School of Natural Sciences and Mathematics

Department of Biological Sciences

Department Objectives

The Graduate Program offers training in those aspects of molecular and cell biology that underpin modern biological and biomedical sciences.

The Master of Science degree in Molecular and Cell Biology is designed for students who wish to learn the methodology of research in molecular and cell biology and the fundamentals of problem solving in these areas.

The Master of Science degree in Molecular and Cell Biology (without thesis) is intended for students who seek to gain knowledge of modern biology without the intent to seek positions as technical laboratory personnel, and for those students who are seeking additional preparation for admission to professional schools.

The Master of Science degree in Biotechnology is intended to prepare students for careers in biotechnology and biomedicine, and to assist currently employed professionals in enhancing their career opportunities.

The Master of Arts in Teaching degree in Science Education with a specialization in Biology is designed to strengthen the knowledge of high school teachers in fundamental aspects of biology and to bring them up to date on advances in this rapidly developing field. For further information on this program and for course descriptions, see the Science/Mathematics Education section of this catalog.

The Doctor of Philosophy degree in Molecular and Cell Biology is appropriate for students who show a potential for originality in research, and is designed to develop a critical and analytical understanding of current developments, which will enable them to keep abreast of the rapid advances that are likely to occur in the biological and biomedical fields.

The MS and PhD degree plans offer students the opportunity to prepare for academic careers in colleges and universities including medical and dental schools, and for careers in industrial, hospital, public health, and environmental and governmental laboratories and organizations.

Specializations

First-year MS and PhD students in Molecular and Cell Biology will complete a body of core courses that emphasize fundamental aspects of biochemistry, quantitative biology, molecular biology, and cell biology. MS Biotechnology students take core courses in genomics, proteomics and bioinformatics, and a laboratory-based course. All students may then proceed to advanced coursework in any of these general areas. Elective courses are open to all qualified students as recommended by their supervising committees. First-year PhD students are required to participate in rotations through research laboratories.

In the second year, MS and PhD students in Molecular and Cell Biology initiate research under the...
supervision of one or more of the Biological Sciences faculty. The faculty and their research interests are listed below. Prospective students should recognize that it is possible to do research in closely related areas not mentioned in this list, provided a faculty member is prepared to supervise the work.

- **Gail A. M. Breen**: Isolation and characterization of the genes that code for proteins of the mammalian mitochondrion; mitochondrial biogenesis; eukaryotic gene regulation.
- **Lee A. Bulla**: Molecular basis of biopesticides.
- **John G. Burr**: Eukaryotic growth regulation; mechanism of viral oncogenic transformation.
- **Jeff L. DeJong**: Eukaryotic transcription; initiation and activation of RNA polymerase II.
- **Nikki Delk**: The role and regulation of autophagy and autophagy-related proteins in bone metastatic prostate cancer cell survival.
- **Rockford K. Draper**: Membrane traffic; protein toxins; bio-nanotechnology.
- **Heng Du**: Role of mitochondria in synaptic and neural degeneration in Alzheimer's disease.
- **Juan E. González**: Cell-cell interactions, role of exopolysaccharides in nodulation of legumes by rhizobia; molecular genetics of plant-microbe interactions.
- **Ernest M. Hannig**: Control of protein synthesis; genetic and biochemical analysis of translation initiation factors; protein-protein interactions.
- **Jung-whan (Jay) Kim**: Cancer cell metabolism and the tumor microenvironment.
- **Tae Hoon Kim**: Genome expression mechanisms involving transcription elongation and insulation; functional genomics tools for understanding and targeting cancer genomes and epigenomes.
- **Dennis L. Miller**: Structure and organization of mitochondrial DNA; mitochondrial gene expression; RNA editing; mitochondrial biogenesis.
- **Kelli Palmer**: Genomic, transcriptomic, and biochemical analysis of antibiotic resistance in pathogenic bacteria.
- **Lawrence J. Reitzer**: Regulation of gene expression and metabolism in prokaryotes.
- **Stephen Spiro**: Regulation of bacterial gene expression by environmental signals; genetic and physiological adaptation to stress.
- **Duane D. Winkler**: Structural, biophysical, and thermodynamic analysis of trans-acting factors responsible for the dynamic nature of nucleosomes with regard to normal DNA metabolism and disease.
- **Zhenyu Xuan**: Computational biology and bioinformatics.
- **Hyuntae Yoo**: Systems biology for drug discovery.
- **Li Zhang**: Molecular mechanisms of cell signaling, heme signaling and oxygen sensing, genomics, and systems biology.
- **Michael Qiwei Zhang**: Computational biology; gene regulation and epigenomics.

## Facilities

Major items of equipment used by the faculty are available for graduate student research. This equipment includes fluorescence and confocal microscope systems, two high throughput sequencing platforms, fluorescence activated cell sorter, isothermal titration calorimeter, protein crystallization robot, Veeco MultiMode SPM atomic force microscope, Molecular Dynamics PhosphorImagers, BioRad
real-time polymerase chain reaction instruments, Beckman scintillation counters and Optima ultracentrifuges, a Jasco J-715 spectropolarimeter, and mass spectrometers for proteomics and metabolomics. Individual laboratories are well-equipped with instrumentation needed for research in molecular and cell biology, including thermal cyclers, spectrophotometers, chromatography and electrophoresis systems, chemical hoods, and mammalian cell culture facilities.

Other shared biology facilities include environmental chambers, two staffed media kitchens with autoclaves and washing machines, a darkroom with an x-ray film developer, and an electronics workshop. There is a modern research animal housing facility on campus, as well as a GE 500 MHz FT multinuclear magnetic resonance spectrometer.

Admission Requirements
The University's general admission requirements are discussed on the [Graduate Admission](catalog.utdallas.edu/2015/graduate/admission) page.

For full participation in the Graduate Program in Molecular and Cell Biology, the student should have a good background in calculus, general physics, organic chemistry, biochemistry, and general biology, including genetics and cell biology. Entering students not having this background may be required to take some additional coursework in their first year or in the summer immediately preceding entry. Students intending to do research in computational biology should have some background in mathematics and in programming. Admission is competitive. A minimum GRE score of 295 (verbal plus quantitative) with a minimum of 147 for the verbal component is required. Average test scores for admitted students vary from year to year. The actual scores required for admission are higher, especially for PhD applicants.

Degree Requirements
The University's general degree requirements are discussed on the [Graduate Policies and Procedures](catalog.utdallas.edu/2015/graduate/policies/policy) page.

Upon satisfactory completion of the core courses (and, for PhD candidates, a favorable evaluation following the spring semester as described below), a supervising committee is appointed for each student (except non-thesis MS students) based upon mutual agreement between student, research mentor and faculty. The supervising professor, possibly with the advice of the supervising committee will help plan an elective course curriculum. The supervising committee will oversee the student's research and thesis or dissertation.

Master of Science in Biotechnology

36 semester credit hours minimum

Department Faculty

Professors: Lee A. Bulla, Rockford K. Draper, Juan E. González, Lawrence J. Reitzer, Stephen Spiro, Li Zhang, Michael Qiwei Zhang

Professors Emeritus: Hans Bremer, Donald M. Gray, Claud S. Rupert
**Associate Professors:** Gail A. M. Breen, John G. Burr, Jeff L. DeJong, Ernest M. Hannig, Tae Hoon Kim, Dennis L. Miller

**Assistant Professors:** Nikki Delk, Heng Du, Jung-whan (Jay) Kim, Kelli Palmer, Duane D. Winkler, Zhenyu Xuan, Hyuntae Yoo

**Research Assistant Professors:** Monique Duncan, Lan Guo

**Senior Lecturers:** Irina Borovkov, Mehmet Candas, Vincent P. Cirillo, Brenna Hill, Wen-Ju Lin, Robert C. Marsh, David Murchison, Jing Pan, Elizabeth Pickett, Ruben D. Ramirez, Scott A. Rippel, Elizabeth L. Rugg, Ilya Sapozhnikov, Uma Srikanth, Michelle Wilson, Wen-Ho Yu

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## Degree Objectives

The MS degree in biotechnology is intended to prepare students for careers in biotechnology and biomedicine and to assist currently employed professionals in enhancing their career opportunities.

Biotechnology captures the exciting possibilities provided by the decoding of the human genome and by advances in bioanalytical instrumentation, and the field is projected for continued rapid growth. The MS in Biotechnology is designed so that students may enter the program with a wide range of prior disciplinary backgrounds, prepare for and take the four core courses, and, by choice from a wide range of approved electives, tailor the remainder of the degree program to their career aspirations. In this manner, students may develop areas of additional depth in fields such as:

- molecular and cell biology
- chemistry
- engineering and computer science
- health care policy
- management and business administration

The MS in Biotechnology requires 36 semester credit hours of courses, typically twelve courses of three semester credit hours each. Students may also elect to prepare and defend a thesis; more than 36 semester credit hours may be required for such a program.

The MS in Biotechnology is administered by the Department of Biological Sciences. Students seeking further information or advisement should contact the Biological Sciences Department office.

## Core Courses

The core consists of four courses: **BIOL 5376** Applied Bioinformatics, **BIOL 5381** Genomics, **BIOL 6373** Proteomics, and **BIOL 6384** Biotechnology Laboratory. **BIOL 6384** Biotechnology Laboratory is a skills based course. Students must show that they have adequate laboratory skills in order to enroll in **BIOL 6384**. Students enrolled in the MS in Biotechnology program will have priority for enrollment in **BIOL 6384**.

The four core courses should be taken in the following order: **BIOL 5376** Applied Bioinformatics, **BIOL 5381** Genomics, **BIOL 6373** Proteomics, **BIOL 6384** Biotechnology Laboratory. Instructor consent is required for core courses taken out of this sequence.
Program Policies

The program is open to all students who hold a bachelor's degree, although those with laboratory science, mathematics, computer science, or engineering degrees are particularly encouraged to apply. In general, students will not be admitted to the MS in Biotechnology program if they require more than two courses in order to be ready to take the core courses.

Every student admitted to the MS in Biotechnology program shall consult with the program advisor(s) and develop a mutually agreed degree plan. All requests for deviations from the degree program described in this catalog shall be discussed first with a program advisor, who will forward the request to the Committee on Biotechnology for decision.

There are no formal prerequisites for most of the core courses, and a student, after obtaining consent from the program advisor, may attempt one or more core courses. However, the level of the BIOL core courses is such that most students will want to have mastered the material in the following courses:

- General Chemistry (two semesters, with lab), Organic Chemistry (two semesters, with lab)
- **BIOL 2311** Introduction to Modern Biology I (with workshop)
- **BIOL 3361** Biochemistry I or **BIOL 6352** Modern Biochemistry I
- **BIOL 3301** Classical and Molecular Genetics or **BIOL 6331** Molecular Genetics
- **BIOL 3302** Eukaryotic Molecular and Cell Biology or **BIOL 6356** Eukaryotic Molecular and Cell Biology

Students who elect to prepare and defend a thesis must satisfy the MS thesis procedures specified by the department of their thesis supervisor.

Elective Courses

As a general rule, any UT Dallas graduate course that is approved by the advisor as being relevant to the student's tailored degree plan may be taken as an elective for the Biotechnology MS program. Students should consult the program advisor for the current list of recommended electives.

Master of Science in Molecular and Cell Biology

*36 semester credit hours minimum*

Department Faculty

Professors: Lee A. Bulla, Rockford K. Draper, Juan E. González, Lawrence J. Reitzer, Stephen Spiro, Li Zhang, Michael Qiwei Zhang

Professor Emeritus: Hans Bremer, Donald M. Gray, Claud S. Rupert

Associate Professors: Gail A. M. Breen, John G. Burr, Jeff L. DeJong, Ernest M. Hannig, Tae Hoon Kim, Dennis L. Miller

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Affiliated Faculty: Stephen D. Levene, Jonathan E. Ploski

Degree Objectives

All students seeking the Master of Science degree in Molecular and Cell Biology must satisfactorily complete a total of at least 36 graduate semester credit hours, which must include the following core courses:

Core Courses

- **BIOL 5410** Biochemistry
- **BIOL 5420** Molecular Biology
- **BIOL 5460** Quantitative Biology
- **BIOL 5440** Cell Biology

MS students intending to submit a thesis must, in addition to the core courses specified above, satisfactorily complete a further 20 semester credit hours of Biology courses which includes **BIOL 619** Colloquium in Molecular and Cell Biology, **BIOL 8V01** Research in Molecular and Cell Biology, **BIOL 6V 98** Thesis, and a minimum of 6 semester credit hours of general electives for which a letter grade is assigned. The remainder of the semester credit hours usually reflects experimental research but may also be based on literature research as determined by mutual agreement of the student and Supervising Committee. For MS (thesis) students, the maximum number of Pass/Fail credits allowed within the 36 semester credit hour minimum is 13 semester credit hours.

MS (non-thesis) students must, in addition to the core courses specified, satisfactorily complete a minimum of four general elective courses in Biology (for which a letter grade is assigned) for a minimum of 9 semester credit hours, up to 11 semester credit hours of special electives, and/or, with approval of the graduate advisor, other graduate courses. For non-thesis MS students, the maximum number of Pass/Fail credits allowed within the 36 semester credit hour minimum is 11 semester credit hours.

Master of Science in Bioinformatics and Computational Biology

36 semester credit hours minimum

Department Faculty

Degree Objectives

In addition to the above Master of Science degrees a bioinformatics and computational biology (BCBM) is offered jointly by the Departments of Mathematics and Molecular and Cell Biology. This program combines coursework from the disciplines of biology, computer science, and mathematics. The BCBM program seeks to answer the demand for a new breed of scientist who has fundamental understanding in the fields of biology, mathematics, statistics, and computer science. With this interdisciplinary training, these scientists will be well prepared to meet the demand and challenges that have arisen and will continue to develop in the biotechnology arena. Faculty from both Mathematics (MMS) and Biological Sciences participate in the Bioinformatics and Computational Biology program with the Mathematics Department serving as the administrative unit. Both departments participate in advising students.

Complete information about the Master of Science in Bioinformatics and Computational Biology Program is available at catalog.utdallas.edu/2015/graduate/programs/nsm/bioinformatics-and-computational-biology.

Doctor of Philosophy in Molecular and Cell Biology

75 semester credit hours minimum beyond the baccalaureate degree

Department Faculty

Professors: Lee A. Bulla, Rockford K. Draper, Juan E. González, Lawrence J. Reitzer, Stephen Spiro, Li Zhang, Michael Qiwei Zhang

Professors Emeritus: Hans Bremer, Donald M. Gray, Claud S. Rupert

Associate Professors: Gail A. M. Breen, John G. Burr, Jeff L. DeJong, Ernest M. Hannig, Tae Hoon Kim, Dennis L. Miller

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Affiliated Faculty: Stephen D. Levene, Jonathan E. Ploski

Degree Objectives

All PhD students must satisfactorily complete a total of at least 75 semester credit hours beyond the
bachelor's degree and four core courses: **BIOL 5410** Biochemistry, **BIOL 5420** Molecular Biology, **BIOL 5460** Quantitative Biology, and **BIOL 5440** Cell Biology.

In the first year, PhD candidates must perform two laboratory rotations, and take **BIOL 6V02** The Art of Scientific Presentation, and **BIOL 6193** Colloquium in Molecular and Cell Biology. At the end of the first year, students are evaluated based upon performance in the core classes, laboratory rotations, and performance as teaching assistants (if applicable). Students who pass this evaluation must then pass an oral qualifying examination within three semesters to determine the student's aptitude for continuation of dissertation research.

After the first year, students must also complete a minimum of four general elective courses in Biology (for which a letter grade is assigned). A dissertation defense will be conducted after the dissertation has been written. All students are required to submit (and have accepted for publication) a minimum of one manuscript for publication in an internationally recognized, peer-reviewed scientific journal. There is no foreign language requirement.

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