ | √ | √ | √ |
| **15** | Analyze 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** | Recognize the molecular and cellular neuroscience concepts and Examine the 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** | Explore the standard methods of preparing research of 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. | √ | √ | √ | √ |
| **18** | Use systematic approaches to design and conduct scientific research. | √ | √ | √ | √ |
| **19** | Conduct research studies that add to the existing specialty knowledge. | √ | √ | √ | √ |

## *Program Courses vs Program ILO's Matrix*

| Course code | ILOS / Courses | a1 | a2 | a3 | a4 | a5 | a6 | a7 | a8 | a9 | a10 | a11 | a12 | a13 | a14 | a15 | a16 | a17 | a18 | a19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **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 | | | | | | | | | | | | | | | | | √ | | |
| **Thesis** | | | | | | | | | | | | | | | | | | | √ | √ |

| Course code | ILOS / Courses | b1 | b2 | b3 | b4 | b5 | b6 | b7 | b8 | b9 | b10 | b11 | b12 | b13 | b14 | b15 | b16 | b17 | b18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | | | | | | | | | | | | | | | | | √ | |
| Thesis | | | | | | | | | | | | | | | | | | | √ |

| Course code | ILOS / Courses | c1 | c2 | c3 | c4 | c5 | c6 | c7 | c8 | c9 | c10 | c11 | c12 | c13 | c14 | c15 | c16 | c17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | ILOS / Courses | c18 | c19 | c20 | c21 | c22 | c23 | c24 | c25 | c26 | c27 | c28 | c29 | c30 | c31 | c32 | c33 | c34 | c35 | c36 | c37 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1712809 | Methods in 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 | | | | | | | | | | | | √ | √ | | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1712815** | biocompatibility | | | | | | | | | | | | | | √ | | | | | | |
| **1712816** | Fundamental neuroscience | | | | | | | | | | | | | | | √ | √ | √ | | | |
| **1712817** | Journal club in medical biophysicsII | | | | | | | | | | | | | | | | | | √ | √ | √ |
| **Thesis** | | | | | | | | | | | | | | | | | | | | | |

| Course code | ILOS<br>Courses | 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 | √ | √ | √ | √ |

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|---|---|---|---|---|---|
| **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 | √ | √ | √ | √ |
| **Thesis** | | | | | |

# ARS vs ILOs Matrix

| ARS | a1 | a2 | a3 | a4 | a5 | a6 | a7 | a8 | a9 | a10 | a11 | a12 | a13 | a14 | a15 | a16 | a17 | a18 | a19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A1** | √ | √ | √ | | | | | | | | | | | | | | | | |
| **A2** | | | | √ | √ | | | | | | | | | | | | | | |
| **A3** | | | | | | √ | √ | | | | | | | | | | | | |
| **A4** | | | | | | | | √ | √ | | | | | | | | | | |
| **A5** | | | | | | | | | | √ | √ | | | | | | | | |
| **A6** | | | | | | | | | | | | √ | √ | | | | | | |
| **A7** | | | | | | | | | | | | | | √ | √ | | | | |
| **A8** | | | | | | | | | | | | | | | | √ | √ | | |
| **A9** | | | | | | | | | | | | | | | | | | √ | √ |

| ILOS ARS | b1 | b2 | b3 | b4 | b5 | b6 | b7 | b8 | b9 | b10 | b11 | b12 | b13 | b14 | b15 | b16 | b17 | b18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **B1** | √ | √ | | | | | | | | | | | | | | | | |
| **B2** | | | √ | √ | | | | | | | | | | | | | | |
| **B3** | | | | | √ | √ | | | | | | | | | | | | |
| **B4** | | | | | | | √ | √ | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **B5** | | | | | | | | | √ | √ | | | | | | | | |
| **B6** | | | | | | | | | | | √ | √ | | | | | | |
| **B7** | | | | | | | | | | | | | √ | √ | | | | |
| **B8** | | | | | | | | | | | | | | | √ | √ | | |
| **B9** | | | | | | | | | | | | | | | | | √ | √ |

| ARS | c1 | c2 | c3 | c4 | c5 | c6 | c7 | c8 | c9 | c10 | c11 | c12 | c13 | c14 | c15 | c16 | c17 | c18 | c19 | c20 | c21 | c22 | c23 | c24 | c25 | c26 | c27 | c28 | c29 | c30 | c31 | c32 | c33 | c34 | c35 | c36 | 37 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **C1** | √ | √ | √ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **C2** | | | | √ | √ | √ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **C3** | | | | | | | √ | √ | √ | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **C4** | | | | | | | | | | √ | √ | √ | | | | | | | | | | | | | | | | | | | | | | | | | |
| **C5** | | | | | | | | | | | | | √ | √ | √ | | | | | | | | | | | | | | | | | | | | | | |
| **C6** | | | | | | | | | | | | | | | | √ | √ | √ | | | | | | | | | | | | | | | | | | | |
| **C7** | | | | | | | | | | | | | | | | | | | √ | √ | √ | | | | | | | | | | | | | | | | |
| **C8** | | | | | | | | | | | | | | | | | | | | | | √ | √ | √ | | | | | | | | | | | | | |
| **C9** | | | | | | | | | | | | | | | | | | | | | | | | | √ | √ | √ | | | | | | | | | | |
| **C10** | | | | | | | | | | | | | | | | | | | | | | | | | | | | √ | √ | √ | | | | | | | |
| **C11** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | √ | √ | √ | | | | |

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| **C12** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | √ | √ | | |
| **C13** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | √ | √ |

| No. | ILOS / ARS | d1 | d2 | d3 | d4 |
|---|---|---|---|---|---|
| 1 | D1. Develop skills in reading. | √ | | | |
| 2 | D2. Develop team work | | √ | | |
| 3 | D3. Use information technology | | | √ | |
| 4 | D4. Increase written and oral skills | | | | √ |

## *Teaching and Learning Methods Vs Courses Matrix (Degree: PhD) Code: 1712800*

| | 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** | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |