

Department of Biology

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| Chairperson: | Knio, Khouzama M. |
| Professors: | Bariche, Michel J.; Baydoun, Elias H.; Gali-Muhtasib, Hala U.; Knio, Khouzama M.; Kreydiyyeh, Sawsan I.; Saoud, Imad P.; Smith, Colin A.; Talhouk, Rabih S. |
| Associate Professors: | Ghanem, Noel D.; Jaalouk, Diana E.; Kambris, Zakaria S.; Osta, Mike A. |
| Assistant Professors: | Dohna, Heinrich; Sadek, Riyadh A. |
| Lecturers: | Rizkallah, Hind D.; Sinno-Saoud, Nada |
| Instructors: | Hajjar, Layane A.M.; Al-Zein, Mohammad S. |
| Adjunct Faculty: | Parker, Bruce; Skinner, Margaret |

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 9-credit 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 3.2 (or 80) or above can register in biology graduate courses with the consent of the 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 Lebanon and the region with qualified researchers and preparing 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 of both BS and MS holders,
- meet Readiness for University Studies in English (RUSE),
- present a statement of purpose,
- be interviewed by a select group of department faculty members (who may require the student to give a seminar presentation),
- and be recommended for admission by the Biology Department.

Program Requirements

The program requirements for BS holders consist of a minimum of 36 credit hours of graduate level coursework and a minimum of 42 credit hours of thesis work. The requirements for MS holders are a minimum of 18 credit hours of graduate level coursework in addition to 30 credit hours of thesis work.

Upon admission into the program, each student will be assisted by the department head who will act as an academic advisor and help the student in the selection of courses. Each student's course of study is designed individually in light of her/his interests and career goals. All duties of the head are transferred to the thesis advisor once selected.

The program incorporates the existing master's program and consists of core courses that address basic principles of cell and protein function, gene expression, bioinformatics and biostatistics.

Required Core Courses

All students are required to take the following six core courses and the seminar (plus tutorial if applicable):

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|-----------------|---------------------------------------------------------------|-------------------|
| BIOL 310 | Biostatistics | 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 370 | Bioinformatics | 3 cr. |
| BIOL 491 | CMBL Tutorial (required only by students holding a BS) | 2 or 3 cr. |
| BIOL 493 | CMBL Seminar | 1 cr. |

If these courses have already been taken as part of the master's program, they may be replaced by others upon departmental approval to complete the 18-credit requirement.

Elective Courses

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

Laboratory Rotations

During the first year of study, students may 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 every term. Academic credit (1 credit) will be received only once during the first year. Subsequent terms will not be credited. *Graded: Pass/No Pass (or Fail)*.

PhD Thesis Committee

Refer to PhD Thesis Committee (page 72).

PhD Qualification Exams Part I and Part II

Refer to PhD Qualification Exam (page 70).

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

Refer to PhD Thesis Format and PhD Thesis Defense under General University Academic Information (page 73-74).

Residence Requirements

For Residence Requirements, refer to Residence Requirements (page 62).

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 3-credit course at minimum
- 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** **Biostatistics** **2.3; 3 cr.**
 This course covers methods of statistical analysis of research data in a wide range of biological fields. It starts from elementary concepts and descriptive statistics to concentrate on hypothesis-testing for one, two and several samples including non-parametric methods. It covers correlation, regression and curve-fitting as well as goodness-of-fit tests applied to various distributions. Appropriate computer applications are used for all statistical analysis procedures. *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 328** **Plant Biochemistry** **3.0; 3 cr.**
 A course that provides information in areas of biochemistry unique to plants, including 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 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 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 this treatment using these compounds. In addition, the course provides information on the research designs, protocols and assays involving natural compounds.
- 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 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, and 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 370 Bioinformatics 2.3; 3 cr.**
A project-based course that teaches computer and statistics skills to handle biological data efficiently and creatively. Projects can involve the analysis of any type of biological data, such as image data, survival data, microarray data, sequence data, next-generation sequencing data, etc. Students can either analyze data from their own work or recapitulate parts of a published analysis. During the course, each student writes analysis scripts in R that automatize an entire workflow from data pre-processing to analysis, output of results and plotting.
- 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.**
Every term. Prerequisites: Graduate standing and consent of instructor. Cannot be repeated for credit. Graded: Pass/No Pass (or Fail).

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| BIOL 393 | Seminar | 1 cr. |
| <i>This course trains students on how to present research findings. Prerequisite: Graduate standing.</i> | | |
| BIOL 395A/ B | Comprehensive Exam | 0 cr. |
| <i>Prerequisite: Consent of advisor.</i> | | |
| BIOL 399 MS | Thesis | 9 cr. |
| BIOL 480 | Qualifying Exam Part I: Comprehensive Exam | 0 cr. |
| <i>Every term. Prerequisite: Completion of a minimum of 18 credit hours of coursework.</i> | | |
| BIOL 481 | Qualifying Exam Part II: Defense of Thesis Proposal | 0 cr. |
| <i>Every term. Pre- or corequisite: BIOL 480.</i> | | |
| BIOL 484¹ | PhD Thesis | 30 cr. |
| <i>Every term. To be taken only by regular track PhD students. Taken at first thesis registration, then registered for every subsequent term with sequential letter annotations (A-L ; 0 credits) until completion of thesis work.</i> | | |
| BIOL 488¹ | PhD Thesis | 42 cr. |
| <i>Every term. To be taken only by accelerated track PhD students. Taken at first thesis registration, then registered for every subsequent term with sequential letter annotations (A-L; 0 credits) until completion of thesis work.</i> | | |
| BIOL 491 | Tutorial | 2 or 3 cr. |
| <i>Every term. Prerequisite: Consent of instructor. Students with an MS are exempted. Cannot be repeated for credit. Graded: Pass/No Pass (or Fail).</i> | | |
| BIOL 493/493A | CMBL Seminar | 1 cr./0 cr. |
| <i>Students enrolled in the CMBL program present research findings. Prerequisite: Enrollment in CMBL program. Academic credit will be received only once during the first year; subsequent terms will be recorded but not credited. Graded: Pass/No Pass (or Fail).</i> | | |
| BIOL 494 | CMBL Laboratory Rotation | 3 cr. |
| <i>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). Graded: Pass/No Pass (or Fail).</i> | | |

1) The choice to register for BIOL 484 or BIOL 488 should be done in consultation with the thesis advisor to ensure that the total number of PhD thesis credits and PhD course credits are met as per AUB rules and regulations.

Sample Student Programs of Study

| BS holder working for MS (21 cr.) | | BS holder working for PhD (36 cr.) | |
|------------------------------------------|--------------|-------------------------------------------|--------------|
| First term | | First term | |
| BIOL 315 | 3 cr. | BIOL 315 | 3 cr. |
| BIOL elective | 3 cr. | BIOL 330 | 3 cr. |
| BIOL 393 | 1 cr. | BIOL 494 | 3 cr. |
| BIOL 391A | 2 cr. | BIOL 493A | 0 cr. |
| | 9 cr. | | 9 cr. |
| Second term | | Second term | |
| BIOL 310 | 3 cr. | BIOL 310 | 3 cr. |
| BIOL elective | 3 cr. | BIOL 332 | 3 cr. |
| BIOL elective | 3 cr. | BIOL 491 | 2 cr. |
| | | BIOL 493 | 1 cr. |
| | 9 cr. | | 9 cr. |
| Third term | | Third term | |
| BIOL elective | 3 cr. | BIOL 370 | 3 cr. |
| | | BIOL 322 | 3 cr. |
| | | BIOL elective | 3 cr. |
| | | BIOL 493A | 0 cr. |
| | 3 cr. | | 9 cr. |
| Fourth term | | Fourth term | |
| | | BIOL elective | 3 cr. |
| | | BIOL elective | 3 cr. |
| | | BIOL elective | 3 cr. |
| | | BIOL 493A | 0 cr. |
| | | | 9 cr. |

| AUB MS holder working for PhD (18 cr.) | | Non-AUB MS holder working for PhD (22 cr.) | |
|-----------------------------------------------|--------------------|---------------------------------------------------|--------------|
| First term | | First term | |
| BIOL 330 | 3 cr. | BIOL 310 | 3 cr. |
| BIOL 332 | 3 cr. | BIOL 493 | 1 cr. |
| BIOL 494 | 3 cr. | BIOL 494 | 3 cr. |
| BIOL 493A | 0 cr. | | |
| | 9 cr. | | 7 cr. |
| Second term | | Second term | |
| BIOL 322 | 3 cr. | BIOL 315 | 3 cr. |
| BIOL 370 | 3 cr. | BIOL 322 | 3 cr. |
| BIOL 493 | 1 cr. | BIOL 370 | 3 cr. |
| Elective | 2 or 3 cr. | BIOL 493A | 0 cr. |
| | 9 or 10 cr. | | 9 cr. |
| Third term | | Third term | |
| | | BIOL 330 | 3 cr. |
| | | BIOL 332 | 3 cr. |
| | | BIOL 493A | 0 cr. |
| | | | 6 cr. |