

PhD IN MOLECULAR MEDICINE

Molecular Medicine is a new field that exploits advances in molecular and cellular biology to characterize how normal cellular processes either fail, or subverted, in disease. Increasingly, medical practitioners, professionals and researchers in the health and life sciences need to understand and evaluate advances in molecular medicine in order to keep abreast with developments in their fields. The PhD in Molecular Medicine, which started in 2006, was established with the aim of offering advanced learning and practical training to:

- Master holders in Medical Sciences planning an academic career in the area of Molecular Medicine
- Technicians with Ms.C. degree wishing to upgrade their expertise in specialized areas of Molecular Medicine
- Personnel engaged in the practice of Molecular Medicine, Genetics and Inherited Diseases, including physicians, who wish to specialize in Molecular Medicine

Vision

The Molecular Medicine program's vision is to be a uniquely, innovative and effective educational and research program to serve the health needs of the GCC citizens, and globally contribute to excellence in research and development, clinical services and health education.

Mission

The mission of the Molecular Medicine Program is to gain theoretical and practical knowledge of molecules and molecular mechanisms of body functions in health and disease for better diagnosis, treatment and protection from common and rare diseases.

1. Learning outcome

A PhD holder in Molecular Medicine will be able to:

- Conduct scientific research investigating a problem in Molecular Medicine, Genetics and Inherited Diseases demonstrating his ability to use a sound scientific approach and competence in Molecular Medicine techniques and methods related to his field of research
- Write scientific papers, grant applications and work independently
- Teach and supervise undergraduate, graduate students and technical staff
- Gain administrative responsibilities, which will allow him to develop, supervise and organize a molecular lab.

2. Program Objectives

- To get theoretical background on the fundamental principles vital to the understanding of molecules that are keys to normal functioning of the body and those related to the deep-seated mechanisms of diseases
- To conduct mission oriented research that is directed to resolving medical issues via in-depth analysis and investigation rendering to molecular diagnosis
- To acquire various skills, among them mastering selected techniques for analysis, measurements and manipulation of these molecules to improve diagnosis, treatment, and prevention of diseases as well expressing scientific findings in oral and written forms producing quality research papers

3. Areas of specialization

The Program offers specialties in the following areas:

- Medical Genetics
- Biochemical Genetics
- Cytogenetics
- Immunology

4. Methods of learning

The program is organized in a semester form where certain courses and research work should be accomplished. The program is dealing with a highly specialized part of Medicine that explains the fundamental principles vital to an understanding of:

1. Molecules that are key to the normal functioning of the body and those related to the fundamental mechanisms of the diseases
2. Manipulation of these molecules to improve the diagnosis, treatment, and prevention of disease
3. Human genome and Genetic engineering

Principles are then applied to the diagnosis and treatment of human disease in:

1. Gene regulated disorders
2. Inherited genetic diseases
3. Inborn errors of metabolism
4. Infectious diseases
5. The immune system and blood cells
6. Cancer
7. Public health

The technology utilized in the program includes basic and advanced techniques in Biochemistry, Molecular Biology, Immunology, Cell Biology, Cytogenetics, Imaging technology and Experimental Models.

5. Admission requirements

- Students must have a Master in Science prior to enrollment in the PhD program.
- The applicant is a citizen of one of the GCC countries or a citizen of an Arab country and is resident in one of the GCC countries.
- Nomination / No objection letter from the Ministry of Higher Education of the applicant's country (GCC citizens).
- Evidence of adequate proficiency in the English language (Minimum TOEFL score of 500 or IELTS of 5.5).
- A satisfactory personal interview

6. Duration of the program

The duration of the program is 4 – 6 years during which the students study 48 credits hours inclusive of a Ph.D. thesis which is equivalent to 24 hours

7. Graduation Requirements

- Successfully complete a minimum of 24 credit hours of course work.
- Carry out a laboratory-based research project and submit and successfully defend a written thesis (24 credit hours).

8. Program outline

The curriculum is organized around 4 - 6 semesters (of 16 weeks duration each). The first semester consists of core courses, while the second semester is devoted to specialized courses. During each semester the student organizes with the supervisor/s the required courses and the research work, which all spread over the semesters of the academic year.

Topics for the thesis will be decided in consultation with the Director of the PhD program taking into consideration the students' interests and ongoing research activities. Thesis work can be partly performed by the student in his/her institution provided that a qualified supervisor is identified and technical

facilities are available to carry out the planned experiments. Internal and external examiners evaluate the written dissertation and examine the student orally.

The PhD degree requirements include 24 credit hours of courses and a 24 credit hour thesis to be completed within 2 - 3 academic years (Total = 48 credit hours).

The program is implemented by a Director and decisions are made by an Academic Committee consisting of members representing, the major specialties in the program.

9. Outline of courses

A. Core Courses in General Science

The requirement of this Core Course must reach at least 6 credits.

B. Basic courses in Molecular Medicine

The requirement of these Basic courses in Molecular Medicine must reach at least 6 credits.

C. Specific courses in Molecular Medicine

The requirement of these Courses must reach at least 3 credits.

D. Molecular Genetics

The requirement of the Molecular Genetics Course must reach 3 credits.

E. Advanced specific courses

The requirement of the advanced specific Courses must reach 6 credits.

K. Ph.D. Project

Twenty four (24) credits hours

10. Course description:

The students study 48 credits hours inclusive of a Ph.D. thesis which is equivalent to 24 hours. The courses cover 24 credit hours selected form the list below.

Category A is mandatory with minimum 6 credit hours. The student can select any category (not necessarily all) that suits his program, but should take the minimum required credit hours.

The selection of courses should be done by the student and the advisor.

A. Core Courses in General Science

The requirement of this Core Course must reach at least 6 credits.

Course A.1

• Philosophy of science and ethics	2 credit
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Course A.2

• Pedagogic/presentation technology	2 credit
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Course A.3

• Information technology	2 credits
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Course A.4

• Good laboratory practice	2 credits
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Course A.5

• Animal models for human diseases	2 credits
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Course A.6

• Medical statistics	2 credits
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Course A.7

• How to write a scientific paper	2 credit
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B. Basic courses in Molecular Medicine

The requirement of these Basic courses in Molecular Medicine must reach at least **6 credits**.

Purpose of the Courses:

The purpose of the course is to extend the students' knowledge of traditional Mendelian transmission genetics to include the molecular character of the gene; to present the fundamentals of molecular genetics with emphasis on the structure and function of the nucleic acids; to apply the concepts of population genetics to human conditions, chromosome organization, molecular evolution and conservation genetics.

Course B.1

The frequency and clinical spectrum of genetic diseases <ul style="list-style-type: none"> • Patterns of inheritance • Spectrum of genetic diseases • Single gene defects • Chromosome abnormalities • Congenital malformation and common diseases: Multifactorial inheritance • Cytoplasmic inheritance 	2 credits
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Course B.2

Structure, organization, and regulation of human genes <ul style="list-style-type: none"> • Structure of genes and the transmission of genetic information DNA • The regulation of gene expression • Coordinated gene expression (contact with the outside world) 	1 credit
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Course B.3

The techniques of gene analysis <ul style="list-style-type: none"> • Basic DNA manipulation methods • Speeding up the analysis of human DNA for diagnostic purposes • Studying the function of isolated genes 	1 credit
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Course B.4

Finding our way round the human genome <ul style="list-style-type: none"> • Approaches to human chromosome mapping • Genetic mapping of the human genome 	2 credits
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<ul style="list-style-type: none"> • Physical mapping techniques • Linking up genetic and physical maps; finding human genes • Reverse genetics 	
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Course B.5

<p>The molecular pathology of single gene disorders</p> <ul style="list-style-type: none"> • Types and levels of abnormal gene expression • Monogenic disorders resulting from the synthesis of an abnormal protein • Molecular lesions that result in the production of reduced gene products • Phenotype/genotype relationships for mutations that alter structural genes • The heterogeneity of monogenic disease Summary 	2 credits
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Course B.6

<p>Molecular genetics and common diseases</p> <ul style="list-style-type: none"> • Approaches to the analysis of the molecular basis for polygenic disease • Diabetes • Other autoimmune diseases • Cardiovascular disease • Neuro-psychiatric disease • Hereditary variability in response to drugs • Infectious disease • Allergy and atopy 	2 credits
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Course B.7

<p>Cancer</p> <ul style="list-style-type: none"> • Oncogenes and anti-oncogenes • How many mutations are required to produce a cancer cell? • Tumour immunology • Molecular aspects of cancer chemotherapy 	2 credits
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Course B.8

<p>Carrier detection and prenatal diagnosis of genetic disease</p> <ul style="list-style-type: none"> • The avoidance of genetic disease • Current methods for prenatal diagnosis • Sources of fetal DNA • How is fetal DNA analyzed for single gene disorders? 	2 credits
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Course B.9

<p>Gene therapy, Gene cloning and Ethical issues</p> <ul style="list-style-type: none"> • Current methods for treatment of genetic disease • Gene replacement or corrective therapy • Specific ethical problems posed by the new genetics 	2 credits
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C. Specific courses in Molecular Medicine

The requirement of these Courses must reach at least **3 credits**.

Course C.1

• Biochemistry of Nucleic Acids	1 credit
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Course C.2

• Chemistry of Proteins	1 credit
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Course C.3

• Applications of mass spectrometry in biochemistry	1 credit
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Course C.4

• Genetic Basis of Metabolic Diseases	1 credit
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Course C.4

• Practical approach to Cytogenetics	1 credit
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Course C.6

• An introduction to Molecular Immunology	1 credit
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Course C.7

• Practical issues in Molecular Diagnostics	1 credit
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D. Molecular Genetics

The requirement of the Molecular Genetics Course must reach **3 credits**.

This course is designed to provide students with a background in molecular genetics. The topics covered include an examination of the structure and replication of DNA, the molecular mechanisms underlying the recombination of DNA, the molecular basis of gene regulation and how gene expression is tied to intracellular and extracellular factors by signal transduction pathways.

Course D.1

Introduction to Molecular Genetics: <ul style="list-style-type: none">• The role of genes within cells• Principles of recombinant DNA technology	1 credit
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Course D.2

<u>PCR and reverse genetics:</u> <ul style="list-style-type: none">Polymerase chain reactionPCR applications<i>In vitro</i> mutagenesis	1 credit
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Course D.3

<p>Gene expression</p> <p><u>Transcription:</u> RNA polymerases Structure of promoter Regulation of transcription</p> <p><u>RNA processing and degradation:</u> RNA capping and polyadenylation RNA splicing and transport RNA stability and degradation</p> <p><u>Genetic code and translation:</u> Translational machinery Genetic code and codon usage Initiation of translation Elongation and termination of translation</p> <p><u>Protein processing, folding and degradation:</u> Protein processing and splicing Protein stability and degradation Regulatory functions of protein phosphorylation Protein folding and chaperones Prions and protein-based inheritance</p>	2 credits
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Course D.4

<p>Genome structure and stability</p> <p><u>Genome structure and replication:</u> Chromatin organization Chromosome replication and segregation</p> <p><u>DNA repair and recombination:</u> Mechanisms of DNA repair Mechanisms of homologous recombination Programmed DNA rearrangements Molecular mechanisms of immune recognition</p> <p><u>Transposable elements:</u> DNA transposons Retrotransposons and retroviruses Mechanisms of reverse transcription</p>	2 credits
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Course D.5

Genetic engineering of eukaryotic organisms. <u>Yeast genetic engineering:</u> Organization of the yeast cell and genome Yeast plasmids and vectors Yeast contribution to molecular genetics <u>Animal and plant genetic engineering:</u> Genetic engineering of animal cells in the culture Transgenic animals <u>Studying whole genomes: genomic sequencing and genome projects</u>	2 credits
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Course D.6

Molecular bases of evolution: Evolution of the translational machinery Origin of introns Evolution of the genome Evolution of the cell and genetic systems of eukaryotic organelles Molecular evidences of human evolution.	2 credits
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E. Advanced specific courses

The requirement of the advanced specific Courses must reach **6 credits**.

E1. Special Topics in Analytical Chemistry (3 credits hours)

A course of lectures and seminars devoted to modern methods in analytical chemistry. Two of the following topics will be considered each semester: instrumental methods in spectroscopic analysis; scattering and diffraction methods; electroanalytical and polarographic techniques, chromatography; separation and purification methods; tracer methods. Readings from the current literature will be the basis of both lectures and seminars.

E2. Enzyme Reaction Mechanisms (3 credits hours)

The mechanism of enzyme action will be examined with emphasis on the following topics: three dimensional structure of enzymes; chemical catalysis; methods of determining enzyme mechanisms; stereochemistry of enzymatic reactions; detection of intermediates; affinity labels and suicide inhibitors; transition state analogs; energy relationships, evolutionarily "perfect" enzymes; genetic engineering and enzymes; use of binding energy in catalysis. Instruction will be in both lecture and seminar format, with emphasis on recent literature.

E3. Special Topics in Biochemistry (3 credits hours)

Series of seminars dealing with topics of current research interest in the field of Biochemistry. A single area, in which advances of major significance have been made, may be chosen.

E4. Special Topics in Chemistry (3 credits hours)

A series of lectures and seminars are dealing with recent or current important developments in chemistry. A single area, in which advances of major significance have been made, will be selected, or a given term, e.g., physical, organic, or inorganic chemistry, will be focused upon.

E5. Proteomics (3 credits hours)

“Proteomics” is derived from the word proteome that refers to the proteins encoded by an entire genome. The last decade has been called the “Decade of Genomics”, and the first decade of the new millennium has been named the “Decade of Proteomics”. The sequencing of entire genomes, including the human genome, is resulting in the identification of a huge number of novel proteins whose functions are unknown. The major challenge of biomedical research during the next decade will include characterization of the properties and biological functions of about 100,000 different human proteins, and how these are involved in human disease. Beside the human proteins, hundreds of thousands of proteins from other eukaryotic and prokaryotic species need to be characterized. This huge work will require multi-methodological efforts requiring the input of methods of genetics, developmental biology, cell and molecular biology, physiology, protein chemistry, as well as structural biology and molecular modeling.

Course program

1. Introduction to Proteomics
2. Bioinformatics – from Gene to Protein Function
3. Analysis of Proteome
4. Enzyme Catalysis
5. Protein Factories
6. Analysis of Proteomes
7. From Protein to Disease and Vice Versa
8. Protein Structure

E6. Developmental Biology and Cellular Signaling (3 credits hours)

This program offers a postgraduate training program curriculum in the fields of Developmental Biology and Cellular Signaling.

Research in these areas encompasses:

1. Cellular and molecular biology
2. Development of various organ systems
3. Stem cell biology
4. Hematology and immunology
5. Molecular and clinical endocrinology
6. Genetics, pediatrics
7. Obstetrics and gynecology.

E7. Inflammation and Allergy (3 credits hours)

The main task is to provide coordinate PhD course of relevance to postgraduate students that are enrolled in the PhD program within Molecular Medicine.

The course includes:

1. Balancing inhibitory and activating receptors during immune responses
2. Cytokines in inflammation
3. Manipulation of Humoral Immunity

E8. Cellular and Molecular Immunology (3 credits hours)

The course covers cells and tissues of the immune system, lymphocyte development, the structure and function of antigen receptors, the cell biology of antigen processing and presentation including molecular structure and assembly of MHC molecules, the biology of cytokines, leukocyte-endothelial interactions, and the pathogenesis of immunologically mediated diseases. The course is structured as a series of lectures and tutorials in which clinical cases are discussed with faculty tutors.

E9. Cellular and Molecular Developmental Biology (3 credits hours)

This course will explore current cellular and molecular concepts in developmental biology. Topics covered will include regulation of development by transcription factors and growth factors, epithelial-

mesenchymal interactions, cell cycle, cell migrational cues, homeobox genes, pattern formation, angiogenesis, and DNA repair.

E10. Introductory Course in Tumor Biology/Oncology (3 credits hours)

The objective is to give students an opportunity to learn more about the theoretical background as well as some practical skills in the area of Oncology/ Tumor Biology.

The course includes:

1. An introduction to Tumor Pathogenesis
2. Causes of Cancer
3. Molecular Cell- and Tumor Biology
4. Tumor Immunology
5. Cancer Genetics

The course will be in the form of lectures, seminars and literature studies. The course touches upon up-to-date results from the frontiers of cancer research and a presentation of the objectives within these research areas. Based on the given objectives the students are encouraged to, under supervision, independently search and evaluate the available literature and to come with suggestions of experimental setups. The main part of the course is devoted to conducting an individual project, focusing on the objectives and methodology of a specific subject area

Ph.D. Project

Twenty four (24) credits hours

Summary of Program

Program	PhD in Molecular Medicine
Target Candidates	<ul style="list-style-type: none">▪ Master holders in Medical Sciences planning an academic career in the area of Molecular Medicine▪ Technicians with Ms.C. degree wishing to upgrade their expertise in specialized areas of Molecular Medicine▪ Personnel engaged in the practice of Molecular Medicine, Genetics and Inherited Diseases, including physicians, who wish to specialize in Molecular Medicine
Admission requirements	Students must have a Master in Science prior to enrollment in the PhD program.
Duration of Program	4 -6 years
Program Design	The program is organized in a semester from where certain courses and research work should be accomplished.
Curriculum Delivery	Fulltime continuous studies
Total Credit Hours	48 credit hours: Courses: 24 hours PhD thesis: 24 hours

Program Faculty

Director

Professor Moiz Bakhiet

Academic Faculty

- Prof. A.Halim Deifalla
- Dr. Ahmed Jaradat
- Dr. Cristina Skrypnyk
- Dr. Durjoy Shome
- Dr. Ghada Al-Kafaji
- Dr. Hayder Giha
- Dr. Einas Al-Harbi
- Dr. Nouredine Ben Khalaf
- Dr. Khaled Tabbara
- Dr. Khaled Greish
- Prof. Moiz Bakhiet
- Dr. Raouf Fadhel
- Dr. Diab Altayeb
- Dr. Safa Taha
- Dr. Wael Elmoslimany

Contact Information

For further information, please contact:

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Applications

University Application

Program Application

Applications should be sent to:

The Registrar

Admission and Registration Unit

Arabian Gulf University

P. O. Box 22979

Manama, Kingdom of Bahrain

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