

Department of Biology

Chairperson:	Smith, Colin A.
Professors:	Baydoun, Elias H.; Darwiche, Nadine D.; Gali-Muhtasib, Hala U.; Knio, Khuzama M.; Kreydiyyeh, Sawsan I.; Talhouk, Rabih S.
Associate Professors:	Bariche, Michel J.; Saoud, Imad P.; Smith, Colin A.
Assistant Professors:	Ghanem, Noel D.; Osta, Mike A.; Sadek, Riyad A.
Lecturers:	Rizkallah, Hind D.; Sinno-Saoud, Nada; Tarraf, Charbel G.
Instructors:	Hajjar, Layane A.M.; ^P Haykal, Joelle

Graduate Program

The graduate program consists of an MS program in Biology and a PhD program in Cell and Molecular Biology.

The Graduate Record Examination (GRE) is required of all applicants for graduate work. Requirements for an MS degree in biology consist of a minimum of 21 credit hours in biology courses numbered 300 or above and a thesis.

The following courses are core courses and should be taken by all graduate students: BIOL 310 (3 cr.), BIOL 315 (3 cr.), and BIOL 393 (1 cr.) or BIOL 394 (1 cr.). Unless otherwise stated, only senior undergraduate biology majors with an average of 80 or above can register in biology graduate courses with the consent of instructor.

MS in Biology

BIOL 310 **Quantitative Methods in Biology** **2.3; 3 cr.**

A course that emphasizes advanced statistical methods for biology; includes use of computers and some software and hardware applications in various fields in biology. *Prerequisite: graduate standing.*

BIOL 315 **Research Methods in Biology** **1.5; 3 cr.**

A core course that provides practical experience in a variety of techniques currently employed in biological research, providing an understanding of their application and result interpretation. *Prerequisite: graduate standing.*

BIOL 324 **Proteins Structure and Function** **3.0; 3 cr.**

A course that covers the structure-function relationship of proteins, both as model systems and as part of biological systems, with special attention to current issues in protein science. Biophysical approaches, structure determination, protein engineering, protein folding, advance enzymology, and biological systems with which to study proteins are included.

BIOL 328 **Plant Biochemistry** **3.0; 3 cr.**

A course that provides information in areas of biochemistry unique to plants, including that of the cell wall, photosynthesis, assimilation of mineral nutrients, natural products, and growth substances.

- BIOL 330** **Molecular Genetics** **3.0; 3 cr.**
A discussion of recent developments in molecular genetics that provides an understanding of the molecular mechanisms underlying gene regulation and tissue-specific gene expression.
- BIOL 331** **Nucleic Acid Structure and Function** **3.0; 3 cr.**
This course covers the principles by which nucleic acid structures regulate gene expression and replication, with special attention to unusual roles and applications. Antiviral drugs, RNA catalysis, mRNA UTR elements, and the origin of life are discussed.
- BIOL 332** **Advanced Cell Biology** **3.0; 3 cr.**
A discussion of recent findings in cell biology, emphasizing understanding of the research approaches used to elucidate major processes that regulate the normal function of the cell.
- BIOL 333** **Signal Transduction** **3.0; 3 cr.**
A study of the common signal transduction pathways mediating the effect of different first messengers. *Prerequisite: graduate standing.*
- BIOL 335** **Molecular Biology of Cancer** **3.0; 3 cr.**
A course that deals with the regulatory mechanisms of neoplastic cell growth and cancer cell metastasis. This course includes a discussion of recent developments in molecular genetics of the intra- and/or inter-cellular mechanisms involved in tumor formation, cellular proliferation, apoptosis, invasion, and metastasis. *Prerequisite: graduate standing.*
- BIOL 336** **Mechanisms of Development** **3.0; 3 cr.**
A course that employs an experimental analysis approach to the study of different developmental events with emphasis on cellular and molecular mechanisms.
- BIOL 341** **Advanced Microbiology** **3.0; 3 cr.**
A study of energy metabolism of various microbial groups emphasizing degradation of organic compounds under aerobic and anaerobic conditions. This course also deals with applications of microorganisms in industrial, medical, and environmental fields.
- BIOL 342** **Microbial Genetics** **3.0; 3 cr.**
A course that trains students to solve problems in bacterial genetics; develop a comprehension of bacterial genetics including the organization and activation of genes; understand and apply a genetic approach to biology's basic questions: read, understand, and critically evaluate scientific research papers published in leading international journals; identify areas that require further investigation and for which a genetic approach can be designed and pursued; design laboratory experiments in bacterial genetics; write and submit a grant proposal to seek funds for research in this area, and present up-to-date published research findings to a specialized audience.
- BIOL 350** **Advanced Reproductive Physiology** **3.0; 3 cr.**
A course that examines the comparative mechanisms of all major aspects of male and female reproductive physiology. Emphasis is given to species variation in regard to reproductive function and to detailed examination of key reproductive events in both sexes.
- BIOL 355** **Neuroimmunology** **3.0; 3 cr.**
A course that focuses on the interactions between the nervous, endocrine, and immune systems. The role of the various biologically important molecules that play an important role in the bi-directional communication between those three systems and their physiological and pharmacological actions is studied.

BIOL 362	Advanced Ecology	2.3; 3 cr.
A discussion and analysis of topics of current interest in ecology with emphasis on population and community dynamics; methods of ecological investigation and analysis; includes field work.		
BIOL 363	Population and Community Ecology	3.0; 3 cr.
A course that introduces the various models and theories of population dynamics and community structure, and their applications in assessing the complex interactions that occur in natural plant-animal systems as a result of long co-evolution, with an emphasis on chemical ecology.		
BIOL 364	Conservation and Restoration Ecology	3.0; 3 cr.
A course that introduces various concepts and applications in the field of conservation and landscape ecology. Degradation processes, principles of restoration ecology, and models of conservation biology are discussed. Part of this course concentrates on the use of remote sensing, GIS, and GPS as tools in landscape ecology.		
BIOL 390	Special Topics in Biology	1, 2, 3, or 4 cr.
<i>Prerequisites: graduate standing and consent of instructor. May be repeated for credit.</i>		
BIOL 391/392	Tutorial	2 or 3 cr.
<i>Prerequisite: graduate standing.</i>		
BIOL 393/394	Seminar	1 cr.
<i>Prerequisite: graduate standing.</i>		
BIOL 395A/395B	Comprehensive Exam	0 cr.
<i>Prerequisite: Consent of adviser.</i>		
BIOL 399	MS Thesis	9 cr.

Doctor of Philosophy in Cell and Molecular Biology

Mission Statement

The doctoral program in Cell and Molecular Biology aims to provide the best training to students for their careers as research scientists in Cell and Molecular Biology. It provides students with the opportunity to develop their capacity for scholarly and independent work, critical analytical thinking, and the ability to communicate knowledge and ideas. It is intended to produce scientists who will make significant original contributions to the biological sciences. The program exposes students to theoretical foundations and practical training in current laboratory techniques. It serves the AUB mission by providing qualified researchers for Lebanon and the region, and prepares students for careers in research, teaching, and public service.

Learning Outcomes

Students are expected to develop:

- theoretical and practical expertise in a current research area of Cell and Molecular Biology;

- skills to identify and pursue basic research questions, by initiating and successfully conducting a sustainable program of original research;
- an ability to generate and analyze data critically, and apply that ability in their own research; and
- skills necessary to communicate findings in both oral and written formats through presentations at scientific meetings and publications in peer-reviewed journals.

Admission Requirements

The PhD program is a 5 year program, with a maximum of 7 years permitted for its completion. Admission to the program will be on a competitive basis. To be eligible for admission, applicants should have a good academic record, demonstrate genuine interest in Cell and Molecular Biology research, and must:

- hold a Bachelor's (BS) or Master's (MS) degree in Biological Sciences or related fields from a recognized institution;
- present three letters of recommendation from previous tutors or employers;
- submit scores from the general Graduate Record Examination (GRE), and the subject GRE either in Biology or Biochemistry, Cell and Molecular Biology. This exam is required by both BS and MS holders. A score on a previously taken GRE will remain valid for 3 years;
- submit a score on the Test of English as a Foreign Language (TOEFL) or English Entrance Examination (EEE) that meets the university requirements (250 for computer-based TOEFL, 600 for paper based TOEFL and 550 for EEE);
- present a statement of purpose;
- be interviewed by a select group of department faculty members. The faculty members may require the student to give a seminar presentation;
- be recommended for admission by the Biology Department.

Program Completion Requirements

A minimum of 36 credit hours beyond the Bachelor's program, or 15 credit hours beyond the Master's program are required. To fulfill course requirements, 6 core courses (18 credits), in addition to elective courses are required. Beyond the Bachelor's program, each PhD candidate would register for 4 semesters of course work for an average of 9 credit hours per semester. A maximum of 21 credit hours may be transferred from the Master's work if considered within the scope of the program.

Upon admission into the program, each student will be assigned an academic adviser who will design the set of elective courses to meet the student's research interests and career goals, and will advise if undergraduate courses are needed to rectify deficiencies. 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 academic adviser will be transferred to the student's thesis adviser, who must be selected not later than the end of the first year for students entering with MS, and by the second year for students entering with BS.

The program incorporates the existing Master's program and consists of 6 core courses that address basic principles of cell and protein function, gene expression and two courses that introduce the students to basic research techniques and bio-statistics. In addition, elective courses are chosen towards the completion of the course requirements.

Core Courses

The following courses are considered as core courses and are required by all students:

BIOL 310	Quantitative Methods in Biology	3 cr.
BIOL 315	Research Methods in Biology	3 cr.
BIOL 322	Advanced Biochemistry	3 cr.
BIOL 330	Molecular Genetics	3 cr.
BIOL 332	Advanced Cell Biology	3 cr.
BIOL 334	Cellular Biophysics	3 cr.

These courses may be replaced by elective courses if the latter are already taken as part of the Master's program.

Elective Courses

Elective courses are taken to meet the credit requirements and to emphasize the student's research work and field of specialty. These courses may be chosen from the Biology Department MS course offerings, or from the courses below, or from course offerings of other departments that fall within the student's field of interest and the scope of the program.

BIOL 324	Proteins Structure and Function	3 cr.
BIOL 331	Nucleic Acid Structure and Function	3 cr.
BIOL 333	Signal Transduction	3 cr.
BIOL 335	Molecular Biology of Cancer	3 cr.
BIOL 337	Molecular Biology of Cell Death	3 cr.
BIOL 338	Cancer and Natural Products	3 cr.
BIOL 339	Membranes and Membrane Transport	3 cr.

Laboratory Rotations

During the first year of study, students must take a minimum of 5 credits as tutorial courses in different faculty research laboratories within the Biology Department or the University. The department considers exposure to different research environments an essential part of training. This requirement may be reduced to one tutorial of 3 credits for students entering with a Master's degree. At least one tutorial must be taken with faculty other than the adviser. A student cannot take more than 7 credits as tutorials including those required.

Seminars

Students are required to attend and participate in seminars and journal clubs on a regular basis. Academic credit (one credit) will be received only in the first semester. Subsequent semesters will not be credited.

Comprehensive Exam and Thesis Proposal Defense

For MS Students, upon completion of a minimum of 15 credits of coursework, the student will sit for a comprehensive exam to determine whether s/he has acquired the necessary background to successfully complete the doctoral program. The student is also expected to orally defend his/her doctoral research proposal and demonstrate the intellectual capacity to pursue and complete an appropriate doctoral research project.

Candidacy

To be admitted to candidacy students should meet the requirements set forth in the catalogue in addition to:

- completing a minimum total of 36 credit hours of course work beyond a Bachelor's degree;
- attaining an average of 85;
- passing the written comprehensive exam; and
- passing an oral defense of the doctoral research proposal.

PhD Thesis Committee

At least eight months prior to the thesis proposal defense, a doctoral thesis committee that provides general guidance and advises the student on the research project will be formed. The committee must be chaired by a full professor other than the thesis advisor. The committee will consist of at least 5 members, two of whom should be from outside the Biology Department, and at least one of the two must be from outside AUB. If the thesis supervisor is an assistant professor then the thesis committee must include a co-supervisor of associate or full professor rank. The doctoral thesis committee will evaluate the thesis proposal and the thesis research and dissertation.

PhD Dissertation and Thesis Defense

After qualifying as a PhD candidate, the student will focus on the doctoral research with continued participation in seminars. A doctoral thesis documents independent original research. The doctoral research, once completed, will be presented publicly, and defended immediately after, in front of the thesis committee. Prior to the defense, all major revisions to the thesis shall have been completed. The decision of the committee will be by consensus.

Residency Requirements

Students admitted with a BS should:

- stay in residence for one full academic year (2 consecutive semesters) as full-time students, preferably teaching in the department;
- register for a minimum of 6 semesters of full tuition; and
- complete all requirements for the PhD degree within a maximum time limit of 7 years. Extension requires approval of the Board of Graduate Studies.

Students admitted with an MS should:

- stay in residence for one full academic year (2 consecutive semesters) as full-time students, preferably teaching in the department;
- register for a minimum of 4 semesters of full tuition; and
- complete all requirements for the PhD degree within a maximum time limit of 5 years. Extension requires approval of the Board of Graduate Studies.

Graduation Requirements

The following is a list of graduation requirements:

- Completion and successful defense of a dissertation;
- Teaching experience (theory or lab) equivalent to a minimum of a 3 credit course;
- Yearly presentation, during candidacy, of research progress to the department;
- Acceptance or publication of at least two internationally refereed papers or one internationally refereed paper and one internationally refereed abstract/proceeding.

In all other respects the graduation requirements set forth in the catalogue for the PhD program will apply.

Financial Support

Teaching assistantship covering tuition fees and stipends are awarded to PhD students when available upon admission to the program. The assistantship entitles the student to a tuition waiver and to a stipend that covers 12 months per academic year at \$800 per month with an annual increase of 2% thereafter. In return, students are expected to help in teaching undergraduate labs, with presentations of introductory courses, and in proctoring and correcting exams.

Courses

- BIOL 322 Advanced Biochemistry 3.0; 3 cr.**
This course presents the relationship of biomolecular structure to function, enzyme catalysis, regulation of gene expression, and selected examples of current biochemical research.
- BIOL 324 Proteins Structure and Function 3.0; 3 cr.**
This course covers the structure-function relationship of protein, both as model systems and as part of biological systems, with special attention to current issues in protein science. Biophysical approaches, structure determination, protein engineering, protein folding, advance enzymology, and biological systems with which to study proteins will be included.
- BIOL 330 Molecular Genetics 3.0; 3 cr.**
A discussion of recent developments in molecular genetics that provides an understanding of the molecular mechanisms underlying gene regulation and tissue-specific gene expression.
- BIOL 331 Nucleic Acid Structure and Function 3.0; 3 cr.**
This course covers the principles by which nucleic acid structures regulate gene expression and replication, with special attention to unusual roles and applications. Antiviral drugs, RNA catalysis, mRNA UTR elements, and the origin of life are discussed.
- BIOL 332 Advanced Cell Biology 3.0; 3 cr.**
A discussion of recent findings in cell biology emphasizing understanding of the research approaches used to elucidate major processes that regulate the normal function of the cell.
- BIOL 333 Signal Transduction 3.0; 3 cr.**
A study of the common signal transduction pathways mediating the effect of different first messengers. *Prerequisite: graduate standing.*
- BIOL 334 Cellular Biophysics 3.0; 3 cr.**
An application of physical concepts and techniques to the study of cell structure and functions.
- BIOL 335 Molecular Biology of Cancer 3.0; 3 cr.**
A course that deals with the regulatory mechanisms of neoplastic cell growth and cancer cell metastasis. This course includes a discussion of recent developments in molecular genetics of the intra- and/or inter-cellular mechanisms involved in tumor formation, cellular proliferation, apoptosis, invasion, and metastasis. *Prerequisite: graduate standing.*
- BIOL 337 Molecular Biology of Cell Death 3.0; 3 cr.**
This course reviews recent developments regarding the signaling and regulation of the different modes of cell death and their particular relevance to multi-step carcinogenesis. It aims at providing a general understanding of the different death processes which will provide a means of manipulating the system for the activation of apoptotic and other modes of cell death in refractory cells. *Prerequisite: BIOL 335 or consent of instructor. Prerequisite: graduate standing.*
- BIOL 338 Cancer and Natural Products 3.0; 3 cr.**
This course is designed to introduce students to the numerous natural compounds that show promise in the treatment of cancer and the mechanism-based approaches to cancer treatment using these compounds. In addition, the course provides information on the research designs, protocols and assays involving natural compounds.

BIOL 339 Membranes and Membrane Transport 3.0; 3cr.

An in-depth study of membrane structure and of different biological transport mechanisms covering their kinetics and regulation. The structure and function of the most important channels, pumps and carriers are emphasized together with their importance in regulating the intracellular environment and their implication in health and disease. Common research methods for the assay of transport processes are also discussed.

BIOL 490 Preparation for Comprehensive Exam 0.0; 0cr.**BIOL 491/492 Tutorial 2 or 3cr.****BIOL 495 Preparation for Dissertation Proposal 0.0; 0cr.**

Research is conducted individually by the student leading to a dissertation proposal.

BIOL 499 PhD Dissertation

Sample Student Programs of Study

BS holder working for MS (21 cr.)		BS holder working for PhD (36 cr.)	
First semester		First semester	
BIOL 315	3 cr	BIOL 315	3 cr.
BIOL Elective	3 cr.	BIOL 330	3 cr.
BIOL Elective	3 cr.	BIOL 491/492	3 cr.
	9 cr.		9 cr.
Second semester		Second semester	
BIOL 310	3 cr.	BIOL 310	3 cr.
BIOL Elective	3 cr.	BIOL 332	3 cr.
BIOL Elective	3 cr.	BIOL 491/492A	2 cr.
		BIOL 394/393	1 cr.
	9 cr.		9 cr.
Third semester		Third semester	
BIOL 393/394	1 cr.	BIOL 334	3 cr.
BIOL 391/392A	2 cr.	BIOL 322	3 cr.
		BIOL elective	3 cr.
	3 cr.		9 cr.
		Fourth semester	
		BIOL elective	3 cr.
		BIOL elective	3 cr.
		BIOL elective	3 cr.
			9 cr.

**MS holder working
for PhD (15 cr.)****First semester**

BIOL 330	3 cr.
BIOL 322	3 cr.
BIOL 334	3 cr.
	9 cr.

Second semester

BIOL 332	3 cr.
BIOL 491/492	3 cr.
	6 cr.
