Faculty of Medicine and Medical Center (FM/AUBMC)

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Historical Background

Since 1867, the founding date of the Faculty of Medicine, both the Faculty of Medicine and the Medical Center have continuously been providing services in the realms of medical education, training and health care to their immediate constituencies in Lebanon and the Middle East region. To date, the Faculty of Medicine has graduated 4,225 physicians, and there is a large postgraduate training program of over 280 residents in most of the departments. The Faculty of Medicine programs have been approved by and registered in the Education Department of the State of New York on a continual basis since 1867. In 1957 the faculty became an institutional member of the Association of American Medical Colleges. It enjoyed this status until 1988, when the new rules of the association precluded membership of institutions outside the confines of the North American continent.

The AUB Medical Center has been accredited by the Joint Commission International (JCI) as of October 2007. Previously, the Medical Center was accredited by the US-based Joint Commission on Accreditation of Healthcare Organizations (JCAHO) from 1965 until 1983, when the civil war in Lebanon prevented review teams from continuing with their periodic site visits. The JCI is the international arm of the JCAHO. The National Board Examinations were administered to the faculty's undergraduate students for credit between 1966 and 1982. The faculty was a regional center for the administration of the examinations of the Educational Commission for Foreign Medical Graduates between 1959 and 1993. In addition, the faculty takes pride in having had very close links with prestigious American medical schools and centers including Columbia University from 1945 to 1955, Harvard School of Medicine from 1955 to 1965, and a formal affiliation with the Johns Hopkins School of Medicine from 1965 to 1975, which was supported by the Commonwealth Fund.

The Faculty of Medicine and the Medical Center have revived and established a number of links and affiliations with the following:

- Columbia University College of Physicians and Surgeons for student elective exchange (since 2002)
- University of George Washington School of Medicine in Washington, DC (as of September 8, 2004)
- Medical University of South Carolina (MUSC) (as of April 1, 2003) for an MD–PhD program that admits up to three medical students annually from AUB/FM
- Johns Hopkins University School of Medicine (as of May 10, 2004) for collaboration in research, education and the provision of medical services training
- University of Paris 7 Denis Diderot for cooperative cancer research (as of December 8, 2004)
- University of Poitiers (France) for cooperative neurosciences research (as of February 3, 2006)
- St. Jude Children's Research Hospital (as of April 19, 2000)
- Laval University in Quebec, Canada
- M.D. Anderson Cancer Center (as of June 6, 2007)
- Palermo University (as of April 23, 2007) for cooperation in research and higher education
- University of Montpellier (France) (as of August 3, 2007)
- The Faculty of Medicine and the Medical Center (FM/AUBMC) are currently accredited by the following American-based accreditation bodies:
- The Middle States Commission on Higher Education

- The Joint Commission International (JCI) for hospital accreditation
- Accreditation of AUBMC by the Lebanese Ministry of Public Health
- Accreditation of the School of Nursing by the Commission on Collegiate Nursing Education (CCNE)
- Accreditation of the Nursing Services at AUBMC by the American Nurses Credentialing Center (ANCC)
- The College of American Pathologists (CAP)
- In addition, the Faculty of Medicine, with its Medical Center, is a member of the following organizations:
- Alpha Omega Alpha (AOA) - Honor Medical Society (The Faculty of Medicine is the only member of the AOA outside North America since 1958)
- The American Medical College Application Service
- The American College of Physicians/American Society of Internal Medicine
- The Association of Program Directors in Internal Medicine

The MD Program

Mission

The mission of the Faculty of Medicine is to provide optimum, advanced, state-of-the-art, comprehensive, timely and cost-effective medical education for each student. The faculty aims to reach this objective by implementing innovative teaching techniques, and by recruiting and retaining outstanding faculty and students. The faculty also strives for improved student performance and career opportunities, as well as improved basic and clinical research, more effective patient management, and new and innovative medical approaches. The faculty focuses on enhancing the regional and global reputation of the AUB Medical Center (AUBMC) by encouraging the development of additional centers of excellence, and developing more effective uses of physical resources and funds.

Vision

The vision of the Faculty of Medicine is to continuously upgrade the quality of education provided to its medical students and postgraduate physicians in the various medical and surgical subspecialties. This vision is implemented by the strong commitment of the faculty to educate young men and women to become excellent physicians with humane and high ethical standards as well as technical expertise. The faculty also aims at providing a better environment for personal growth and recognition for all its students by inspiring them to become leaders in their fields. The Faculty of Medicine will always endeavor to provide opportunities for its students to develop individual initiative, creative ability and professional leadership through participation in extracurricular seminars, discussion groups, research projects and student organizations.

Admission

The Faculty of Medicine was established to give properly qualified candidates, particularly from Lebanon and the Near East, the opportunity for sound education in both the art and science of medicine. All applicants must hold a bachelor's degree and must have completed the premedical requirements as well as the Medical College Admission Test (MCAT). Applicants in their senior year expecting to graduate with a bachelor's degree in June are eligible to apply provided they have completed the premedical requirements and have taken the MCAT by the end of the first of their senior year. For applicants holding (or expecting) a bachelor's degree, consideration for acceptance is limited to students with a minimum cumulative general average of 75 percent in each of the following: 1) all courses, 2) the required premedical core courses, and 3) major courses. For applicants from North American colleges, a minimum GPA of 3.2 is required. Applications from individuals holding (or expecting by June of the same year) a master's or a doctoral degree are encouraged. These applicants will be considered based upon their academic performance and their research productivity; in these cases, some of the premedical requirements may be waived depending on the field of study.

Interviews are granted to a selected group of applicants based on their MCAT scores and their academic achievement. Granting an interview does not necessarily imply that the applicant will be accepted. Students are accepted to medical school on the basis of their academic qualifications, their MCAT score and the results of their interviews. In addition, due consideration is given to the applicants' letters of recommendation from their teachers and mentors, their curriculum vitae, as well as their personal statements. Among the traits that the successful applicant will demonstrate are humanistic and ethical attitudes, good communication and interpersonal skills, emotional maturity, and personal integrity. Previous experience in research, community service and volunteer work are considered positive attributes.

The Faculty of Medicine at AUB does not discriminate on the basis of age, gender, nationality, ethnic origin or religion.

The minimal premedical requirements are summarized below:

A bachelor's degree in any field of study is required. Historically, the vast majority of applicants to the Faculty of Medicine have been holders of bachelor's degrees in biology or chemistry. In an effort to diversify the pool of applicants, graduates from other majors are strongly encouraged to apply as long as they complete the premedical core courses required for admission to the Faculty of Medicine. Students can take some of the premedical courses as electives in their respective majors.

Premedical core course requirements

The minimal premedical requirements include biology with laboratory (7 credits), chemistry with laboratory (15 credits including 8 credits of organic chemistry), physics and basic electronics with laboratory (8 credits), English (6 credits at AUB or exemption), social sciences and/or humanities (6 credits). To facilitate applications by non-science majors and from diverse fields of study, some courses taken in the Lebanese Baccalaureate Program may count towards fulfillment of the premedical core course requirements as detailed in Table 1. Table 2 presents the recommended courses depending on the major of study at AUB.

Table 1: Premedical core course requirements and credit equivalents according to Lebanese Baccalaureate Program Subject

Premedical Requirements	Required Premedical Credits	Lebanese Baccalaureate Credit Equivalents According to Program				Remaining Credits
		Life Sciences	General Sciences	Economics and Sociology	Literature and Humanities	
Biology	7	3	-	-	-	**4-7**
Chemistry	15	4	4	-	-	**11-15**
Physics	8	5	5	3	3	**3-5**
English	6[1]	-	-	-	-	
CS/ Humanities	6[1]	-	-	-	-	
Total	**42**	**12**	**9**	**3**	**3**	**30-39**

1) The new MCAT to be implemented in 2015 places significant emphasis on psychological and sociological concepts and on critical analysis and reasoning. Students planning to apply to medical school are advised to take PSYC 201 and SOAN 201, any two CVSP courses and PHIL 210.

Table 2: Recommended premedical core courses according to field of study at AUB

Premedical Requirements	AUB Courses	Biology Major	Chemistry Major	Physics Major	Other Majors
English (6 cr.)	ENGL 203 (3 cr.)				
	ENGL204 (3 cr.)	X	X	X	X
Humanities + Social Sciences (6 cr.)	Fulfilled by the general education requirements of the University, which include 6 credits in the humanities/6 credits in CVSP courses and 6 credits in the social sciences	X	X	X	X
Biology[1] (7 cr.)	BIOL 101 (3 cr.) or equivalent	X	X	X	X
	BIOL 201 (4 cr.)	X	X	X	X
Physics (8 cr.)	PHYS 101 (4 cr.) PHYS 101L (1 cr.) or equivalent	X	X	X	X
	PHYS 204 (3 cr.) + PHYS 204L (1 cr.) or PHYS 205 (3 cr.) + PHYS 205L (1 cr.)	X			X
	PHYS 211 (3 cr.) + PHYS 211L (1 cr.)		X		
	PHYS 210 (3 cr.) + PHYS 210L (1 cr.)			X	
Chemistry (15 cr.)	CHEM 101 (3 cr.) + CHEM 101L (1 cr.) or equivalent	X	X	X	X
	CHEM 201 (3 cr.)	X	X	X	X
	CHEM 211 (3 cr.)	X	X	X	X
	CHEM 212 (3 cr.)	X	X	X	X
	CHEM 210 (2 cr.)	X		X	X
	CHEM 225 (4 cr.)		X		

MCAT. A competitive score in the MCAT, which may be taken twice only, is required. If taken twice, the higher score is considered. The MCAT score must be available at the time the application is submitted. Since 2015, a new MCAT has been implemented which contains, in addition to the biological and physical sciences, a new section on the social and behavioral sciences. Students are encouraged to review the content of the new MCAT and plan their studies accordingly, e.g., by taking additional courses in psychology, sociology and anthropology, and in biology, chemistry and physics, after consultation with their advisors.

1) Biology 200 is a very general course that does not prepare students well for the MCAT. Biology 201 and 202 provide better preparation,and students are advised to take both courses.

Applicants expecting to receive a bachelor's degree after the deadline for application should be aware of the following:

- Applicants must be in their senior year.
- The cumulative average of 70 credits or more (at the time of application) should be equal to or higher than 75 percent for students from AUB or its equivalent for those from other universities. All required core courses must have been completed by the end of the fall term of the senior year with an average of at least 75 percent or its equivalent. The cumulative average in the major courses completed by the end of the fall term of the senior year must also be equal to or greater than 75 percent.
- Admission to medical school is contingent upon completion of graduation requirements and obtaining the bachelor's degree, which should be achieved by the end of the spring term of the student's senior year.
- Applicants expecting to receive a master's or doctoral degree after the deadline for application should be aware of the following:
- A minimum cumulative grade average of 80 percent or its equivalent is required.
- Admission to medical school is contingent upon completion of graduation requirements and obtaining the master's or doctoral degree, which should be achieved by the end of the spring term.

Conditional acceptance to the faculty is issued by the middle of April and is finalized upon completion of the requirements for the bachelor's, master's or doctoral degree.

Graduation Requirements

To be eligible for the degree of Doctor of Medicine, a student must satisfactorily complete the curriculum of the Faculty of Medicine and must be recommended by the Academic Committee. The degree may be granted with distinction to students who attain a grade of "Excellent" in at least 50 percent of the credits and a grade of "Pass" in no more than 20 percent of the credit hours in years 3 and 4, and who achieve a cumulative average ≥ 88% in years 1 and 2, with no failures in any course or clerkship.

The Faculty of Medicine offers post-graduate training positions in the various academic departments at AUBMC to AUB and non-AUB medical graduates. However, these positions are limited and are granted on a highly competitive basis.

Dean's Honor List

To be placed on the dean's honor list, a student must be full-time and must not be repeating the year. The dean's honor list is those ranking in the top 15 percent of the class and is offered in years 3 and 4 of the medical program only.

Academic Rules and Regulations

See General University Academic Information on page 52.

Attendance

Regular attendance is required at lectures, laboratories, clerkships, examinations and other assigned duties. Credit is not given for work not performed. Students absent on account of illness or other valid reasons are requested to confer with course or clerkship coordinators or the Director of Student Affairs. The committees concerned will review prolonged or repeated absences and decide on the appropriate course of action.

Language Requirement

The language of instruction is English. However, students must have speaking knowledge of Arabic before entering the third year. This requirement may be waived by special vote of the Academic Committee.

Promotions and Deficiencies

In the first and second years, the performance of students is evaluated as either pass or fail based on absolute standards of grading, with no ranking. Numerical grades will be kept in the students' records for reference, and may be used for providing a descriptive account of student performance and for recommendation letters by the Dean's Office. Numerical grades may be used to decide on graduating students with distinction, granting of awards (e.g. Penrose Award, Alpha Omega Alpha Honor Medical Society) and if requested by students for scholarship or financial aid granting bodies that require them. In the third and fourth years, a student's performance is evaluated as Excellent (E), Good (G), Pass (P), or Fail (F), based on normative grading. In this case, the distribution of grades in a class is as follows: the top 10-15 percent are granted an "E", the following 35-40 percent a "G", and the remaining 50 percent a "P". A student whose scores distinctly below the class distribution (usually more than 2 standard deviations below the mean) will receive a grade of Fail. The evaluation of the student in each subject is based on his/her total performance and not solely on the results of examinations.

The student's performance is evaluated by appropriate class teaching committees, which make recommendations to the Academic Committee. The action of the Academic Committee is final. The class teaching committees and Academic Committee give due consideration to a general evaluation of fitness for a career in medicine. Only those students who, in the opinion of the committees, give promise of being a credit to themselves, the faculty and the medical profession are advanced.

To be promoted, a student must attain a grade of Pass or better in all courses or clerkships and must be recommended by the committees concerned. However, a student with a grade of Pass in all courses or clerkships may, at the discretion of the committees, be promoted on probation, be asked to do remedial work and pass the re-examinations in designated courses or clerkships or repeat the year.

In order to pass a clerkship in the third or fourth year, a student must demonstrate competence in both clinical performance and knowledge of the discipline. Failure of either component is considered a failure of the clerkship . Normally, a student in the first or second year who fails 25 percent or more credits in that year may be asked to repeat the year or withdraw from the faculty. A student who fails less than 25 percent of credits

may be asked to do remedial work and pass the re-examination, repeat the year or leave the faculty. At the discretion of the committees concerned, and in exceptional cases, a student repeating the year may be asked to repeat all or some of the courses.

A student in the third or fourth year who fails 50 percent or more of clerkship hours may be asked to repeat the year or withdraw from the faculty. A student who fails less than 50 percent of clerkship hours may be asked to do remedial work and pass the re-examinations, repeat a clerkship, repeat the year or leave the faculty. At the discretion of the committees concerned, a student repeating the year may be asked to repeat all or some of the clerkships.

A student who is repeating a year and fails any course or does not attain a grade of Good or better, or its equivalent in years 1 and 2 in 50 percent of credits may be asked to withdraw from the faculty.

A student who is placed on probation cannot graduate unless probation has been removed.

Specific guidelines for clinical clerkships:

This part is not included in the Catalogue but provides guidelines to the Academic Committee: Decisions regarding failed clerkships or parts of clerkships are normally made at the end of the year, when the overall performance of the student is reviewed. Below are guidelines that describe potential courses of action, but the final decision is made by the Academic Committee based on an overall assessment of the student's performance and fitness for promotion or graduation.

- In clinical clerkships in years 3 and 4, students must demonstrate acquisition of adequate clinical performance and skills, as shown by performance evaluations, OSCE scores and other assessment measures defined by the specific clerkship, AND an appropriate fund of knowledge as demonstrated primarily by a passing grade on the final written examination (usually an NBME examination).
- If a student fails both the clinical performance and the final written examination of a clerkship, he/she will be deemed to have failed the entire clerkship and will be required to repeat it in its entirety: the clinical components and a repeat final written examination.
- If a student fails the final examination of a clerkship, he/she will be required to repeat it. If the student fails a second time, this is considered a failure of the entire clerkship and the students will be required to repeat it in its entirety: both the clinical components and a repeat final written examination.
- If a student fails the clinical performance component, he/she will be asked to repeat the clinical components of the rotation (totally or partly as determined by the department concerned). If the student fails the clinical component a second time, this is considered a failure of the entire clerkship and the student will be required to repeat it in its entirety: both the clinical components and a repeat final written examination.
- If a student is found to have failed 50% or more of the clerkship hours in the year, he/she will be asked to repeat the year or withdraw from the program at the discretion of the Academic Committee.

Courses

Numbers Preceding Course Titles

Courses required for the Doctor of Medicine degree are numbered 200 to 299 as follows:

- 200 to 239 indicate courses given in first and second year medicine.
- 240 to 259 indicate courses given in third year medicine.
- 260 to 279 indicate courses given in fourth year medicine.
- 280 to 299 are reserved for clinical clerkships during the year of internship.

For the first and second years, odd numbers refer to first term courses and even numbers to second term courses. Year courses are indicated by a hyphen between the two numbers.

Graduate courses leading to the Master and Doctor of Philosophy degrees are numbered 300 to 399.

Regular medical courses approved for graduate work (MS and PhD programs) have two numbers.

Numbers preceded by the letters ID (Interdepartmental) or FM (Faculty of Medicine) indicate integrated courses taught by two or more departments together.

Numbers Following Course Titles

The first number following the title of a course indicates the total number of lectures, conferences, and discussion hours given, except where otherwise stated.

The second number indicates the total laboratory or clinical practice hours, except where otherwise stated.

The third number indicates the number of term credit hours. Credit hours are used in conjunction with first and second year courses only.

Course Descriptions

All the following courses, except those listed as electives, are required of students working toward the degree of Doctor of Medicine. The electives designated may be chosen with the consent of the instructor. Detailed course descriptions are available under individual departments.

Curricula

First Year		No. of Weeks	Lecture and Clinical Recitation	Laboratory or Clerkship Hrs.	Total Hrs.	Credits
IDTH 201	Cellular and Molecular Basis of Medicine	15	90	40	118	7
IDTH 202	Clinical Anatomy	15	38	110	148	6
IDTH 203	The Immune System in Health and Disease	8	37	28	75	3
IDTH 204	Basic Pathological Mechanisms	8	29	14	43	2
IDTH 205	Microbiology and Infectious Diseases	9	56	44	100	5
IDTH 210	Fundamentals of Medical Research	9	30	20	50	3
IDTH 211	The Blood	4	30	30	60	3
IDTH 225	The Liver and Gastrointestinal System	4	40	40	80	4
IDTH 229	The Skin	2	20	20	40	2
IDTH 213	Becoming a Doctor 1: Clinical Skills -I	45	20	80	100	4
IDTH 214	Becoming a Doctor 2: Physicians Patients and Society - I	16	16	16	32	2
IDTH 215	Becoming a Doctor 3: Global Health and Social Medicine	21	21	21	42	2
IDTH 216	Becoming a Doctor 4: Learning Communities	45	0	36	36	1
				Total	**924**	**44**

Second Year		No. of Weeks	Lecture and Clinical Recitation	Laboratory or Clerkship Hrs.	Total Hrs.	Credits
IDTH 226	The Cardiovascular System	4	40	40	80	4
IDTH 227	The Respiratory System	4	40	40	80	4
IDTH 228	The Kidneys and Urinary System	4	40	40	80	4
IDTH 212	Endocrinology and Reproduction	6	46	36	80	4
IDTH 230	Brain and Cognition	8	80	80	160	8
IDTH 230	Human Development and Psychopathology	4	40	40	80	4
IDTH 232	Research Design and Development	30	10	80	90	3
IDTH 233	Physicians Patients and Society-II	20	20	20	40	2
IDTH 234	Clinical Skills-II	30	20	50	70	3
IDTH 235	Learning Communities-II	30	0	30	30	1
				Total	**790**	**37**

Third Year		No. of Weeks	Lecture and Clinical Recitation	Laboratory or Clerkship Hrs.	Total Hrs.	Credits
Clinical Conferences		46	240	–	240	–
INMD 246	Clinical Clerkship	10	100	450	550	–
FMMD 242	Physicians, Patients and Society III	2	16	24	40	–
NEUR 247	Clinical Clerkship	2		90	90	
ANES 247	Clinical Clerkship	3	15	120	135	
INMD 254	Infection Control	–	6	34	40	–
PSYT 252	Clinical Clerkship	4	25	180	205	–
OBGY 247	Clinical Clerkship	8	47	360	407	–
PEDT 246	Clinical Clerkship	8	35	360	395	–
SURG 246	Clinical Clerkship	9	45	405	450	–
				Total	**2552**	

Fourth Year		No. of Weeks	Lecture and Clinical Recitation	Laboratory or Clerkship Hrs.	Total Hrs.	Credits
Clinical Conferences		46	–	240	240	–
INMD 262	Clinical Clerkship	10	–	450	450	–
NEUR 262	Clinical Clerkship	2	-	90	90	
EMMD 262	Clinical Clerkship	6		279	279	
PEDT 267	Clinical Clerkship	4	–	180	180	–
2 selectives in any of the following: Dermatology, Radiology, Ophthalmology, Otolaryngology or Surgical Specialty		8		360	360	
Elective in any department		8	–	360	360	–
IDTH 268	Clerkship in Preventive Medicine and Public Health	2	10	80	90	–
FMMD 262	Clinical Clerkship	4	30	150	180	–
IDTH 262	Capstone Course	1	10	40	45	
				Total	**2274**	

Interdepartmental Courses – Medical Program

First and Second Years

IDTH 201 Cellular and Molecular Basis of Medicine 90.40; 7 cr.
An interdisciplinary course that presents the cellular and molecular concepts and principles that underlie the normal structure and function of the human body. It covers cellular structure and function, including mechanisms and regulation of gene expression, protein synthesis, structure and function, signaling mechanisms, membrane transport, energy metabolism, contractility, and excitability, and the basic principles of drug action. Clinical examples and correlations are presented to illustrate the relevance of cellular and molecular function to medicine.

IDTH 202 Clinical Anatomy 38.110; 6 cr.
A regional dissection of the entire human body supplemented by embryology, clinical lectures and discussions. The student is also introduced to radiographic anatomy based on various imaging modalities in addition to computer-assisted instruction.

IDTH 203 The Immune System in Health and Disease 37.28; 3 cr.
A course that deals with the immune system's responses in states of normalcy and disease, from the molecular to the clinical level, and covers the pathophysiology, clinical manifestations, diagnosis and management of major rheumatologic diseases.

IDTH 204 Basic Pathological Mechanisms 29.14; 2 cr.
The course covers the basic pathological mechanisms of disease at the cellular and molecular levels, their microscopic, gross and clinical manifestation, and some pharmacological interventions that apply to them.

IDTH 205 Microbiology and Infectious Diseases 56.44; 5 cr.
The course provides the principles and concepts of basic and medical microbiology. Emphasis is placed on the basic properties, pathogenesis, preventive measures and laboratory diagnosis of bacteria, viruses, parasites and fungi, and the clinical outcome, management and treatment of patients infected by these etiologic agents.

IDTH 210 Fundamentals of Medical Research 40.10; 3 cr.
The course provides first year medical students with their first exposure to research methodology. Fundamental principles and concepts of evidence-based medicine, epidemiology and biostatistics are presented and discussed.

IDTH 211 The Blood 30.30; 3 cr.
An integrated course that covers the anatomy, histology, physiology, pathology, pathophysiology and pharmacology related to the blood and lymphatic systems. Concepts in social medicine and global health, preventive medicine, epidemiology and medical ethics are explored in relation to diseases of the blood.

IDTH 212 Endocrinology and Reproduction 46.36; 4 cr.
An integrated course that covers the anatomy, histology, physiology, pathology, pathophysiology and pharmacology related to the endocrine and reproductive systems. Concepts in social medicine and global health, preventive medicine, epidemiology and medical ethics are explored in relation to diseases of the endocrine and reproductive systems.

IDTH 213 Becoming a Doctor 1: Clinical Skills – I 20.80; 4 cr.
The course introduces students to the art of medicine: communication skills, history taking, physical examination and clinical reasoning. The course runs throughout the year and is closely integrated with the organ-system based courses being studied by the students to integrate clinical and basic science knowledge and skills.

IDTH 214 Becoming a Doctor 2: Physicians Patients and Society – I 19.19; 2 cr.
The course explores the place of medicine, illness, suffering and the human body in human culture expressed through art, literature and history of medicine, and through close encounters with patients.

IDTH 215 Becoming a Doctor 3: Global Health and Social Medicine 21.21; 2 cr.
The course introduces students to central issues in the practice of social medicine and global health and the connection between them. It examines how social forces become embodied as pathologies, how political, economic, and historic trends influence the distribution of disease among different populations, and how new trends in the organization of care affect the most vulnerable members of society.

IDTH 216 Becoming a Doctor 4: Learning Communities 0.36; 1 cr.
The course covers topics and issues important for the personal and professional development of students, with emphasis on reflection. Students are encouraged to make use of experiences for shared learning and to develop a sense of community and belonging, thus promoting well-being.

IDTH 225 The Liver and Gastrointestinal System 40.40; 4 cr.
An integrated course that covers the anatomy, histology, physiology, pathology, pathophysiology and pharmacology related to the liver and gastrointestinal tract. In addition, concepts in social medicine and global health, preventive medicine, epidemiology and medical ethics are explored in relation to diseases of this system.

IDTH 226 The Cardiovascular System 40.40; 4 cr.
An integrated course that covers the anatomy, histology, physiology, pathology, pathophysiology and pharmacology related to the cardiovascular system. In addition, concepts in social medicine and global health, preventive medicine, epidemiology and medical ethics are explored in relation to diseases of this system.

IDTH 227 The Respiratory System 40.40; 4 cr.
An integrated course that covers the anatomy, histology, physiology, pathology, pathophysiology and pharmacology related to the respiratory system. In addition, concepts in social medicine and global health, preventive medicine, epidemiology and medical ethics are explored in relation to diseases of this system.

IDTH 228 The Kidneys and Urinary System 40.40; 4 cr.
An integrated course that covers the anatomy, histology, physiology, pathology, pathophysiology and pharmacology related to the kidneys and urinary system. In addition, concepts in social medicine and global health, preventive medicine, epidemiology and medical ethics are explored in relation to diseases of this system.

IDTH 229 The Skin 20.20; 2 cr.
This course integrates the anatomy, histology, physiology, pathology, pathophysiology and pharmacology related to the skin. Basic concepts are presented in which students are expected to learn the scientific basis of the normal physiology and pathology of the skin and its appendages including hair and nails as well as mucosal surfaces. Mechanisms of disease causation are illustrated with clinically relevant examples. Concepts in preventive medicine, epidemiology and medical ethics are explored in relation to diseases of the skin.

IDTH 230 Brain and Cognition 80.80; 8 cr.
This course is intended to provide preclinical medical students with an integrated approach to the structure and function of the nervous system. Basic principles of neuroanatomy, neurocytology, neuroembryology, neuroradiology, neurophysiology and neurology will be related to the function of the normal and diseased human nervous system, and the action of drugs. Concepts in social and preventive medicine, epidemiology and medical ethics are explored in relation to diseases of the nervous system.

IDTH 231 Human Development and Psychopathology 40.40; 4 cr.
This is a multidisciplinary course that integrates human development, psychopathological processes and their underlying neural circuitries along with basic and clinical psychopharmacology and relevant ethical, professional and public health issues. It teaches psychopathology through a lifespan approach and uses a variety of teaching/learning techniques such as didactics, team based learning, case studies and workshops.

IDTH 232 Research Design and Development 10.80; 3 cr.
The aim of the course is to provide the opportunity to learn and apply research methods to investigate a local health problem. It will provide a hands-on research experience, building on the basic knowledge and skills learned in the Fundamentals of Medical Research course in year 1. Students will learn the phases of the research process from conception to design to implementation. Through a combination of class sessions, meetings with research advisors and independent work, students, in groups, will identify a local health problem that is of particular interest to them, and will design and conduct a study relevant to it.

IDTH 233 Physicians Patients and Society – II 20.20; 2 cr.
This course explores medicine, illness and suffering as seen through the lens of bioethics, spirituality in medicine, palliative care and the nursing experience. It will bring together information related to the biophysical, psychological, humane, spiritual and social factors of illness - a holistic approach that focuses on the patient as a person.

IDTH 224 Clinical Skills – II 20.50; 3 cr.
This course is a continuation of IDTH 213 and further develops the student's communication skills, history taking, physical examination and clinical reasoning. It runs throughout the year and is closely aligned with the organ-system based courses being studied by the students in year 2 of medical school, to integrate clinical and basic science knowledge and skills.

IDTH 225 Learning Communities – II 0.30; 1 cr.
The course covers topics and issues important for the personal and professional development of students, with emphasis on reflection. Students are encouraged to make use of experiences for shared learning and to develop a sense of community and belonging, thus promoting well-being.

Fourth Year

IDTH 268 Clerkship in Preventive Medicine and Public Health 10.80.
In this clerkship, teams of senior medical students assess, critique and propose solutions to problems of public health or clinical significance. The students examine policy, organizational, social and individual challenges to these problems, addressing issues such as equity in health and setting public health programs, and identifying opportunities for change. Data collection and statistical analysis are secondary objectives.

IDTH 264 Capstone Course 10.70.
The two-week course aims to provide students with an opportunity to reflect on their undergraduate experience and the personal, social, emotional and practical issues of transition beyond medical school and graduate training or professional career. It deals with issues of ethics, law, insurance, social medicine, professionalism, life-long learning among many others.

Graduate Studies in Biomedical Sciences

The graduate program in Biomedical Sciences is designed to provide a multidisciplinary educational and training environment that will prepare students for independent research and teaching careers. It is centered in the Faculty of Medicine, where investigative collaborations among basic and clinical scientists are fostered. The program emphasizes concepts and state-of-the-art techniques of molecular and cellular medicine, and integrates students into the extensive and rapidly expanding translational research programs. Students may choose a discipline of study from the several research areas/programs offered by the Faculty of Medicine.

For general requirements about graduate study at AUB, refer to the Admissions section on page 35 of this catalogue.

MS Disciplines

Admission to MS Programs

Course and Thesis Requirements

Students must complete a minimum of 21 credits of graduate course work with a minimum general average of 80. Graduate students who intend to apply to the medical program should complete 21 credits of graduate courses, 10 credits of which are not integral to the structured medical curriculum. Medical students and medical graduates who wish to join the MD–MS program are required to complete a minimum of 10 credits of graduate courses not integral to the structured medical curriculum and earn a minimum general average of 80. Those with a degree in dental or veterinary medicine are required to complete a minimum of 15 credits of graduate course work. In addition, all students must pass a comprehensive examination and complete a thesis project equivalent to 9 credits. The thesis must be presented and defended to the satisfaction of the examining committee.

Students following the non-thesis master's program are required to take a minimum of 30 graduate credit hours, 3 credits of which may be a project and should follow a course of study approved by the department/program and the concerned faculty Graduate Studies Committee.

PhD Program

Mission

The mission of the Doctoral Program in Biomedical Sciences (DBMS) is to provide excellent educational and research opportunities for students to develop into independent researchers and educators who will enrich the research and teaching output from Lebanon, the Middle East and beyond. The program will provide the students with the theoretical foundations and the special skills and attitudes that will allow them to develop their critical thinking and creative potential, conduct high caliber research in the biomedical sciences, contribute to the advancement of science, uphold the principles of intellectual honesty and become leaders in their chosen fields of study.

Program Objectives

Students are expected to:

- design and pursue pertinent research in biomedical science questions by devising and implementing a research plan to test a novel hypothesis,
- generate and analyze data critically, and utilize such analysis in devising, revising and/or refining a research plan,
- communicate findings, in both oral and written formats, through presentations at scientific meetings, publications in peer-reviewed journals and tutoring of junior students,
- demonstrate knowledge and integration of the fundamental principles of the various biomedical sciences,
- demonstrate theoretical and practical expertise in a specific field of research in the biomedical sciences,
- appreciate the complexity and volume of emerging new scientific information and its technical components, and be able to cope with it and manage one's learning efficiently and effectively,
- and appreciate the importance of openness, teamwork and integrity in the advancement of knowledge through research.

PhD Disciplines

- Biochemistry and Molecular Genetics
- Biomedical Engineering
- Cell Biology of Cancer
- Microbiology and Immunology
- Neurosciences Program
- Nutrition (Interfaculty)
- Pharmacology and Toxicology
- Physiology

Academic Governance

Oversight of the DBMS Program occurs at three levels: at the PhD Program Committee level with faculty representation from the department and program of study and the coordinator of the PhD Program, at the Faculty of Medicine Dean's Office represented by the Faculty of Medicine Graduate Studies Committee and at the university level through the Board of Graduate Studies.

Admission Requirements

Admission to the program will be on a competitive basis. Students eligible for admission to the DBMS must have a sound academic record (85% or its equivalent in the major field of study), a demonstrated, genuine interest in biomedical research and, preferably, research experience.

Minimum requirements for admission into the program are the following:

- Students with a BS degree or its equivalent in mathematics, biology, physics or chemistry in the Faculty of Arts and Sciences, as well as advanced courses in other medical science disciplines, and preferably with research experience, are eligible to apply (accelerated track PhD). Applicants with other degrees such as master's (MS), Medical Doctor (MD), Pharmacist (Pharm D or equivalent), Veterinarian Doctor (VMD), Dental Doctor (DMD, DDS), will also be considered for admission into the program (regular track PhD).
- Students should provide three letters of recommendation.
- General Graduate Record Examination (GRE), which is less than 5 years old, is required (applicant can use unofficial scores in the application and send the official copy after the application submission deadline). Total score of minimum 304 (equivalent to 1100 converted old GRE score) in the verbal and quantitative reasoning sections of the GRE test is required. Applicants to the graduate program, other than AUB graduates and graduates of colleges or universities recognized and located in North America, Great Britain, Australia and New Zealand, must meet the Readiness for University Studies in English (RUSE). Refer to catalogue section on Readiness for University Studies in English on page 42.
- Provide a personal statement (500 words maximum).
- Students should be interviewed by the PhD Committee members.
- Students should be recommended for admission by the PhD Committee.

FM accepts applications for the PhD program during fall and in the early application cycle.

Financial Support

The PhD program offers, on a competitive basis, substantial support which fully covers tuition and includes a monthly stipend and housing. In return, students are expected to help in teaching and in proctoring exams.

Program Requirements

50 credit hours of course work beyond the bachelor's program or 29 credit hours of course work beyond the master's program are required. To fulfill course requirements, 16 required core courses (34 credits), in addition to elective courses, are offered. A maximum of 21 credit hours may be transferred from the master's work if considered within the scope of the program. Students are expected to register for 24 credits of thesis.

Upon admission into the program, each student will be advised by the coordinator of the PhD program. After the first year, each student will have selected a thesis advisor who will design the set of elective courses to meet the student's research interests and career goals. Each student's course of study will be designed individually in light of the student's interests and career goals. All the duties of the coordinator of the PhD program will be transferred to the student's thesis advisor, who must be selected no later than the end of the first year for students entering into an MS program.

Core Courses

First Year		Credits	
BIOC 321	Nucleic Acids and Basic Genetics	1	Required
BIOC 322	Protein Biochemistry	1	Required
BIOC 323	Cellular Metabolism and Regulation	2	Required
PHYL 310	Cell Physiology and Biophysics	3	Required
BIOC 325	Receptor and Signal Transduction	2	Required
HUMR 305	Cell and Tissue Biology	3	Required
EPHD 310	Biostatistics	3	Required
BIOM 491	Laboratory Rotation	1	Required
HUMR 310	Methods in Biomedical Sciences	3	Required
PHRM 315	Principles of Pharmacology	2	Required
BIOM 385	Research Ethics	1	Required

Second Year		Credits	
MBIM 309 or MBIM 310	Basic Microbiology	3	Required
	Basic Immunology	3	
HUMR 314	Seminar and Journal Club	1	Required
BIOM 375	Principles of Learning and Assessment	2	Required
IDTH 301	Scientific Communication	2	Required
PHYL 302[1]	Cardiovascular Physiology	2	Elective
IDTH 308A[1]	Neuroanatomy	3	Elective
IDTH 308B[1]	Neurophysiology	3	Elective
PHYL 300[1]	Pulmonary – Renal	2	Elective
PHYL 304[1]	GL – Endocrine – Reproductive	3	Elective

For other elective courses, refer to MS disciplines.

- BIOC Courses Refer to page 550
- HUMR Courses Refer to page 544
- PHYL Courses Refer to page 546
- IDTH Courses Refer to page 548
- PHRM Courses Refer to page 585
- MBIM Courses Refer to page 579

Course Descriptions

BIOM 375 Principles of Learning and Assessment 28.0; 2 cr.
This course provides students with the theoretical background and approaches to teaching science at the university level with emphasis on the nature of science and learner cognition. In addition, students are expected to apply principles and techniques of teaching and assessment of science in a teaching context. This is a core course for PhD students in Biomedical Sciences and is an elective for MS students. *First term.*

BIOM 385 Research Ethics 15.0; 1 cr.
This course introduces the fundamentals of responsible conduct of research, emphasizing the ethical practice of human research. The course recaps history of ethical principles and the development of research codes of conduct and ethical practices, familiarizes students with different kinds of ethical issues that they might come across throughout their careers and allows scholars to reflect critically about what it means to be an ethical and responsible researcher. *Summer term.*

BIOM 480 Qualifying Exam Part I: Comprehensive Exam 0 cr.
All students admitted to the PhD program must successfully complete a comprehensive examination. The purpose of the comprehensive exam is to ascertain the student's knowledge in his/her field of specialization and related areas. The exam will cover major topics from within the concentration area and related fields.

Students who do not pass the comprehensive exam may, upon the recommendation of the thesis committee, take it for a second time in the following term. Failure on the second attempt will result in the student's discontinuation from the PhD program.

BIOM 481 Qualifying Exam Part II: Defense of Thesis Proposal 0 cr.
All students must successfully complete a qualifying examination, which is to be taken at least two terms prior to the final defense of the PhD thesis. The qualifying exam, administered by the thesis committee, is an oral exam in which the student presents his/her research proposal.

The objective of the oral exam is to determine whether the candidate's proposal and methodology are adequate for a PhD thesis. The candidate must show positive preliminary results and considerable promise of original research. It is the responsibility of the student to inform and update the thesis committee members about his/her research progress, especially during the period between the comprehensive and qualifying exams. Students who do not pass the qualifying exam are allowed to take it for a second time in the following term. Failure on the second attempt will result in the student's discontinuation from the graduate program.

BIOM 491 PhD Laboratory Rotations 0.30; 1 cr.
During the first year of study, PhD students in Biomedical Sciences must take a minimum of two laboratory rotations (1 credit each) in different faculty research laboratories within the Faculty of Medicine. Students may also enroll in the summer in a third elective laboratory rotation (1 credit). This course aims to familiarize students with potential thesis mentors and expose them to different research environments. Open to PhD students in Biomedical Sciences. *First and second terms and summer.*

BIOM 499 PhD Thesis 24 cr.
A/B/C/D/E
In partial fulfillment of the requirements for the degree of Doctor of Philosophy, a student must submit a thesis (equivalent to 24 credit hours) that is expected to make a significant and original contribution to his/her field of research.

PhD Thesis Requirements

Thesis Committee

The PhD Thesis Committee should consist of at least five members. Two members should be from outside AUB, and the chair of the PhD Thesis Committee should be a faculty member holding the rank of a full professor and different from the thesis advisor. Refer to PhD Thesis Committee under General University Academic Information, page 72.

Thesis Defense

After qualifying as a PhD candidate, the student will focus on the doctoral research with continued participation in seminars. The doctoral research, once completed, will be presented publicly and defended immediately after in front of the PhD Thesis Committee. Prior to the defense, all major revisions to the thesis must be completed. The decision of the committee will be by consensus. Refer to PhD Thesis Defense under General University Academic Information, page 54.

Publication Requirements

PhD students should have published or have in press one journal publication and one abstract in an international conference related to their thesis topics.

Candidacy and Residency Requirements

All students admitted to the PhD program must successfully complete the qualifying exam part I (written) and qualifying exam part II (oral defense of thesis proposal).

To satisfy the minimum residency requirements for the PhD degree, all students must register and be in residence for at least three years beyond the completion of the master's degree. The requirements for the degree of Doctor of Philosophy must be completed within a period of 5 years after joining the PhD program. Extension beyond the 5-year period will require Graduate Council approval upon the recommendation of the faculty Graduate Studies Committee.

Graduation Requirements

To earn a PhD degree in Biomedical Sciences, a student must fulfill the following graduation requirements:

- attain a minimum cumulative average of 85 at the PhD level
- pass qualifying exams part I and II
- pass the PhD thesis defense
- satisfy the minimum residency requirements
- have a publication in a leading international journal, based on the PhD research
- have at least one accepted abstract in an international conference, based on the PhD research
- satisfy all pertinent AUB regulations

In addition to the AUB general requirements for graduate study, the Faculty of Medicine graduate study requirements and regulations are as follows:

- **Application and Notification of Acceptance:** For application submission deadlines and admissions decision notifications, refer to Application Procedures under Admissions section on page 42.
- **Acceptance:** Acceptance offers are issued in duplicates including category offered, registration period and date of start of classes. These dates are mentioned in the university calendar issued annually by the Office of the Registrar.
- Candidates must sign a copy of the above letter indicating acceptance and return it to the Office of Admissions at the due date. If acceptance letters are not signed and sent back by the set deadline, positions will be re-assigned to candidates on the waiting list.
- **Periods of Study:** The graduate program, once initiated, proceeds without interruption through the first term, the second term and the summer session.
- **Transfer Students:** See Transfer of Credits into a PhD Degree Program under General University Academic Information section on page 59.
- **Categories of Graduate Students:** The categories applicable at the university in general are also applicable in the Faculty of Medicine with the following modifications: Students are given a regular graduate student status when they have a cumulative undergraduate average in the major field of study of at least 80 or its equivalent, and they are given a graduate on special status when they have a cumulative undergraduate average in the major field of study or an overall average of 75 or higher but lower than 80 or equivalent. Graduates on probation status are transferred to regular status upon achieving an overall average of at least 80 in 9 credits of graduate courses within two terms.
- **Visiting Graduate Students:** is a status applicable to students who pay a fee to attend a period of observership in an ongoing research project.
- **Exchange students:** is a status applicable to students who participate in the graduate program in accordance with formal agreements between the Faculty of Medicine and other institutions.

In all instances, candidates must submit applications which are reviewed and acted upon by the Graduate Studies Committee.

Leave of Absence

See Leave of Absence under General University Academic Information section on page 52.

Interdepartmental Courses – Graduate Program

IDTH 301 Introduction to Medical Science Literature 16.32; 2 cr.
A multidisciplinary approach to the use of medical science publications. Open to beginning graduate students in the Faculty of Medicine.

IDTH 302 Methods 16.64; 3 cr.
Theory and practice of techniques used in various disciplines of medical sciences.

IDTH 303/304/305/306 Integrated Graduate Course I–IV 32.0; 2 cr. (each)
An integrated lecture seminar course introducing graduate students to the thinking in various medical science disciplines (required of all PhD students in the Faculty of Medicine). *Four terms. One two–hour session a week each.*

IDTH 307 Biomedical Electronics 32.16; 3 cr.
An introductory course in electricity and electronics as applied to biology and medicine. *Alternate years.*

IDTH 308A Neuroanatomy 31.27; 3 cr.
A course similar to the first part of 208, offered to graduate students, covering the normal structure of the human nervous system. See Department of Human Morphology. *Three weeks.*

IDTH 308B Neurophysiology 31.27; 3 cr.
A course similar to the second part of 208, offered to graduate students, covering the function of the human nervous system. See Department of Physiology. *Three weeks.*

IDTH 309 Biology of Nerve and Muscle 48.0; 3 cr.
A multi–disciplinary study of anatomy, physiology, biochemistry, pharmacology, and pathology of nerve and muscle. *Alternate years.*

IDTH 310 Basic Pathological Mechanisms 29.14; 2 cr.
The course covers the basic pathological mechanisms of disease at the cellular and molecular levels; their microscopic, gross and clinical manifestation; and some pharmacological interventions that apply to them.

IDTH 311 Foundations of Biomedical Science 90.40; 7 cr.
An interdisciplinary course that presents the cellular and molecular concepts and principles that underlie the normal structure and function of the human body. It covers cellular structure and function, including mechanisms and regulation of gene expression, protein synthesis, structure and function, signaling mechanisms, membrane transport, energy metabolism, contractility and excitability, and the basic principles of drug action.

IDTH 317 Perspectives in Medical Sciences 32.0; 2 cr.
A course of selected readings and seminars in the history, philosophy and methodology of medical and related sciences.

IDTH 319/320 Integrated Research Seminars 16.0; 1 cr. (each)
Participation of all PhD students and professors.

IDTH 330 Medical Pedagogy 3 cr.
A tutorial in teaching methods and practical experience under supervision. *Open to PhD candidates only*.

IDTH 333/334 Projects 2 cr. (each)
Two months half-time in a department other than the student's major occurring toward the end of the PhD candidate's residency.

Biomedical Engineering Graduate Program

Coordinator:	Dawy, Zaher (Electrical & Computer Engineering, MSFEA)
Co-coordinator:	Jaffa, Ayad (Biochemistry & Molecular Genetics, FM)
Coordinating Committee Members:	Amatoury, Jason (Biomedical Engineering, MSFEA) Daou, Arij (Biomedical Engineering, MSFEA) Darwiche, Nadine (Biochemistry & Molecular Genetics, FM) Khoueiry, Pierre (Biochemistry & Molecular Genetics, FM) Khraiche, Massoud (Biomedical Engineering, MSFEA) Mhanna, Rami (Biomedical Engineering, MSFEA) Oweis, Ghanem (Mechanical Engineering, MSFEA)

Background

The Biomedical Engineering Graduate Program (BMEP) is a joint MSFEA and FM interdisciplinary program that offers two degrees: Master of Science (MS) in Biomedical Engineering and Doctor of Philosophy (PhD) in Biomedical Engineering. The BMEP is housed in the MSFEA and administered by both MSFEA and FM via a joint program coordinating committee (JPCC).

The mission of the BMEP is to provide excellent education and promote innovative research enabling students to apply knowledge and approaches from the biomedical and clinical sciences in conjunction with design and quantitative principles, methods and tools from the engineering disciplines to address human health related challenges of high relevance to Lebanon, the Middle East and beyond. The program prepares its students to be leaders in their chosen areas of specialization committed to lifelong learning, critical thinking and intellectual integrity.

The curricula of the MS and PhD degrees are composed of core and elective courses balanced between biomedical sciences and engineering and between fundamental and applied knowledge.

The curricula include the following three research focus areas:

- **Biomedical Systems:** This focus area includes research directions such as devices, instrumentation, biomechanics, biomaterials, drug delivery systems and tissue engineering.
- **Biomedical Cybernetics:** This focus area includes research directions such as biomedical and health informatics, computational biology, biomedical signal/image processing and biomedical systems engineering.
- **Cardiovascular and Pulmonary Engineering:** This focus area includes research directions such as fluid mechanics, modeling, simulation, imaging, devices, and implants related to both human cardiovascular and pulmonary systems.

A student may select his/her courses to satisfy the requirements of one of the three focus areas.

The MS and PhD degrees are open to students holding degrees from relevant fields of study including basic sciences, biomedical sciences, computer science, engineering, health sciences, and mathematics. Due to the interdisciplinary nature of the program, eight remedial undergraduate courses in sciences, math and engineering have been identified to cover the needed prerequisite knowledge; the remedial courses required by each admitted students are customized on a case-by-case basis depending on the student's undergraduate degree. Remedial undergraduate courses do not count as credit towards the MS or PhD degree completion. Grades on these remedial courses will appear on the transcript as Pass/Fail with a passing grade of 70/100.

Master of Science in Biomedical Engineering

The BMEP offers a Master of Science (MS) degree in Biomedical Engineering with two options: thesis option and non-thesis option.

Admission Requirements

The application procedures and admission requirements to the MS program follow AUB's General University Academic Information as documented in the Graduate Catalogue. To be considered for admission, applicants must hold a bachelor's degree in a relevant field of study from AUB or its equivalent, or from a recognized institution of higher learning.

Accepted students in the thesis option are eligible to apply to the Graduate Fellowship and Assistantship Program (GFAP).GFAP support cannot be used to cover the tuition for remedial undergraduate courses.

Course Requirements

The MS program consists of 30 credits. The curriculum design is divided into core courses and elective courses in addition to a master's thesis for the thesis option. This program does not provide credit towards New York State licensure.

Core graduate courses: 18 credits of core courses from biomedical sciences and engineering.

Required core courses (18 cr.)		Credits
BIOC 321	Nucleic Acids and Basic Genetics	1
BIOC 322	Protein Biochemistry	1
BMEN 600	Biomedical Engineering Applications	3
BMEN 601	Computational Modeling of Physiological Systems	3
BMEN 672	Hospital Lab Rotation	0
BMEN 673L	Biomedical Engineering Lab	1
EPHD 310	Basic Biostatistics[1]	3
HUMR 310 (A, B, or C)	Biomedical Research Techniques	1
HUMR 314	Research Seminar	1
PHYL 346	Human Physiology	4

1) EPHD 310 can be replaced by another advanced level statistics course based on JPCC's approval.

Restricted elective graduate courses: 6 credits restricted elective courses customized per focus area and required by both thesis and non-thesis options.

Restricted elective courses (6 cr.)		Credits	Systems	Cyber-netics	Cardio-vascular
BIOC 325	Receptors and Signal Transduction	2		X	
BIOC 326A	Bioinformatics Tools and Applications in Genomics	1		X	
BMEN 603	Tissue Engineering	3	X		X
BMEN 604	Engineering of Drug Delivery Systems	3	X		X
BMEN 605	Biomedical Imaging	3		X	X
BMEN 606	Nanobiosensors	3	X	X	
BMEN 607	Biomechanics	3	X		
BMEN 608	Biomaterials and Medical Devices	3	X		X
BMEN 609 or EECE 605	Computational Neuroscience or Neuromuscular Engineering	3	X	X	
BMEN 610	Micro and Nano Neural Interfaces	3	X		
BMEN 611	Computational Modeling in Biomechanics	3	X	X	X
EECE 601 or EECE 602	Biomedical Engineering I or Biomedical Engineering II	3	X	X	X
EECE 601 or EECE 602	Biomedical Engineering I or Biomedical Engineering II	3	X	X	X
EECE 603	Biomedical Signal and Image Processing	3		X	X
EECE 633 or EECE 663 or EECE 667 or EECE 693	Data Mining or System Identification or Pattern Recognition or Neural Networks	3		X	
HUMR 305	Cell and Tissue Biology	3	X		
PHYL 302	Cardiovascular Physiology	2			R
PHYL 300A	Pulmonary Physiology	1			R

Free elective graduate courses for the non-thesis option: 6 credits additional elective courses. These courses should be taken from engineering and should be approved by the student's advisor and the coordinator of the joint program coordinating committee.

Master thesis for the thesis option: 6 credits master's thesis in biomedical engineering. The thesis requirements follow AUB's General University Academic Information as documented in the Graduate Catalogue.

PhD in Biomedical Engineering

Admission Requirements

The application procedures and admission requirements to the PhD program follow AUB's General University Academic Information as documented in the Graduate Catalogue. To be considered for admission, applicants must hold a bachelor's or master's degree in a relevant field of study from AUB or its equivalent, or from a recognized institution of higher learning.

Acceptance into the PhD program is determined by academic performance as well as an assessment of readiness, potential and ability to develop into independent researchers as judged by interviews by faculty members, a written statement, letters of recommendation, GRE scores, and other means of assessment such as publications and industrial experience.

Accepted students are eligible to receive scholarships that fully cover their tuition fees and provide a monthly stipend.

Degree Requirements

General requirements for master's degree holders: Based on AUB's guidelines, a minimum of 48 credit hours beyond those required for the master's degree, of which a minimum of 18 credit hours must be in graduate level course work and a minimum of 24 credit hours of thesis work, must be taken. Requirements also allow a maximum of 3 credit hours out of the 18 credits of coursework as tutorial course and include a 0-credit comprehensive examination preparation course and a 0-credit thesis proposal preparation course.

General requirements for bachelor's degree holders: Based on AUB's guidelines, a minimum of 78 credit hours beyond those required for the bachelor's degree, of which a minimum of 36 credit hours must be in graduate level coursework and a minimum of 30 credit hours of thesis work, must be taken. Requirements also allow a maximum of 6 credit hours out of the 36 credits of coursework as tutorial courses and include a 0-credit comprehensive examination preparation course and a 0-credit thesis proposal preparation course.

To earn a PhD degree in Biomedical Engineering, the student must complete the following requirements:

- Satisfy the course and research credit requirements
- Satisfy the residence requirement and all other pertinent AUB regulations
- Have at least one international refereed journal article based on the PhD thesis
- Have at least one refereed conference paper based on the PhD thesis
- Have a cumulative average of 85 or above
- Pass the comprehensive and oral qualifying examinations
- Successfully defend the PhD thesis

The following are the graduate level course requirements for students admitted with a bachelor's degree. The total number of credits is at least 36 credits divided among core, restricted elective and free elective courses. Students admitted with a master's degree can waive as many courses as possible without going below the minimum required 18 credits of coursework.

Core graduate courses: 21 credits of core courses from biomedical sciences and engineering.

Required core courses (21 cr.)		Credits
BIOC 321	Nucleic Acids and Basic Genetics	1
BIOC 322	Protein Biochemistry	1
BIOM 385	Research Ethics	1
BMEN 600	Biomedical Engineering Applications	3
BMEN 601	Computational Modeling of Physiological Systems	3
BMEN 671	PhD Lab Rotation[1]	1+1
BMEN 672	Hospital Lab Rotation	0
BMEN 673L	Biomedical Engineering Lab	1
BMEN 675	Approved Experience	0
EPHD 310	Basic Biostatistics[2]	3
HUMR 310 (A, B, or C)	Biomedical Research Techniques	1
HUMR 314	Research Seminar	1
PHYL 346	Human Physiology	4

Restricted elective graduate courses: 9 credits restricted elective courses customized per focus area.[3]

Restricted elective courses (9 cr.)[3]		Credits	Systems	Cyber-netics	Cardio-vascular
BIOC 325	Receptors and Signal Transduction	2		R	
BIOC 326A	Bioinformatics Tools and Applications in Genomics	1		R	
BMEN 603	Tissue Engineering	3	X		X
BMEN 604	Engineering of Drug Delivery Systems	3	X		X
BMEN 605	Biomedical Imaging	3		X	X
BMEN 606	Nanobiosensors	3	X	X	
BMEN 607	Biomechanics	3	X		
BMEN 608	Biomaterials and Medical Devices	3	X		X
BMEN 609 or EECE 605	Computational Neuroscience or Neuromuscular Engineering	3	X	X	
BMEN 610	Micro and Nano Neural Interfaces	3	X		
BMEN 611	Computational Modeling in Biomechanics	3	X	X	X
EECE 601 or EECE 602	Biomedical Engineering I or Biomedical Engineering II	3	X	X	X

1) Students are required to take two PhD lab rotation courses where each lab rotation is 1 credit (one lab rotation in MSFEA and one lab rotation in FM).
2) EPHD 310 can be replaced by another advanced level statistics course based on JPCC's approval.
3) Courses marked as "R" are required, and courses marked as "X" are possible elective options.

EECE 603	Biomedical Signal and Image Processing	3		X	X
EECE 633 or EECE 663 or EECE 667 or EECE 693	Data Mining or System Identification or Pattern Recognition or Neural Networks	3		X	
HUMR 305	Cell and Tissue Biology	3	R		
PHYL 300A	Pulmonary Physiology	1			R
PHYL 302	Cardiovascular Physiology	2			R

Free elective graduate courses: 6 credits additional elective courses. These courses should be taken based on the student's specific area of research as approved by the student's advisor.

Course Descriptions

BMEN 600 Biomedical Engineering Applications 3 cr.
Biomedical engineering is an interdisciplinary domain which applies principles of engineering to find solutions for biological and health problems. Biomedical engineering aims to improve our fundamental understanding of biological processes and develop approaches for optimized therapeutic/diagnostic healthcare procedures. The field of biomedical engineering involves the development of materials to replace or enhance the operation of damaged or malfunctioning biological entities, development of diagnostic and therapeutic tools, modeling of biological systems, signal processing and bioinformatics. This course will introduce students to biomedical engineering and provide insight into the various applications in the biomedical engineering field. The course will be divided into modules, and each will be given by a specialist in a certain biomedical engineering area.

BMEN 601 Computational Modeling of Physiological Systems 3 cr.
This course focuses on the quantitative modeling of different physiological systems. It provides students with current concepts of the mathematical modeling, and different quantitative descriptions of cellular and organ physiology. At the subcellular/cellular level, we will examine mechanisms of regulation and homeostasis. At the system level, the course will cover basic aspects of anatomical and pathophysiological features of the nervous, neural, cardiovascular and respiratory systems. Several physiological processes are treated as case studies for increasing complexity in modeling dynamical systems. *Prerequisite: MATH 202 and PHYL 346, or consent of instructor.*

BMEN 602 Computational Modeling of Cardiovascular and Pulmonary Systems 3 cr.
The need for better understanding the mechanics and tools for computational modeling of cardiovascular and respiratory systems in healthy and diseased conditions is constantly increasing. This is a result of the enormous advances made in the science and engineering of both surgical and therapeutic medicine. This course covers the modeling and simulation of cardiovascular and respiratory systems. It will provide the students with a thorough understanding of the anatomy, physiology and mechanics of cardiovascular and respiratory systems as well as the computational tools for modeling and simulation of cardiac, circulatory and respiratory systems in healthy and diseased conditions.

BMEN 603/ CHEN 675 **Tissue Engineering** **3 cr.**

In a world of aging population, an ever-increasing demand for improvement of healthcare services and need for replacement organs and tissues are arising. The limited pool of donors together with the problem of donor organ rejection is a strong driver for engineering tissues and other body parts. Tissue engineering is an interdisciplinary field that uses cells, biomaterials, biochemical (e.g. growth factors) and physical (e.g. mechanical stimulation) signals, as well as their combination to generate tissue-like structures. The goal of tissue engineering is to provide biological substitutes that can maintain, restore or improve the function of damaged organs in the body. This course will introduce interested students to the new field of tissue engineering and provide insight on cutting edge applications in this area.

BMEN 604/ CHEN 673 **Engineering of Drug Delivery Systems** **3 cr.**

This course focuses on recent advances in the development of novel drug delivery systems. The fundamentals of drug delivery are discussed. Various strategies to tune and control the release of active agents for optimized therapeutic outcomes are explored. The course covers polymers and techniques used to produce drug nanoparticles, with specific examples of nanoparticle-based drug delivery systems. *Prerequisites: CHEN 314 and CHEN 411, or consent of instructor.*

BMEN 605 **Biomedical Imaging** **3 cr.**

Biomedical imaging offers an unprecedented view into the structure and function of a living body, and as such plays an essential role in medical practice and research. This course will provide students with an overview of the key concepts underlying the primary diagnostic biomedical imaging modalities, including: ultrasound, x-ray, computed tomography, magnetic resonance and nuclear imaging. In particular, students will gain an understanding of the physical principles and theoretical bases governing the operation of each imaging modality, the technology that translates theory into practice, and the basic methods involved in image formation. Students will also learn the limitations of each imaging procedure, while being exposed to their vast applications in the clinic and research.

BMEN 606 **Nanobiosensors** **3 cr.**

This course will provide a comprehensive analysis of the field of nanoengineering with a focus on biosensors including common modalities, basic theoretical considerations for sensor operation, physics of detection and applications in research and medical diagnostics. The course will cover the major types of electronic nanobiosensors for biological signal detection (potentiometric, amperometric, and mass based sensors) and their applications in the fields of neural engineering, DNA sequencing and cardiovascular early disease detection. The course will enable students to have a strong grasp of fundamentals of biosensor design, select sensors for various applications and evaluate new and emerging technologies. *Prerequisites: EECE 210 (or equivalent) and BIOL 210 (or equivalent); or consent of instructor.*

BMEN 607/ MECH 633 **Biomechanics** **3 cr.**

A course on the study of the biomechanical principles underlying the kinetics and kinematics of normal and abnormal human motion. Emphasis is placed on the interaction between biomechanical and physiologic factors (bone, joint, connective tissue, and muscle physiology and structure) in skeleto-motor function and the application of such in testing and practice in rehabilitation. The course is designed for engineering students

with no previous anatomy/physiology. *Prerequisites: CIVE 210, MECH 320 or CIVE 310; or consent of instructor.*

BMEN 608/ MECH 634 Biomaterial and Medical Devices 3 cr.

A course that examines the structure-property relationships for biomaterials and the medical applications of biomaterials and devices. The first part of the course focuses on the main classes of biomaterials, metal, ceramic, polymeric and composite implant materials, as well as on their interactions with the human body (biocompatibility). The second part of the course examines the various applications of biomaterials and devices in different tissue and organ systems such as orthopedic, cardiovascular, dermatologic and dental applications. Experts from the medical community will be invited to discuss the various applications. *Prerequisite: MECH 340 or consent of instructor.*

BMEN 609 Computational Neuroscience 3 cr.

The human brain, perhaps the most complex, sophisticated, and complicated learning system, controls virtually every aspect of our behavior. The central assumption of computational neuroscience is that the brain computes. What does that mean? Generally speaking, a computer is a dynamical system whose state variables encode information about the external world. In short, computation equals coding plus dynamics. Some neuroscientists study the way that information is encoded in neural activity and other dynamical variables of the brain. Others try to characterize how these dynamical variables evolve with time. The study of neural dynamics can be subdivided into two separate strands. One tradition, exemplified by the work of Hodgkin and Huxley, focuses on the biophysics of single neurons. The other focuses on the dynamics of networks, concerning itself with phenomena that emerge from the interactions between neurons. Therefore computational neuroscience can be divided into three subspecialties: neural coding, biophysics of neurons, and neural networks. This course will introduce engineers, physicists, computational scientists, mathematicians and other audiences to the neurosciences from the cellular level and the network level as seen from computational lenses. *Prerequisite: BIOL 201 (or equivalent) and Math 202, or consent of instructor.*

BMEN 610 Micro and Nano Neural Interfaces 3 cr.

Neural interfaces are micro and nano devices that form the connection between the biological neural tissue and the external electronic devices. These devices are designed for mapping, assisting, augmenting, or repairing neural pathways. The course will focus on physical, chemical and neurophysiological principles of neural interfaces, theoretical and functional basis for their design, micro and nano fabrication techniques and applications in neural prosthesis for Brain Machine Interface. Topics covered in class will include; Neural Engineering, Brain Machine Interface, Microfabrication, Nanofabrication, Soft-lithography, Electrokinetics, Electrochemistry, Neural probes, Biocompatibility, Microelectrodes, NeuroMEMS (neuro microelectromechanical systems, BioMEMS (biomedical microelectromechanical systems).

BMEN 611 Computational Modeling in Biomechanics 3 cr.

This course provides students with a glimpse into the world of computational finite element modeling and simulation in biomechanics to investigate and solve biomedical problems. Students will take a journey through the processes involved in producing a computational finite element model in the biomedical field; starting at construction of model geometry, particularly from medical imaging data (CT/MRI), through to model creation, simulation and visualization using finite element analysis software (ANSYS Workbench). Students will also be exposed to a selection of experimental lab techniques

in biomechanics and physiology to acquire data required for model development and validation. In pursuit of developing an appreciation for the areas covered, the course will incorporate a mix of theory, demonstrations, practice, real-world modeling applications and research seminars. In addition to skills gained in modeling and basic experimentation, the course will provide students with an opportunity to enhance vital skills in scientific writing and oral communication. Prerequisite: Math 202 or consent of instructor.

BMEN 671 PhD Lab Rotation 1 cr.
PhD students in Biomedical Engineering are required take two laboratory rotations (1 credit each) in different faculty research laboratories within the MSFEA and/or FM. Students may also enroll in a third elective laboratory rotation. This aims to familiarize students with potential thesis mentors and expose them to different research environments.

BMEN 672 Hospital Lab Rotation 0 cr.
MS and PhD students in Biomedical Engineering are required to do a lab rotation in the Medical Engineering Department at AUB Medical Center (AUBMC). This aims to familiarize students with the typical activities and responsibilities of a biomedical engineer in a working environment and expose them to different equipment and tools.

BMEN 673L Biomedical Engineering Lab 1 cr.
This laboratory course aims to introduce students to the practical issues in the areas of biomedical instrumentation design and biological signal processing. A particular emphasis will be placed on signal transduction, electronic circuit design for recording and conditioning physiological signals. The lab will introduce hand-on laboratory experiments on biomedical sensors, analog signal amplifiers and filters, digital acquisition and transmission, and basic digital filtering. In addition, some experiments cover topics that demonstrate the various levels of complexity that characterize biological signals. Signal processing tools include spectral and cepstral analysis, de-noising and artifact removal, filter banks and wavelet decompositions, Hilbert transforms, and information-theoretic measures.

BMEN 675 Approved Experience 0 cr.

BMEN 796 Special Project in Biomedical Engineering 3 cr.

BMEN 797 Special Topics in Biomedical Engineering 1 cr.

BMEN 798 Special Topics in Biomedical Engineering 3 cr.

BMEN 799T MS Comprehensive Exam 0 cr.
Every term.

BMEN 799 MS Thesis 6 cr.
Every term. Prerequisite: BMEN 799T.

BMEN 980 Qualifying Exam Part I: Comprehensive Exam 0 cr.
Every term.

BMEN 981 Qualifying Exam Part II: Defense of Thesis Proposal 0 cr.
Every term. Prerequisite: BMEN 980.

BMEN 982 PhD Thesis 3 cr.
Every term. Taken while total required credit hours have been completed.

BMEN 983 PhD Thesis 6 cr.
Every term. Taken while total required credit hours have not been completed.

BMEN 984 PhD Thesis 9 cr.
Every term. Taken while total required credit hours have not been completed.

BMEN 985 PhD Thesis 12 cr.
Every term. Taken while total required credit hours have not been completed.

BMEN 986 PhD Thesis 0 cr.
Every term. Taken while total required credit hours have not been completed.

BMEN 987 PhD Thesis Defense 0 cr.
Every term. Prerequisite: BMEN 981.

BIOC 321 Nucleic Acids and Basic Genetics 15.0; 1 cr.
This course discusses the principles of nucleic acid structure and function in eukaryotes. It includes the information for basic genetics in terms of genome structure as well as the diversity of gene regulation. Required from MS and PhD students in biomedical Sciences. requires consent of coordinator for other graduate disciplines. *First term.*

BIOC 322 Protein Biochemistry 10.10; 1 cr.
This course deals with the biochemistry of proteins including their basic units, different structures, folding process and protein-protein interactions. It focuses on how changes at the structural level modify function. The course also covers the principles of protein purification and sequencing, and introduces students to protein database, molecular modeling and systems biology. Required from MS and PhD students in biomedical sciences. Requires coordinator approval for other graduate disciplines. *First term.*

BIOC 325 Receptors and Signal Transduction 25.10; 2 cr.
This course covers classical pathways involved in receptor signaling and activation of downstream targets and the molecular mechanisms involved. It deals with the inter- and intracellular communication, from the generation of signaling molecules through the cellular responses. Required from MS and PhD students in biomedical sciences. Requires consent of coordinator for other graduate disciplines. *First term.*

BIOC 326A Bioinformatics Tools and Applications in Genomics 1 cr.
This course will discuss the relationships among sequence, structure and function in biological networks, as well as advances in modeling of quantitative, functional and comprehensive genomics analyses. It will assess computational issues arising from high-throughput techniques recently introduced in biomedical sciences, and cover very recent developments in computational genomics, including genome structural variant discovery, epigenome analysis, cancer genomics and transcriptome analysis.

BIOM 385 Research Ethics 15.0; 1 cr.
This course introduces the fundamentals of responsible conduct of research, emphasizing the ethical practice of human research. The course recaps history of ethical principles, the development of research codes of conduct and ethical practices, familiarizes students with the different kinds of ethical issues that they might come across throughout their careers and allows scholars to reflect critically on what it means to be an ethical and responsible researcher. *Summer term.*

EECE 601 Biomedical Engineering I 3 cr.
This course includes an introduction to: general instrumentation configuration and performance of instrumentation systems; types and characteristics of transducers; sources and characteristics of bioelectric signals; types and characteristics of electrodes; temperature regulation and measurement; cardiovascular system, measurements and diagnostic equipment; blood instruments; patient care and monitoring; and electrical safety of medical equipment. *Prerequisites: BIOL 210 or BIOL 202 or PHYL 246, and EECE 210; or PHYS 228 and PHYS 228L; or consent of instructor.*

EECE 603 Biomedical Signal and Image Processing 3 cr.
Fundamentals of digital signal processing as implemented in biomedical applications. It provides a concise treatment of the tools utilized to describe deterministic and random signals as the basis of analyzing biological signals: data acquisition; imaging; denoising and filtering; feature extraction; modeling. The course is tightly coupled with a practical component through laboratory projects. Examples include the auditory system, speech generation, electrocardiogram, neuronal circuits and medical imaging. Students should have reasonable software skills in Matlab. *Prerequisites: STAT 230 and EECE 340, or equivalent; or consent of instructor.*

EECE 633 Data Mining 3 cr.
This course is an introduction to data mining. Data mining refers to knowledge discovery from huge amounts of data to find non-trivial conclusions. Topics will range from statistics to machine learning to database, with a focus on analysis of large data sets. The course will target at least one new data mining problem involving real data for which the students will have to find a solution. *Prerequisite: EECE 330 or consent of instructor.*

EECE 663 System Identification 3 cr.
This course introduces the basic mathematical tools to fit models into empirical input-output data. General time-series modeling and forecasting, such as stock prices, biological data and others. Topics include nonparametric identification methods: time and frequency response analysis; parametric identification: prediction error, least squares, linear unbiased estimation and maximum likelihood; convergence, consistency and asymptotic distribution of estimates; properties and practical modeling issues: bias distribution, experiment design and model validation.

EECE 667 Pattern Recognition 3 cr.
The course provides an overview of the algorithms used in machine learning. The course discusses modern concepts for model selection and parameter estimation, decision-making and statistical learning. Special emphasis will be given to regression and classification for a supervised mode of learning. Students will be assigned typical machine learning problems to investigate as projects.

EECE 693 Neural Networks 3 cr.
The course provides a comprehensive foundation to artificial neural networks and machine leaning with applications to pattern recognition and data mining; learning processes: supervised and unsupervised, deterministic and statistical; clustering; single layer and multilayer perceptrons; least-mean-square, back propagation and Al-Alaoui algorithms; radial-basis function networks; committee machines; principal component analysis; self-organizing maps; and current topics of interest.

EPHD 310 Basic Biostatistics 2.2; 3 cr.
An introductory biostatistics course that covers basic concepts in statistical methods. The course demonstrates methods of exploring, organizing and presenting data. The course presents the foundation of statistical inference from estimation, to confidence interval and testing of hypothesis. Applications include comparing population means or proportions via data obtained from paired or independent samples, one-way ANOVA. Also, it introduces simple linear regression, correlations, logistic regression and nonparametric methods for data analysis.

HUMR 305 Cell and Tissue Biology 30.33; 3 cr.
Consists of the first half of Basic Histology, HUMR 209, covering cells and tissues. Open to graduate students outside the department.

HUMR 310 Biomedical Research Techniques 1 cr.
(A, B, or C)
A guided laboratory course in research methods used in cell biology and physiology. HUMR 310A covers Cell Biology Techniques; HUMR 310B covers Genomics and Proteomics; HUMR 310C covers Mouse Models and In Vivo Studies. Used in cell biology and physiology.

HUMR 314 Research Seminar 0.32; 1 cr.
Presentation and discussion of timely research topics designated by members of the department.

PHYL 302 Cardiovascular Physiology 31.6; 2 cr.
Presents the cardiovascular system with clear reference to pathophysiological and clinical events. Didactic lectures and seminar sessions define physiological concepts and emphasize structure-function relationships. Laboratory sessions familiarize the student with instrumentation and techniques in the cardiovascular field. *Open to all graduate students in the department.*

PHYL 346 Human Physiology for Paramedical and Undergraduate Students 48; 4 cr.
Outlines fundamental principles of human physiology and the mechanisms governing the function of different body organs. *Prerequisites: BIOC 246 and BIOL 201 (or BIOL 210).*