Department of Biology

Chairperson: Knio, Khuzama M.
Professors: Baydoun, Elias H.; 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.; Jaalouk, Diana E.; Kambris, Zakaria S.; Osta, Mike A.; Sadek, Riyad A.; zu Dohna, Heinrich
Lecturers: Rizkallah, Hind D.; Sinno-Saoud, Nada; Tarraf, Charbel G.
Instructor: Hajjar, Layane A.M.

MS in Biology

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 Master's students: BIOL 310 (3 cr.), BIOL 315 (3 cr.), and BIOL 393 (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.

PhD 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.

Admission Requirements

The PhD program is a five year program. 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). This exam is required by both BS and MS holders;
• meet “English Language Proficiency Requirements”, see page 37;
• 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 Requirements

A minimum of 36 credit hours of course work beyond the Bachelor’s program, or 18 credit hours of course work beyond the Master’s program are required. To fulfill course requirements, six required core courses (18 credits), in addition to elective courses are offered. Beyond the Bachelor’s program, each PhD candidate would register for four semesters of course work for an average of nine 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 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:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 310</td>
<td>Quantitative Methods in Biology</td>
<td>3 cr.</td>
</tr>
<tr>
<td>BIOL 315</td>
<td>Research Methods in Biology</td>
<td>3 cr.</td>
</tr>
<tr>
<td>BIOL 322</td>
<td>Advanced Biochemistry</td>
<td>3 cr.</td>
</tr>
<tr>
<td>BIOL 330</td>
<td>Molecular Genetics</td>
<td>3 cr.</td>
</tr>
<tr>
<td>BIOL 332</td>
<td>Advanced Cell Biology</td>
<td>3 cr.</td>
</tr>
<tr>
<td>BIOL 334</td>
<td>Cellular Biophysics</td>
<td>3 cr.</td>
</tr>
<tr>
<td>BIOL 491</td>
<td>CMBL Tutorial (students joining with an MS are exempted)</td>
<td>2 or 3 cr.</td>
</tr>
<tr>
<td>BIOL 493</td>
<td>CMBL Seminar</td>
<td>1 cr.</td>
</tr>
<tr>
<td>BIOL 494</td>
<td>CMBL Laboratory Rotation</td>
<td>3 cr.</td>
</tr>
</tbody>
</table>

If these courses have already been taken as part of the Master’s program, they may be replaced by others with departmental approval.
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 course offerings of other departments that fall within the student's field of interest and the scope of the program.

Laboratory Rotations

During the first year of study, students must take the laboratory rotation course (BIOL 494), conducting research in two different faculty laboratories within the Biology Department or the University. The department considers exposure to different research environments an essential part of training. Students entering with only a BS must also register for an additional 2 or 3 credit laboratory tutorial in their first year.

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.

PhD Thesis Committee

The thesis committee should be composed of at least five members, one of whom should be from outside the department/program and one from outside the university. The thesis adviser and at least three of the thesis committee members must be of professorial rank. All members of the thesis committee must hold a doctoral degree in a relevant field. The chair of the thesis committee must be a full professor who is not the PhD thesis adviser (requirement of the Lebanese Ministry of Higher Education).

Members of the doctoral thesis committee are recommended by the student's thesis adviser and approved by the department, the Faculty Graduate Studies Committee, and the Graduate Council. The doctoral thesis committee approves the thesis topic, research plan, conducts the thesis proposal defense (Part II of the Qualifying Exam) and conducts the thesis defense. The thesis proposal and the selection of the thesis committee should be approved at least two semesters before the student defends his/her thesis. The PhD thesis topic, examining committee, and admission to candidacy require Graduate Council approval.

PhD Qualification Exams Part I and Part II

For MS Students, upon completion of a minimum of 30 credits of coursework, the student will sit for a comprehensive exam (PhD Qualification Exam Part I) to determine whether the student has acquired the necessary background to successfully complete the doctoral program. The student is also expected to orally defend (PhD Qualification Exam Part II) the doctoral research proposal and demonstrate the intellectual capacity to pursue and complete an appropriate doctoral research project.
Candidacy and Residency
Refer to General University Academic Information, Requirements for the Degree of Doctor of Philosophy, section that has clearly defined candidacy and residency requirements.

PhD Thesis 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.

Residence Requirements
For Residence Requirements, see Residence Requirements, page 37.

Graduation Requirements
The following is a list of graduation requirements:

• Completion and successful defense of a thesis;
• Teaching experience (theory or lab) equivalent to a minimum of a three 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 or proceeding.

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

Financial Support
The department offers, on a selective basis, substantial support which fully covers tuition and includes a monthly stipend. There are also some funds available to support participation in international conferences; these funds are awarded on a competitive basis. In return, students are expected to help in teaching undergraduate labs, with presentations of introductory courses, and in proctoring and correcting exams.

Course Descriptions

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 322  Advanced Biochemistry 3.0; 3 cr.
This course presents the relationship of biomolecular structure to function, enzyme catalysis, regulation, and selected examples of current biochemical research.

BIOL 324  Protein 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 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 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 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. Prerequisites: BIOL 335 or consent of instructor and 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 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.
Prerequisites: graduate standing and consent of instructor. May be repeated for credit.

BIOL 391  Tutorial  2 or 3 cr.
Prerequisite: graduate standing.

BIOL 393  Seminar  1 cr.
This course trains students how to present research findings. Prerequisite: graduate standing.

BIOL 395A/395B  Comprehensive Exam  0 cr.
Prerequisite: Consent of adviser.

BIOL 399  MS Thesis  9 cr.

BIOL 480  Qualifying Exam Part I: Comprehensive Exam  0 cr.
Every Semester

BIOL 481  Qualifying Exam Part II: Defense of Thesis Proposal  0 cr.
Every Semester

BIOL 482* PhD Thesis  24 cr.
Every Semester. Taken at first thesis registration, then registered for every subsequent semester with sequential letter annotations (a-l; 0 credits) until completion of thesis work.

BIOL 483* PhD Thesis  27 cr.
Every Semester. Taken at first thesis registration, then registered for every subsequent semester with sequential letter annotations (a-l; 0 credits) until completion of thesis work.

BIOL 484* PhD Thesis  30 cr.
Every Semester. Taken at first thesis registration, then registered for every subsequent semester with sequential letter annotations (a-l; 0 credits) until completion of thesis work.

BIOL 491  Tutorial  2 or 3 cr.

BIOL 493  CMBL Seminar  1 cr.
Students enrolled in the CMBL program present research findings. Prerequisite: Enrollment in CMBL program. Academic credit will be received only in the first semester, subsequent semesters will be recorded but not credited.

BIOL 494  CMBL Laboratory Rotation  3 cr.
Students taking this course will be conducting a small research project in any area pertinent to the field of Cell and Molecular Biology. The research has to be conducted in two different laboratories under the supervision of a faculty member from the Biology Department. The supervisor should ensure that the student receives the necessary training in safety and technical issues required for the successful progress of the project and that the work involved meets the ethical criteria set by AUB Human Research Protection Program and Institutional Animal Care and Use Committee (IACUC).

* The choice to register for BIOL 482, 483, or 484 should be done in consultation with thesis advisor to ensure that total number of PhD thesis credits and PhD course credits are met as per AUB rules and regulations.
### Sample Student Programs of Study

<table>
<thead>
<tr>
<th>BS holder working for MS (21 cr.)</th>
<th>BS holder working for PhD (36 cr.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First semester</strong></td>
<td><strong>First semester</strong></td>
</tr>
<tr>
<td>BIOL 315</td>
<td>3 cr.</td>
</tr>
<tr>
<td>BIOL Elective</td>
<td>3 cr.</td>
</tr>
<tr>
<td>BIOL 393</td>
<td>1 cr.</td>
</tr>
<tr>
<td>BIOL 391A.</td>
<td>2 cr.</td>
</tr>
<tr>
<td><strong>Second semester</strong></td>
<td><strong>Second semester</strong></td>
</tr>
<tr>
<td>BIOL 310</td>
<td>3 cr.</td>
</tr>
<tr>
<td>BIOL Elective</td>
<td>3 cr.</td>
</tr>
<tr>
<td>BIOL Elective</td>
<td>3 cr.</td>
</tr>
<tr>
<td>BIOL Elective</td>
<td>2 cr.</td>
</tr>
<tr>
<td>BIOL 493</td>
<td>1 cr.</td>
</tr>
<tr>
<td>BIOL 493</td>
<td>0 cr.</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>Total</strong></td>
</tr>
<tr>
<td>9 cr.</td>
<td>9 cr.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Third semester</th>
<th>Third semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL Elective</td>
<td>3 cr.</td>
</tr>
<tr>
<td>BIOL Elective</td>
<td>3 cr.</td>
</tr>
<tr>
<td>BIOL electives</td>
<td>3 cr.</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>Total</strong></td>
</tr>
<tr>
<td>3 cr.</td>
<td>9 cr.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fourth semester</th>
<th>Fourth semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL electives</td>
<td>3 cr.</td>
</tr>
<tr>
<td>BIOL electives</td>
<td>3 cr.</td>
</tr>
<tr>
<td>BIOL electives</td>
<td>3 cr.</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>Total</strong></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>Total</strong></td>
</tr>
<tr>
<td>9 cr.</td>
<td>9 cr.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MS holder working for PhD (18 cr.)</th>
<th>MS holder working for PhD (18 cr.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First semester</strong></td>
<td><strong>First semester</strong></td>
</tr>
<tr>
<td>BIOL 330</td>
<td>3 cr.</td>
</tr>
<tr>
<td>BIOL 322</td>
<td>3 cr.</td>
</tr>
<tr>
<td>BIOL 494</td>
<td>3 cr.</td>
</tr>
<tr>
<td><strong>Second semester</strong></td>
<td><strong>Second semester</strong></td>
</tr>
<tr>
<td>BIOL 332</td>
<td>3 cr.</td>
</tr>
<tr>
<td>BIOL 334</td>
<td>3 cr.</td>
</tr>
<tr>
<td>BIOL 493 or ELECTIVE</td>
<td>1 or 3 cr.</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>Total</strong></td>
</tr>
<tr>
<td>7 or 9 cr.</td>
<td>9 cr.</td>
</tr>
</tbody>
</table>