Cancer, Developmental and Regenerative Biology — M.S., Ph.D.

Co-program directors
Mary Kearns-Jonker
Julia Unternaehrer-Hamm

The School of Medicine offers basic sciences curricula leading to the Master of Science and Doctor of Philosophy degrees. The core curriculum provides a broad background in molecular biology, cell biology, and biochemistry. Advanced courses allow each student to fully develop an area of interest.

Research strengths of the program include: cancer biology (prostate, breast, thyroid, ovarian, cervical, pancreatic, and leukemia), molecular mechanisms controlling normal development and regeneration, stem cell-based cardiovascular repair, oxidative stress in mechanism of anticancer agents, stem cell delivery of gene therapy for regenerative medicine, neuronal injury and axonal regeneration, transcriptional regulation, normal and malignant immune cell development and function, nanoparticles for therapeutic applications, cellular and molecular mechanisms of cardiovascular diseases and aging, plasticity and interconnection between normal and cancer stem cells, miRNA regulation in ovarian cancer and early development, epigenomic/transcriptomic reprogramming and longevity, calcium signaling during lung development, developmental programming of health and disease, stem cell reprogramming, and genome editing.

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. The non-thesis Master of Science degree provides content appropriate for secondary teachers in universities or in the biotechnology industry. 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. The non-thesis Master of Science degree provides content appropriate for secondary teachers in universities or in the biotechnology industry.

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 coursework 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>Program specific courses</th>
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<tbody>
<tr>
<td>IBGS 501 Biomedical Communication and Integrity 2</td>
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<tr>
<td>IBGS 502 Biomedical Information and Statistics 2</td>
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<tr>
<td>IBGS 511 Cellular Mechanisms and Integrated Systems I 6</td>
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<td>IBGS 512 Cellular Mechanisms and Integrated Systems II 6</td>
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<tr>
<td>IBGS 522 Cellular Mechanisms and Integrated Systems Journal Club 2</td>
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<tr>
<th>Seminars (all required)</th>
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<tbody>
<tr>
<td>IBGS 604 Introduction to Integrative Biology Presentation Seminar 1</td>
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<tr>
<th>Religion</th>
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<tr>
<td>REL, ____ Graduate-level religion course (RELE, RELR, or RELT) 3</td>
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<tr>
<th>Program completion options</th>
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<tr>
<td>Choose from the following:</td>
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<tr>
<td>ANAT 507 Stem Cell Biology and Medicine</td>
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<td>ANAT 544 Human Embryology Lecture</td>
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<td>BCHM 544 Advanced Topics in Biochemistry</td>
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<td>BCHM 605 Seminar in Stem Cells and Cancer</td>
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<td>or BCHM 61 Cancer Journal Club</td>
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<td>CRBB 555 Biology of Cancer</td>
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<tr>
<td>Electives (8 units)</td>
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<tr>
<td>Research track:</td>
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<tr>
<td>BCHM 697 Research</td>
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<td>IBGS 698 Thesis (1-3 units)</td>
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<td>Elective (0-2 units)</td>
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<th>Total Units</th>
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Available Electives
- ANAT 548 Introductory Flow Cytometry 1
- BCHM 530 Biochemical Basis of Human Disease SM 2
- IBGS 525 Translational Research Training 2
- MDCJ 520 Basis of Medical Genetics 2
- MDCJ 560 Basis of Medical Genetics 2
- MICR 515 Introduction to Bioinformatics and Genomics 2
- MICR 530 Basic Immunology 4
- MICR 537 Selected Topics in Molecular Biology 1-3
- PHSL 541 Cell and Molecular Biology 4
- PHSL 587 Physiology of Reproduction 2

Program learning outcomes
By the end of this program, the graduate should be able to:

1. Demonstrate a broad knowledge of the biomedical sciences.
2. Demonstrate subject mastery in cancer, developmental, or regenerative biology.
3. Interpret the current literature in the field.
4. Design hypothesis-driven studies to address key questions in the field.
5. Make original contributions to the body of biomedical knowledge.
6. Demonstrate the principles of scientific and professional ethics.
7. Write effective scientific publications and grant proposals.

*This outcome is not applicable to M.S. degree students.
Registration and attendance required every quarter in residence, but units do not count toward total required for graduation.

Service learning requirement
This requirement may be met by taking IBGS 525 Translational Research Training or a religion course designated as a service learning course. For more information about this requirement and a list of religion courses that fulfill it, see section on academic service learning (http://llucatalog.llu.edu/about-university/academic-policies-information/degree-completion-requirements/) in this CATALOG.

Noncourse requirements
Coursework track: a comprehensive written examination over the graduate coursework in lieu of preparing a thesis.

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

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

Comparison
See the comparison (http://llucatalog.llu.edu/medicine/cancer-dev-and-regen-biology/comparison/) of the M.S. and Ph.D. degree programs.

Ph.D. requirements
For the Ph.D. degree, students must complete a minimum of 61 units— as detailed in the table below— and must maintain a GPA 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

Seminars (all required)
IBGS 604 Introduction to Integrative Biology Presentation Seminar 1
IBGS 605 Integrative Biology Presentation Seminar (1) 2
IBGS 607 Integrated Biomedical Graduate Studies Seminar 1

Religion
RELE 5__ Must be numbered 500 or above 3
RELR 5__ Must be numbered 500 or above 3
RELT 5__ Must be numbered 500 or above 3

Program specific courses
BCHM 610 Cancer Journal Club 1

Emphasis: Developmental/regenerative biology
ANAT 507 Stem Cell Biology and Medicine
ANAT 544 Human Embryology Lecture

Electives: 6-12
Choose from the following and other courses as approved by advisor:
BCHM 530 Biochemical Basis of Human Disease SM
CDRB 550 Clinical Exposure in Oncology
IBGS 525 Translational Research Training
IBGS 537A Special Topics in Biomedical Sciences
MDCJ 560 Basis of Medical Genetics
MICR 515 Introduction to Bioinformatics and Genomics
MICR 530 Basic Immunology
NSBB 506 Fundamentals of Electrophysiology
PHSL 541 Cell and Molecular Biology
PHSL 587 Physiology of Reproduction

Research and dissertation
BCHM 697 Research (1-10) 12
IBGS 696 Research Rotations (1) 2
IBGS 699 Dissertation (1-5) 1-5

Total Units 62

Registration and attendance required every quarter in residence, but units do not count toward total required for graduation.

Service learning requirement
This requirement may be met by taking IBGS 525 Translational Research Training or a religion course designated as a service learning course. For more information about this requirement and a list of religion courses that fulfill it, see section on academic service learning (http://llucatalog.llu.edu/about-university/academic-policies-information/degree-completion-requirements/) in this CATALOG.

Noncourse requirements
• Pass 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
Four (4) years — full-time enrollment; part time permitted

Comparison
See the comparison (http://llucatalog.llu.edu/medicine/cancer-dev-and-regen-biology/comparison/) of the M.S. and Ph.D. degree programs.