

# All-University Programs and Faculty

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# All-University Programs and Faculty

## General Information

The Graduate School offers several programs jointly between two campuses of the University of Minnesota. All-University master of science and doctor of philosophy programs in integrated biosciences, toxicology, and water resources science are offered jointly between the Twin Cities and Duluth campuses. An All-University masters of science and doctor of philosophy program in biomedical informatics and computation biology is offered jointly between the Twin Cities and Rochester campuses. All programs are under the jurisdiction of the Graduate School dean and have comparable admission, candidacy, and degree requirements. General Graduate School regulations, including those for minimum degree requirements, apply to programs offered on all campuses (see General Information at the beginning of this catalog).

## Financial Aid

Information about assistantships, fellowships, and other financial assistance available to graduate students can be found in the General Information section at the beginning of this catalog. Assistantships (teaching and research) are normally granted through the individual departments. Students can obtain information by writing to the director of graduate studies for their particular program. Some residence counseling positions may be available on the Duluth campus. For information, write to the Housing Office, 149 Lake Superior Hall, University of Minnesota Duluth, MN 55812.

## Program Statements

Brief descriptions of the various degree programs are listed on the following pages. Course offerings are listed in this catalog, the University of Minnesota Duluth Catalog, and online at [www.catalogs.umn.edu/courses.html](http://www.catalogs.umn.edu/courses.html). General information concerning graduate work on the Duluth campus may be obtained from the Graduate School Office—Duluth, University of Minnesota Duluth, 431 Darland Administration Building, 1049 University Drive, Duluth, MN 55812. Information is also available at [www.d.umn.edu/grad](http://www.d.umn.edu/grad). General information concerning the Rochester campus may be obtained from University of Minnesota Rochester (UMR) Student Services, 111 South Broadway, Rochester, MN 55904 (507-280-2831 or 1-800-947-0117; [stuserv@umn.edu](mailto:stuserv@umn.edu)). Information is also available at [www.r.umn.edu](http://www.r.umn.edu).

## Key to All-University Program Abbreviations

### Faculty

Graduate faculty are listed at the beginning of each degree program. After the faculty name, the home department will be listed (unless the department is the same as the program name), followed by the graduate faculty status in the program. Professors emeriti are identified by “(emeritus).”

### Membership Categories

**Senior Member (SM)**—Authorization to advise students at all levels, including the doctorate; to serve as a thesis reviewer and as an examiner on student examining committees, including service as chair of doctoral committees; to teach courses for graduate credit; and to participate in governance. In fields that also offer a professional doctorate, some senior member appointments may be restricted to the supervision of students seeking the professional degree.

**Affiliate Senior Member (ASM)**—Authorization to assume the same responsibilities as senior member, but not to participate in governance. In fields that also offer a professional doctorate, some affiliate senior member appointments may be restricted to the supervision of students seeking the professional degree.

### Member/Advising (M2)

Authorization to advise students at the master’s level; to serve as a thesis reviewer at the master’s level and as an examiner on student examining committees at the master’s and postbaccalaureate certificate levels; to teach courses for graduate credit; and to participate in governance. At the discretion of the appointing program, may also include authorization to co-advise doctoral students with a senior member or affiliate senior member of the graduate faculty, and to serve as a thesis reviewer and examining committee member for doctoral students, but not as chair.

**Affiliate Member/Advising (AM2)**—Authorization to assume the same responsibilities as member/advising, but not to participate in governance.

**Member (M)**—Authorization to serve as a thesis reviewer at the master’s level and as an examiner on student examining committees at the master’s and postbaccalaureate certificate levels; to teach courses for graduate credit; and to participate in governance. At the discretion of the appointing program, may also include authorization to serve as a thesis reviewer and examining committee member for doctoral students, but not as chair.

### Affiliate Member (AM)

Authorization to assume the same responsibilities as member, but not to participate in governance.

**Examining Status (E)**—Authorization to serve as a thesis reviewer and as an examiner on student examining committees at all levels, but not as chair, and to teach courses for graduate credit. Examining status does not include membership on the graduate faculty and does not confer governance privileges.

### Tests

The following test abbreviations appear throughout graduate program listings.

**ECFMG**—Educational Commission Foreign Medical Graduates

**GMAT**—Graduate Management Admission Test

**GRE**—Graduate Record Examination

**IELTS**—International English Language Testing System

**MELAB**—Michigan English Language Assessment Battery

**SPEAK**—Speaking Proficiency English Assessment Kit

**TOEFL**—Test of English as a Foreign Language

**TSE**—Test of Spoken English

**USMLE**—United States Medical Licensing Examination

# Duluth and Twin Cities Campus Degree Programs

## Integrated Biosciences M.S. and Ph.D.

**Contact Information**—Integrated Biosciences Graduate Program, University of Minnesota, 162 Medical School Duluth, 1035 University Drive, Duluth, MN 55812 (218-726-6898; fax: 218-726-8152; [ibs@d.umn.edu](mailto:ibs@d.umn.edu); [www.d.umn.edu/ibs](http://www.d.umn.edu/ibs)).

For latest graduate faculty listings, see [www.grad.umn.edu/faculty\\_rosters/faculty.html](http://www.grad.umn.edu/faculty_rosters/faculty.html).

### Professor

Mustafa N. al'Absi, Behavioral Sciences, SM  
 Matthew T. Andrews, Biology, M2  
 Gregory J. Beilman, Surgery, Twin Cities, SM  
 Yosef Cohen, Fisheries, Wildlife, and Conservation Biology, Twin Cities, M2  
 Timothy P. Craig, Biology, M2  
 Lester R. Drewes, Biochemistry and Molecular Biology, SM  
 Barbara A. Elliott, Family Medicine and Community Health, SM  
 Goran B. Hellekant, Physiology and Pharmacology, M2  
 Lois J. Heller, Physiology and Pharmacology, M2  
 Randall E. Hicks, SM  
 Alan B. Hooper, Biochemistry, Molecular Biology and Biophysics, Twin Cities, M2  
 John J. Pastor, Biology, SM  
 Joseph R. Prohaska, Biochemistry and Molecular Biology, SM  
 Jean F. Regal, Biochemistry and Molecular Biology, SM  
 George J. Trachte, Pharmacology, M2  
 Kendall B. Wallace, Biochemistry and Molecular Biology, M2

### Adjunct Professor

Janet R. Keough, Biology, AM2  
 Carl Richards, Biology, M2

### Associate Professor

Gerald T. Ankley, Fisheries, Wildlife, and Conservation Biology, Twin Cities, SM  
 Edgar Arriaga, Chemistry, Twin Cities, SM  
 Benjamin L. Clarke, Medical Microbiology and Immunology, M2  
 Haim Einat, Pharmacy, SM  
 Julie R. Etterson, Plant Biology, SM  
 Janet L. Fitzakerley, Pharmacology, M2  
 Jon M. Holy, Anatomy and Cell Biology, SM  
 Allen Mensinger, Biology, SM  
 Ayman M. Noreddin, Pharmacy, SM

### Adjunct Associate Professor

M. K. Froberg, Pathology and Laboratory Medicine, M2

### Assistant Professor

Grant W. Anderson, Pharmacy, SM  
 Lucia P. Barker, Medical Microbiology and Immunology, M2

Bjoern Bauer, Pharmacy, M2  
 Steven M. Berry, Chemistry and Biochemistry, SM  
 Clay J. Carter, SM  
 Stephanie J. Guildford, Biology, M2  
 Marshall E. Hampton, Biology, M2  
 Anne Hinderliter, Chemistry and Biochemistry, M2  
 Tim L. Kroft, Biology, SM  
 Venkatram R. Mereddy, Chemistry and Biochemistry, M2  
 Glenn R. Nordehn, Family Medicine, M2  
 Teresa Rose-Hellekant, Physiology and Pharmacology, M2  
 Jon N. Rumbley, Chemistry and Biochemistry, SM  
 Gregory Rutkowski, Chemical Engineering, M2  
 Patricia M. Scott, Biochemistry and Molecular Biology, M2

### Adjunct Assistant Professor

Joseph L. Johnson, Chemistry and Biochemistry, SM

### Senior Research Associate

Richard P. Axler, Natural Resources Research Institute, SM  
 Subhash C. Basak, Natural Resources Research Institute, M2  
 Donn K. Branstrator, Natural Resources Research Institute, M2  
 Brian H. Hill, Natural Resources Research Institute, ASM  
 George E. Host, Natural Resources Research Institute, SM  
 Thomas R. Hrabik, Natural Resources Research Institute, SM  
 Lucinda B. Johnson, Natural Resources Research Institute, SM  
 John R. Kelly, Natural Resources Research Institute, ASM  
 David R. Mount, Natural Resources Research Institute, ASM  
 Gerald J. Niemi, Natural Resources Research Institute, SM

### Research Associate

Valerie J. Brady, Natural Resources Research Institute, M2  
 Sigmund J. Degitx Jr., Natural Resources Research Institute, AM2  
 Rodney D. Johnson, Natural Resources Research Institute, AM2  
 Ron Moen, Natural Resources Research Institute, M2  
 Euan D. Reavie, Natural Resources Research Institute, M2  
 Patrick K. Schoff, Natural Resources Research Institute, M2

Along with the program-specific requirements listed below, please read the General Information section of this catalog for Graduate School requirements that apply to all major fields.

**Curriculum**—The all-University integrated biosciences graduate program offers study toward the master of science (M.S.) degree under Plan A (coursework and original thesis) and the doctor of philosophy (Ph.D.) degree. The program has two areas of emphasis: cell, molecular, and physiological

(CMP) biology and ecology, organismal, and population (EOP) biology.

**M.S. and Ph.D. Prerequisites for Admission**—Undergraduate admission standards for the M.S. and Ph.D. graduate program in integrated biosciences include a bachelor's degree or equivalent from an accredited college or university in the biological or physical sciences or a related field. Background in a wide variety of subdisciplines is appropriate preparation for the Integrated Biosciences Graduate program. Examples include, but are not limited to: biochemistry, botany, cell biology, developmental biology, ecology, evolution, genetics, immunology, limnology, microbiology, molecular biology, neuroscience, physiology, and zoology.

Applicants with a GPA of 3.00 or better and 60th percentile placement in the GRE general test are preferred. Applicants for whom English is not a native language should submit TOEFL, MELAB, or IELTS scores whose standards are those of the U of M Graduate School ([www.grad.umn.edu/prospective\\_students/application\\_information/TOEFL.html](http://www.grad.umn.edu/prospective_students/application_information/TOEFL.html)).

No single deficiency automatically disqualifies an application from being considered. Applicants deficient in some requirements may be admitted with the provision that specific courses are completed within the first year of the program. Coursework used to make up deficiencies may not be applied toward fulfillment of the graduate degree.

### M.S. and Ph.D. Special Application Requirements

The GRE test is required. Applicants with a GPA of 3.0 or better and 60th percentile placement in the GRE general test are preferred. Applicants for whom English is not a native language should submit TOEFL, MELAB, or IELTS scores whose standards are those of the U of M Graduate School ([www.grad.umn.edu/prospective\\_students/application\\_information/TOEFL.html](http://www.grad.umn.edu/prospective_students/application_information/TOEFL.html)).

### M.S. and Ph.D. Degree Requirements

The following comprises the core curriculum for all IBS students pursuing either a M.S. or Ph.D. degree: IBS 8011 (Integrated Biological Systems), IBS 8012 (Integrated Evolutionary Processes), IBS 8099 (The Biological Practitioner), STAT 5411 (Analysis of Variance), IBS 8020 (IBS Colloquia—two semesters), and IBS 8030 (IBS Research Club—four semesters).

**Language Requirements**—None

## M.S. Plan A Degree Requirements

**Prerequisites for Admission**—Additional recommended undergraduate courses for applicants pursuing the M.S. degree include one year each of chemistry, biology, and physics. One semester of calculus is also recommended. Applicants are strongly encouraged to have taken other advanced courses in chemistry, biology, additional calculus, and introductory statistics.

**Curriculum**—Students must complete at least 14 course credits in the major; a minimum of 6 credits of electives in another graduate program or programs (for a minor or related field) or in the IBS emphasis other than that which comprises the major program; and at least 10 thesis credits. Students must designate one of the areas of emphasis in the second semester of their first year.

**Language Requirements**—None.

**Final Exam**—Students must present a department seminar and pass a final oral exam.

## Ph.D. Degree Requirements

**Prerequisites for Admission**—Additional recommended undergraduate courses for applicants pursuing the Ph.D. degree include one year each of chemistry, biology, physics, calculus, and advanced chemistry. One semester (minimum) of statistics is also recommended.

Additional recommended courses for students in the Ecology, Organismal and Population (EOP) emphasis include one year of calculus, one semester each of ecology and evolutionary biology along with one course in two of the following subjects: genetics, cell biology, biochemistry.

Additional recommended courses for students in the Cell, Molecular and Physiological (CMP) emphasis include one year of organic chemistry plus one course in each of the following: genetics, cell biology and biochemistry.

**Curriculum**—Students must complete at least 14 course credits in the major; a minimum of 6 credits of electives in another graduate program or programs (for a minor or related field) or in the IBS emphasis other than that which comprises the major program; and at least 10 thesis credits. Students must designate one of the areas of emphasis in their second semester.

**Ph.D. Written Preliminary Examination**—In addition to completing the curriculum for the major and internal related fields, students will be required to

pass both a written and oral preliminary examination prior to completing the Ph.D. program. The preliminary written examination will be administered once the student has completed the majority of the required coursework. This will typically occur in the summer of the second year. The written examination will consist of a completed NIH or NSF grant application for the student's proposed research project. The project will be evaluated by the Thesis Examining Committee, which will also serve as the student's Final Oral Examining Committee to provide continuity of advice during the length of the student's research program.

**Ph.D. Oral Preliminary Examination**—The oral preliminary examination will be administered within two months of the successful completion of the preliminary written examination. The examination will be administered by the graduate faculty according to Graduate School regulations and all students will be required to pass the oral examination to continue in the Ph.D. program. Within one semester of passing the preliminary oral examination, each Ph.D. student must file a Thesis Proposal Form with the Graduate School.

**Ph.D. Final Oral Defense**—It is anticipated that most students will complete the requirements for the Ph.D. degree within five years. The final oral defense will be conducted by the graduate faculty according to Graduate School regulations. It will consist of a public seminar presented by the student, followed by a closed examination with the student's examining committee.

## Toxicology M.S. and Ph.D.

**Contact Information**—Toxicology Graduate Program, Medical School Duluth, 162 SMed, 1035 University Drive, Duluth, MN 55812 (218-726-6354; fax: 218-726-8014; [toxgrad@d.umn.edu](mailto:toxgrad@d.umn.edu); [www.d.umn.edu/medweb/toxicology](http://www.d.umn.edu/medweb/toxicology)).

For latest graduate faculty listings, see [www.grad.umn.edu/faculty\\_rosters/faculty.html](http://www.grad.umn.edu/faculty_rosters/faculty.html).

### Professor

**Yusuf J. Abul-Hajj**, Medicinal Chemistry, Pharmacognasy, Twin Cities, SM  
**David R. Brown**, Veterinary Biosciences, Twin Cities, SM  
**Robert M. Carlson**, Chemistry and Biochemistry, SM  
**Lester R. Drewes**, Biochemistry and Molecular Biology, SM  
**Vincent F. Garry Jr.**, Laboratory Medicine/Pathology, Twin Cities, SM  
**Patrick E. Hannah**, Medicinal Chemistry, Pharmacognasy, Twin Cities, SM

**Michael J. Murphy**, Veterinary Population Medicine, Twin Cities, SM  
**Joseph R. Prohaska**, Biochemistry and Molecular Biology, SM  
**Jean F. Regal**, Biochemistry and Molecular Biology, SM  
**W. Thomas Shier**, Medicinal Chemistry, Pharmacognasy, Twin Cities, SM  
**Lawrence P. Wackett**, Biotechnology Institute, Twin Cities, SM  
**Kendall B. Wallace**, Biochemistry and Molecular Biology, SM

### Adjunct Professor

**Anthony Kiorpes**, Veterinary Population Medicine, Twin Cities, ASM

### Associate Professor

**Gerald T. Ankley**, Fisheries, Wildlife, and Conservation Biology, Twin Cities, AM2  
**Yinduo Ji**, Veterinary and Biomedical Sciences, Twin Cities, SM  
**Ayman M. Noreddin**, Pharmacy, SM  
**Mark S. Rutherford**, Veterinary and Biomedical Sciences, Twin Cities, SM  
**Ashok K. Singh**, Veterinary Population Medicine, Twin Cities, SM

### Assistant Professor

**Robert T. Cormier**, Biochemistry and Molecular Biology, SM

### Adjunct Assistant Professor

**Hillary M. Carpenter**, Environmental Health Sciences, Twin Cities, AM2  
**John W. Nichols**, Pharmacology, AM2  
**Geary W. Olsen**, Environmental Health Sciences, Twin Cities, AM2  
**Robert Roy**, Environmental Health Sciences, Twin Cities, AM2

### Senior Research Associate

**Subhash C. Basak**, Natural Resources Research Institute, AM2  
**Gerald J. Niemi**, Natural Resources Research Institute, SM

Along with the program-specific requirements listed below, please read the General Information section of this catalog for Graduate School requirements that apply to all major fields.

**Curriculum**—This University-wide program provides comprehensive training in the broad scope of toxicology. Toxicology, the science of poisons, is devoted to identifying and quantifying potential noxious agents in our environment. Although most chemical agents at sufficiently large doses may be toxic, not all present a significant risk to human health or to environmental organisms or ecosystems. Accordingly, the essence of the science of toxicology is defining the fine line that distinguishes a risk from a residue. To accomplish this requires scientific expertise in such areas as analytical and environmental chemistry, biology, and mathematics. Advanced courses and research are also available in such subdisciplines as human health risk assessment, epidemiology,



environmental chemistry and engineering ecotoxicology food additives and nutritional toxicology biochemical and physiological mechanisms histopathology diagnostic and analytical toxicology drug metabolism chemical carcinogenesis behavioral toxicology and the toxicity of noxious agents to various organ systems (e.g., nervous, heart, liver, kidneys).

**Prerequisites for Admission**—Applicants must have a bachelor's degree or its foreign equivalent from a recognized college or university. At least a full year each of biology, organic chemistry, and physics as well as mathematics through calculus are expected.

**Special Application Requirements**—GRE General Test scores are required; international students must also submit TOEFL scores.

### M.S. Degree Requirements

The master of science degree is offered under Plan A and Plan B. Plan A requires 22 course credits and 10 thesis credits; Plan B requires 30 course credits. A core curriculum of 8 credits in toxicology (TXCL 8012, 8013, and 8100) is required for both plans. Additional courses are arranged on an individual basis.

**Language Requirements**—None.

**Final Exam**—The final exam is oral.

### Ph.D. Degree Requirements

The doctor of philosophy degree requires core courses in physiology (4 credits), biochemistry (6 credits), statistics (2 credits), and toxicology (10 credits). Students must also complete 12 credits in a minor or supporting program and 24 thesis credits. Because the program spans the Duluth and Twin Cities campuses, the required courses differ on each campus.

Additional advanced courses in toxicology or related fields may be specified by the adviser. Students must complete and defend an original research project.

### Minor Requirements for Students

**Majoring in Other Fields**—A minor is available at the doctoral level and requires 12 credits—8 credits of core courses and 4 credits of advanced toxicology courses.

## Water Resources Science M.S. and Ph.D.

**Contact Information**—Water Resources Science Graduate Program, 205 RLB, 2205 E. 5th Street, Duluth, MN 55812 (218-726-7435; fax: 218-726-6979; [wrs@umn.edu](mailto:wrs@umn.edu); [www.wrs.umn.edu](http://www.wrs.umn.edu)).

For latest graduate faculty listings, see [www.grad.umn.edu/faculty\\_rosters/faculty.html](http://www.grad.umn.edu/faculty_rosters/faculty.html).

### Professor

**E. Calvin Alexander Jr.**, Earth Science, Geology and Geophysics, Twin Cities, SM  
**Dorothy H. Anderson**, Forest Resources, Twin Cities, SM  
**Roger E. Arndt**, Civil Engineering, Twin Cities, SM  
**John M. Baker**, Soil, Water, and Climate, Twin Cities, SM  
**Marvin E. Bauer**, Forest Resources, Twin Cities, SM  
**Jay Bell**, Soil, Water, and Climate, Twin Cities, SM  
**David D. Biesboer**, Plant Biology, Twin Cities, SM  
**Stephen A. Bortone**, Biology, SM  
**Patrick L. Brezonik**, Civil Engineering, Twin Cities, SM  
**Kenneth N. Brooks**, Forest Resources, Twin Cities, SM  
**Erik T. Brown**, Geological Sciences, SM  
**H. H. Cheng**, Soil, Water, and Climate, Twin Cities, ASM  
**Charles J. Clanton**, Bioproducts and Biosystems Engineering, Twin Cities, SM  
**Steve M. Colman**, Geological Sciences, SM  
**James B. Cotner**, Ecology, Evolution and Behavior, Twin Cities, SM  
**K. William Easter**, Applied Economics, Twin Cities, SM  
**Leonard C. Ferrington**, Entomology, Twin Cities, SM  
**Efi Foufoula**, Civil Engineering, Twin Cities, SM  
**Susan M. Galatowitsch**, Horticultural Science, Twin Cities, SM  
**Philip J. Gersmehl**, Geography, Twin Cities, SM  
**Florence K. Gleason**, Plant Biology, Twin Cities, SM  
**John S. Gulliver**, Civil Engineering, Twin Cities, SM  
**Satish C. Gupta**, Soil, Water, and Climate, Twin Cities, SM  
**Robert E. Hecky**, Biology, SM  
**Randall E. Hicks**, Biology, SM  
**Miki Hondzo**, Civil Engineering, Twin Cities, SM  
**Emi Ito**, Earth Science, Geology and Geophysics, Twin Cities, SM  
**Thomas C. Johnson**, Geological Sciences, SM  
**Nicholas R. Jordan**, Agronomy and Plant Genetics, Twin Cities, SM  
**Mary H. Meyer**, Horticulture, Twin Cities, SM  
**John F. Moncrief**, Soil, Water, and Climate, Twin Cities, SM  
**Howard D. Mooers**, Geological Sciences, SM  
**D. J. Mulla**, Soil, Water, and Climate, Twin Cities, SM  
**Ed Nater**, Soil, Water, and Climate, Twin Cities, SM  
**Raymond M. Newman**, Fisheries, Wildlife, and Conservation Biology, Twin Cities, SM

**Chris Paola**, Earth Science, Geology and Geophysics, Twin Cities, SM  
**John J. Pastor**, Biology, SM  
**Jim A. Perry**, Fisheries, Wildlife, and Conservation Biology, Twin Cities, SM  
**Hans-Olaf Pfannkuch**, Earth Science, Geology and Geophysics, Twin Cities, SM  
**David G. Pitt**, Landscape Architecture, Twin Cities, SM  
**Alan S. Polasky**, Ecology, Evolution and Behavior, Twin Cities, SM  
**Carl J. Rosen**, Soil, Water, and Climate, Twin Cities, SM  
**Michael J. Sadowsky**, Soil, Water, and Climate, Twin Cities, SM  
**Ingrid E. Schneider**, Forest Resources, Twin Cities, SM  
**Mark W. Seeley**, Soil, Water, and Climate, Twin Cities, SM  
**Peter W. Sorenson**, Fisheries, Wildlife, and Conservation Biology, Twin Cities, SM  
**Fotis Sotiropoulos**, Civil Engineering, Twin Cities, SM  
**Susan G. Stafford**, Forest Resources, Twin Cities, SM  
**Heinz G. Stefan**, Civil Engineering, Twin Cities, SM  
**Robert W. Sterner**, Ecology, Evolution, and Behavior, Twin Cities, SM  
**Deborah L. Swackhamer**, Environmental Health Sciences, Twin Cities, SM  
**Michael Sydor**, Physics, SM  
**Harvey Thorleifson**, Earth Science, Geology and Geophysics, Twin Cities, SM  
**Vaughan R. Voller**, Civil Engineering, Twin Cities, SM  
**Bruce N. Wilson**, Bioproducts and Biosystems Engineering, Twin Cities, SM

### Adjunct Professor

**Janet R. Keough**, Biology, AM2  
**Carl Richards**, Biology, SM  
**Carlisle F. Runge**, Forest Resources, Twin Cities, SM  
**Bruce Vondracek**, Fisheries, Wildlife, and Conservation Biology, Twin Cities, SM

### Associate Professor

**William Arnold**, Civil Engineering, Twin Cities, SM  
**Todd W. Arnold**, Fisheries, Wildlife, and Conservation Biology, Twin Cities, SM  
**Randal J. Barnes**, Civil Engineering, Twin Cities, SM  
**Christina Gallup**, Geological Sciences, SM  
**Timothy J. Griffis**, Soil, Water, and Climate, Twin Cities, SM  
**Sarah E. Hobbie**, Ecology, Evolution, and Behavior, Twin Cities, SM  
**Frances R. Homans**, Applied Economics, Twin Cities, SM  
**Raymond N. Hozalski**, Civil Engineering, Twin Cities, SM  
**Katherine Klink**, Geography, Twin Cities, SM  
**Timothy M. LaPara**, Civil Engineering, Twin Cities, SM  
**Kristopher McNeill**, Chemistry, Twin Cities, SM  
**Elizabeth C. Minor**, Chemistry and Biochemistry, SM  
**Laura R. Musacchio**, Landscape Architecture, Twin Cities, SM  
**Kristen C. Nelson**, Forest Resources, Twin Cities, SM  
**John L. Nieber**, Bioproducts and Biosystems Engineering, Twin Cities, SM

Paige J. Novak, Civil Engineering, Twin Cities, SM  
 Gary R. Sands, Bioproducts and Biosystems Engineering, Twin Cities, SM  
 Matt Simcik, Environmental Health Sciences, Twin Cities, SM  
 Steven P. Sternberg, Chemical Engineering, SM  
 Jeffrey S. Strock, Soil, Water, and Climate, Twin Cities, M2  
 John B. Swenson, Geological Sciences, SM  
 Steven J. Taff, Applied Economics, Twin Cities, SM  
 Josef P. Werne, Chemistry and Biochemistry, SM  
 Tongxin Zhu, Geography, M2

**Adjunct Associate Professor**

David Fulton, Fisheries, Wildlife, and Conservation Biology, Twin Cities, SM  
 Naomi Zeitouni, Applied Economics, Twin Cities, SM

**Assistant Professor**

Jay A. Austin, Large Lakes Observatory, M2  
 Dennis R. Becker, Forest Resources, Twin Cities, M2  
 Jacques Finlay, Ecology, Evolution, and Behavior, Twin Cities, M2  
 Jeffrey A. Gralnick, Biotechnology Institute, Twin Cities, SM  
 Karen B. Gran, Geological Sciences, M2  
 Stephanie J. Guildford, Biology, SM  
 Kimberly Hill, Civil Engineering, Twin Cities, SM  
 Qiuqiong Huang, Applied Economics, Twin Cities, M2  
 Sergei Katsev, Physics, M2  
 Joe Knight, Forest Resources, Twin Cities, M2  
 Katsumi Matsumoto, Earth Science, Geology and Geophysics, Twin Cities, M2  
 Lee Penn, Chemistry, Twin Cities, SM  
 Fernando Porte-Agel, Civil Engineering, Twin Cities, SM  
 Anthony C. Runkel, Earth Science, Geology and Geophysics, Twin Cities, AM2  
 Martin O. Saar, Earth Science, Geology and Geophysics, Twin Cities, M2  
 Sangwon Suh, Bioproducts and Biosystems Engineering, Twin Cities, SM  
 Brandy M. Toner, Soil, Water, and Climate, Twin Cities, M2

**Adjunct Assistant Professor**

James Almendinger, Fisheries, Wildlife, and Conservation Biology, Twin Cities, AM2  
 Paul D. Capel, Civil Engineering, Twin Cities, ASM  
 Karlyn Eckman, Forest Resources, Twin Cities, M2  
 Mark Edlund, Earth Science, Geology and Geophysics, Twin Cities, ASM  
 Mindy L. Erickson, Bioproducts and Biosystems Engineering, Twin Cities, AM2  
 Carrie E. Jennings, Geology and Geophysics, Twin Cities, AM2  
 Joe Magner, Fisheries, Wildlife, and Conservation Biology, Twin Cities, ASM  
 Tyson Ochsner, Soil, Water, and Climate, Twin Cities, ASM  
 Pamela Rice, Soil, Water, and Climate, Twin Cities, AM2  
 Edward B. Swain, Fisheries, Wildlife, and Conservation Biology, Twin Cities, AM2

**Senior Research Associate**

Richard P. Axler, Natural Resources Research Institute, SM  
 Paul R. Bloom, Soil, Water, and Climate, Twin Cities, SM  
 Donn K. Branstrator, Natural Resources Research Institute, SM  
 Brian H. Hill, Natural Resources Research Institute, ASM  
 George E. Host, Natural Resources Research Institute, SM  
 Thomas R. Hrabik, Natural Resources Research Institute, SM  
 Lucinda B. Johnson, Natural Resources Research Institute, SM

**Research Associate**

Valerie J. Brady, Natural Resources Research Institute, M2  
 Daniel R. Engstrom, Earth Science, Geology and Geophysics, Twin Cities, ASM  
 Lorin K. Hatch, Fisheries, Wildlife, and Conservation Biology, Twin Cities, AM2  
 Euan D. Reavie, Natural Resources Research Institute, M2

**Senior Fellow**

Larry Baker, Water Resources Center, SM

Along with the program-specific requirements listed below, please read the General Information section of this catalog for Graduate School requirements that apply to all major fields.

**Curriculum**—This cross-campus interdisciplinary program provides comprehensive training in water resources science, with integration across scientific disciplines. A structured interdisciplinary graduate curriculum is offered. The program includes a set of core courses plus electives in the following areas of emphasis at the M.S. and Ph.D. levels: aquatic biology, environmental chemistry, hydrologic science, limnology, water management technology, water policy, water quality, and watershed science and management. Approximately 80 courses offered within 15 other graduate programs are available to students majoring in water resources science.

The goal of the program is to produce scientists with strong technical skills in disciplines relevant to water resources and a broad understanding of 1) the hydrologic cycle and associated ecosystems, 2) the interconnectedness of the sciences involved in managing aquatic resources, and 3) the interplay between the biophysical sciences and social sciences in developing and implementing public policies related to water.

The program involves faculty from the following departments on the Twin Cities campus: Applied Economics; Bioproducts and Biosystems Engineering; Civil Engineering; Ecology, Evolution, and

Behavior; Entomology; Environmental and Occupational Health; Fisheries, Wildlife, and Conservation Biology; Forest Resources; Geography; Horticultural Science; Geology and Geophysics; Microbiology, Plant Biology; Soil, Water, and Climate; and the Humphrey Institute of Public Affairs. It also involves faculty from the following departments on the Duluth campus: Biology, Chemical Engineering, Chemistry, Geography, Geological Sciences, Physics, and Political Science, as well as the Large Lakes Observatory and the Natural Resources Research Institute in Duluth.

**Prerequisites for Admission**—The program is flexible enough to accommodate students from a variety of backgrounds. Normally students have a bachelor's degree in physical or biological science or engineering. Recommended academic preparation includes one year (or two semesters) each of calculus, physics, and chemistry and one biology course. Further preparation may be expected from students wishing to specialize in certain areas of the program. Students who do not have a master's degree in a related subject are admitted to the M.S. program first, even if their long-term goal is a Ph.D. degree. Availability of funding and willingness of a member of the graduate faculty to serve as an advisor are important criteria for admission to the Ph.D. program.

**Special Application Requirements**—Applicants must submit three letters of recommendation via the Graduate School ApplyYourself Web site. These letters should be from professors qualified to estimate applicant's class rank and evaluate their ability to complete a program of graduate study, or from persons who can assess their professional or research potential. These letters also may be used in applying for financial aid.

Applicants must also submit a résumé of their academic history and professional experience and a statement of purpose, including the proposed area of emphasis. Applicants should submit results of the GRE; only rarely, under extenuating circumstances, will students be considered for admission without GRE scores. Students may be admitted any semester but are strongly encouraged to begin fall semester and to submit their application by January 1 in the year they expect to begin their studies.

**Courses**—Refer to Water Resources Science (WRS) in the course section of this catalog for courses pertaining to the program. Check the program Web site at <http://wrs.umn.edu> for additional course information.

**Use of 4xxx Courses**—Use of 4xxx courses is permitted for degree requirements based on approval by the advisor and the director of graduate studies.

## M.S. Degree Requirements

Students may choose Plan A, which requires a thesis, or Plan B, which requires additional coursework and a major project. Both plans incorporate courses offered on the Twin Cities and Duluth campuses.

Students must complete courses in four core areas: 1) hydrology (surface and/or hydrogeology); 2) environmental/water chemistry; 3) limnology; and 4) water resources policy, economics, and management, and two electives in such areas of emphasis as aquatic biology, hydrologic science, watershed science and management, and water management technology. One elective must be from an approved list of technical courses dealing with water quality science/management. A minimum of two supporting courses (at least 6 credits) outside of aquatic science also are required. Training in responsible conduct of research and ethics is also required. Approved core and area of emphasis courses are listed on the program Web site at <http://wrs.umn.edu>.

A minimum of 20 course credits (plus 10 thesis credits) are required for Plan A and a minimum of 30 credits are required for Plan B (up to 3 credits may be used for the Plan B project). Students who had classes equivalent to those in the WRS core as undergraduates may substitute other classes to meet the Graduate School minimum credit requirements.

**Language Requirements**—None.

**Final Exam**—The final exam is oral.

## Minor Requirements for Students

**Majoring in Other Fields**—A master's minor requires 9 credits, including WRS 5101 (3 credits) or in Duluth POL 4201 (4 credits) and two of the other core courses described under M.S. degree requirements.

## Ph.D. Degree Requirements

Coursework is tailored to student interests, and many areas of emphasis are possible. Core courses are offered on both the Twin Cities and Duluth campuses.

Students complete coursework equivalent to that of an M.S. in Water Resources Science, with additional coursework in an area of emphasis. There are no specific credit requirements in the major, but Ph.D. programs normally include at least 40 course credits beyond the B.S. level, including relevant coursework taken for a master's

degree and a required minimum of 12 credits in a minor or supporting program.

**Language Requirements**—None.

## Minor Requirements for Students

**Majoring in Other Fields**—Doctoral students must complete 12 credits, including WRS 5101 (3 credits) or in Duluth POL 4201 (4 credits), a core courses described under the M.S. degree requirements, and two electives from one of the areas of emphasis.

# Rochester and Twin Cities Campus Degree Program

## Biomedical Informatics and Computational Biology M.S. and Ph.D.

**Contact Information**—Biomedical Informatics and Computational Biology, University of Minnesota Rochester, 300 University Square, 111 South Broadway, Rochester, MN 55904 (507-281-7791; [bicgrad@umn.edu](mailto:bicgrad@umn.edu))

For latest graduate faculty listings, see [www.grad.umn.edu/faculty\\_rosters/faculty.html](http://www.grad.umn.edu/faculty_rosters/faculty.html).

### Professor

**Massoud Amin**, Electrical and Computer Engineering, SM  
**Ann Bode**, Cellular and Molecular Biology, Hormel Institute, SM  
**Daniel Boley**, Computer Science and Engineering, SM  
**John Carlis**, Computer Science and Engineering, SM  
**Connie W. Delaney**, School of Nursing, SM  
**Zigang Dong**, Cellular and Molecular Biology, Hormel Institute, SM  
**Lynda Ellis** *Medicine and Pathology*, SM  
**Jiali Gao**, Chemistry, SM  
**Vipin Kumar**, Computer Science and Engineering, SM  
**Mitchell Luskin**, Mathematics, SM  
**Claudia Neuhauser**, University of Minnesota Rochester, SM  
**Hans Othmer**, Mathematics, SM  
**Wei Pan**, School of Public Health, SM  
**Stuart Speedie**, Laboratory Medicine and Pathology, SM  
**Ahmed Tewfik**, Electrical and Computer Engineering  
**Larry Wackett**, Biochemistry, Molecular Biology, and Biophysics, SM

### Adjunct Professor

**Karla Ballman**, Biostatistics, Mayo Clinic, SM  
**Zeljko Bajzer**, Biochemistry, Mayo Clinic, SM  
**Christopher Chute**, Medical Informatics, Mayo Clinic, SM

**Stephen Ekker**, Biochemistry and Molecular Biology, Mayo Clinic, SM  
**Peter Li**, Biomedical Informatics, Mayo Clinic, SM  
**Yuan-Ping Pang**, Pharmacology, Mayo Clinic, SM

### Associate Professor

**Yang Da**, Animal Science, SM  
**Fumiaki Katagiri**, Plant Biology, SM  
**Arkady Khodursky**, Biochemistry, Molecular Biology, and Biophysics, SM  
**Cavan Reilly**, School of Public Health, SM  
**Darrin York**, Chemistry, SM

### Adjunct Associate Professor

**Armando Manduca**, Biophysics, Mayo Clinic, SM

### Assistant Professor

**Elizabeth Amin**, College of Pharmacy, SM  
**Rui Kuang**, Computer Science and Engineering, SM  
**Mohamed Mokbel**, Computer Science and Engineering, SM  
**Chad Myers**, Computer Science and Engineering, SM  
**Marc Riedel**, Electrical and Computer Engineering, SM  
**William Schuler**, Computer Science and Engineering, SM

### Adjunct Assistant Professor

**John W Eberhard**, IBM, SM  
**Jean-Pierre Kocher**, Biomedical Informatics, Mayo Clinic, SM  
**George Paulik**, IBM, SM  
**Carlos Sosa**, IBM, SM  
**George Vasmatazis**, Laboratory Medicine, Mayo Clinic, SM

### Other

**Drew Flaada**, IBM, M2  
**Mike Good**, IBM, M2  
**Paul Mattson**, IBM, M2

Along with the program-specific requirements listed below, please read the General Information section of this catalog for Graduate School requirements that apply to all major fields.

**Curriculum**—The graduate program in biomedical informatics and computational biology offers course work in five core areas: 1) biochemistry, molecular and cell biology; 2) database, data mining, and computing; 3) informatics, analysis, and machine learning; 4) mathematics, biostatistics, and statistics; and 5) computational and systems biology. In addition, students select courses from a diverse set of fields, including chemistry, chemical engineering, physics, biophysics, structural biology, imaging, signal processing, and clinical and translational sciences. The curriculum is individualized to fit the student's interest and research direction. Prior coursework may be used to fill the requirements if appropriate. Students may pursue a minor in a different program.



All students receive training in ethics, leadership, and management, including legal and intellectual property issues and entrepreneurship. The Ph.D. program includes an industrial or clinical internship. Students interested in an academic career have the opportunity to participate in development programs that focus on aspects of teaching and learning.

**Prerequisites for Admission**—The program expects incoming graduate students to have a strong background in the quantitative sciences and varied backgrounds in the life/health sciences. We expect incoming graduate students to have taken the following courses at the undergraduate level prior to entering the program: calculus (one year), introductory computer science course and basic programming skills (one semester), chemistry (one year), general biology (one semester). In addition, we expect students to have background in two of the three areas: 1) multivariable calculus, differential equations, linear algebra; 2) algorithms and data structure, discrete mathematics; 3) statistics or biostatistics, probability theory. Students with a stronger training in the life/health sciences may replace one of the three areas by one of the following two areas: 1) biochemistry, genetics, and cell biology; or 2) health sciences (pharmacology, physiology, or related areas). The expected competencies of incoming students may be demonstrated by coursework completed at the undergraduate level or by informal competency examinations. Some deficiencies may be made up during the first year of study through coursework or individualized study.

**Special Application Requirements**—Three letters of recommendation and scores from the General Test of the GRE are required. Applicants are considered for admission only for the fall semester.

**Courses**—Refer to Biomedical Informatics and Computational Biology (BICB) in the course section of this catalog for courses pertaining to the program and to the BICB program web site for a list of courses that may be used to fulfill program requirements.

**Use of 4xxx Courses**—Inclusion of 4xxx courses on degree program forms is subject to adviser and director of graduate studies approval. There is a limit of one 4xxx course.

## M.S. Degree Requirements

The M.S. is offered under two plans: Plan A (with thesis), and Plan B (with project). Plan A is considered suitable for students planning to pursue a career that requires a limited research experience or to continue their education in a Ph.D. program. Plan A students defend their thesis in public and must pass an oral examination. Plan A is suitable for students with full-time employment whose thesis can be related to their work assignments. Plan B is suitable for students planning to work in settings where technical knowledge is more germane than research experience. Plan B students complete a project under the direction of a faculty member and present the work to their faculty committee in an oral exam. The requirements include 20 course credits for Plan A and 30 course credits for Plan B.

**Language Requirements**—None.

**Final Exam**—The final exam is oral.

### Minor Requirements for Students

**Majoring in Other Fields**—Programs are arranged on an individual basis. A minimum of 9 credits must be completed in Core Area 1 and one of the Core Areas 2–5.

## Ph.D. Degree Requirements

Ph.D. students take preliminary written exams at the end of the second year of study that consists of a research proposal. An oral preliminary exam focuses on the plan for thesis research and the student's coursework and is taken by the fall of the third year of full-time registration or its equivalent. At least 24 course credits are required to gain competency in both biology and quantitative areas related to biomedical informatics and computational biology. An internship is required, which may be waived for students with equivalent experience. Additionally, 24 thesis credits are required. Ph.D. students defend their thesis in public and must pass an oral examination.

**Language Requirements**—None.

### Minor Requirements for Students

**Majoring in Other Fields**—Programs are arranged on an individual basis. A minimum of 12 credits must be completed in Core Area 1 and two of the Core Areas 2–5.