Molecular Genetics — M.S., Ph.D.

Program coordinator
Hansel M. Fletcher

The School of Medicine’s Division of Microbiology and Molecular Genetics offers curricula leading to the Master of Science and Doctor of Philosophy degrees. The core curriculum provides a broad background in molecular biology, immunology, and medical microbiology and infectious diseases. Advanced courses allow each student to develop fully an area of interest. Research strengths of the department include: signal transduction in bacteria, molecular genetics of virulence in bacteria, mechanisms of oxidative stress resistance, mechanisms of cell death, cellular and tumor immunology, autoimmunity, chaperonins and protein folding, mechanisms of posttranslational modification, cancer biology, and DNA restriction modification.

The thesis or research Master of Science degree provides training for individuals who will become technicians involved in biomedical research in universities or in the biotechnology industry, and for medical technologists seeking specialized research training. The nonthesis Master of Science degree provides content appropriate for medical technologists preparing for the specialist in microbiology certification; for secondary teachers seeking advanced training in areas such as molecular biology, immunology, or microbiology; and for students seeking admission to a professional school, such as medicine or dentistry.

The Doctor of Philosophy degree is designed to prepare students for a career in independent research and teaching in a university, clinical, or biotechnology environment. Doctoral degree students are expected to develop creativity and independence in addition to technical skills.

Program student learning outcomes
1. Students will demonstrate a broad knowledge of the biomedical sciences.
2. Students will demonstrate subject mastery in molecular, cellular, and integrative aspects of microbiology and molecular genetics.
3. Students will interpret the current literature in microbiology and molecular genetics.
4. Students will make original contributions to the body of biomedical knowledge.
5. Students will demonstrate an understanding of the principles of scientific and professional ethics.
6. Students will understand the process of applying for external funding.*

* This objective is not applicable to M.S. degree students.

Admissions
In addition to Loma Linda University (http://llucatalog.llu.edu/about-university/admission-policies-information/#admissionrequirementstext) application requirements, the applicant must also complete the following prerequisites:

- a bachelor’s degree from an accredited U.S. college or the equivalent from an international university.
- general test of the Graduate Record Examination (GRE): A total (verbal plus quantitative) score of no less than the sum of the scores corresponding to the 50th percentile of each, with neither score less than the 35th percentile; analytical writing 4.0. GRE scores older than 5 years from the date of matriculation are not considered.
- a full year of each of the following undergraduate courses:
  - general biology
  - general chemistry
  - organic chemistry
  - general physics.
  - biochemistry (a minimum of one quarter/semester)

Strongly Recommended:
- upper division biology (such as cell and molecular biology)
- a full year of biochemistry with labs
- research experience
- calculus

PLEASE NOTE: CLEP (College-Level Examination Program), pass/fail performances, and online classes are not acceptable for the science required courses. Additionally, science credits earned in professional schools (e.g., allied health professions, business, dentistry, nursing or pharmacy) do not fulfill requirements for admissions to the graduate program.

The program reserves the right to decide on the equivalence of courses presented by the applicant.

M.S. requirements
A minimum of 45 units is required for the M.S. degree, as detailed in the table below. Two options, a research track and a course work track, are available. Students must maintain a G.P.A. of at least 3.0. Students must adhere to all University and program policies as published in the Student Handbook, University CATALOG, or "Student Guide." Policies and requirements are subject to change.

<table>
<thead>
<tr>
<th>Basic science core</th>
<th>IBGS 501 Biomedical Communication and Integrity</th>
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<tr>
<td></td>
<td>IBGS 502 Biomedical Information and Statistics</td>
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<tr>
<td></td>
<td>IBGS 511 Cellular Mechanisms and Integrated Systems I</td>
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<td>IBGS 512 Cellular Mechanisms and Integrated Systems II</td>
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<td>IBGS 522 Cellular Mechanisms and Integrated Systems Journal Club</td>
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<td>IBGS 523 Cellular Mechanisms and Integrated Systems II Journal Club</td>
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<tr>
<th>Major</th>
<th>Microbiology specific courses</th>
<th>12</th>
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| Seminars | IBGS 607 Integrated Biomedical Graduate Studies Seminar | 0 |
| Religion | RELE 525 Ethics for Scientists | 3 |

Degree completion options
- Coursework track:
  - MICR__ Graduate Microbiology Elective (9 units)
**Research track:**
- **IBGS 604** Introduction to Integrative Biology Presentation Seminar (1 unit)
- **IBGS 605** Integrative Biology Presentation Seminar (1 unit)
- **MICR 697** Research (9 units)

Total Units | 45

1 Registration and attendance required every quarter in residence, but units do not count toward total required for graduation
2 May substitute with another religion course at the 500-level or greater.

**Noncourse requirements**

Course work track: a comprehensive written examination over the graduate course work in lieu of preparing a thesis.

Research track: pass an oral examination given by his/her graduate guidance committee after the thesis has been completed.

**Normal time to complete the program**
2 years — based on full-time enrollment; part-time permitted

**Comparison**
See the comparison (http://llucatalog.llu.edu/medicine/microbiology-molecular-genetics/comparison) of the M.S. Course work, M.S. Research and Ph.D. tracks of this program.

**Ph.D. requirements**
For the Ph.D. degree, students must complete a minimum of 75 units— as detailed in the table below—and must maintain a G.P.A. of at least 3.0. Students must adhere to all University and program policies as published in the Student Handbook, University CATALOG, or "Student Guide." Policies and requirements are subject to change.

**Basic science core**
- **IBGS 501** Biomedical Communication and Integrity | 2
- **IBGS 502** Biomedical Information and Statistics | 2
- **IBGS 503** Biomedical Grant Writing | 2
- **IBGS 511** Cellular Mechanisms and Integrated Systems I | 6
- **IBGS 512** Cellular Mechanisms and Integrated Systems II | 6
- **IBGS 522** Cellular Mechanisms and Integrated Systems II Journal Club | 2
- **IBGS 523** Cellular Mechanisms and Integrated Systems III Journal Club | 2

**Major**
Choose from the following: | 12
- **MICR 521** Medical Microbiology
- **MICR 530** Immunology
- **MICR 537** Selected Topics in Molecular Biology
- **MICR 540** Physiology and Molecular Genetics of Microbes
- **MICR 570** Mechanisms of Microbial Pathogenesis

**Seminars**
- **IBGS 604** Introduction to Integrative Biology Presentation Seminar | 1
- **IBGS 605** Integrative Biology Presentation Seminar | 2
- **IBGS 607** Integrated Biomedical Graduate Studies Seminar | 0

**Religion**
- **RELE 525** Ethics for Scientists | 4
- **REL R 588** Personal and Family Wholeness | 4
- **RELT 617** Seminar in Religion and the Sciences | 4

**Research/Dissertation or Thesis**
- **IBGS 696** Research Rotations | 2
- **MICR 697** Research (1.0-7.0) | 12

Total Units | 60

1 Must include at least 6 units in a didactic, literature-based course
2 Registration and attendance required every quarter in residence, but units do not count toward total required for graduation
3 Multiple registrations required to fulfill total units required.
4 May substitute with another graduate religion course with the same prefix and numbered 500 or above.

**Noncourse requirements**
- pass both written and oral comprehensive examinations in order to advance to candidacy.
- successfully defend the dissertation before their guidance committee prior to being awarded the Ph.D. degree.

**Normal time to complete the program**
4 years — based on full-time enrollment; part-time permitted

**Comparison**
See the comparison (http://llucatalog.llu.edu/medicine/microbiology-molecular-genetics/comparison) of the M.S. Course work, M.S. Research and Ph.D. tracks of this program.

**Courses**
- **MICR 515. Introduction to Bioinformatics and Genomics.** 2 Units.
  Introduces computer-aided analysis of macromolecules and the study of genes and their products on the level of whole genomes.
- **MICR 521. Medical Microbiology.** 8 Units.
  Systematically studies bacteria, fungi, viruses, and animal parasites of medical importance; pathogenic mechanisms; methods of identification and prevention; and clinical correlation.
- **MICR 530. Immunology.** 4 Units.
  Introduces selected topics of modern immunology to graduate students, emphasizing understanding key paradigms.
- **MICR 537. Selected Topics in Molecular Biology.** 1-3 Units.
  Critically evaluates current progress in a specific research area of molecular biology, including recently published papers and unpublished manuscripts. May be repeated for additional credit. Prerequisite: MICR 539, CMBL 502.
- **MICR 540. Physiology and Molecular Genetics of Microbes.** 3 Units.
  Advanced graduate course covering various hot topics in both microbial physiology and molecular genetics—such as diversity of microbes on earth, engineering new metabolic pathways, mechanisms of gene regulation and gene transfer, and comparative genomics.
MICR 547. Medical Microbiology. 4.5 Units.
Supports the organ system curriculum in the sophomore year. Covers
the basic biology of microbial pathogens and the mechanism of their
disease pathologies. Teaches students the signs and symptoms of
major infectious diseases and provides practice in developing differential
diagnoses and fundamentals for treatment and prevention of these
diseases. Discusses relevant, medically important microbial pathogens
in the context of organ system(s) affected by these agents. Utilizes
lectures, laboratory exercises, team-based learning, and interactive
learning sessions to teach the major infectious causes of disease,
detail their morphology and their identification, explain their pathogenic
mechanisms, and highlight their disease manifestations.

MICR 570. Mechanisms of Microbial Pathogenesis. 3 Units.
In-depth exploration of molecular mechanisms of pathogenesis and host
response for selected bacteria, viruses, and parasites. Topics include
endotoxins, exotoxins, tools to identify genes crucial to virulence, and a
discussion of selected paradigms of microbe-host interaction. Vaccine
development serves as a unifying theme linking the host-pathogen
interactions. Focuses on evidence for current concepts, using primary
journal articles.

MICR 605. Colloquium. 1 Unit.
Presentations by peers on a topic selected and directed by a faculty
member. (All students required to attend the colloquium. Students
registered for colloquium are required to give a presentation.).

MICR 606. Graduate Seminar. 1 Unit.
Student presentation in the form of a seminar. (Course requirement
normally fulfilled by presentation of the dissertation or thesis seminar.
Other major student presentations may also qualify.).

MICR 624. Special Problems in Microbiology. 2-4 Units.
Designed primarily for students enrolled in a course work M.S. degree
program who elect to work on a research problem.

MICR 625. Independent Study in Microbiology Literature. 2-4 Units.
Explores in depth a specific topic, selected in consultation with the
mentor, such as the antecedents for theses or dissertation research.
(Formal proposal for the scope and evaluation of the independent study
must be approved by the faculty prior to enrollment in this course. Does
not satisfy an elective requirement in the microbiology and molecular
genetics program.).

MICR 626. Special Topics in Microbiology. 2-4 Units.
Critically evaluates current progress in a specific research area, including
recently published papers and unpublished manuscripts. (Each course
taught by a resident or a visiting scientist who is a recognized authority
in the research area under discussion. Students may register for multiple
courses under this designation.).

MICR 697. Research. 1-7 Units.

MICR 698. Thesis. 1-3 Units.

MICR 699. Dissertation. 2-5 Units.

MICR 891. Microbiology Elective. 1.5-12 Units.
Offers fourth-year medical students the opportunity to explore various
areas of microbiology, including research.