Twin Cities Campus

Biochemistry, Molecular Biology and Biophysics M.S.

Biochemistry, Molecular Biology, & Biophysics TCBS

Graduate School

Link to a list of faculty for this program.

Contact Information:
Department of Biochemistry, Molecular Biology and Biophysics
6-155 Jackson Hall
321 Church St. SE
Minneapolis, MN 55455
612-625-6100
Email: bmbbgp@umn.edu
Website: http://cbs.umn.edu/academics/departments/bmbb/graduate-program/about-graduate-program

- Program Type: Master's
- Requirements for this program are current for Fall 2018
- Length of program in credits: 30
- This program requires summer semesters for timely completion.
- Degree: Master of Science

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

The biochemistry, molecular biology and biophysics (BMBB) graduate program is an interdisciplinary program that is supported by the College of Biological Sciences (CBS) and the Medical School of the University of Minnesota. The program provides a broad research-based education involving faculty from BMBB, as well as many faculty members from several other departments in CBS, the Medical School, the College of Science and Engineering (CSE), the College of Food, Agricultural and Natural Resources Sciences (CFANS), and the College of Veterinary Medicine.

BMBB focuses on determining the molecular mechanisms that underlie basic biological functions using an integrated approach that encompasses biochemistry, chemistry, biophysics, genomics, molecular biology, proteomics, and structural biology. Special emphasis is placed on revealing how biological processes go awry in diseases including cancer, diabetes, heart disease, and AIDS. The program has four areas of emphasis: synthetic biology and biotechnology, molecular biology, metabolic and systems biology, and chemical and structural biology. All students are expected to demonstrate a minimum level of competence in these areas, but will emphasize the area most related to their thesis project.

While graduate training in a BMBB laboratory involves first-year coursework and associated preliminary examinations, the focal point for graduate education is thesis research. Laboratory-based exploration coupled with journal clubs, seminars, scientific meetings and retreats, career counseling, and scientific ethics constitutes the major components of the program. Support for graduate education comes from a variety of sources but is augmented by several NIH and NSF-based training grants. Most graduate students from the University of Minnesota obtain full-time employment immediately after graduation or pursue advanced training in academic or corporate positions.

Students pursuing a degree in BMBB are only admitted to the PhD program (see note below) under the auspices of Molecular, Cellular and Structural Biology (MCSB), a first-year program administered by BMBB and the Molecular, Cellular, Developmental Biology and Genetics (MCDB&G) graduate programs. After the first year, students select either BMBB or MCDB&G to complete their degree.

Note: One cannot apply for admission to the master's degree in BMBB. Students are only admitted to the BMBB PhD program. Alternative, related master's degree programs that admit students are the master's in biological Sciences (MBS) (http://cce.umn.edu/master-of-biological-sciences) and the master's in microbial engineering (http://bti.umn.edu/MicE/).

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The program can accommodate for a variety of educational backgrounds. However, applications from students with an undergraduate degree in the biological, chemical, or physical sciences are encouraged.
The program can accommodate for a variety of educational backgrounds. However, applications from students with an advanced degree in the biological, chemical, or physical sciences are encouraged.

Other requirements to be completed before admission:
Recommended academic preparation includes one year each of calculus, organic chemistry, and basic biology, including biochemistry and genetics. For students of demonstrated ability, background deficiencies can be made up during the first year of graduate study.

Successful applicants must have previous research experience in an academic or industrial setting, in addition to any course-related laboratory experiences. It is important to demonstrate familiarity, with an aptitude for basic science research prior to embarking on a graduate career in this program.

***Note: Students are admitted only to the PhD program for BMBB (see additional note below).

Special Application Requirements:
Additionally, applicants must submit three letters of recommendation from persons familiar with their academic and research capabilities. A statement of interests and goals, a complete set of transcripts, and official scores from the General Test of the GRE are required. The GRE Subject Test in biochemistry, cell and molecular biology, biology, or chemistry is strongly recommended, but not required.

The deadline to submit a completed application is December 1. Completed files are reviewed between January and February. Graduate studies begin fall semester only.

Note: One cannot apply for admission to the master's degree in BMBB. Students are only admitted to the BMBB PhD program. Alternative, related master's degree programs that admit students are the Master of Biological Sciences (MBS) (http://cce.umn.edu/master-of-biological-sciences) and the Master in Microbial Engineering (http://bti.umn.edu/MicE/).

Applicants must submit their test score(s) from the following:
• GRE

Key to test abbreviations (GRE).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
Plan A: Plan A requires 20 major credits, 0 credits outside the major, and 10 thesis credits. The final exam is oral.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 3.0 is required for students to remain in good standing.

All students are expected to participate in seminars involving student reports on current literature and research.

Biochemistry Core (1 Credit)
Take the following core course for 1 credit:
BIOC 8401 - Ethics, Public Policy, and Careers in Molecular and Cellular Biology (1.0 cr)

Laboratory and Field Course (1 Credit)
Take MCDG 8920 for at least 1 credit. In August of the first year, BMBB students must register for this hands-on, intensive lab course that takes place at the Itasca Biological Station and Laboratories, which provides first-year students with exposure to a range of modern methods and model systems.
MCDG 8920 - Special Topics (1.0 - 4.0 cr)

Module Options (6 Credits)
Complete 6 credits in consultation with the director of graduate studies.
BIOC 5535 - Introduction to Modern Structural Biology - Diffraction (2.0 cr)
BIOC 5536 - Introduction to Modern Structural Biology - Nuclear Magnetic Resonance (2.0 cr)
BIOC 8005 - Biochemistry: Structure and Catalysis (2.0 cr)
BIOC 8006 - Biochemistry: Metabolism and Control (2.0 cr)
BIOC 8007 - Molecular Biology of DNA (2.0 cr)
BIOC 8008 - Molecular Biology of RNA (2.0 cr)
Electives (12 Credits)
Take 12 credits of coursework in one of the four BMBB emphases: synthetic biology and biotechnology, molecular biology, metabolic and systems biology, or chemical and structural biology. Courses from disciplines other than BMBB, in consultation with the advisor, may be used to build an emphasis.

Take 12 or more credit(s) from the following:

- BIOC 5352 - Biotechnology and Bioengineering for Biochemists (3.0 cr)
- BIOC 5361 - Microbial Genomics and Bioinformatics (3.0 cr)
- MICA 8002 - Structure, Function, and Genetics of Bacteria and Viruses (4.0 cr)
- GCD 8151 - Cellular Biochemistry and Cell Biology (2.0 - 4.0 cr)
- MICA 8003 - Immunity and Immunopathology (4.0 cr)
- MICA 8004 - Cellular and Cancer Biology (4.0 cr)
- GCD 8131 - Advanced Molecular Genetics and Genomics (3.0 cr)
- GCD 8008 - Mammalian Gene Transfer and Genome Engineering (2.0 cr)
- PUBH 6450 - Biostatistics I (4.0 cr)
- SSB 8181 - Stem Cell Biology (3.0 cr)
- STAT 5021 - Statistical Analysis (4.0 cr)
- MICA 8010 - Microbial Pathogenesis (3.0 cr)
- BIOC 5216 - Current Topics in Signal Transduction (3.0 cr)
- BIOC 5527 - Introduction to Modern Structural Biology (4.0 cr)
- BIOC 5528 - Spectroscopy and Kinetics (4.0 cr)
- CHEN 8754 - Systems Analysis of Biological Processes (3.0 cr)
- BIOC 5213 - Selected Topics in Molecular Biology (3.0 cr)
- BIOC 5444 - Muscle (3.0 cr)
- CHEM 8011 - Mechanisms of Chemical Reactions (4.0 cr)
- CHEM 8021 - Computational Chemistry (4.0 cr)
- CHEM 8411 - Introduction to Chemical Biology (4.0 cr)
- CHEM 8412 - Chemical Biology of Enzymes (4.0 cr)
- CHEM 8735 - Bioinorganic Chemistry (4.0 cr)
- PHCL 5111 - Pharmacogenomics (3.0 cr)
- PUBH 7445 - Statistics for Human Genetics and Molecular Biology (3.0 cr)
- MICA 8013 - Translational Cancer Research (2.0 cr)
- GRAD 8101 - Teaching in Higher Education (3.0 cr)
- GRAD 8200 - Teaching and Learning Topics in Higher Education (1.0 cr)
- BIOC 5309 - Biocatalysis and Biodegradation (3.0 cr)
- BIOC 5351 - Protein Engineering (3.0 cr)
- CSCI 5461 - Functional Genomics, Systems Biology, and Bioinformatics (3.0 cr)
- GRAD 5102 - Preparation for University Teaching for Nonnative English Speakers (2.0 cr)
- BIOC 8184 - Graduate Seminar (1.0 cr)
- BIOC 8084 - Research and Literature Reports (1.0 cr)
- BIOL 8100 - Improvisation for Scientists (1.0 cr)
- GCD 5005 - Computer Programming for Biology (3.0 cr)

Thesis Credits
Take at least 10 master's thesis credits.

BIOC 8777 - Thesis Credits: Master's (1.0 - 18.0 cr)
Biochemistry, Molecular Biology and Biophysics Minor

Twin Cities Campus
Biochemistry, Molecular Biology, & Biophysics TCBS
Graduate School

Link to a list of faculty for this program.

Contact Information:
Department of Biochemistry, Molecular Biology and Biophysics
6-155 Jackson Hall
321 Church St. SE
Minneapolis, MN 55455
612-625-6100
Email: bmbbgp@umn.edu
Website: http://cbs.umn.edu/academics/departments/bmbb/graduate-program/about-graduate-program

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2018
- Length of program in credits (Masters): 6
- Length of program in credits (Doctorate): 12
- This program does not require summer semesters for timely completion.

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

The biochemistry, molecular biology and biophysics (BMBB) program is an interdisciplinary program that is supported by the College of Biological Sciences (CBS) and the Medical School of the University of Minnesota. The program provides a broad research-based education involving faculty from BMBB as well as many faculty members from several other departments in CBS, the Medical School, the College of Science and Engineering (CSE), the College of Food, Agricultural and Natural Resources Sciences (CFANS), and the College of Veterinary Medicine.

BMBB focuses on determining the molecular mechanisms that underlie basic biological functions using an integrated approach that encompasses biochemistry, chemistry, biophysics, genomics, molecular biology, proteomics, and structural biology. Special emphasis is placed on revealing how biological processes go awry in diseases including cancer, diabetes, heart disease, and AIDS. The program has four areas of emphasis: synthetic biology and biotechnology, molecular biology, metabolic and systems biology, and chemical and structural biology. All students are expected to demonstrate a minimum level of competence in these areas, but will emphasize the area most related to their thesis project.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
Use of 4xxx courses towards program requirements is not permitted.

Program Sub-plans
Students are required to complete one of the following sub-plans.
Students may not complete the program with more than one sub-plan.

Masters
Required Courses (6 Credits)
Select at least six credits of BMBB coursework, chosen in consultation with the BMBB director of graduate studies. In extenuating cases, an alternative course may be substituted with the approval of the director of graduate studies.
Doctoral Modules (6 Credits)
Take at least 6 credits from the following, in consultation with the BMBB director of graduate studies.

- BIOC 5535 - Introduction to Modern Structural Biology - Diffraction (2.0 cr)
- BIOC 5536 - Introduction to Modern Structural Biology - Nuclear Magnetic Resonance (2.0 cr)
- BIOC 8005 - Biochemistry: Structure and Catalysis (2.0 cr)
- BIOC 8006 - Biochemistry: Metabolism and Control (2.0 cr)
- BIOC 8007 - Molecular Biology of DNA (2.0 cr)
- BIOC 8008 - Molecular Biology of RNA (2.0 cr)

Biochemistry Electives (6 Credits)
Take at least six credits, chosen in consultation with the BMBB director of graduate studies, to complete the 12-credit requirement. In extenuating cases, an alternative course may be substituted with the approval of the director of graduate studies.

- BIOC 5xxx
- BIOC 6xxx
- BIOC 7xxx
- BIOC 8xxx
- GCD 5036 - Molecular Cell Biology (3.0 cr)
Twin Cities Campus
Biochemistry, Molecular Biology and Biophysics Ph.D.
Biochemistry, Molecular Biology, & Biophysics TCBS
Graduate School

Link to a list of faculty for this program.

Contact Information:
Department of Biochemistry, Molecular Biology and Biophysics
6-155 Jackson Hall
321 Church St. SE
Minneapolis, MN 55455
612-625-6100
Email: bmbbgp@umn.edu
Website: http://cbs.umn.edu/academics/departments/bmbb/graduate-program/about-graduate-program

- Program Type: Doctorate
- Requirements for this program are current for Fall 2018
- Length of program in credits: 48
- This program requires summer semesters for timely completion.
- Degree: Doctor of Philosophy

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

The Biochemistry, Molecular Biology and Biophysics (BMBB) graduate program is an interdisciplinary program that is supported by the College of Biological Sciences (CBS) and the Medical School of the University of Minnesota. The program provides a broad research-based education involving faculty from BMBB as well as many faculty members from several other departments in CBS, the Medical School, the College of Science and Engineering (CSE), the College of Food, Agricultural and Natural Resources Sciences (CFANS), and the College of Veterinary Medicine.

BMBB focuses on determining the molecular mechanisms that underlie basic biological functions using an integrated approach that encompasses biochemistry, chemistry, biophysics, genomics, molecular biology, proteomics, and structural biology. Special emphasis is placed on revealing how biological processes go awry in diseases including cancer, diabetes, heart disease, and AIDS. The program has four areas of emphasis: synthetic biology and biotechnology, molecular biology, metabolic and systems biology, and chemical and structural biology. All students are expected to demonstrate a minimum level of competence in these areas but will emphasize the area most related to their thesis project.

While graduate training in a BMBB laboratory involves first-year coursework and associated preliminary examinations, the focal point for graduate education is thesis research. Laboratory-based exploration coupled with journal clubs, seminars, scientific meetings and retreats, career counseling and scientific ethics constitutes the major components of the program. Support for graduate education comes from a variety of sources but is augmented by several NIH and NSF-based training grants. PhD graduates from the University of Minnesota obtain full-time employment immediately after graduation or pursue advanced training in academic or corporate postdoctoral positions.

Students pursuing the PhD are admitted to BMBB under the auspices of Molecular, Cellular and Structural Biology (MCSB), a first year program administered by BMBB and the Molecular, Cellular, Developmental Biology and Genetics (MCDB&G) graduate programs. After the first year, students select either BMBB or MCDB&G to complete their degree.

Related PhD and MS programs in BMBB:

As a part of the BMBB program, graduate studies leading to a PhD degree may be pursued on the Duluth campus. A PhD in BMBB may also be obtained through the Combined MD-PhD program. Please visit the program website for more information (http://www.med.umn.edu/mdphd/index.htm).

Note: One cannot apply for admission to the master's degree in BMBB. Students are only admitted to the BMBB PhD program. Alternative, related master's degree programs that admit students are the master's of biological sciences (MBS) (http://cce.umn.edu/master-of-biological-sciences) and the master's in microbial engineering (http://blt.umn.edu/MicE/).

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)
Prerequisites for Admission
The program can accommodate for a variety of educational backgrounds. However, applications from students with an undergraduate degree in the biological, chemical, or physical sciences are encouraged.

The program can accommodate for a variety of educational backgrounds. However, applications from students with an advanced degree in the biological, chemical, or physical sciences are encouraged.

Other requirements to be completed before admission:
Recommended academic preparation includes one year each of calculus, organic chemistry, and basic biology, including biochemistry and genetics. For students of demonstrated ability, background deficiencies can be made up during the first year of graduate study.

Successful applicants must have previous research experience in an academic or industrial setting in addition to any course-related laboratory experiences. It is important to demonstrate an aptitude for basic science research prior to embarking on a graduate career in this program.

Special Application Requirements:
Additionally, applicants must submit three letters of recommendation from persons familiar with their academic and research capabilities. A statement of interests and goals, and a complete set of transcripts are required.

The deadline to submit a completed application is December 1. Completed files are reviewed between January and February. Graduate studies begin fall semester only.

Related Ph.D. and M.S. Programs in BMBB:
As a part of the BMBB program, graduate studies leading to a PhD degree may be pursued on the Duluth Campus. A PhD in BMBB may also be obtained through the Combined MD-PhD Program. Please visit the program website for more information (http://www.med.umn.edu/mdphd/index.htm).

Note: One cannot apply for admission to the master's degree in BMBB. Students are only admitted to the BMBB PhD program. Alternative, related master's degree programs that admit students are the Master of Biological Sciences (MBS) (http://cce.umn.edu/master-of-biological-sciences) and the Master in Microbial Engineering (http://bti.umn.edu/MicE/).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
24 credits are required in the major.
0 credits are required outside the major.
24 thesis credits are required.

This program may not be completed with a minor.

Use of 4xxx courses towards program requirements is not permitted.

A minimum GPA of 3.00 is required for students to remain in good standing.

Requirements include core coursework, thesis credits, and laboratory experiences, as well as coursework in one of the four BMBB emphases listed below.

Additional requirements for the PhD degree include seminar presentations, examinations, and teaching assignments. BIOC 8084 is a weekly student seminar on current literature and research, and students must register for 1 credit of BIOC 8084 each term until they have reached advanced doctoral status. BIOC 8184 is a departmental seminar involving prominent national and international scientists. Students must attend at least 50% of weekly meetings for BIOC 8084 and BIOC 8184. Students are also required to complete two semesters of teaching, typically between years 2 to 4.

Biochemistry Core Coursework (3 Credits)
Complete the following core courses. MCDBG 8920 must be taken for two credits.
BIOC 8401 - Ethics, Public Policy, and Careers in Molecular and Cellular Biology (1.0 cr)
MCDBG 8920 - Special Topics (1.0 - 4.0 cr)
Complete six credits, in consultation with the director of graduate studies, from the following list:
BIOC 5535 - Introduction to Modern Structural Biology -- Diffraction (2.0 cr)
BIOC 5536 - Introduction to Modern Structural Biology - Nuclear Magnetic Resonance (2.0 cr)
BIOC 8005 - Biochemistry: Structure and Catalysis (2.0 cr)
BIOC 8006 - Biochemistry: Metabolism and Control (2.0 cr)
BIOC 8007 - Molecular Biology of DNA (2.0 cr)
BIOC 8008 - Molecular Biology of RNA (2.0 cr)

Emphasis Electives (15 Credits)
Complete 15 credits of coursework in one of the four BMBB emphases: synthetic biology and biotechnology, molecular biology, metabolic and systems biology, or chemical and structural biology. Courses from disciplines other than BMBB may be used to build an emphasis in consultation with the advisor.
Take 15 or more credit(s) from the following:
• BIOC 5352 - Biotechnology and Bioengineering for Biochemists (3.0 cr)
• BIOC 5361 - Microbial Genomics and Bioinformatics (3.0 cr)
• MICA 8002 - Structure, Function, and Genetics of Bacteria and Viruses (4.0 cr)
• GCD 8151 - Cellular Biochemistry and Cell Biology (3.0 cr)
• MICA 8003 - Immunity and Immunopathology (4.0 cr)
• MICA 8004 - Cellular and Cancer Biology (4.0 cr)
• GCD 8131 - Advanced Molecular Genetics and Genomics (3.0 cr)
• GCD 8008 - Mammalian Gene Transfer and Genome Engineering (2.0 cr)
• PUBH 6450 - Biostatistics I (4.0 cr)
• SCB 8181 - Stem Cell Biology (3.0 cr)
• STAT 5021 - Statistical Analysis (4.0 cr)
• MICA 8010 - Microbial Pathogenesis (3.0 cr)
• BIOC 5216 - Current Topics in Signal Transduction (3.0 cr)
• BIOC 5527 - Introduction to Modern Structural Biology (4.0 cr)
• BIOC 5528 - Spectroscopy and Kinetics (4.0 cr)
• CHEN 8754 - Systems Analysis of Biological Processes (3.0 cr)
• BIOC 5213 - Selected Topics in Molecular Biology (3.0 cr)
• BIOC 5444 - Muscle (3.0 cr)
• CHEM 8011 - Mechanisms of Chemical Reactions (4.0 cr)
• CHEM 8021 - Computational Chemistry (4.0 cr)
• CHEM 8411 - Introduction to Chemical Biology (4.0 cr)
• CHEM 8412 - Chemical Biology of Enzymes (4.0 cr)
• CHEM 8735 - Bioinorganic Chemistry (4.0 cr)
• PHCL 5111 - Pharmacogenomics (3.0 cr)
• PUBH 7445 - Statistics for Human Genetics and Molecular Biology (3.0 cr)
• MICA 8013 - Translational Cancer Research (2.0 cr)
• GRAD 8101 - Teaching in Higher Education (3.0 cr)
• GRAD 8200 - Teaching and Learning Topics in Higher Education (1.0 cr)
• BIOC 5309 - Biocaltasis and Biodegradation (3.0 cr)
• BIOC 5351 - Protein Engineering (3.0 cr)
• CSCI 5461 - Functional Genomics, Systems Biology, and Bioinformatics (3.0 cr)
• GRAD 5102 - Preparation for University Teaching for Nonnative English Speakers (2.0 cr)
• BIOC 8084 - Research and Literature Reports (1.0 cr)
• BIOC 8184 - Graduate Seminar (1.0 cr)
• BIOL 8100 - Improvisation for Scientists (1.0 cr)
• GCD 5005 - Computer Programming for Biology (3.0 cr)

Thesis Credits
Take 24 doctoral thesis credits.
BIOC 8888 - Thesis Credit: Doctoral (1.0 - 24.0 cr)

Joint- or Dual-degree Coursework: MD/PhD-Biochemistry, Molecular Biology and BiophysicsStudent may take a total of 18 credits in common among the academic programs.
Twin Cities Campus
Bioethics M.A.
Bioethics, Center for
Graduate School

Link to a list of faculty for this program.

Contact Information:
Center for Bioethics, University of Minnesota, Suite N504 Boynton, 410 Church Street SE, Minneapolis, MN 55455 (612-624-9440; fax: 612-624-9108)
Email: bthxed@umn.edu
Website: http://www.bioethics.umn.edu/education/master-arts-bioethics

- Program Type: Master's
- Requirements for this program are current for Fall 2018
- Length of program in credits: 30
- This program does not require summer semesters for timely completion.
- Degree: Master of Arts

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

Admissions for the Bioethics MA Program are currently on hold. Please contact bthxed@umn.edu for updates.

The Center for Bioethics offers two kinds of MA degrees: Plan A and Plan B with a major in bioethics. The curriculum for both Plan A and Plan B degrees includes a set of required core courses, bioethics electives, and a requirement for coursework in fields related to bioethics. The Plan A culminates in a substantial, 10-credit master's thesis. In lieu of a thesis, the Plan B culminates in a 4-credit practicum, a 3-credit capstone project and final exam. Electives comprise the additional 3 credits in the Plan B degree.

Graduates of the MA in bioethics greatly enhance their professional opportunities in the field when they combine their bioethics degree with a terminal graduate or professional degree in another field. Examples of degree combinations can include an MA degree in bioethics with a JD, PhD, MD, nursing, or others. This model of pairing the MA in bioethics with another degree prompts students to acquire a firm disciplinary grounding as well as interdisciplinary bioethics expertise, a practice which best prepares students for the interdisciplinary career options related to bioethics. Some examples of careers include work in the fields of genetics, social work, public health, veterinary science, religious studies, psychology, biology and philosophy.

Program Delivery
This program is available:
• via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

A bachelor's degree is required for admission.

Special Application Requirements:
Transcripts of all postsecondary academic work, a personal statement, a writing sample (preferably on a topic in bioethics), a description of research or relevant work experience, a C.V. or résumé, and at least three letters of reference are required. Applicants may also submit a statement on “Extenuating Circumstances” and “Diversity.” See program website for more details.

Students are admitted to the Bioethics M.A. program for fall semester only. Applications are accepted as early as the first day of fall semester prior to the proposed start of the student's M.A. program. Our primary deadline is March 1 with an extended deadline of May 1 if space in our program remains available.

Students are encouraged to link their degree in bioethics to a degree in a related field (either before entering the bioethics M.A. program or at the same time). Given the fundamentally interdisciplinary nature of bioethics, prospective students are advised against viewing the bioethics M.A. as a stand-alone degree that prepares them for career placement. This model prompts students to acquire a firm disciplinary grounding as well as interdisciplinary bioethics expertise—a practice that best prepares students for bioethics-related career placement. Thus, the admissions process will give preference to students who have already earned or are in the process of earning an advanced degree in a related field, although this will not strictly be required for admission.
Because our program recommends pairing the Bioethics degree with another graduate or professional degree, we recognize applicants may need to answer to another program prior to our deadline. If this is the case, please email bthxed@umn.edu with your concern.

Applicants must submit their test score(s) from the following:

• GRE
• MCAT
• LSAT

International applicants must submit score(s) from one of the following tests:

• TOEFL
  - Internet Based - Total Score: 100
  - Paper Based - Total Score: 600

Key to test abbreviations (GRE, MCAT, LSAT, TOEFL).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements

Plan A: Plan A requires 14 major credits, 6 credits outside the major, and 10 thesis credits. The final exam is oral.

Plan B: Plan B requires 21 major credits and 9 credits outside the major. The final exam is written and oral. A capstone project is required.

Capstone Project: Students will design and undertake a project and its corollary product relevant to their interests, experience, and intended use of the MA in bioethics. The experiential component is designed to be flexible, allowing the student to undertake an internship, shadow physicians or other health care personnel, or use their own work experience when relevant to cater a project to their intended goals. Rigor is maintained through committee oversight, nature of the experience, and number of hours undertaken.

Products are also designed to be flexible while retaining rigor, innovation, and written analysis. Original research is not required (as with a thesis), but a thorough literature review and accompanying overview or synthesis of the arena of which the project is a part is necessary, as is a thorough explanation of the final product. Full committee approval of the final product before the project is undertaken is required.

This program may be completed with a minor.

Use of 4xxx courses towards program requirements is not permitted.

A minimum GPA of 3.00 is required for students to remain in good standing.

Joint- or Dual-degree Coursework: Joint Degree Program in Law, Health, and the Life Sciences Student may take a total of 11 credits in common among the academic programs.
Bioethics Minor
Bioethics, Center for
Graduate School

Link to a list of faculty for this program.

Contact Information:
Center for Bioethics, University of Minnesota, N504 Boynton, 410 Church Street SE, Minneapolis, MN 55455 (612-624-9440; fax: 612-624-9108)
Email: bthxed@umn.edu
Website: http://www.bioethics.umn.edu/education/graduate-minor-bioethics

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2018
- Length of program in credits (Masters): 8
- Length of program in credits (Doctorate): 14
- This program does not require summer semesters for timely completion.

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

The minor is administered by the Center for Bioethics and is designed for University of Minnesota students interested in deepening their knowledge of the ethical issues surrounding health and the life sciences. Explore your interests in bioethics while also earning a degree in your home discipline.

The minor is open to students in many of the University's masters or doctoral degree programs. Some professional degree-seeking students also may elect a minor, including MEd, MPH, MHA, MN, DNP, MOT, MPSE, MDH, MDT, and MPS students. To be eligible, the degree program must offer the option to pursue a minor; please consult with your director of graduate studies in your major field to determine if this option is open for you. At this time, students in first-professional programs (JD, MD, PharmD, DVM, DDS, and LLM) are not eligible for minors.

Enrollment is contingent upon approval by the director of graduate studies in bioethics. Students work with the director of graduate studies to tailor their minor program to their individual needs and interests.

Program Delivery
This program is available:
* via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
Other requirements to be completed before admission:
For an online application or for more information about graduate education admissions, see the General Information section of this website.

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
Use of 4xxx courses towards program requirements is not permitted.

Courses must be chosen in consultation with the bioethics director of graduate studies.

Philosophy students are expected to have successfully completed at least one course in ethical theory at the 5xxx or 8xxx level prior to undertaking coursework in the minor.

Students must complete the minor with a 3.00 GPA.

Bioethics Minor Required Courses
Complete either BTHX 5010 or BTHX 5325, not both.

BTHX 5010 - Bioethics Proseminar (2.0 cr)

or BTHX 5325 - Biomedical Ethics (3.0 cr)

Select one course.

BTHX 5300 - Foundations of Bioethics (3.0 cr)
or PHIL 5320 - Intensive Study of a Historical Moral Theory (3.0 cr)
or PHIL 8310 - Seminar: Moral Philosophy (3.0 cr)

Electives

Doctoral students must also take additional ethics courses to total 14 credits of required plus elective courses; at least 3 credits of the electives must be BTHX courses. Masters students must also take additional credits of ethics courses for a total of 8 credits of required plus elective courses. Any of the following BTHX courses may be taken as electives. The student may take courses offered through other designators only if they have the permission of the bioethics DGS.

BTHX 5000 - Topics in Bioethics (1.0 - 4.0 cr)
or BTHX 5100 - Introduction to Clinical Ethics (3.0 cr)
or BTHX 5110 - Ethical Issues in Pediatrics (2.0 cr)
or BTHX 5120 - Dying in Contemporary Medical Culture (2.0 cr)
or BTHX 5210 - Ethics of Human Subjects Research (3.0 cr)
or BTHX 5400 - Intro Ethics in Hlth Policy (3.0 cr)
or BTHX 5411 - Health Law and Policy (3.0 cr)
or BTHX 5453 - Law, Biomedicine, and Bioethics (3.0 cr)
or BTHX 5510 - Gender and the Politics of Health (3.0 cr)
or BTHX 5520 - Social Justice and Bioethics (3.0 cr)
or BTHX 5540 - Bioethics, Psychiatry & Psychology (3.0 cr)
or BTHX 5610 - Research & Publication Seminar (1.0 cr)
or BTHX 5620 - Social Context of Health and Illness (3.0 cr)
or BTHX 5630 - Bioethics Colloquium (1.0 cr)
or BTHX 5650 - Disability Ethics (3.0 cr)
or BTHX 5900 - Independent Study in Bioethics (1.0 - 4.0 cr)
or BTHX 8000 - Advanced Topics in Bioethics (1.0 - 4.0 cr)
or BTHX 8114 - Ethical and legal Issues in Genetic Counseling (3.0 cr)
or BTHX 8120 - Dying in Contemporary Medical Culture (2.0 cr)
or BTHX 8500 - Practicum in Bioethics (1.0 - 4.0 cr)
or BTHX 8510 - Gender and the Politics of Health (3.0 cr)
or BTHX 8520 - Social Justice and Bioethics (3.0 cr)
or BTHX 8610 - Medical Consumerism (3.0 cr)

Program Sub-plans

Students are required to complete one of the following sub-plans.

Students may not complete the program with more than one sub-plan.

Masters

Doctoral
**Twin Cities Campus**

**Biomedical Informatics and Computational Biology M.S.**

*R Bioscience/Biotechnology*

**Graduate School**

Link to a list of faculty for this program.

**Contact Information:**
Biomedical Informatics and Computational Biology, 300 University Square, 111 South Broadway, Rochester, MN 55904 (507-258-8006; fax: 507-258-8066)
Email: bicbgrad@umn.edu
Website: http://www.r.umn.edu/academics-research/bicb

- Program Type: Master's
- Requirements for this program are current for Fall 2018
- Length of program in credits: 30
- This program does not require summer semesters for timely completion.
- The Biomedical Informatics and Computational Biology Program is an all-University program delivered on the Rochester and Twin Cities campuses. The University of Minnesota Twin Cities is the degree-granting authority for delivery of the Biomedical Informatics and Computational Biology Program in Rochester.
- Degree: Master of Science

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

The graduate program in biomedical informatics and computational biology (BICB) 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. Those interested in academic careers have the opportunity to participate in development programs that focus on aspects of teaching and learning.

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 careers that require a limited research experience or those planning to continue their education in a Ph.D. program. It is also 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.

**Program Delivery**
This program is available:
- via classroom (the majority of instruction is face-to-face)

**Prerequisites for Admission**
Other requirements to be completed before admission:
The program expects incoming graduate students to have a strong background in the quantitative sciences and varied backgrounds in the life/health sciences. The expected competencies of incoming students may be demonstrated by coursework completed at the undergraduate level or by informal competency examinations.

In addition to completing the online application form, applicants must submit a personal statement, which describes past experiences and career aspirations, and reasons for pursuing graduate studies in biomedical informatics and computational biology. Applicants should also indicate the names of the BICB graduate faculty whose interests overlap their own. Although there is no page limit for the personal statement, 2-3 pages are recommended.

**Special Application Requirements:**
Applications for the M.S. program are accepted throughout the year for either fall or spring.

GRE scores may be waived for students with significant work or academic experience.
Applicants must submit their test score(s) from the following:
- GRE

International applicants must submit score(s) from one of the following tests:
- TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
  - Paper Based - Total Score: 550
- IELTS
  - Total Score: 6.5
- MELAB
  - Final score: 80

Key to test abbreviations (GRE, TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements

**Plan A:** Plan A requires 14 major credits, up to null credits outside the major, and 10 thesis credits. The final exam is oral.

**Plan B:** Plan B requires 24 major credits and up to null credits outside the major. The final exam is oral. A capstone project is required.

**Capstone Project:** 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.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 2.80 is required for students to remain in good standing.

At least 1 semesters must be completed before filing a Degree Program Form.

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 careers that require a limited research experience or those planning 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.

The requirements include 20 course credits for Plan A and 30 course credits for Plan B.

Up to 6 credits outside the major may be taken but are not required.

Program Sub-plans

A sub-plan is not required for this program. Students may not complete the program with more than one sub-plan.

Rochester
Twin Cities Campus
Biomedical Informatics and Computational Biology Minor
R Bioscience/Biotechnology
Graduate School

Link to a list of faculty for this program.

Contact Information:
Biomedical Informatics and Computational Biology, 300 University Square, 111 South Broadway, Rochester, MN 55904 (507-258-8006; fax: 507-258-8066)
Email: bicbgrad@umn.edu
Website: http://www.r.umn.edu/academics-research/bicb

• Program Type: Graduate minor related to major
• Requirements for this program are current for Fall 2018
• Length of program in credits (Masters): 9
• Length of program in credits (Doctorate): 12
• This program does not require summer semesters for timely completion.
• The Biomedical Informatics and Computational Biology Program is an all-University program delivered on the Rochester and Twin Cities campuses. The University of Minnesota Twin Cities is the degree-granting authority for delivery of the Biomedical Informatics and Computational Biology Program in Rochester.

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

The graduate program in biomedical informatics and computational biology (BICB) 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. Students interested in academic careers have the opportunity to participate in development programs that focus on aspects of teaching and learning.

Program Delivery
This program is available:
• via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
Special Application Requirements:
Minor programs are arranged on an individual basis.

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

Master's Minor: A minimum of 9 credits must be completed in Core Area 1 and one of Core Areas 2-5.

Doctoral Minor: A minimum of 12 credits must be completed in Core Area 1 and two of Core Areas 2-5.

Graduate students choose from a list of courses that satisfy requirements in core areas and electives.

There are five core areas:
1. Biochemistry, molecular and cell biology
2. Database, data mining, and computing

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Information current as of August 31, 2018
3. Informatics, analysis, and machine learning
4. Mathematics, biostatistics, and statistics
5. Computational and systems biology

Students choose elective courses from the following eight areas:
1. Biochemistry, molecular and cell biology
2. Informatics, database, data mining, and computing
3. Mathematics, biostatistics, and statistics
4. Chemistry, chemical engineering, and physics
5. Biophysics and structural biology
6. Imaging, information theory, and signal processing
7. Computational chemistry, medicinal chemistry, and drug design
8. Clinical and translational sciences

Core/elective courses are listed on the courses page of the BICB Student Handbook (http://r.umn.edu/academics-research/bicb/graduate-program/student-handbook/courses). The adviser(s), together with the DGS, will ensure that the student selects appropriate courses.
Twin Cities Campus
Biomedical Informatics and Computational Biology Ph.D.
R Bioscience/Biotechnology
Graduate School

Link to a list of faculty for this program.

Contact Information:
Biomedical Informatics and Computational Biology, 300 University Square, 111 South Broadway, Rochester, MN 55904 (507-258-8006; fax: 507-258-8066)
Email: biobgrad@umn.edu
Website: http://www.r.umn.edu/academics-research/bicb

• Program Type: Doctorate
• Requirements for this program are current for Fall 2018
• Length of program in credits: 60
• This program requires summer semesters for timely completion.
• The Biomedical Informatics and Computational Biology Program is an all-University program delivered on the Rochester and Twin Cities campuses. The University of Minnesota Twin Cities is the degree-granting authority for delivery of the Biomedical Informatics and Computational Biology Program in Rochester.
• Degree: Doctor of Philosophy

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

The graduate program in biomedical informatics and computational biology (BICB) 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 academic careers have the opportunity to participate in development programs that focus on aspects of teaching and learning.

Program Delivery
This program is available:
• via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
Other requirements to be completed before admission:
The program expects incoming graduate students to have a strong background in the quantitative sciences and varied backgrounds in the life/health sciences. The expected competencies of incoming students may be demonstrated by coursework completed at the undergraduate level or by informal competency examinations.

In addition to completing the online application form, applicants must submit a personal statement, which describes past experiences and career aspirations, and reasons for pursuing graduate studies in biomedical informatics and computational biology. Prospective students should also indicate the names of the BICB graduate faculty whose interests overlap with their own. The department strongly encourages applicants to contact these faculty members before applying. Although there is no page limit for the personal statement, 2-3 pages are recommended.

Special Application Requirements:
Three letters of recommendation and scores from the General Test of the GRE are required. Applicants are admitted only for the fall semester.

GRE scores may be waived for students with significant work or academic experience.

Applicants must submit their test score(s) from the following:
• GRE
International applicants must submit score(s) from one of the following tests:

- **TOEFL**
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
  - Paper Based - Total Score: 550

- **IELTS**
  - Total Score: 6.5

- **MELAB**
  - Final score: 80

Key to test abbreviations (GRE, TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

**Program Requirements**

30 credits are required in the major.

24 thesis credits are required.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 2.80 is required for students to remain in good standing.

Ph.D. students take preliminary written exams at the end of the second year of study, which focuses on the development 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.

An internship is required, which may be waived for students with equivalent experience.

Up to 9 credits outside the major may be taken but are not required.

**Program Sub-plans**

A sub-plan is not required for this program.

Students may not complete the program with more than one sub-plan.

Rochester
Twin Cities Campus

Biophysical Sciences and Medical Physics M.S.

Radiology Graduate School

Link to a list of faculty for this program.

Contact Information:
University of Minnesota School of Medicine, Department of Radiology, Box 292 UMHC, 420 Delaware Street S.E., Minneapolis, MN 55455 (612-626-0131; fax: 612-626-1951)
Email: riten001@tc.umn.edu
Website: http://www.med.umn.edu/radiology/research/physics/home.html

- Program Type: Master's
- Requirements for this program are current for Fall 2018
- Length of program in credits: 30
- This program does not require summer semesters for timely completion.
- Degree: Master of Science

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

This interdisciplinary program includes faculty members who have primary appointments in fields such as radiobiology, physics, engineering, computer science, physiology, dentistry, genetics, and biochemistry. Students concentrate in research areas such as molecular biophysics, medical imaging, magnetic resonance imaging and spectroscopy, radiobiology, radiation therapy physics, and mathematical biophysics and computation. A limited number of students prepare for employment as hospital-based medical physicists through a program that includes opportunities for coursework, laboratory work, and directed study to provide experience in areas such as purchase specification, acceptance testing, quality assurance, and radiation safety.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
Other requirements to be completed before admission:
All students should have some familiarity with physical chemistry, intermediate physics, intermediate mathematics, biostatistics, computer programming, biology, physiology, and biochemistry. This may be demonstrated by coursework completed at the undergraduate level or as part of the graduate program; by reading or practical experience; or by informal competency examinations.

Special Application Requirements:
Three letters of recommendation and scores from the General Test of the GRE are required. Applicants are considered for admission in both semesters.

Applicants must submit their test score(s) from the following:
- GRE

Key to test abbreviations (GRE).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
Plan A: Plan A requires 14 major credits, 6 credits outside the major, and 10 thesis credits. The final exam is oral.

Plan B: Plan B requires 14 major credits and 6 credits outside the major. The final exam is oral.

This program may be completed with a minor.
Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 2.80 is required for students to remain in good standing.

The M.S. is offered under two plans: Plan A, (with thesis), and Plan B, (with project). Plan A is considered suitable for students with full-time employment whose thesis can be related to their work assignments. Plan B is more suitable for students planning to work in government or hospital 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. A total of 30 credits is required, including 14 in the major and 6 in a related field or minor.
Twin Cities Campus

Biophysical Sciences and Medical Physics Minor

Radiology

Graduate School

Link to a list of faculty for this program.

Contact Information:
University of Minnesota School of Medicine, Department of Radiology, Box 292 UMHC, 420 Delaware Street S.E., Minneapolis, Minnesota 55455 (612-626-0131; fax: 612-626-1951)
Email: riten001@tc.umn.edu
Website: http://www.med.umn.edu/radiology/research/physics/home.html

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2018
- Length of program in credits (Masters): 6
- Length of program in credits (Doctorate): 12
- This program does not require summer semesters for timely completion.

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

This interdisciplinary program includes faculty members who have primary appointments in fields such as radiobiology, physics, engineering, computer science, physiology, dentistry, genetics, and biochemistry. Students concentrate in research areas such as molecular biophysics, medical imaging, magnetic resonance imaging and spectroscopy, radiobiology, radiation therapy physics, and mathematical biophysics and computation. A limited number of students prepare for employment as hospital-based medical physicists through a program that includes opportunities for coursework, laboratory work, and directed study to provide experience in areas such as purchase specification, acceptance testing, quality assurance, and radiation safety.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

Programs are arranged on an individual basis and must consist of courses that represent a subfield of the discipline, e.g., radiobiology or medical physics.
Twin Cities Campus
Biophysical Sciences and Medical Physics Ph.D.
Radiology Graduate School

Link to a list of faculty for this program.

Contact Information:
University of Minnesota School of Medicine, Department of Radiology, Box 292 UMHC, 420 Delaware Street S.E., Minneapolis, MN 55455 (612-626-0131; fax: 612-626-1951)
Email: riten001@tc.umn.edu
Website: http://www.med.umn.edu/radiology/research/physics/home.html

- Program Type: Doctorate
- Requirements for this program are current for Fall 2018
- Length of program in credits: 36
- This program does not require summer semesters for timely completion.
- Degree: Doctor of Philosophy

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

This interdisciplinary program includes faculty members who have primary appointments in fields such as radiobiology, physics, engineering, computer science, physiology, dentistry, genetics, and biochemistry. Students concentrate in research areas such as molecular biophysics, medical imaging, magnetic resonance imaging and spectroscopy, radiobiology, radiation therapy physics, and mathematical biophysics and computation. A limited number of students prepare for employment as hospital-based medical physicists through a program that includes opportunities for coursework, laboratory work, and directed study to provide experience in areas such as purchase specification, acceptance testing, quality assurance, and radiation safety.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
Other requirements to be completed before admission:
All students should have some familiarity with physical chemistry, intermediate physics, intermediate mathematics, biostatistics, computer programming, biology, physiology, and biochemistry. This may be demonstrated by coursework completed at the undergraduate level or as part of the graduate program; by reading or practical experience; or by informal competency examinations.

Special Application Requirements:
Three letters of recommendation and scores from the General Test of the GRE are required. Applicants are considered for admission in both semesters.

Applicants must submit their test score(s) from the following:
- GRE

Key to test abbreviations (GRE).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
12 credits are required outside the major.
24 thesis credits are required.

This program may not be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.
Ph.D. students take preliminary written exams at the end of the first year of study or as soon as possible after completing the core course sequence in topics in physics for medicine and biology. An oral preliminary exam focuses on the plan for thesis research and the student's grasp of related information and is taken by the fall of the third year of full-time registration or its equivalent. At least 12 credits are required in a minor or supporting program. Additionally, 24 thesis credits are required.
Clinical Ethics Postbaccalaureate Certificate

Bioethics, Center for Graduate School

Link to a list of faculty for this program.

Contact Information:
Center for Bioethics
N504 Boynton
410 Church St SE
Minneapolis, MN 55455
Email: bthxed@umn.edu
Website: http://www.bioethics.umn.edu/education/clinical-ethics-certificate-program

- Program Type: Post-baccalaureate credit certificate/licensure/endorsement
- Requirements for this program are current for Fall 2018
- Length of program in credits: 13
- This program does not require summer semesters for timely completion.
- Degree: Clinical Ethics PBacc Certificate

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

Admissions to the clinical ethics post-baccalaureate certificate are currently on hold. Please contact bthxed@umn.edu for updates.

The clinical ethics post-baccalaureate certificate will offer a graduate level educational opportunity for practicing professionals including physicians, nurses, social workers, chaplains, and others. Students will engage in classwork and practical experience geared toward mastery of the knowledge and skills needed for work in clinical ethics, including participation on ethics committees, clinical ethics consultation services, institutional and regional clinical ethics policy bodies such as organ allocation committees or brain death committees, support for institutional staff development programs in their professional fields, or simply being better prepared to meet the ethical challenges that arise in their work. The curriculum will fulfill the health care ethics core competencies promulgated by the American Society for Bioethics and Humanities.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
A graduate or professional degree in a field related to clinical ethics is required for admission.

International applicants must submit score(s) from one of the following tests:
- TOEFL
  - Internet Based - Total Score: 100
  - Paper Based - Total Score: 600

Key to test abbreviations (TOEFL).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
Use of 4xxx courses towards program requirements is not permitted.

A minimum GPA of 3.0 is required for students to remain in good standing.

At least 1 semesters must be completed before filing a Degree Program Form.

Required Courses
NB: BTHX 8500 will be taken twice, 2 cr each time, once fall once spring.

BTHX 5100 - Introduction to Clinical Ethics (3.0 cr)
BTHX 5110 Ethical Issues in Pediatrics (2.0 cr)
BTHX 5120 Dying in Contemporary Medical Culture (2.0 cr)
BTHX 8100 Advanced Theory and Practice of Clinical Ethics (2.0 cr)
BTHX 8500 - Practicum in Bioethics (1.0 - 4.0 cr)
Twin Cities Campus
Health Care Design and Innovation Postbaccalaureate Certificate

School of Nursing
Graduate School

Link to a list of faculty for this program.

Contact Information:
Densford International Center for Nursing Leadership, University of Minnesota School of Nursing, 4-185 Weaver-Densford Hall, 308 Harvard St SE, Minneapolis, MN 55455 (612-625-1187; fax: 612-624-0908)
Email: nursecerts@umn.edu
Website: http://www.hcdi.umn.edu

- Program Type: Post-baccalaureate credit certificate/licensure/endorsement
- Requirements for this program are current for Fall 2018
- Length of program in credits: 12
- This program does not require summer semesters for timely completion.
- Degree: Health Care Design & Innovation PBacc Certificate

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

The postbaccalaureate certificate in health care design and innovation prepares health care and design practitioners to create optimal healing environments. Students learn how to apply design thinking in creating new processes, systems, and care environments. The certificate emphasizes principles that promote healing and safe patient care while maximizing clinical and financial outcomes.

Program Delivery
This program is available:
- partially online (between 50% to 80% of instruction is online)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

Admittance to the certificate program requires a baccalaureate degree from an accredited institution in a health-related field, interior design, architecture, or other design-related area.

Other requirements to be completed before admission:
Applicants are required to submit transcripts from all institutions where postsecondary credit was earned, reference materials containing an Admission Reference Form and personal letter of reference from two separate individuals, one essay, a current curriculum vitae/resume, and English language proficiency scores (if applicable). This certificate has two application deadlines: November 1 for spring admission and July 1 for fall admission.

International applicants must submit score(s) from one of the following tests:
- TOEFL
  - Internet Based - Total Score: 79
  - Paper Based - Total Score: 550

The preferred English language test is Test of English as Foreign Language

Key to test abbreviations (TOEFL).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
Use of 4xxx courses towards program requirements is not permitted.

A minimum GPA of 2.8 is required for students to remain in good standing.
Required Courses
CSPH 5711 - Optimal Healing Environments (3.0 cr)
NURS 7610 - System Leadership and Innovation (3.0 cr)
HUMF 5874 - Service Design: Designing complex systems to improve service delivery (4.0 cr)
NURS 6707 - Health Care Design and Innovation Practicum (2.0 cr)
Health Informatics (also known as biomedical informatics) is an interdisciplinary field of scholarship that applies computer, information, statistical, management, and related scientific methods to enable biomedical discovery and support the effective and efficient use and analysis of data, management of information, and application of knowledge across the spectrum from basic science to clinical care. The ultimate goal of the field is to improve the health, well-being, and economic functioning of society. Students take a sequence of core courses in health informatics and biostatistics and take electives in technical and health science areas.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)
- completely online (all program coursework can be completed online)
- primarily online (at least 80% of the instruction for the program is online with short, intensive periods of face-to-face coursework)
- partially online (between 50% to 80% of instruction is online)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

Applicants are expected to have at least a bachelor of science or equivalent degree from a regionally accredited institution of higher education or an international equivalent.

Required prerequisites

Health or Biological Sciences
Applicants must have taken 6 semester-credits or 9 quarter-credits at the undergraduate or graduate level in medical, life, or biological sciences from a regionally accredited institution of higher learning or equivalent. This broadly defined requirement includes most courses with a health or biology emphasis, including biostatistics, health services research, and public health, as well as more traditional biology or life science courses.

Programming Language
Documented work or educational experience working with a programming language such as C, C++, Java, Python, R, Visual Basic, etc.
- or HINF 5502 - Python Programming Essentials for the Health Sciences (1.0 cr)
- or Department Consent

Applicants must submit their test score(s) from the following:
- GRE
  - General Test - Verbal Reasoning: 151
  - General Test - Quantitative Reasoning: 153
  - General Test - Analytical Writing: 4
International applicants must submit score(s) from one of the following tests:

- **TOEFL**
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
- **IELTS**
  - Total Score: 6.5
  - Reading Score: 6.5
  - Writing Score: 6.5
- **MELAB**
  - Final score: 80

The preferred English language test is Test of English as Foreign Language

Key to test abbreviations (GRE, TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

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**Program Requirements**

**Plan C**: Plan C requires 31 major credits and up to null credits outside the major. The is no final exam. A capstone project is required.

**Capstone Project**: The capstone project is a 3- or 4-credit course in which students apply their newly acquired knowledge and skills to a project involving a practical problem in health informatics. Students learn how to design these projects properly through review of past exemplary projects. With the help of their advisors and the capstone course director, students design and carry out their own projects, which can take a variety of forms, including developing design and evaluation specifications for software to address a specific healthcare need; working on, observing, analyzing, and reporting the actions of a team involved in implementing a new information system; or observing and measuring the impact of such a system in a healthcare setting. Students submit a written project report, graded by the capstone project instructor and the student's advisor, in lieu of a final examination.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 2.80 is required for students to remain in good standing.

At least 1 semesters must be completed before filing a Degree Program Form.

**HINF Courses**

Take HINF 5436 AHC Informatics Grand Rounds twice for a total of 2 credits.
- HINF 5430 - Foundations of Health Informatics I (3.0 cr)
- HINF 5431 - Foundations of Health Informatics II (3.0 cr)
- HINF 5436 - AHC Informatics Grand Rounds (1.0 cr)
- HINF 5510 - Applied Health Care Databases: Database Principles and Data Evaluation (3.0 cr)
- HINF 5520 - Informatics Methods for Health Care Quality, Outcomes, and Patient Safety (2.0 cr)
- HINF 5531 - Health Data Analytics and Data Science (3.0 cr)

**Other Required Courses**

- NURS 5116 - Consumer Health Informatics (1.0 cr)
- NURS 7108 - Population Health Informatics (2.0 cr)
- PUBH 6450 - Biostatistics I (4.0 cr)

**Final Project**

- MHI students take HINF 5499 (3 credits).
- MD/MHI students take LAMP 7195 (4 credits).
- HINF 5499 - Capstone Project for the Masters of Health Informatics (3.0 cr)
- or LAMP 7195 - Medical Informatics (4.0 cr)

**Electives**

Take electives as needed to meet the 31-credit minimum. If labs or practicums are selected as electives, they must be taken concurrently with the associated course (i.e. take HINF 8430 with HINF 5430). Electives must be approved by the advisor.
- BIOC 5361 - Microbial Genomics and Bioinformatics (3.0 cr)
- BIOC 8007 - Molecular Biology of DNA (2.0 cr)
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<td>Advanced Algorithms and Data Structures</td>
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<td>Introduction to Machine Learning</td>
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<td>Software Engineering I</td>
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<td>Intermediate Statistical Methods</td>
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<td>Foundations of Translational Bioinformatics Lab</td>
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<td>Healthcare Delivery Innovations:Optimizing Cost and Quality</td>
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<td>Medical Industry Valuation Laboratory</td>
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<td>NURS 5117</td>
<td>Consumer Health Informatics Practicum</td>
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<td>NURS 6105</td>
<td>Systems Analysis and Design</td>
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<td>NURS 7106</td>
<td>Knowledge Representation and Interoperability Practicum</td>
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<td>NURS 7113</td>
<td>Clinical Decision Support: Theory</td>
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<td>NURS 7114</td>
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<td>NURS 7118</td>
<td>Human Factors and Human-Computer Interaction in Health Informatics</td>
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NURS 7610 - System Leadership and Innovation (3.0 cr)
PHAR 6224 - Pharmacogenomics: Genetic Basis for Variability in Drug Response (2.0 cr)
PUBH 6020 - Fundamentals of Social and Behavioral Science (2.0 cr)
PUBH 6025 - Designing e-Interventions for Public Health (2.0 cr)
PUBH 6102 - Issues in Environmental Health (2.0 cr)
PUBH 6131 - Working in Global Health (2.0 cr)
PUBH 6320 - Fundamentals of Epidemiology (3.0 cr)
PUBH 6325 - Data Processing with PC-SAS (1.0 cr)
PUBH 6341 - Epidemiologic Methods I (3.0 cr)
PUBH 6386 - Public Health Aspects of Cardiovascular Disease (2.0 cr)
PUBH 6420 - Introduction to SAS Programming (1.0 cr)
PUBH 6541 - Statistics for Health Management Decision Making (3.0 cr)
PUBH 6555 - Topics in Health Economics (2.0 cr)
PUBH 6556 - Health and Health Systems (3.0 cr)
PUBH 6557 - Health Finance I (3.0 cr)
PUBH 6558 - Health Finance II (3.0 cr)
PUBH 6560 - Operations Research and Quality in Health Care (3.0 cr)
PUBH 6562 - Information Technology in Health Care (2.0 cr)
PUBH 6564 - Private Purchasers of Health Care: Roles of Employers and Health Plans in U.S. Health Care System (2.0 cr)
PUBH 6565 - Innovation of Healthcare Services (2.0 cr)
PUBH 6617 - Practical Methods for Secondary Data Analysis (3.0 cr)
PUBH 6717 - Decision Analysis for Health Care (2.0 cr)
PUBH 6724 - The Health Care System and Public Health (3.0 cr)
PUBH 6742 - Ethics in Public Health: Research and Policy (1.0 cr)
PUBH 6751 - Principles of Management in Health Services Organizations (2.0 cr)
PUBH 6765 - Continuous Quality Improvement: Methods and Techniques (3.0 cr)
PUBH 6780 - Topics: Public Health Administration and Policy (1.0 - 3.0 cr)
PUBH 6800 - Topics: Health Services Research and Policy (0.5 - 4.0 cr)
PUBH 6802 - Managing Electronic Health Information (3.0 cr)
PUBH 6803 - Conducting a Systematic Literature Review (3.0 cr)
PUBH 6809 - Advanced Methods in Health Decision Science (3.0 cr)
PUBH 6814 - Data and Information for Population Health Management (2.0 cr)
PUBH 6832 - Economics of the Health Care System (3.0 cr)
PUBH 6862 - Cost-Effectiveness Analysis in Health Care (3.0 cr)
PUBH 6863 - Understanding Health Care Quality (2.0 cr)
PUBH 6876 - Public Health Systems Analysis and Design (2.0 cr)
PUBH 7400 - Biostatistics Modeling and Methods (4.0 cr)
PUBH 7401 - Fundamentals of Biostatistical Inference (4.0 cr)
PUBH 7402 - Biostatistics Modeling and Methods (4.0 cr)
PUBH 7405 - Biostatistics: Regression (4.0 cr)
PUBH 7407 - Analysis of Categorical Data (3.0 cr)
PUBH 7415 - Introduction to Clinical Trials (3.0 cr)
PUBH 7420 - Clinical Trials: Design, Implementation, and Analysis (3.0 cr)
PUBH 7430 - Statistical Methods for Correlated Data (3.0 cr)
PUBH 7440 - Introduction to Bayesian Analysis (3.0 cr)
PUBH 7445 - Statistics for Human Genetics and Molecular Biology (3.0 cr)
PUBH 7460 - Advanced Statistical Computing (3.0 cr)
PUBH 7475 - Statistical Learning and Data Mining (3.0 cr)
PUBH 7588 - Information Uses in Long-Term Care (2.0 cr)
PUBH 8432 - Probability Models for Biostatistics (3.0 cr)
PUBH 8442 - Bayesian Decision Theory and Data Analysis (3.0 cr)
PUBH 8445 - Statistics for Human Genetics and Molecular Biology (3.0 cr)
PUBH 8446 - Advanced Statistical Genetics and Genomics (3.0 cr)
PUBH 8452 - Advanced Longitudinal Data Analysis (3.0 cr)
PUBH 8462 - Advanced Survival Analysis (3.0 cr)
PUBH 8472 - Spatial Biostatistics (3.0 cr)
PUBH 8800 - Health Services Policy Analysis: Theory (3.0 cr)
PUBH 8810 - Research Studies in Health Care (3.0 cr)
STAT 5101 - Theory of Statistics I (4.0 cr)
STAT 5302 - Applied Regression Analysis (4.0 cr)
STAT 5303 - Designing Experiments (4.0 cr)
STAT 5401 - Applied Multivariate Methods (3.0 cr)
STAT 5511 - Time Series Analysis (3.0 cr)
STAT 8051 - Advanced Regression Techniques: linear, nonlinear and nonparametric methods (3.0 cr)
STAT 8052 - Applied Statistical Methods 2: Design of Experiments and Mixed -Effects Modeling (3.0 cr)
STAT 8053 - Applied Statistical Methods 3: Multivariate Analysis and Advanced Regression (3.0 cr)

Joint- or Dual-degree Coursework: MD/MHI program Student may take a total of 3 credits in common among the academic programs.
**Twin Cities Campus**

Health Informatics M.S.

Health Informatics, AHC Inst

Graduate School

Link to a list of faculty for this program.

**Contact Information:**

Physical Address: 8-100 PWB, 516 Delaware St. SE, Minneapolis, MN 55455

Mailing Address: MMC 912, 420 Delaware St. SE, Minneapolis, MN 55455

Email: ihi@umn.edu

Website: http://healthinformatics.umn.edu

- Program Type: Master's
- Requirements for this program are current for Fall 2018
- Length of program in credits: 36
- This program does not require summer semesters for timely completion.
- Degree: Master of Science

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

Health informatics (also known as biomedical informatics) is an interdisciplinary field of scholarship that applies computer, information, statistical, management, and related scientific methods to enable biomedical discovery and support the effective and efficient use and analysis of data, management of information, and application of knowledge across the spectrum from basic science to clinical care. The ultimate goal of the field is to improve the health, well-being, and economic functioning of society. Students take a sequence of core courses in health informatics, computing, and biostatistics, and electives in technical and health science areas. Possible areas of emphasis include health information systems, telehealth, bioinformatics, user interface design, system impact evaluation, database construction and analysis, clinical decision-making, evaluation of health programs, and physiological monitoring and control.

The health informatics MS is intended for students who are interested in research, but who do not have the background or are not ready to commit to the PhD program.

**Program Delivery**

This program is available:
- via classroom (the majority of instruction is face-to-face)
- partially online (between 50% to 80% of instruction is online)

**Prerequisites for Admission**

The preferred undergraduate GPA for admittance to the program is 3.30.

Applicants are expected to have at least a bachelor of science or equivalent degree from a regionally accredited institution of higher education.

**Required prerequisites**

Health or Biological Sciences

Applicants must have taken 6 semester-credits or 9 quarter-credits at the undergraduate or graduate level in medical, life, or biological sciences from a regionally accredited institution of higher learning or equivalent. This broadly defined requirement includes most courses with a health or biology emphasis, including biostatistics, health services research, and public health, as well as more traditional biology or life science courses.

Programming Language

Documented work or educational experience working with a programming language such as C, C++, Java, Python, R, Visual Basic, etc.

or HINF 5502 - Python Programming Essentials for the Health Sciences (1.0 cr)

or Department Consent

Applicants must submit their test score(s) from the following:
- GRE
  - General Test - Verbal Reasoning: 151
  - General Test - Quantitative Reasoning: 160
General Test - Analytical Writing: 4

International applicants must submit score(s) from one of the following tests:

- **TOEFL**
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19

- **IELTS**
  - Total Score: 6.5
  - Reading Score: 6.5
  - Writing Score: 6.5

- **MELAB**
  - Final score: 80

The preferred English language test is Test of English as Foreign Language

Key to test abbreviations (GRE, TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the [General Information](#) section of the catalog website.

**Program Requirements**

**Plan A:** Plan A requires 26 major credits, up to null credits outside the major, and 10 thesis credits. The final exam is written and oral.

**Plan B:** Plan B requires 36 major credits and up to null credits outside the major. The final exam is written and oral.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 3.00 is required for students to remain in good standing.

At least 1 semesters must be completed before filing a Degree Program Form.

**Required HINF Courses (16 credits)**

- All students must take AHC Informatics Grand Rounds (HINF 5436) twice for a total of two credits.
- HINF 5430 - Foundations of Health Informatics I (3.0 cr)
- HINF 5431 - Foundations of Health Informatics II (3.0 cr)
- HINF 5436 - AHC Informatics Grand Rounds (1.0 cr)
- HINF 5510 - Applied Health Care Databases: Database Principles and Data Evaluation (3.0 cr)
- HINF 5520 - Informatics Methods for Health Care Quality, Outcomes, and Patient Safety (2.0 cr)
- HINF 5531 - Health Data Analytics and Data Science (3.0 cr)

**Other Required Courses (7 credits)**

- NURS 5116 - Consumer Health Informatics (1.0 cr)
- NURS 7108 - Population Health Informatics (2.0 cr)
- PUBH 6450 - Biostatistics I (4.0 cr)

**Electives**

Plan A students must take at least 3 credits, and Plan B students must take at least 9 credits of electives to meet the 36-credit minimum. If labs or practicums are selected as electives, they must be taken concurrently with the associated course (i.e. take HINF 8430 with HINF 5430). Electives must be approved by the advisor.

- BIOC 5361 - Microbial Genomics and Bioinformatics (3.0 cr)
- BIOC 8007 - Molecular Biology of DNA (2.0 cr)
- BIOC 8008 - Molecular Biology of RNA (2.0 cr)
- CGSC 8410 - Perspectives in Learning, Perception, and Cognition (2.0 cr)
- CSCI 5106 - Programming Languages (3.0 cr)
- CSCI 5115 - User Interface Design, Implementation and Evaluation (3.0 cr)
- CSCI 5271 - Introduction to Computer Security (3.0 cr)
- CSCI 5421 - Advanced Algorithms and Data Structures (3.0 cr)
- CSCI 5461 - Functional Genomics, Systems Biology, and Bioinformatics (3.0 cr)
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<td>HINF 8430</td>
<td>Foundations of Health Informatics I Lab</td>
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<td>HINF 8431</td>
<td>Foundations of Health Informatics II Lab</td>
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<td>HINF 8440</td>
<td>Foundations of Translational Bioinformatics Lab</td>
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<td>Advanced Readings or Research in Health Informatics</td>
<td>1.0 - 6.0</td>
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<td>HINF 8525</td>
<td>Health Informatics Teaching</td>
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<tr>
<td>HINF 8535</td>
<td>Advanced Health Informatics Research Methods</td>
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<td>IDSC 6040</td>
<td>Information Technology Management</td>
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<td>Information Technologies and Solutions</td>
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<td>IDSC 6471</td>
<td>Knowledge Management</td>
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<td>Semantics</td>
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<td>Mathematical Analysis of Biological Networks</td>
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<td>Introduction to the Mathematics of Image and Data Analysis</td>
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<td>Introduction to Stochastic Processes</td>
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<td>MEDC 5245</td>
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<td>MILI 6992</td>
<td>Healthcare Delivery Innovations; Optimizing Cost and Quality</td>
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<td>MILI 6995</td>
<td>Medical Industry Valuation Laboratory</td>
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<td>Pharmacogenomics: Genetic Basis for Variability in Drug Response</td>
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<td>PUBH 6131</td>
<td>Working in Global Health</td>
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<tr>
<td>PUBH 6320</td>
<td>Fundamentals of Epidemiology</td>
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PUBH 6420 - Introduction to SAS Programming (1.0 cr)
PUBH 6541 - Statistics for Health Management Decision Making (3.0 cr)
PUBH 6555 - Topics in Health Economics (2.0 cr)
PUBH 6556 - Health and Health Systems (3.0 cr)
PUBH 6557 - Health Finance I (3.0 cr)
PUBH 6558 - Health Finance II (3.0 cr)
PUBH 6560 - Operations Research and Quality in Health Care (3.0 cr)
PUBH 6562 - Information Technology in Health Care (2.0 cr)
PUBH 6564 - Private Purchasers of Health Care: Roles of Employers and Health Plans in U.S. Health Care System (2.0 cr)
PUBH 6565 - Innovation of Healthcare Services (2.0 cr)
PUBH 6617 - Practical Methods for Secondary Data Analysis (3.0 cr)
PUBH 6717 - Decision Analysis for Health Care (2.0 cr)
PUBH 6724 - The Healthcare System and Public Health (3.0 cr)
PUBH 6742 - Ethics in Public Health: Research and Policy (1.0 cr)
PUBH 6751 - Principles of Management in Health Services Organizations (2.0 cr)
PUBH 6765 - Continuous Quality Improvement: Methods and Techniques (3.0 cr)
PUBH 6780 - Topics: Public Health Administration and Policy (1.0 - 3.0 cr)
PUBH 6800 - Topics: Health Services Research and Policy (0.5 - 4.0 cr)
PUBH 6802 - Managing Electronic Health Information (3.0 cr)
PUBH 6803 - Conducting a Systematic Literature Review (3.0 cr)
PUBH 6809 - Advanced Methods in Health Decision Science (3.0 cr)
PUBH 6814 - Data and Information for Population Health Management (2.0 cr)
PUBH 6832 - Economics of the Health Care System (3.0 cr)
PUBH 6862 - Cost-Effectiveness Analysis in Health Care (3.0 cr)
PUBH 6863 - Understanding Health Care Quality (2.0 cr)
PUBH 6876 - Public Health Systems Analysis and Design (2.0 cr)
PUBH 7400 - Topics: Biostatistics (0.5 - 4.0 cr)
PUBH 7401 - Fundamentals of Biostatistical Inference (4.0 cr)
PUBH 7402 - Biostatistics Modeling and Methods (4.0 cr)
PUBH 7405 - Biostatistics: Regression (4.0 cr)
PUBH 7407 - Analysis of Categorical Data (3.0 cr)
PUBH 7415 - Introduction to Clinical Trials (3.0 cr)
PUBH 7420 - Clinical Trials: Design, Implementation, and Analysis (3.0 cr)
PUBH 7430 - Statistical Methods for Correlated Data (3.0 cr)
PUBH 7440 - Introduction to Bayesian Analysis (3.0 cr)
PUBH 7445 - Statistics for Human Genetics and Molecular Biology (3.0 cr)
PUBH 7460 - Advanced Statistical Computing (3.0 cr)
PUBH 7475 - Statistical Learning and Data Mining (3.0 cr)
PUBH 7588 - Information Uses in Long-Term Care (2.0 cr)
PUBH 8432 - Probability Models for Biostatistics (3.0 cr)
PUBH 8442 - Bayesian Decision Theory and Data Analysis (3.0 cr)
PUBH 8445 - Statistics for Human Genetics and Molecular Biology (3.0 cr)
PUBH 8446 - Advanced Statistical Genetics and Genomics (3.0 cr)
PUBH 8452 - Advanced Longitudinal Data Analysis (3.0 cr)
PUBH 8462 - Advanced Survival Analysis (3.0 cr)
PUBH 8472 - Spatial Biostatistics (3.0 cr)
PUBH 8801 - Health Services Policy Analysis: Theory (3.0 cr)
PUBH 8810 - Research Studies in Health Care (3.0 cr)
STAT 5101 - Theory of Statistics I (4.0 cr)
STAT 5302 - Applied Regression Analysis (4.0 cr)
STAT 5303 - Designing Experiments (4.0 cr)
STAT 5401 - Applied Multivariate Methods (3.0 cr)
STAT 5511 - Time Series Analysis (3.0 cr)
STAT 8051 - Advanced Regression Techniques: Linear, Nonlinear and Nonparametric Methods (3.0 cr)
STAT 8052 - Applied Statistical Methods 2: Design of Experiments and Mixed-Effects Modeling (3.0 cr)
STAT 8053 - Applied Statistical Methods 3: Multivariate Analysis and Advanced Regression (3.0 cr)

Plan Options

Plan A
Take at least 10 master's thesis credits.
HINF 8777 - Thesis Credits: Master's (1.0 - 18.0 cr)
Plan B
Take the following course:
HINF 8770 - Plan B Project (4.0 cr)

Program Sub-plans
A sub-plan is not required for this program.
Students may not complete the program with more than one sub-plan.
Twin Cities Campus

Health Informatics Minor
Health Informatics, AHC Inst
Graduate School

Link to a list of faculty for this program.

Contact Information:
Physical Address: 8-100 PWB, 516 Delaware St. SE, Minneapolis, MN 55455
Mailing Address: MMC 912, 420 Delaware St. SE, Minneapolis, MN 55455
Email: ihi@umn.edu
Website: http://healthinformatics.umn.edu

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2018
- Length of program in credits (Masters): 6
- Length of program in credits (Doctorate): 12
- This program does not require summer semesters for timely completion.

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

Health informatics (also known as biomedical informatics) is an interdisciplinary field of scholarship that applies computer, information, statistical, management, and related scientific methods to enable biomedical discovery and support the effective and efficient use and analysis of data, management of information, and application of knowledge across the spectrum from basic science to clinical care. The ultimate goal of the field is to improve the health, well-being, and economic functioning of society. The minor provides an opportunity for students to supplement their primary training with additional knowledge and skills in health informatics.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)
- primarily online (at least 80% of the instruction for the program is online with short, intensive periods of face-to-face coursework)
- partially online (between 50% to 80% of instruction is online)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

Required prerequisites

Health or Biological Sciences
Applicants must have taken 6 semester-credits or 9 quarter-credits at the undergraduate or graduate level in medical, life, or biological sciences from a regionally accredited institution of higher learning or equivalent. This broadly defined requirement includes most courses with a health or biology emphasis, including biostatistics, health services research, and public health, as well as more traditional biology or life science courses.

Programming language
Documented work or educational experience working with a programming language such as C, C++, Java, Python, R, Visual Basic, etc.
- or HINF 5502 - Python Programming Essentials for the Health Sciences (1.0 cr)
- or Department Consent

Special Application Requirements:
Applicants must be earning a graduate-level degree from the University of Minnesota.

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
Use of 4xxx courses towards program requirements is not permitted.

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The University of Minnesota is an equal opportunity educator and employer.
Information current as of August 31, 2018
Required Coursework
All students pursuing the Health Informatics minor must complete the following course:
HINF 5430 - Foundations of Health Informatics I (3.0 cr)

Program Sub-plans
Students are required to complete one of the following sub-plans. Students may not complete the program with more than one sub-plan.

Masters
Required Course
Take the following course to complete the 6-credit minimum for the master's minor:
HINF 5431 - Foundations of Health Informatics II (3.0 cr)

Doctoral
Required courses
HINF 5440 - Foundations of Translational Bioinformatics (3.0 cr)

Foundations Lab
Students must take at least one lab concurrently with the associated course (i.e. take 8430 concurrently with 5430 or 8440 concurrently with 5440).
Take 1 - 2 course(s) from the following:
• HINF 8430 - Foundations of Health Informatics I Lab (2.0 cr)
• HINF 8440 - Foundations of Translational Bioinformatics Lab (2.0 cr)

Electives
Take HINF electives to meet the 12-credit minimum for the doctoral minor.
HINF 5431 - Foundations of Health Informatics II (3.0 cr)
HINF 5436 - AHC Informatics Grand Rounds (1.0 cr)
HINF 5450 - Foundations of Precision Medicine Informatics (3.0 cr)
HINF 5494 - Topics in Health Informatics (3.0 cr)
HINF 5510 - Applied Health Care Databases: Database Principles and Data Evaluation (3.0 cr)
HINF 5520 - Informatics Methods for Health Care Quality, Outcomes, and Patient Safety (2.0 cr)
HINF 5531 - Health Data Analytics and Data Science (3.0 cr)
HINF 5610 - Foundations of Biomedical Natural Language Processing (3.0 cr)
HINF 5620 - Data Visualization for the Health Sciences (3.0 cr)
HINF 5630 - Clinical Data Mining (3.0 cr)
HINF 5640 - Advanced Translational Bioinformatics Methods (3.0 cr)
HINF 5650 - Integrative Genomics and Computational Methods (3.0 cr)
HINF 8220 - Computational Causal Analytics (3.0 cr)
HINF 8405 - Advanced Topics in Health Informatics I (1.0 - 4.0 cr)
HINF 8406 - Advanced Topics in Health Informatics II (1.0 - 4.0 cr)
HINF 8492 - Advanced Readings or Research in Health Informatics (1.0 - 6.0 cr)
Health Informatics Ph.D.

Twin Cities Campus
Health Informatics, AHC Inst
Graduate School

Link to a list of faculty for this program.

Contact Information:
Physical Address: 8-100 PWB, 516 Delaware St. SE, Minneapolis, MN 55455
Mailing Address: MMC 912, 420 Delaware St. SE, Minneapolis, MN 55455
Email: ihi@umn.edu
Website: http://healthinformatics.umn.edu

- Program Type: Doctorate
- Requirements for this program are current for Fall 2018
- Length of program in credits: 70
- This program does not require summer semesters for timely completion.
- Degree: Doctor of Philosophy

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

Health informatics (also known as biomedical informatics) is an interdisciplinary field of scholarship that applies computer, information, statistical, management, and related scientific methods to enable biomedical discovery and support the effective and efficient use and analysis of data, management of information, and application of knowledge across the spectrum from basic science to clinical care. The ultimate goal of the field is to improve the health, well-being, and economic functioning of society. Students take a sequence of core courses in health informatics, computing, and biostatistics, and electives in technical and health science areas, and pursue one of four tracks: data science and informatics for learning health systems; clinical informatics; translational bioinformatics; or precision and personalized medicine (PPM) informatics. Students pursuing the data science and informatics for learning health systems track are expected to complete the University's data science MS degree en route to the PhD. Students pursuing any of the other three tracks are expected to complete the health informatics MS degree en route to the PhD. Phase I is the MS phase, and Phase II is the PhD phase of the program. Phase II is completed after students have earned the MS degree. Students who have an MS in data science or health informatics from a comparable program may be exempt from this requirement in whole or in part, subject to Academic Program Committee (APC) review and approval.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.50.

Applicants must have a BS or equivalent in science, technology, engineering, computer science, math, or another pertinent field from a regionally accredited university or international equivalent.

Required prerequisites

Health or Biological Sciences
Applicants must have taken 6 semester-credits or 9 quarter-credits at the undergraduate or graduate level in medical, life, or biological sciences from a regionally accredited institution of higher learning or equivalent. This broadly defined requirement includes most courses with a health or biology emphasis, including biostatistics, health services research, and public health, as well as more traditional biology or life science courses.
6-9 credits

Computer Science
Clinical Informatics Track
Documented work or educational experience working with a general purpose programming language such as C, C++, Java, Visual Basic, PASCAL, etc.
or HINF 5502 - Python Programming Essentials for the Health Sciences (1.0 cr)
or Other Tracks
Applicants to the data science for learning health systems, translational bioinformatics, and precision and personalized medicine informatics tracks must also have taken an introduction to data structures and algorithms, such as the course listed below.
CSCI 1933 - Introduction to Algorithms and Data Structures (4.0 cr)

Track-Specific Prerequisites
Applicants to the data science for learning health systems, translational bioinformatics, and precision and personalized medicine informatics tracks must also have the following prerequisites or must take remedial courses at the discretion of the admissions committee:

Mathematics
Applicants must have college-level calculus and linear algebra, such as the courses listed below.
- MATH 1271 - Calculus I [MATH] (4.0 cr)
- CSCI 2033 - Elementary Computational Linear Algebra (4.0 cr)
  or MATH 4242 - Applied Linear Algebra (4.0 cr)

Statistics
Applicants must have college-level statistics, such as the courses below.
- STAT 3011 - Introduction to Statistical Analysis [MATH] (4.0 cr)
  or STAT 3021 - Introduction to Probability and Statistics (3.0 cr)

Applicants must submit their test score(s) from the following:
- GRE
  - General Test - Verbal Reasoning: 151
  - General Test - Quantitative Reasoning: 160
  - General Test - Analytical Writing: 4

International applicants must submit score(s) from one of the following tests:
- TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
- IELTS
  - Total Score: 6.5
  - Reading Score: 6.5
  - Writing Score: 6.5
- MELAB
  - Final score: 80

The preferred English language test is Test of English as Foreign Language

Key to test abbreviations (GRE, TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
46 credits are required in the major.
24 thesis credits are required.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 3.00 is required for students to remain in good standing.

At least 2 semesters must be completed before filing a Degree Program Form.

All courses taken, milestones met, and progress made in the program are subject to Academic Program Committee (APC) review. The inclusion of 4000-level coursework requires APC approval.

Required Core Coursework (14 credits)
Phase I (12 credits)
All students take the following core coursework for a total of 12 credits. HINF 5436 must be taken twice.
- HINF 5430 - Foundations of Health Informatics I (3.0 cr)
- HINF 8430 - Foundations of Health Informatics I Lab (2.0 cr)
- HINF 5436 - AHC Informatics Grand Rounds (1.0 cr)
HINF 5440 - Foundations of Translational Bioinformatics (3.0 cr)
HINF 8440 - Foundations of Translational Bioinformatics Lab (2.0 cr)

Phase II (2 credits)
All students take the following core course after completing the Phase I core, and with the approval of the APC.
HINF 8525 - Health Informatics Teaching (2.0 cr)

Doctoral Thesis Credits (24 credits)
All students must take at least 24 doctoral thesis credits, in consultation with the APC.
HINF 8888 - Thesis Credit: Doctoral (1.0 - 24.0 cr)

Program Sub-plans
Students are required to complete one of the following sub-plans. Students may not complete the program with more than one sub-plan.

Clinical Informatics
The clinical informatics track provides instruction and training for students interested in clinical applications methods and applications. The curriculum includes instruction in health data and coding, systems analysis, human-computer interaction, current informatics research, and current applications such as decision support systems, natural language processing, and predictive modeling. Additionally, students learn biostatistical methods, relational database theory and practice, analytics and data science methodologies, consumer health informatics, and interprofessional practice. Electives supplement individual student interests in areas such as computer programming, health data management, health care finance, and public and population health (with scope to include person-empowered participation and inter-professional engagement). Courses use a mixture of theoretical and applied subject matter to provide a solid grounding in current informatics thinking and practice.

Students who pursue the clinical informatics track must complete the health informatics MS degree on route to completing the PhD. Students must consult with the APC to coordinate completion of coursework and other requirements for the health informatics MS, the health informatics PhD, and the clinical informatics track. Students who have an MS in health informatics from a comparable program may be exempt from this requirement in whole or in part, subject to APC review and approval.

Clinical Informatics Coursework (32 credits)
Core Coursework (16 credits)
Take the following core courses:
HINF 5431 - Foundations of Health Informatics II (3.0 cr)
HINF 8431 - Foundations of Health Informatics II Lab (2.0 cr)
HINF 5510 - Applied Health Care Databases: Database Principles and Data Evaluation (3.0 cr)
HINF 5520 - Informatics Methods for Health Care Quality, Outcomes, and Patient Safety (2.0 cr)
HINF 5531 - Health Data Analytics and Data Science (3.0 cr)
NURS 5116 - Consumer Health Informatics (1.0 cr)
NURS 7108 - Population Health Informatics (2.0 cr)

Required Biostatistics Coursework (8 credits)
Take the following two courses:
PUBH 6450 - Biostatistics I (4.0 cr)
PUBH 6451 - Biostatistics II (4.0 cr)

Electives
Select at least 8 elective credits, in consultation with the APC, to complete the 46 course credits required for the PhD degree.
BIOC 5361 - Microbial Genomics and Bioinformatics (3.0 cr)
BIOC 8007 - Molecular Biology of DNA (2.0 cr)
BIOC 8008 - Molecular Biology of RNA (2.0 cr)
CGSC 8410 - Perspectives in Learning, Perception, and Cognition (2.0 cr)
CSCI 5108 - Programming Languages (3.0 cr)
CSCI 5115 - User Interface Design, Implementation and Evaluation (3.0 cr)
CSCI 5271 - Introduction to Computer Security (3.0 cr)
CSCI 5421 - Advanced Algorithms and Data Structures (3.0 cr)
CSCI 5461 - Functional Genomics, Systems Biology, and Bioinformatics (3.0 cr)
CSCI 5481 - Computational Techniques for Genomics (3.0 cr)
CSCI 5511 - Artificial Intelligence I (3.0 cr)
CSCI 5521 - Introduction to Machine Learning (3.0 cr)
CSCI 5525 - Machine Learning (3.0 cr)
CSCI 5607 - Fundamentals of Computer Graphics 1 (3.0 cr)
CSCI 5608 - Fundamentals of Computer Graphics 2 (3.0 cr)
CSCI 5707 - Principles of Database Systems (3.0 cr)
CSCI 5708 - Architecture and Implementation of Database Management Systems (3.0 cr)
CSCI 5801 - Software Engineering I (3.0 cr)
CSCI 8725 - Databases for Bioinformatics (3.0 cr)
DES 5185 - Human Factors in Design (3.0 cr)
EPSY 5244 - Survey Design, Sampling, and Implementation (3.0 cr)
EPSY 5262 - Intermediate Statistical Methods (3.0 cr)
EPSY 5621 - Assessment and Instructional Design for Students with Developmental Disabilities (3.0 cr)
GCD 8103 - Human Histology (5.0 cr)
HINF 5450 - Foundations of Precision Medicine Informatics (3.0 cr)
HINF 5494 - Topics in Health Informatics (3.0 cr)
HINF 5496 - Internship in Health Informatics (1.0 - 6.0 cr)
HINF 5502 - Python Programming Essentials for the Health Sciences (1.0 cr)
HINF 5610 - Foundations of Biomedical Natural Language Processing (3.0 cr)
HINF 5620 - Data Visualization for the Health Sciences (3.0 cr)
HINF 5630 - Clinical Data Mining (3.0 cr)
HINF 5640 - Advanced Translational Bioinformatics Methods (3.0 cr)
HINF 5650 - Integrative Genomics and Computational Methods (3.0 cr)
HINF 8405 - Advanced Topics in Health Informatics I (1.0 - 4.0 cr)
HINF 8406 - Advanced Topics in Health Informatics II (1.0 - 4.0 cr)
HINF 8492 - Advanced Readings or Research in Health Informatics (1.0 - 6.0 cr)
HINF 8535 - Advanced Health Informatics Research Methods (3.0 cr)
IDSC 6040 - Information Technology Management (2.0 cr)
IDSC 6050 - Information Technologies and Solutions (2.0 cr)
IDSC 6471 - Knowledge Management (2.0 cr)
IDSC 8721 - Behavioral Decision Theory (3.0 cr)
IE 8521 - Optimization (4.0 cr)
IE 8531 - Discrete Optimization (4.0 cr)
KIN 5001 - Foundations of Human Factors/Ergonomics (3.0 cr)
LING 5001 - Introduction to Linguistics (4.0 cr)
LING 5205 - Semantics (3.0 cr)
LING 5801 - Introduction to Computational Linguistics (3.0 cr)
MATH 5445 - Mathematical Analysis of Biological Networks (4.0 cr)
MATH 5467 - Introduction to the Mathematics of Image and Data Analysis (4.0 cr)
MATH 5652 - Introduction to Stochastic Processes (4.0 cr)
MEDC 5245 - Introduction to Drug Design (3.0 cr)
MILI 6992 - Healthcare Delivery Innovations: Optimizing Cost and Quality (2.0 cr)
MILI 6995 - Medical Industry Valuation Laboratory (2.0 cr)
NURS 5115 - Interprofessional Health Care Informatics (3.0 cr)
NURS 6117 - Consumer Health Informatics Practicum (1.0 cr)
NURS 6105 - Systems Analysis and Design (3.0 cr)
NURS 7106 - Knowledge Representation and Interoperability Practicum (2.0 cr)
NURS 7109 - Population Health Informatics Practicum (2.0 cr)
NURS 7113 - Clinical Decision Support: Theory (2.0 cr)
NURS 7114 - Clinical Decision Support Practicum (2.0 cr)
NURS 7118 - Human Factors and Human-Computer Interaction in Health Informatics (3.0 cr)
NURS 7610 - System Leadership and Innovation (3.0 cr)
PHAR 6224 - Pharmacogenomics: Genetic Basis for Variability in Drug Response (2.0 cr)
PHUB 6020 - Fundamentals of Social and Behavioral Science (2.0 cr)
PHUB 6025 - Designing e-Interventions for Public Health (2.0 cr)
PHUB 6102 - Issues in Environmental Health (2.0 cr)
PHUB 6131 - Working in Global Health (2.0 cr)
PHUB 6320 - Fundamentals of Epidemiology (3.0 cr)
PHUB 6325 - Data Processing with PC-SAS (1.0 cr)
PHUB 6341 - Epidemiologic Methods I (3.0 cr)
PHUB 6386 - Public Health Aspects of Cardiovascular Disease (2.0 cr)
PHUB 6420 - Introduction to SAS Programming (1.0 cr)
PHUB 6541 - Statistics for Health Management Decision Making (3.0 cr)
PHUB 6555 - Topics in Health Economics (2.0 cr)
PHUB 6556 - Health and Health Systems (3.0 cr)
PHUB 6557 - Health Finance I (3.0 cr)
PHUB 6558 - Health Finance II (3.0 cr)
PHUB 6560 - Operations Research and Quality in Health Care (3.0 cr)
PHUB 6562 - Information Technology in Health Care (2.0 cr)
PHUB 6564 - Private Purchasers of Health Care: Roles of Employers and Health Plans in U.S. Health Care System (2.0 cr)
PHUB 6565 - Innovation of Healthcare Services (2.0 cr)
PHUB 6617 - Practical Methods for Secondary Data Analysis (3.0 cr)
PHUB 6717 - Decision Analysis for Health Care (2.0 cr)
PUBH 6724 - The Health Care System and Public Health (3.0 cr)
PUBH 6742 - Ethics in Public Health: Research and Policy (1.0 cr)
PUBH 6751 - Principles of Management in Health Services Organizations (2.0 cr)
PUBH 6765 - Continuous Quality Improvement: Methods and Techniques (3.0 cr)
PUBH 6780 - Topics: Health Services Research and Policy (0.5 - 4.0 cr)
PUBH 6802 - Managing Electronic Health Information (3.0 cr)
PUBH 6803 - Conducting a Systematic Literature Review (3.0 cr)
PUBH 6809 - Advanced Methods in Health Decision Science (3.0 cr)
PUBH 6814 - Data and Information for Population Health Management (2.0 cr)
PUBH 6832 - Economics of the Health Care System (3.0 cr)
PUBH 6862 - Cost-Effectiveness Analysis in Health Care (3.0 cr)
PUBH 6863 - Understanding Health Care Quality (2.0 cr)
PUBH 6876 - Public Health Systems Analysis and Design (2.0 cr)
PUBH 7400 - Topics: Biostatistics (0.5 - 4.0 cr)
PUBH 7401 - Fundamentals of Biostatistical Inference (4.0 cr)
PUBH 7402 - Biostatistics Modeling and Methods (4.0 cr)
PUBH 7405 - Biostatistics: Regression (4.0 cr)
PUBH 7407 - Analysis of Categorical Data (3.0 cr)
PUBH 7415 - Introduction to Clinical Trials (3.0 cr)
PUBH 7420 - Clinical Trials: Design, Implementation, and Analysis (3.0 cr)
PUBH 7430 - Statistical Methods for Correlated Data (3.0 cr)
PUBH 7440 - Introduction to Bayesian Analysis (3.0 cr)
PUBH 7445 - Statistics for Human Genetics and Molecular Biology (3.0 cr)
PUBH 7460 - Advanced Statistical Computing (3.0 cr)
PUBH 7475 - Statistical Learning and Data Mining (3.0 cr)
PUBH 7568 - Information Uses in Long-Term Care (2.0 cr)
PUBH 8432 - Probability Models for Biostatistics (3.0 cr)
PUBH 8442 - Bayesian Decision Theory and Data Analysis (3.0 cr)
PUBH 8445 - Statistics for Human Genetics and Molecular Biology (3.0 cr)
PUBH 8446 - Advanced Statistical Genetics and Genomics (3.0 cr)
PUBH 8452 - Advanced Longitudinal Data Analysis (3.0 cr)
PUBH 8462 - Advanced Survival Analysis (3.0 cr)
PUBH 8472 - Spatial Biostatistics (3.0 cr)
PUBH 8801 - Health Services Policy Analysis: Theory (3.0 cr)
PUBH 8810 - Research Studies in Health Care (3.0 cr)
STAT 5101 - Theory of Statistics I (4.0 cr)
STAT 5302 - Applied Regression Analysis (4.0 cr)
STAT 5303 - Designing Experiments (4.0 cr)
STAT 5401 - Applied Multivariate Methods (3.0 cr)
STAT 5511 - Time Series Analysis (3.0 cr)
STAT 8051 - Advanced Regression Techniques: linear, nonlinear and nonparametric methods (3.0 cr)
STAT 8052 - Applied Statistical Methods 2: Design of Experiments and Mixed -Effects Modeling (3.0 cr)
STAT 8053 - Applied Statistical Methods 3: Multivariate Analysis and Advanced Regression (3.0 cr)

Data Science and Informatics for Learning Health Systems

The data science and informatics for learning health systems track builds on the highly regarded data science program offered jointly by the School of Engineering, School of Public Health, and School of Statistics. It also takes advantage of School of Nursing's breadth of nursing and health informatics courses. It requires students to fulfill the requirements of the master's in data science program and use their elective courses to gain exposure to health sciences and health care in the form of a suite of required foundational courses: Foundations of Health Informatics I and Lab, Foundations of Translational Bioinformatics I and Lab and the US Health Care System offered by the Institute for Health Informatics. The MS capstone project will address a research question related to health sciences or healthcare. Specialization to the health care field intensifies at the PhD level by offering additional courses focusing on advanced analytics and its applications to healthcare. The thesis research will naturally relate to health science or healthcare.

Students who pursue the data science and informatics for learning health systems track are expected to earn the University's data science MS degree en route to completing the PhD. Students will have to apply and be admitted to both the PhD in health informatics and the MS in data science separately. Acceptance into one program does not guarantee acceptance into the other program. Students must meet the requirements of both programs as determined by each program. See the data science catalog page and website (https://datascience.umn.edu) for more information about the MS in data science requirements. Students must consult with the APC to coordinate completion of coursework and other requirements for the data science MS, the health informatics PhD, and the data science and informatics for learning health systems track. Credits earned in the University's data science MS program may be used to fulfill required courses or elective credits in the data science and informatics for learning health systems track, subject to APC approval. Students who have an MS in data science from a comparable program may be exempt from this requirement in whole or in part, subject to APC review and approval.

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Information current as of August 31, 2018
Data Science and Informatics Coursework (32 credits)

Core Coursework (18 credits)
Take the following courses, in consultation with the APC, after completion of the data science MS degree. Take HINF 5496 and HINF 8492 for at least 3 credits each.
- HINF 5496 - Internship in Health Informatics (1.0 - 6.0 cr)
- HINF 5510 - Applied Health Care Databases: Database Principles and Data Evaluation (3.0 cr)
- HINF 5630 - Clinical Data Mining (3.0 cr)
- HINF 8220 - Computational Causal Analytics (3.0 cr)
- HINF 8492 - Advanced Readings or Research in Health Informatics (1.0 - 6.0 cr)

Elective Coursework (14 credits)
Select at least 14 elective credits from the following list, in consultation with the APC, to complete the 46 course credits required for the PhD degree. Credits earned in pursuit of the data science MS may be used to fulfill elective course requirements for this track, subject to APC approval.
Take 14 or more course(s) from the following:

Informatics
Take 0 or more course(s) from the following:
- HINF 5431 - Foundations of Health Informatics II (3.0 cr)
- HINF 8431 - Foundations of Health Informatics II Lab (2.0 cr)
- HINF 5610 - Foundations of Biomedical Natural Language Processing (3.0 cr)
- HINF 5620 - Data Visualization for the Health Sciences (3.0 cr)
- MATH 5467 - Introduction to the Mathematics of Image and Data Analysis (4.0 cr)

Applications
Take 0 or more course(s) from the following:
- PUBH 7113 - Clinical Decision Support: Theory (2.0 cr)
- PUBH 6102 - Issues in Environmental Health (2.0 cr)
- PUBH 6560 - Operations Research and Quality in Health Care (3.0 cr)
- PUBH 6717 - Decision Analysis for Health Care (2.0 cr)
- PUBH 6751 - Principles of Management in Health Services Organizations (2.0 cr)
- PUBH 6765 - Continuous Quality Improvement: Methods and Techniques (3.0 cr)
- PUBH 6809 - Advanced Methods in Health Decision Science (3.0 cr)
- PUBH 6814 - Data and Information for Population Health Management (2.0 cr)
- PUBH 6862 - Cost-Effectiveness Analysis in Health Care (3.0 cr)
- PUBH 6876 - Public Health Systems Analysis and Design (2.0 cr)

Advanced Methodology
Take 0 or more course(s) from the following:
- PUBH 8452 - Advanced Longitudinal Data Analysis (3.0 cr)
- PUBH 8462 - Advanced Survival Analysis (3.0 cr)
- PUBH 8472 - Spatial Biostatistics (3.0 cr)

Data Science
Take 0 or more course(s) from the following:
- STAT 5101 - Theory of Statistics I (4.0 cr)
- STAT 5102 - Theory of Statistics II (4.0 cr)
- STAT 5302 - Applied Regression Analysis (4.0 cr)
- STAT 5511 - Time Series Analysis (3.0 cr)
- STAT 5401 - Applied Multivariate Methods (3.0 cr)
- STAT 8051 - Advanced Regression Techniques: linear, nonlinear and nonparametric methods (3.0 cr)
- PUBH 7440 - Introduction to Bayesian Analysis (3.0 cr)
- CSCI 5521 - Introduction to Machine Learning (3.0 cr)
- CSCI 5523 - Introduction to Data Mining (3.0 cr)
- CSCI 5525 - Machine Learning (3.0 cr)
- PUBH 8475 - Statistical Learning and Data Mining (3.0 cr)
- CSCI 5105 - Introduction to Distributed Systems (3.0 cr)
- CSCI 5451 - Introduction to Parallel Computing: Architectures, Algorithms, and Programming (3.0 cr)
- CSCI 5707 - Principles of Database Systems (3.0 cr)

Translational Bioinformatics
The translational bioinformatics track bridges genomics and bioinformatics to precision medicine through its methods and techniques development and innovation that directly relate to the study of basic biological science and diseases. The computational methods related to genomics, epigenomics, transcriptomics, proteomics, metabolomics and pharmacogenomics are included, which build the connection of molecular findings and phenotypes to characterize disease susceptibility or determine disease markers, and predict response to treatment and prognosis. The program offers three specialized areas: structural and functional genomics, microbiomics and metagenomics, and cancer genomics.
Students pursuing the translational bioinformatics track are expected to earn the health informatics MS degree en route to completing the PhD. Students must consult with the APC to coordinate completion of coursework and other requirements for the health informatics MS, the health informatics PhD, and the translational bioinformatics track. Students who have an MS in health informatics from a comparable program may be exempt from this requirement in whole or in part, subject to APC review and approval.

Translational Bioinformatics Coursework (32 credits)

Phase I (22 credits)
Take the following courses for a total of 22 credits:
- CSCI 5521 - Introduction to Machine Learning (3.0 cr)
- CSCI 5421 - Advanced Algorithms and Data Structures (3.0 cr)
- HINF 8220 - Computational Causal Analytics (3.0 cr)
- HINF 5650 - Integrative Genomics and Computational Methods (3.0 cr)
- STAT 8051 - Advanced Regression Techniques: linear, nonlinear and nonparametric methods (3.0 cr)
- STAT 8052 - Applied Statistical Methods 2: Design of Experiments and Mixed -Effects Modeling (3.0 cr)
- BIOC 8007 - Molecular Biology of DNA (2.0 cr)
- BIOC 8008 - Molecular Biology of RNA (2.0 cr)

Phase II (6 credits)
Take the following courses after completing Phase I, and with the approval of the APC:
- HINF 5496 - Internship in Health Informatics (1.0 - 6.0 cr)
- HINF 8492 - Advanced Readings or Research in Health Informatics (1.0 - 6.0 cr)

Elective Coursework (4 credits)
Select at least 4 elective credits from the following list, in consultation with the APC, to complete the 46 course credits required for the PhD degree.
- HINF 5431 - Foundations of Health Informatics II (3.0 cr)
- HINF 8431 - Foundations of Health Informatics II Lab (2.0 cr)
- HINF 5450 - Foundations of Precision Medicine Informatics (3.0 cr)
- HINF 5610 - Foundations of Biomedical Natural Language Processing (3.0 cr)
- MEDC 5245 - Introduction to Drug Design (3.0 cr)
- PHAR 6224 - Pharmacogenomics: Genetic Basis for Variability in Drug Response (2.0 cr)
- PUBH 7415 - Introduction to Clinical Trials (3.0 cr)
- PUBH 7420 - Clinical Trials: Design, Implementation, and Analysis (3.0 cr)
- PUBH 8445 - Statistics for Human Genetics and Molecular Biology (3.0 cr)
- STAT 8053 - Applied Statistical Methods 3: Multivariate Analysis and Advanced Regression (3.0 cr)

Precision and Personalized Medicine Informatics

The precision and personalized medicine informatics track provides a didactic program for students training in informatics who will develop specialized knowledge in precision informatics methods applied to personal and population health-focused problems. The scope of this track includes social determinants of health and inter-professional research and expertise. Students will develop skills in quantitative methods and biomedical sciences for their application to precision medicine. In addition, students will gain an understanding of medical and biological science to provide needed context on which to apply informatics methods.

Students who pursue the precision and personalized medicine informatics track are expected to earn the health informatics MS degree en route to completing the PhD. Students must consult with the APC to coordinate completion of coursework and other requirements for the health informatics MS, the health informatics PhD, and the precision and personalized medicine informatics track. Students who have an MS in health informatics from a comparable program may be exempt from this requirement in whole or in part, subject to APC review and approval.

Precision and Personalized Medicine Informatics Coursework (32 credits)

Phase I (19 credits)
Take the following coursework for at least 19 credits.
- HINF 5450 - Foundations of Precision Medicine Informatics (3.0 cr)
- HINF 5510 - Applied Health Care Databases: Database Principles and Data Evaluation (3.0 cr)
- HINF 5520 - Informatics Methods for Health Care Quality, Outcomes, and Patient Safety (2.0 cr)
- PUBH 7401 - Fundamentals of Biostatistical Inference (4.0 cr)
- PUBH 7402 - Biostatistics Modeling and Methods (4.0 cr)
- HINF 5531 - Health Data Analytics and Data Science (3.0 cr)
- or HINF 5630 - Clinical Data Mining (3.0 cr)

Phase II (8 credits)
Take the following courses after completing Phase I, and with the approval of the APC. Take HINF 5496 and HINF 8492 for at least 3 credits each.
- HINF 5496 - Internship in Health Informatics (1.0 - 6.0 cr)
- HINF 8492 - Advanced Readings or Research in Health Informatics (1.0 - 6.0 cr)
- PHAR 6224 - Pharmacogenomics: Genetic Basis for Variability in Drug Response (2.0 cr)

Elective Coursework (5 credits)
Select at least 5 elective credits, in consultation with the APC, to complete the 46 course credits required for the PhD degree.
HINF 5431 - Foundations of Health Informatics II (3.0 cr)
MATH 5652 - Introduction to Stochastic Processes (4.0 cr)
MATH 5445 - Mathematical Analysis of Biological Networks (4.0 cr)
PUBH 7430 - Statistical Methods for Correlated Data (3.0 cr)
PUBH 7440 - Introduction to Bayesian Analysis (3.0 cr)
PUBH 7445 - Statistics for Human Genetics and Molecular Biology (3.0 cr)
PUBH 8432 - Probability Models for Biostatistics (3.0 cr)
PUBH 8442 - Bayesian Decision Theory and Data Analysis (3.0 cr)
PUBH 8445 - Statistics for Human Genetics and Molecular Biology (3.0 cr)
PUBH 8446 - Advanced Statistical Genetics and Genomics (3.0 cr)
STAT 5511 - Time Series Analysis (3.0 cr)
STAT 5401 - Applied Multivariate Methods (3.0 cr)
**Twin Cities Campus**

**Health Journalism and Communication M.A.**

*School of Journalism & Mass Communication*

**Graduate School**

Link to a list of faculty for this program.

**Contact Information:**
Health Journalism and Communication M.A. Program, School of Journalism and Mass Communication, 111 Murphy Hall, 206 Church Street S.E., Minneapolis MN 55455 (612-626-1851; fax 612-625-9525)
Email: dans@umn.edu
Website: [http://sjmc.umn.edu/grad/hjComm.html#degree](http://sjmc.umn.edu/grad/hjComm.html#degree)

- Program Type: Master's
- Requirements for this program are current for Fall 2018
- Length of program in credits: 33
- This program does not require summer semesters for timely completion.
- Degree: Master of Arts

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

Note: This program has been temporarily suspended. Applications are not being accepted at this time. Please contact Graduate Student Services at sjmcgrad@umn.edu with questions.

A joint program of the School of Journalism and Mass Communication and the School of Public Health, the professional master's in health journalism and communication promotes improved public communication about health matters by combining knowledge, skills, and experience from both disciplines. The program is designed for journalists and health professionals, who earn a master's degree in health journalism. Journalists and communications professionals learn the fundamentals of medical research and public health. Health professionals learn basic journalistic principles and ethics, and how to develop meaningful health stories. Those pursuing other master's degrees, (e.g., master's in public health), earn the M.A. in health journalism and communication in addition to the other degree.

The Health Journalism and Communication program has two distinct, but overlapping, programs of study. Students in the health journalism emphasis will gain advanced knowledge about public health and the evaluation of claims from health, medical, and scientific sources, as well as advanced training on reporting health stories for different media. Students in the health communication emphasis will learn the fundamentals of writing about health topics for different audiences in different formats, as well as health campaign development and evaluation.

**Program Delivery**
This program is available:
- via classroom (the majority of instruction is face-to-face)

**Prerequisites for Admission**

**Special Application Requirements:**
Applications to this master's program are not currently being accepted. Please contact sjmcgrad@umn.edu with questions.

Applicants must submit their test score(s) from the following:
- GRE

International applicants must submit score(s) from one of the following tests:
- TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
  - Paper Based - Total Score: 550
- IELTS
  - Total Score: 6.5

Key to test abbreviations (GRE, TOEFL, IELTS).

For an online application or for more information about graduate education admissions, see the General Information section of the
Program Requirements

Plan B: Plan B requires 25 major credits and 6 credits outside the major. The final exam is oral. A capstone project is required.

Capstone Project: Contact the program for capstone project information.

This program may not be completed with a minor.

Use of 4xxx courses towards program requirements is not permitted.

The M.A. in health journalism and communication requires a minimum of 33 semester credits, to be completed over a two-year schedule. The program has two distinct areas of emphasis: health journalism and health communication. Students in the health journalism emphasis area learn to evaluate claims from health, medical, and scientific sources and to tell health-oriented stories in broadcast or magazine journalism. Students in the health communication emphasis learn the fundamentals of writing about health topics for different audiences, as well as health campaign development and evaluation.
Twin Cities Campus
Health Journalism and Communication Minor
School of Journalism & Mass Communication
Graduate School

Link to a list of faculty for this program.

Contact Information:
Health Journalism and Communication M.A. Program, School of Journalism and Mass Communication, 111 Murphy Hall, 206 Church Street S.E., Minneapolis MN 55455 (612-626-1851; fax 612-625-9525)
Email: dans@umn.edu
Website: http://sjmc.umn.edu/grad/hjComm.html#degree

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2018
- Length of program in credits (Masters): 6
- Length of program in credits (Doctorate): 12
- This program does not require summer semesters for timely completion.

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

Note: This program has been temporarily suspended. Applications are not being accepted at this time. Please contact the School of Journalism’s Graduate Student Services office at sjmcgrad@umn.edu with questions.

A joint program of the School of Journalism and Mass Communication and the School of Public Health, the professional master's in health journalism and communication promotes improved public communication about health matters by combining knowledge, skills, and experience from both disciplines. The program is designed for journalists and health professionals, who earn a master's degree in health journalism. Journalists and communications professionals learn the fundamentals of medical research and public health. Health professionals learn basic journalistic principles and ethics, and how to develop meaningful health stories. Those pursuing other master's degrees, (e.g., master's in public health), earn the M.A. in health journalism and communication in addition to the other degree.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
Use of 4xxx courses towards program requirements is not permitted.

The master's minor requires 6 credits. The doctoral minor requires 12 credits.
Twin Cities Campus
History of Science, Technology, and Medicine M.A.
History of Science & Technology
Graduate School

Link to a list of faculty for this program.

Contact Information:
Program in the History of Science, Technology, and Medicine, University of Minnesota, 154 Shepherd Labs, 100 Union Street S.E., Minneapolis, MN 55455 (612-624-7069; fax: 612-301-1442)
Email: hstm@umn.edu
Website: http://www.hstm.umn.edu

• Program Type: Master's
• Requirements for this program are current for Fall 2018
• Length of program in credits: 30 to 31
• This program does not require summer semesters for timely completion.
• Degree: Master of Arts

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

The program offers opportunities for advanced research and study in the history of science and technology (with particular expertise in the history of the physical sciences, history of the biological sciences, history of technology, and history of American science and technology) and in the history of medicine.

Program Delivery
This program is available:
• via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

Other requirements to be completed before admission:
Students must have a bachelor's degree with a preferred grade average of B or better and must be capable of interdisciplinary study. Depending on background and career objectives, additional preparatory studies may be necessary in either the science-technology area or in the humanities and social sciences.

Although it is not strictly required for admission, it's strongly recommended that applicants submit a GRE score.

Special Application Requirements:
All application materials are submitted online to the University. Check the HSTM website (www.hstm.umn.edu) for more information. Applications are accepted for fall admission only. The application deadline is December 1.

International applicants must submit score(s) from one of the following tests:
• TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
  - Paper Based - Total Score: 550
• IELTS
  - Total Score: 6.5
• MELAB
  - Final score: 80

Key to test abbreviations (TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.
Program Requirements

**Plan A:** Plan A requires 15 major credits, 6 credits outside the major, and 10 thesis credits. The final exam is oral.

**Plan B:** Plan B requires 24 major credits and 6 credits outside the major. The final exam is written.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

Language Requirement: Reading proficiency in one foreign language.

A minimum GPA of 3.30 is required for students to remain in good standing.

The MA is offered under Plan A and Plan B. Following the guidelines in the Graduate Student Handbook for the program (www.hstm.umn.edu), MA students select one of two tracks, the history of science and technology or the history of medicine, and, within the chosen track, select courses subject to distribution requirements in terms of area and period. All of the courses selected for the requirements must be passed with a grade of B or better.

Plan A requires 31 credits consisting of 6 credits in the required courses HSCI/HMED 8112 and 8113, 9 additional credits in HSCI or HMED, 6 credits in an outside field or in a minor, and 10 thesis credits.

Plan B requires 30 credits consisting of 6 credits in the required courses HSCI/HMED 8112 and 8113, 15 additional credits in HSCI or HMED, 3 credits in a directed study course, and 6 credits in an outside field or in a minor.

Program Sub-plans

Students are required to complete one of the following sub-plans. Students may not complete the program with more than one sub-plan.

**History of Medicine**

**Plan A**

**Required Courses**
- Take the two-semester sequence of historiography and research preparation, plus an additional 9 credits in HMED chosen in consultation with advisor.
- HMED 8112 - Historiography of Science, Technology, and Medicine (3.0 cr)
- HMED 8113 - Research Methods in the History of Science, Technology, and Medicine (3.0 cr)

**Outside Field Coursework**
- In consultation with advisor and the director of graduate studies, take 6 credits in courses from either the track alternative to the one in which you are enrolled, in outside fields, or in a minor.

**Thesis Credits**
- Take 10 thesis credits
- HMED 8777 - Thesis Credits: Master's (1.0 - 18.0 cr)

**Plan B**

**Required Courses**
- Take the two-semester sequence of historiography and research preparation, plus an additional 15 credits in HMED chosen in consultation with advisor.
- HMED 8112 - Historiography of Science, Technology, and Medicine (3.0 cr)
- HMED 8113 - Research Methods in the History of Science, Technology, and Medicine (3.0 cr)

**Outside Field Coursework**
- In consultation with advisor and the director of graduate studies, take 6 credits in courses from either the track alternative to the one in which you are enrolled, in outside fields, or in a minor.

**Directed Study**
- Take 3 credits in a directed study course.
- HMED 8631 - Directed Study (1.0 - 6.0 cr)
- or HMED 8632 - Directed Study (1.0 - 6.0 cr)

**History of Science and Technology**

**Plan A**

**Required Courses**
- Take the two-semester sequence of historiography and research preparation, plus an additional 9 credits in HSCI chosen in
consultation with advisor.
HSCI 8112 - Historiography of Science, Technology, and Medicine (3.0 cr)
HSCI 8113 - Research Methods in the History of Science, Technology, and Medicine (3.0 cr)

Outside Field Coursework
In consultation with advisor and the director of graduate studies, take 6 credits in courses from either the track alternative to the one in which you are enrolled, in outside fields, or in a minor.

Thesis Credits
Take 10 thesis credits
HSCI 8777 - Thesis Credits: Master's (1.0 - 18.0 cr)

Plan B

Required Courses
Take the two-semester sequence of historiography and research preparation, plus an additional 15 credits in HSCI chosen in consultation with advisor.
HSCI 8112 - Historiography of Science, Technology, and Medicine (3.0 cr)
HSCI 8113 - Research Methods in the History of Science, Technology, and Medicine (3.0 cr)

Outside Field Coursework
In consultation with advisor and the director of graduate studies, take 6 credits in courses from either the track alternative to the one in which you are enrolled, in outside fields, or in a minor.

Directed Study
Take 3 credits in a directed study course.
HSCI 8993 - Directed Studies (1.0 - 5.0 cr)
or HSCI 8994 - Directed Research (1.0 - 5.0 cr)
Twin Cities Campus

History of Science, Technology, and Medicine Minor

History of Science & Technology

Graduate School

Link to a list of faculty for this program.

Contact Information:
Program in the History of Science, Technology, and Medicine, University of Minnesota, 154 Shepherd Labs, 100 Union Street SE, Minneapolis, MN 55455 (612-624-7069; fax: 612-301-1442)
Email: hstm@umn.edu
Website: http://www.hstm.umn.edu

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2018
- Length of program in credits (Masters): 6
- Length of program in credits (Doctorate): 12
- This program does not require summer semesters for timely completion.

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

The program offers opportunities for advanced research and study in the history of science and technology (with particular expertise in the history of the physical sciences, history of the biological sciences, history of technology, and history of American science and technology) and in the history of medicine.

Program Delivery
This program is available:
• via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
Other requirements to be completed before admission:
Students must have a bachelor's degree with a preferred grade average of B or better and must be capable of interdisciplinary study. Depending on background and career objectives, additional preparatory studies may be necessary in either the science-technology area or in the humanities and social sciences.

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
Use of 4xxx courses towards program requirements is not permitted.

Students who wish to take the graduate minor in the history of science, technology, and medicine are required to take 6 credits for the master's minor and 12 credits for a doctoral minor. The historiography course (HSCI or HMED 8112) is strongly recommended, along with other courses that are selected to define a course of study that should have some identifiable focus but also a certain breadth. Students should not plan to take all courses in the minor from the same faculty member.

Program Sub-plans
Students are required to complete one of the following sub-plans. Students may not complete the program with more than one sub-plan.

Masters
The master's minor requires two 3-credit courses in HSTM or HMED at the 5xxx level or above.

Recommended Courses
HSCI 8112 - Historiography of Science, Technology, and Medicine (3.0 cr)
or HMED 8112 - Historiography of Science, Technology, and Medicine (3.0 cr)
Doctoral
The doctoral minor requires four 3-credit courses in HSTM or HMED at the 5xxx level or above.

Recommended Courses

- HSCI 8112 - Historiography of Science, Technology, and Medicine (3.0 cr)
- or HMED 8112 - Historiography of Science, Technology, and Medicine (3.0 cr)
Twin Cities Campus
History of Science, Technology, and Medicine Ph.D.
History of Science & Technology
Graduate School

Link to a list of faculty for this program.

Contact Information:
Program in the History of Science, Technology, and Medicine, University of Minnesota, 154 Shepherd Labs, 100 Union Street S.E., Minneapolis, MN 55455 (612-624-7069; fax: 612-301-1442)
Email: hstm@umn.edu
Website: http://www.hstm.umn.edu

- Program Type: Doctorate
- Requirements for this program are current for Fall 2018
- Length of program in credits: 54
- This program does not require summer semesters for timely completion.
- Degree: Doctor of Philosophy

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

The program offers opportunities for advanced research and study in the history of science and technology (with particular expertise in the history of the physical sciences, history of the biological sciences, history of technology, and history of American science and technology) and in the history of medicine.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

Other requirements to be completed before admission:
Students must have a bachelor's degree with a preferred grade average of B or better and must be capable of interdisciplinary study. Depending on background and career objectives, additional preparatory studies may be necessary in either the science-technology area or in the humanities and social sciences.

Although it is not strictly required for admission, it's strongly recommended that applicants submit a GRE score.

Special Application Requirements:
All application materials are submitted online to the University. Check the HSTM website (www.hstm.umn.edu) for more information. Applications are accepted for fall semester only. The application deadline is December 1.

International applicants must submit score(s) from one of the following tests:
- TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
  - Paper Based - Total Score: 550
- IELTS
  - Total Score: 6.5
- MELAB
  - Final score: 80

Key to test abbreviations (TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.
Program Requirements
24 credits are required in the major.
6 credits are required outside the major.
24 thesis credits are required.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

Language Requirement: Reading proficiency in two foreign languages.

A minimum GPA of 3.30 is required for students to remain in good standing.

Following the guidelines in the Graduate Student Handbook for the program (www.hstm.umn.edu), Ph.D. students select one of two tracks: the history of science and technology or the history of medicine; and within the chosen track, select courses subject to distribution requirements in terms of area and period. All of the courses selected for the requirements must be passed with a grade of B or better.

The PhD requires 54 credits consisting of the following: 6 credits in the required courses HSCI/HEMD 8112 and 8113, 15 additional credits in HSCI or HMED courses, 3 credits in a directed study course, 6 credits in outside fields, and 24 thesis credits.

Program Sub-plans
Students are required to complete one of the following sub-plans. Students may not complete the program with more than one sub-plan.

History of Medicine
Required Courses
Take the two-semester sequence of historiography and research preparation, plus an additional 15 credits in HMED chosen in consultation with advisor.
HMED 8112 - Historiography of Science, Technology, and Medicine (3.0 cr)
HMED 8113 - Research Methods in the History of Science, Technology, and Medicine (3.0 cr)

Directed Study
Take 3 credits in a directed study course.
HMED 8631 - Directed Study (1.0 - 6.0 cr)
or HMED 8632 - Directed Study (1.0 - 6.0 cr)

Outside Field Coursework
In consultation with advisor and the director of graduate studies, take 6 credits in courses from either the track alternative to the one in which you are enrolled, in outside fields, or towards a doctoral minor.

Thesis Credits
Take 24 credits after passing preliminary oral exam.
HMED 8888 - Thesis Credit: Doctoral (1.0 - 24.0 cr)

History of Science and Technology
Required Courses
Take the two-semester sequence of historiography and research preparation, plus an additional 15 credits in HSCI chosen in consultation with advisor.
HSCI 8112 - Historiography of Science, Technology, and Medicine (3.0 cr)
HSCI 8113 - Research Methods in the History of Science, Technology, and Medicine (3.0 cr)

Directed Study
Take 3 credits in a directed study course.
HSCI 8993 - Directed Studies (1.0 - 5.0 cr)
or HSCI 8994 - Directed Research (1.0 - 5.0 cr)

Outside Field Coursework
In consultation with advisor and the director of graduate studies, take 6 credits in courses from either the track alternative to the one in which you are enrolled, in outside fields, or towards a doctoral minor.

Thesis Credits
Take 24 credits after passing preliminary oral exam.
HSCI 8888 - Thesis Credit: Doctoral (1.0 - 24.0 cr)
Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

The master's of human rights is a two-year interdisciplinary professional master's degree to prepare students to work in the field of human rights or to advance their knowledge and skills in the field. This degree equips graduate students with core professional and conceptual knowledge and analytical tools necessary to operate on the professional level in the field of human rights, along with the in-depth academic and professional training needed for the specific human rights area in which they practice or intend to practice. Students follow a core curriculum that includes the study of human rights norms and law, methodology, critical views of human rights, and human rights policy that will equip them with the skills needed to address the problems.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergradu ate GPA for admittance to the program is 3.00.

Other requirements to be completed before admission:
Complete application will include a University of Minnesota application, personal statement, resume or C.V., transcripts, GRE scores, TOEFL scores (if applicable), at least three letters of recommendation, and an optional diversity statement.

Applicants must submit their test score(s) from the following:
- GRE

International applicants must submit score(s) from one of the following tests:
- TOEFL
  - Internet Based - Total Score: 100
  - Paper Based - Total Score: 600

Key to test abbreviations (GRE, TOEFL).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
Plan C: Plan C requires 45 major credits and up to null credits outside the major. The is no final exam. A capstone project is required.
Capstone Project: Students will participate in a three-credit capstone seminar rather than a thesis. The capstone seminar is one of the required core courses.

This program may be completed with a minor.
Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 2.8 is required for students to remain in good standing.

At least 1 semesters must be completed before filing a Degree Program Form.

In addition to course requirements, a non-credit professional internship of 400 hours, supervised by the Human Rights Program, is required. Ideally, it will be completed during the summer after the first year.

4xxx-level courses are limited to language courses; other subjects allowed only with DGS approval.

**Human Rights Core**
- PA 5885 - Human Rights Policy: Issues and Actors (3.0 cr)
- PA 5886 - Master of Human Rights Cohort Seminar I (1.0 cr)
- PA 5887 - Master of Human Rights Cohort Seminar II (1.0 cr)
Take 2 or more course(s) totaling 6 or more credit(s) from the following:
  - LAW 6886 - International Human Rights Law (3.0 cr)
  - GLOS 5403 - Human Rights Advocacy (3.0 cr)
  - SOC 8171 - Cross-Disciplinary Perspectives in Human Rights (3.0 cr)

**Professional Core**
Minimum 12 credits

**Quantitative**
- Higher-level options available for students with strong statistical background, with DGS approval.
- Take 1 or more course(s) from the following:
  - PA 5031 - Statistics for Public Affairs (4.0 cr)
  - PA 5032 - Applied Regression (2.0 cr)
  - PA 5033 - Multivariate Techniques (2.0 cr)
  - PA 5044 - Applied Regression, Accelerated (2.0 cr)
  - SOC 5811 - Social Statistics for Graduate Students [MATH] (4.0 cr)
  - STAT 5021 - Statistical Analysis (4.0 cr)
  - STAT 5201 - Sampling Methodology in Finite Populations (3.0 cr)
  - STAT 5401 - Applied Multivariate Methods (3.0 cr)

**Qualitative**
- Take 1 or more course(s) from the following:
  - PA 5041 - Qualitative Methods for Policy Analysts (4.0 cr)
  - OLPD 5061 - Ethnographic Research Methods (3.0 cr)
  - SOC 8852 - Advanced Qualitative Research Methods: Ethnographic Practicum (3.0 cr)

**Management**
- Take 1 or more course(s) from the following:
  - PA 5011 - Management of Organizations (3.0 cr)
  - PA 5101 - Management and Governance of Nonprofit Organizations (3.0 cr)
  - PA 5151 - Organizational Perspectives on Global Development & Humanitarian Assistance (3.0 cr)

**Policy and Economic Analysis**
- Take 1 or more course(s) from the following:
  - PA 5002 - Introduction to Policy Analysis (1.5 cr)
  - PA 5021 - Microeconomics for Policy Analysis (3.0 cr)
  - PA 5012 - The Politics of Public Affairs (3.0 cr)
  - PA 5801 - Global Public Policy (3.0 cr)

**Capstone or Professional Paper**
- Take 1 or more course(s) from the following:
  - PA 8081 - Capstone Workshop (3.0 cr)
  - PA 8082 - Professional Paper-Writing Seminar (3.0 cr)
  - PA 8921 - Master’s: Professional Paper (Individual Option) (1.0 - 3.0 cr)

**Concentration and Electives**
- Concentration (12 credits) plus electives to bring total credits to 45.

**Concentrations: Pre-Designed**
Students complete 12 credits in a pre-designed or self-designed concentration. Pre-designed concentrations are listed below. Consult the program or adviser for courses which do not appear but which may be eligible with consent of adviser.

**Human Rights, Race, and Ethnicity**
Take 12 or more credit(s) from the following:

- AFRO 5866 - The Civil Rights and Black Power Movement, 1954-1984 (3.0 cr)
- AFRO 8202 - Seminar: Intellectual History of Race (3.0 cr)
- AFRO 8554 - Seminar: Gender, Race, Nation, and Policy—Perspectives from Within the African Diaspora (3.0 cr)
- PA 5002 - Introduction to Policy Analysis (1.5 cr)
- PA 5311 - Program Evaluation (3.0 cr)
- PA 5422 - Diversity and Public Policy (3.0 cr)
- PA 5421 - Racial Inequality and Public Policy (3.0 cr)
- PA 8302 - Applied Policy Analysis (4.0 cr)
- PA 8312 - Analysis of Discrimination (4.0 cr)
- PSY 8210 - Law, Race, and Social Psychology (3.0 cr)

-OR-

Human Rights, Gender, and Sexuality

Take 12 or more credit(s) from the following:

- GWSS 5104 - Transnational Feminist Theory (3.0 cr)
- GWSS 8101 - Intellectual History of Feminism (3.0 cr)
- GWSS 8103 - Feminist Theories of Knowledge (3.0 cr)
- LAW 6827 - Women's International Human Rights (2.0 cr)
- PA 5601 - Global Survey of Gender and Public Policy (3.0 cr)
- PA 5561 - Gender and International Development (3.0 cr)
- PUBH 6675 - Women's Health (2.0 cr)

-OR-

Human Rights in the Arts and Humanities

Take 12 or more credit(s) from the following:

- ARTS 5710 - Advanced Photography (4.0 cr)
- ARTS 5760 - Experimental Film and Video (4.0 cr)
- ENGW 5102 - Graduate Fiction Writing (4.0 cr)
- ENGW 5106 - Graduate Literary Nonfiction Writing (4.0 cr)

-OR-

Human Rights, NGO Leadership, and Management Course

Take 12 or more credit(s) from the following:

- PA 5101 - Management and Governance of Nonprofit Organizations (3.0 cr)
- PA 5104 - Strategic Human Resource Management (3.0 cr)
- PA 5108 - Board leadership development (1.0 cr)
- PA 5116 - Financing Public and Nonprofit Organizations (1.5 cr)
- PA 5123 - Philanthropy in America: History, Practice, and Trends (3.0 cr)
- PA 5137 - Project Management in the Public Arena (1.5 cr)
- PA 5144 - Social Entrepreneurship (3.0 cr)
- PA 5145 - Civic Participation in Public Affairs (3.0 cr)
- PA 5151 - Organizational Perspectives on Global Development & Humanitarian Assistance (3.0 cr)
- PA 5251 - Strategic Planning and Management (3.0 cr)
- PA 5311 - Program Evaluation (3.0 cr)
- PA 5405 - Public Policy Implementation (3.0 cr)
- PA 5501 - Theories and Policies of Development (3.0 cr)
- PA 5801 - Global Public Policy (3.0 cr)
- PA 5927 - Effective Grantwriting for Nonprofit Organizations (1.5 cr)

-OR-

Human Rights and Project/Policy Evaluation

Take 12 or more credit(s) from the following:

- PA 5311 - Program Evaluation (3.0 cr)
- PA 5103 - Leadership and Change (3.0 cr)
- PA 5104 - Strategic Human Resource Management (3.0 cr)
- PA 5105 - Integrative Leadership Seminar (3.0 cr)
- PA 5145 - Civic Participation in Public Affairs (3.0 cr)
- PA 5251 - Strategic Planning and Management (3.0 cr)
- PA 5405 - Public Policy Implementation (3.0 cr)
- PUBH 6852 - Program Evaluation in Health and Mental Health Settings (2.0 cr)
- SW 8602 - Direct Practice Evaluation (2.0 cr)

-OR-
Human Rights and Development
Take 12 or more credit(s) from the following:
• ESPM 5251 - Natural Resources in Sustainable International Development (3.0 cr)
• OLPD 5104 - Strategies for International Development of Education Systems (3.0 cr)
• OLPD 5107 - Gender, Education, and International Development (3.0 cr)
• OLPD 5121 - Educational Reform in International Context (3.0 cr)
• PA 5151 - Organizational Perspectives on Global Development & Humanitarian Assistance (3.0 cr)
• PA 5405 - Public Policy Implementation (3.0 cr)
• PA 5501 - Theories and Policies of Development (3.0 cr)
• PA 5503 - Economics of Development (3.0 cr)
• PA 5521 - Development Planning and Policy Analysis (4.0 cr)
• PA 5522 - International Development Policy, Families, and Health (3.0 cr)
• PA 5561 - Gender and International Development (3.0 cr)
• PA 5601 - Global Survey of Gender and Public Policy (3.0 cr)

-OR-

Human Rights, Conflict and International Security
Take 12 or more credit(s) from the following:
• LAW 6027 - Law of the Sea (2.0 cr)
• LAW 6889 - Laws of War (3.0 cr)
• LAW 6918 - Rule of Law (2.0 cr)
• PA 5801 - Global Public Policy (3.0 cr)
• PA 5813 - US Foreign Policy: The Institutional Basis (3.0 cr)
• PA 5823 - Managing Humanitarian and Refugee Crises: Challenges for Policymakers & Practitioners (1.0 cr)
• PA 8821 - National Security Policy (3.0 cr)
• POL 5885 - International Conflict and Security (3.0 cr)
• POL 5465 - Democracy and Dictatorship in Southeast Asia [GP] (3.0 cr)
• SOC 5315 - Never Again! Memory & Politics after Genocide [GP] (3.0 cr)
• GLOS 5315 - Never Again! Memory & Politics after Genocide [GP] (3.0 cr)
• SOC 5411 - Terrorist Networks & Counterterror Organizations (3.0 cr)

-OR-

Human Rights and Migration
Take 12 or more credit(s) from the following:
• PA 5281 - Immigrants, Urban Planning and Policymaking in the U.S. (3.0 cr)
• PA 5301 - Population Methods & Issues for the United States & Global South (3.0 cr)
• PA 5451 - Immigration, Health and Public Policy (3.0 - 4.0 cr)
• PA 5452 - Immigration and Public Policy (3.0 cr)
• PA 5801 - Global Public Policy (3.0 cr)
• LAW 6027 - Law of the Sea (2.0 cr)
• LAW 6872 - Immigration Law (3.0 cr)
• CHIC 5374 - Migrant Farmworkers in the United States: Families, Work, and Advocacy [CIV] (4.0 cr)

-OR-

Human Rights: Crime, Law, and Justice
Take 12 or more credit(s) from the following:
• LAW 6648 - International Criminal Law (3.0 cr)
• LAW 6893 - Transitional Justice (2.0 cr)
• LAW 6918 - Rule of Law (2.0 cr)
• POL 5403 - Constitutions, Democracy, and Rights: Comparative Perspectives (3.0 cr)
• POL 5492 - Law and (In)Justice in Latin America (3.0 cr)
• SOC 5104 - Crime and Human Rights (3.0 cr)
• SOC 5170 - Sociology of International Law: Human Rights, Trafficking, and Business Regulation [GP] (3.0 cr)
• SOC 5411 - Terrorist Networks & Counterterror Organizations (3.0 cr)
• SOC 5315 - Never Again! Memory & Politics after Genocide [GP] (3.0 cr)
• GLOS 5315 - Never Again! Memory & Politics after Genocide [GP] (3.0 cr)

-OR-

Human Rights and Research Methods (Qualitative and/or Quantitative)
Take 12 or more credit(s) from the following:
• OLPD 5061 - Ethnographic Research Methods (3.0 cr)
• PA 5031 - Statistics for Public Affairs (4.0 cr)
• PA 5032 - Applied Regression (2.0 cr)
• PA 5033 - Multivariate Techniques (2.0 cr)
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA 5041</td>
<td>Qualitative Methods for Policy Analysts</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>PA 5044</td>
<td>Applied Regression, Accelerated</td>
<td>2.0 cr</td>
</tr>
<tr>
<td>PUBH 6803</td>
<td>Conducting a Systematic Literature Review</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>PUBH 6845</td>
<td>Using Demographic Data for Policy Analysis</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>PUBH 6810</td>
<td>Survey Research Methods</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>PUBH 6815</td>
<td>Community-based Participatory Research</td>
<td>2.0 cr</td>
</tr>
<tr>
<td>PUBH 7250</td>
<td>Designing and Conducting Focus Group Interviews</td>
<td>1.0 cr</td>
</tr>
<tr>
<td>SOC 5811</td>
<td>Social Statistics for Graduate Students [MATH]</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>PUBH 6815</td>
<td>Survey Research Methods</td>
<td>3.0 cr</td>
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<td>PUBH 6815</td>
<td>Community-based Participatory Research</td>
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<td>Conducting and Designing Focus Group Interviews</td>
<td>1.0 cr</td>
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<tr>
<td>STAT 5021</td>
<td>Statistical Analysis</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>STAT 5201</td>
<td>Sampling Methodology in Finite Populations</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>STAT 5401</td>
<td>Applied Multivariate Methods</td>
<td>3.0 cr</td>
</tr>
</tbody>
</table>

**OR**

**Human Rights and Area Studies (Latin America, Asia, Middle East, Africa, etc.)**

The potential area studies courses offered at the University are vast. Students will work with their advisor to select at least 12 credits for an area studies concentration.

Take 12 or more credit(s) from the following:

**OR**

**Human Rights and Public Health**

Take 12 or more credit(s) from the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BTHX 5520</td>
<td>Social Justice and Bioethics</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>CSPH 5111</td>
<td>Ways of Thinking about Health</td>
<td>2.0 cr</td>
</tr>
<tr>
<td>PA 5451</td>
<td>Immigration, Health and Public Policy</td>
<td>3.0 - 4.0 cr</td>
</tr>
<tr>
<td>PUBH 6034</td>
<td>Evaluation</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>PUBH 6115</td>
<td>Worker Protection Law</td>
<td>1.0 cr</td>
</tr>
<tr>
<td>PUBH 6134</td>
<td>Sustainable Development and Global Public Health</td>
<td>2.0 cr</td>
</tr>
<tr>
<td>PUBH 6320</td>
<td>Fundamentals of Epidemiology</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>PUBH 6606</td>
<td>Children's Health: Issues, Programs, and Policies</td>
<td>2.0 cr</td>
</tr>
<tr>
<td>PUBH 6634</td>
<td>Children and Families: Public Health Policy and Advocacy</td>
<td>2.0 cr</td>
</tr>
<tr>
<td>PUBH 6801</td>
<td>Health and Human Rights</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>PUBH 6804</td>
<td>Community Mental Health</td>
<td>2.0 cr</td>
</tr>
</tbody>
</table>

**OR**

**Human Rights and Environment**

Take 12 or more credit(s) from the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESPM 5251</td>
<td>Natural Resources in Sustainable International Development</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>LAW 6215</td>
<td>Environmental Law</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>LAW 6400</td>
<td>International Environmental Law</td>
<td>2.0 cr</td>
</tr>
<tr>
<td>LAW 7012</td>
<td>CL: Environment and Energy Law</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>PA 5242</td>
<td>Environmental Planning, Policy, and Decision Making</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>PA 5711</td>
<td>Science, Technology &amp; Environmental Policy</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>PA 5721</td>
<td>Economics of Natural Resource and Environmental Policy</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>PA 5722</td>
<td>Water Policy</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>PA 5724</td>
<td>Climate Change Policy</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>PA 5752</td>
<td>Material-Energy Flows &amp; Sustainable Development</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>PA 5721</td>
<td>Energy Systems and Policy</td>
<td>3.0 cr</td>
</tr>
</tbody>
</table>
Twin Cities Campus
Integrated Biosciences M.S.
Medical School - Adm
Graduate School

Link to a list of faculty for this program.

Contact Information:
University of Minnesota, 251 Swenson Science Building, 1035 Kirby Drive, Duluth, MN 55812 (218-726-6898; fax: 218-726-8152)
Email: ibs@d.umn.edu
Website: http://www.d.umn.edu/ibs

- Program Type: Master's
- Requirements for this program are current for Fall 2018
- Length of program in credits: 30
- This program requires summer semesters for timely completion.
- Degree: Master of Science

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

The all-University integrated biosciences graduate program offers study toward the master of science (M.S.) degree under Plan A (coursework and original thesis). The program has two areas of emphasis: cell, molecular, and physiological (CMP) biology; and ecology, organismal, and population (EOP) biology.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

A bachelor's degree or equivalent from an accredited college/university in the biological or physical sciences or a related field. Background in a variety of subdisciplines is appropriate preparation.

Other requirements to be completed before admission:
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.

Applicants must submit their test score(s) from the following:
- GRE

International applicants must submit score(s) from one of the following tests:
- TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
  - Paper Based - Total Score: 550
- IELTS
  - Total Score: 6.5
- MELAB
  - Final score: 80

The preferred English language test is Test of English as Foreign Language

Key to test abbreviations (GRE, TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.
Program Requirements

Plan A: Plan A requires 14 major credits, 6 credits outside the major, and 10 thesis credits. The final exam is oral.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 3.00 is required for students to remain in good standing.

At least 2 semesters must be completed before filing a Degree Program Form.

Required Coursework
Twin Cities Campus
Integrated Biosciences Ph.D.
Medical School - Adm
Graduate School

Link to a list of faculty for this program.

Contact Information:
Integrated Biosciences Graduate Program, University of Minnesota, 251 Swenson Science Building, 1035 Kirby Drive, Duluth, MN 55812 (218-726-6898; fax: 218-726-8152)
Email: ibs@d.umn.edu
Website: http://www.d.umn.edu/ibs

- Program Type: Doctorate
- Requirements for this program are current for Fall 2018
- Length of program in credits: 56
- This program does not require summer semesters for timely completion.
- The Integrated Biosciences Ph.D. is an All-University program delivered on the Twin Cities and Duluth Campuses. The University of Minnesota Twin Cities is the degree granting authority for the Integrated Biosciences Ph.D. program in Duluth.
- Degree: Doctor of Philosophy

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

The all-University integrated biosciences graduate program offers study toward 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.

Program Delivery
This program is available:
• via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

A bachelor's degree or equivalent from an accredited college or university in the biological or physical sciences or a related field.

Other requirements to be completed before admission:
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.

Applicants must submit their test score(s) from the following:
• GRE

International applicants must submit score(s) from one of the following tests:
• TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
  - Paper Based - Total Score: 550
• IELTS
  - Total Score: 6.5
• MELAB
  - Final score: 80
The preferred English language test is Test of English as Foreign Language

Key to test abbreviations (GRE, TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
20 credits are required in the major.
12 credits are required outside the major.
24 thesis credits are required.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 3.00 is required for students to remain in good standing.

At least 2 semesters must be completed before filing a Degree Program Form.

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 University regulations and all students will be required to pass the oral examination to continue in the Ph.D. program.

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 University regulations. It will consist of a public seminar presented by the student.
**Twin Cities Campus**  
**Integrative Health & Wellbeing Coaching M.A.**  
*Spirituality and Healing, Earl E Bakken Center for Graduate School*

Link to a list of faculty for this program.

**Contact Information:**  
Earl E. Bakken Center for Spirituality & Healing  
C591 Mayo Memorial Building  
420 Delaware St SE  
Minneapolis, MN 55455  
Email: fider002@umn.edu  
Website: [http://www.csh.umn.edu](http://www.csh.umn.edu)

- Program Type: Master's  
- Requirements for this program are current for Fall 2018  
- Length of program in credits: 38  
- This program requires summer semesters for timely completion.  
- Degree: Master of Arts

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

Health coaching is an emerging method of partnering with clients to achieve their overall goals. It is practiced from a holistic perspective that views each person as intrinsically whole and the ultimate expert in his or her healing journey. Health coaching is being offered in a wide range of venues including hospitals, clinics, community health and fitness facilities, corporations, educational institutions, and private practices. The Earl E. Bakken Center for Spirituality & Healing is a pioneer in the field of health coaching, working to advance education, research and care model innovation.

The master's of arts degree is designed for individuals with a bachelor's degree in either a healthcare or non-healthcare field. Students without healthcare backgrounds are eligible for admission with the prior completion of required prerequisites. The degree is designed for students who wish to further their education so that they may hold positions of responsibility coaching individuals and groups, initiating and leading new coaching service lines, and developing outcomes assessments for coaching initiatives. Although the instruction is based on research in the field, this Plan B degree is not intended to provide intensive research training and is understood to be a terminal degree. The degree consists of 38 credits of coursework, including 6 credits of electives, and a minimum 2-credit project that is presented in both verbal and written format prior to graduation. Elective credits may be chosen from CSPH courses or students may complete a minor from other departments, if approved by their academic adviser. In all cases, the student's faculty advisor will work with the student in designing a program plan that accommodates the student's unique learning objectives.

The program is structured to prepare a wide variety of students to be skilled and knowledgeable advocates and support agents for individuals on their path to greater health and healing. Students must be able to demonstrate the following competencies prior to being admitted into the Advanced Health Coaching Seminar:

- Demonstrate appropriate knowledge of major health problems.
- Demonstrate familiarity with the routine mechanics of the conventional healthcare system and its processes.
- Demonstrate basic knowledge of physical and psychological symptoms related to disease and treatment.
- Demonstrate basic knowledge of pharmacology, pathophysiology of disease, and assessment of symptoms across the life span.

Students whose previous coursework does not enable them to meet these competencies may arrange with the program director to do additional outside coursework during the first year of the program.

University of Minnesota health coaching programs are accredited by the National Consortium for Credentialing Health and Wellness Coaches ([www.nccchw.org](http://www.nccchw.org)). Students in the MA program are eligible to sit for National Board Certification when the required core courses are completed (CSPH 5701-5702-5703-5705-5706).

**Program Delivery**  
This program is available:

- primarily online (at least 80% of the instruction for the program is online with short, intensive periods of face-to-face coursework)

**Prerequisites for Admission**  
The preferred undergraduate GPA for admittance to the program is 3.00.

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Information current as of August 31, 2018
Bachelor's degree in a health-related field or a bachelor's in a non-health-related field with specific coursework in psychology, physiology, and statistics from an accredited institution.

**Required prerequisites**

**Required Prerequisite Coursework**

Previous coursework in basic psychology, human physiology, and statistics must have been completed. Statistics must be completed within 7 years prior to application. All prerequisites must be completed at an accredited institution for a grade equal to B (3.0) or better.

Other requirements to be completed before admission:

In addition to the University's online application, applicants submit a personal statement describing their goals for the program and their professional qualifications. This three to five page statement should focus on what led to the applicant's interest in health coaching as a professional activity, including a description of interest in, and experience with, holistic integrative health and healing. Three letters of recommendation, transcripts and a current CV or resume are also required. All items are uploaded into the University's online application. Selected applicants will be invited for admissions interviews.

**Special Application Requirements:**

The M.A. is designed for individuals with a bachelor's degree in a health-related field, or for professionals without healthcare backgrounds who have extensive interest in working with individuals and groups to optimize wellbeing, assuming completion of required prerequisites. All applicants must have completed the prerequisite courses in Physiology, Statistics (within past 7 years) and Psychology before beginning core health coaching coursework the Fall semester of entrance. All prerequisite courses must be completed at an accredited institution with a grade equal to B (3.0) or better.

International applicants must submit score(s) from one of the following tests:

- **TOEFL**
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
  - Paper Based - Total Score: 550
- **IELTS**
  - Total Score: 6.5
- **MELAB**
  - Final score: 80

The preferred English language test is Test of English as Foreign Language

Key to test abbreviations (TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the [General Information](#) section of the catalog website.

**Program Requirements**

**Plan B:** Plan B requires 32 to 38 major credits and 0 to 6 credits outside the major. The final exam is written and oral. A capstone project is required.

**Capstone Project:** Culminating course for the master's of arts in integrative health and wellbeing coaching program. Students use coaching data collected during the Advanced Health Coaching Practicum, Health Coaching Professional Internship, or group health coaching course to write and orally present a research-informed concept analysis and retrospective narrative case report. Prerequisites: Integrative Health and Wellbeing Coaching MA student, CSPH 5701, 5702, 5703, 5704, 5706, 5707, 5709* (*may be taken concurrently).

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 3.0 is required for students to remain in good standing.

At least 1 semesters must be completed before filing a Degree Program Form.

Up to 3 credits of CSPH courses at the 4xxx-level may be used for elective credits.
Core Required Coursework
Core courses require a grade of B (3.0) or higher, except CSPH 5705 and 8701, which require a grade of S. Final skills assessments for CSPH 5702, 5703, 5705 and 5709 must earn scores of at least 80%. If a core course or skills assessment is not successfully completed, students may be required at instructors' discretion to repeat the course and/or take CSPH 5712 for 1-2 credits for remediation within one calendar year. CSPH 5712 taken for remediation cannot be counted as an elective.
- CSPH 5701 - Fundamentals of Health Coaching I (4.0 cr)
- CSPH 5702 - Fundamentals of Health Coaching II (4.0 cr)
- CSPH 5703 - Advanced Health Coaching Practicum (3.0 cr)
- CSPH 5704 - Business of Health Coaching (2.0 cr)
- CSPH 5705 - Health Coaching Professional Internship (2.0 cr)
- CSPH 5706 - Lifestyle Medicine (2.0 cr)
- CSPH 5707 - Coaching People with Clinical Conditions (2.0 cr)
- CSPH 5709 - Health and Wellbeing Group Coaching (2.0 cr)
- CSPH 8701 - Integrative Health and Wellbeing Coaching MA Capstone Project (2.0 cr)

Additional Required Coursework
Each additional required course must be taken on an A-F grading basis and requires a grade of B- or higher. Failure to earn at least a B- may result in required remediation work at the discretion of the instructor, the program director, and the director of graduate studies. Remediation work may include repeating the course for an acceptable grade within one calendar year.
- CSPH 5101 - Introduction to Integrative Healing Practices (3.0 cr)
- CSPH 5431 - Functional Nutrition: An Expanded View of Nutrition, Chronic Disease, and Optimal Health (2.0 cr)
- CSPH 5708 - Mind-Body Science and the Art of Transformation (1.0 cr)
- KIN 5123 - Motivational Interventions in Physical Activity (3.0 cr)

Electives
Complete 6 CSPH credits. Up to 3 credits may be from 4xxx-level CSPH courses. Electives require a passing grade of C- or higher or S, provided an overall GPA of 3.0 is maintained.
Take 6 or more credit(s) from the following:
- CSPH 4311 - Foundations of Hatha Yoga: Alignment & Movement Principles (3.0 cr)
- CSPH 4312 - Hatha Yoga Philosophy, Lifestyle, & Ethics (3.0 cr)
- CSPH 4313 - Hatha Yoga Teaching Principles & Methodology (2.0 cr)
- CSPH 5000 - Explorations in Integrative Therapies and Healing Practices (1.0 - 4.0 cr)
- CSPH 5102 - Art of Healing: Self as Healer (1.0 cr)
- CSPH 5111 - Ways of Thinking about Health (2.0 cr)
- CSPH 5115 - Cultural Awareness, Knowledge and Health (3.0 cr)
- CSPH 5118 - Whole Person, Whole Community: The Reciprocity of Wellbeing (3.0 cr)
- CSPH 5121 - Whole Systems Healing: Health and the Environment (2.0 cr)
- CSPH 5201 - Spirituality and Resilience (2.0 cr)
- CSPH 5211 - Peacemaking and Spirituality: A Journey Toward Healing and Strength (2.0 - 3.0 cr)
- CSPH 5212 - Peacebuilding Through Mindfulness: Transformative Dialogue in the Global Community (3.0 cr)
- CSPH 5215 - Forgiveness and Healing: A Journey Toward Wholeness (3.0 cr)
- CSPH 5225 - Meditation: Integrating Body and Mind (2.0 cr)
- CSPH 5226 - Advanced Meditation: Body, Brain, Mind, and Universe (1.0 cr)
- CSPH 5311 - Introduction to Traditional Chinese Medicine (2.0 cr)
- CSPH 5313 - Acupressure (1.0 cr)
- CSPH 5315 - Traditional Tibetan Medicine: Ethics, Spirituality, and Healing (2.0 cr)
- CSPH 5317 - Yoga: Ethics, Spirituality, and Healing (2.0 cr)
- CSPH 5318 - Tibetan Medicine, Ayurveda, and Yoga in India (4.0 cr)
- CSPH 5319 - Yoga and Ayurveda in India (4.0 cr)
- CSPH 5331 - Foundations of Shamanism and Shamanic Healing (2.0 cr)
- CSPH 5332 - Global Healing Traditions: Amazonia Plant Spirit Medicine (2.0 cr)
- CSPH 5341 - Overview of Indigenous Hawaiian Healing (2.0 cr)
- CSPH 5343 - Ayurveda Medicine: The Science of Self-healing (2.0 cr)
- CSPH 5401 - People, Plants, and Drugs: Introduction to Ethnopharmacology (3.0 cr)
- CSPH 5421 - Botanical Medicines in Integrative Healthcare (3.0 cr)
- CSPH 5423 - Botanical Medicines: Foundations and Practical Applications (1.0 cr)
- CSPH 5431 - Functional Nutrition: An Expanded View of Nutrition, Chronic Disease, and Optimal Health (2.0 cr)
- CSPH 5503 - Aromatherapy Fundamentals (1.0 cr)
- CSPH 5511 - Interdisciplinary Palliative Care: An Experiential Course in a Community Setting (2.0 cr)
- CSPH 5512 - Spiritual Aspects of Palliative Care (2.0 cr)
- CSPH 5513 - Living Well, Dying Well: Empowering Patient Communication at the End of Life (2.0 cr)
- CSPH 5521 - Therapeutic Landscapes (3.0 cr)
- CSPH 5522 - Therapeutic Horticulture (3.0 cr)
- CSPH 5523 - Applications in Therapeutic Horticulture (2.0 cr)
- CSPH 5533 - Introduction to Energy Healing (2.0 cr)
• CSPH 5535 - Reiki Healing (1.0 cr)
• CSPH 5536 - Advanced Reiki Healing: Level II (1.0 cr)
• CSPH 5541 - Emotional Healing and Happiness: Eastern and Western Approaches to Transforming the Mind (2.0 cr)
• CSPH 5555 - Introduction to Body and Movement-based Therapies (2.0 cr)
• CSPH 5561 - Overview of the Creative Arts in Health and Healing (2.0 cr)
• CSPH 5601 - Music, Health and Healing (2.0 cr)
• CSPH 5605 - Movement and Music for Well-being and Healing (2.0 cr)
• CSPH 5631 - Healing Imagery I (2.0 cr)
• CSPH 5641 - Animals in Health Care: The Healing Dimensions of Human/Animal Relationships (3.0 cr)
• CSPH 5642 - Nature Heals: An Introduction to Nature-Based Therapeutics (3.0 cr)
• CSPH 5643 - Horse as Teacher: Intro to Nature-Based Therapeutics Equine-Assisted Activities & Therapies (EAAT) (3.0 cr)
• CSPH 5711 - Optimal Healing Environments (3.0 cr)
• CSPH 5712 - Supervised Health Coaching Skills Advancement (1.0 - 2.0 cr)
• CSPH 5713 - Health Coaching for Health Professionals (2.0 cr)
• CSPH 5805 - Wellbeing in the Workplace (3.0 cr)
• CSPH 5806 - Wellbeing and Resiliency for Health Professionals (1.0 cr)
• CSPH 5807 - Mindfulness in the Workplace: Pause, Practice, Perform (2.0 cr)
• CSPH 5905 - Food Matters: Cook Like Your Life Depends On It (1.0 cr)
• CSPH 6000 - Integrative Therapies and Healing Practices Topics (1.0 - 4.0 cr)
• CSPH 8101 - Critiquing and Synthesizing Complementary and Alternative Healing Practices (CAHP) Research (2.0 cr)
• CSPH 8191 - Independent Study in Integrative Therapies and Healing Practices (1.0 - 6.0 cr)
Twin Cities Campus
Integrative Therapies and Healing Practices Minor
Spirituality and Healing, Earl E Bakken Center for
Graduate School

Link to a list of faculty for this program.

Contact Information:
Earl E. Bakken Center for Spirituality & Healing, Mayo Memorial Building, Room C591, MMC 505, 420 Delaware Street SE, Minneapolis, MN 55455 (612-624-9459; fax: 612-626-5280)
Website: http://www.csh.umn.edu

• Program Type: Graduate free-standing minor
• Requirements for this program are current for Fall 2018
• Length of program in credits (Masters): 8
• Length of program in credits (Doctorate): 12
• This program does not require summer semesters for timely completion.

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

The integrative therapies and healing practices minor is an interdisciplinary program designed to expose students to a global range of integrative, complementary, cross-cultural and spiritual healing practices. Courses enhance the preparation of graduate students in health sciences and other disciplines by developing knowledge and skills in the emerging field of integrative health care. Specifically, the minor provides students with a theoretical basis for applying integrative therapies and healing practices; prepares students to research integrative therapies and healing practices; and prepares students to work collaboratively with other health professionals and patients in a multicultural, pluralistic healthcare system. The curriculum includes a core introductory course that provides the theoretical foundation for the program. Students choose additional courses offered by the Earl E. Bakken Center for Spirituality & Healing in clinical applications, spirituality, or cross-cultural health and healing. The program draws upon the rich expertise of University and community-based faculty who encourage and challenge students to discover new ways of caregiving, and to cultivate diverse skills that will transform their life’s work, experiences and relationships with others.

Program Delivery
This program is available:
• via classroom (the majority of instruction is face-to-face)
• completely online (all program coursework can be completed online)
• primarily online (at least 80% of the instruction for the program is online with short, intensive periods of face-to-face coursework)
• partially online (between 50% to 80% of instruction is online)

Prerequisites for Admission
The minor is designed for graduate students pursuing health or other careers, and who are seeking to deepen their understanding of integrative therapeutic topics.

Graduate students come from wide-ranging backgrounds and careers, including nursing, pharmacy, medicine, nutrition, psychology, physical therapy, liberal studies and public health.

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
Use of 4xxx courses towards program requirements is not permitted.

Note that students may not use course credits to satisfy requirements for both a major and the minor.

Program Sub-plans
Students are required to complete one of the following sub-plans.
Students may not complete the program with more than one sub-plan.
Masters

Required Course
All students complete the Introduction to Integrative Therapies and Healing Practices course.
CSPH 5101 - Introduction to Integrative Healing Practices (3.0 cr)

Elective Options
Take 2 or more course(s) totaling 5 or more credit(s) from the following:
- CSPH 5000 - Explorations in Integrative Therapies and Healing Practices (1.0 - 4.0 cr)
- CSPH 5102 - Art of Healing: Self as Healer (1.0 cr)
- CSPH 5111 - Ways of Thinking about Health (2.0 cr)
- CSPH 5115 - Cultural Awareness, Knowledge and Health (3.0 cr)
- CSPH 5118 - Whole Person, Whole Community: The Reciprocity of Wellbeing (3.0 cr)
- CSPH 5121 - Whole Systems Healing: Health and the Environment (2.0 cr)
- CSPH 5201 - Spirituality and Resilience (2.0 cr)
- CSPH 5211 - Peacemaking and Spirituality: A Journey Toward Healing and Strength (2.0 - 3.0 cr)
- CSPH 5212 - Peacebuilding Through Mindfulness: Transformative Dialogue in the Global Community (3.0 cr)
- CSPH 5215 - Forgiveness and Healing: A Journey Toward Wholeness (3.0 cr)
- CSPH 5225 - Meditation: Integrating Body and Mind (2.0 cr)
- CSPH 5226 - Advanced Meditation: Body, Brain, Mind, and Universe (1.0 cr)
- CSPH 5311 - Introduction to Traditional Chinese Medicine (2.0 cr)
- CSPH 5313 - Acupressure (1.0 cr)
- CSPH 5315 - Traditional Tibetan Medicine: Ethics, Spirituality, and Healing (2.0 cr)
- CSPH 5317 - Yoga: Ethics, Spirituality, and Healing (2.0 cr)
- CSPH 5318 - Tibetan Medicine, Ayurveda, and Yoga in India (4.0 cr)
- CSPH 5319 - Yoga and Ayurveda in India (4.0 cr)
- CSPH 5331 - Foundations of Shamanism and Shamanic Healing (2.0 cr)
- CSPH 5392 - Global Healing Traditions: Amazonia Plant Spirit Medicine (2.0 cr)
- CSPH 5341 - Overview of Indigenous Hawaiian Healing (2.0 cr)
- CSPH 5343 - Ayurveda Medicine: The Science of Self-healing (2.0 cr)
- CSPH 5401 - People, Plants, and Drugs: Introduction to Ethnopharmacology (3.0 cr)
- CSPH 5421 - Botanical Medicines in Integrative Healthcare (3.0 cr)
- CSPH 5423 - Botanical Medicines: Foundations and Practical Applications (1.0 cr)
- CSPH 5431 - Functional Nutrition: An Expanded View of Nutrition, Chronic Disease, and Optimal Health (2.0 cr)
- CSPH 5503 - Aromatherapy Fundamentals (1.0 cr)
- CSPH 5511 - Interdisciplinary Palliative Care: An Experiential Course in a Community Setting (2.0 cr)
- CSPH 5512 - Spiritual Aspects of Palliative Care (2.0 cr)
- CSPH 5513 - Living Well, Dying Well: Empowering Patient Communication at the End of Life (2.0 cr)
- CSPH 5521 - Therapeutic Landscapes (3.0 cr)
- CSPH 5522 - Therapeutic Horticulture (3.0 cr)
- CSPH 5523 - Applications in Therapeutic Horticulture (2.0 cr)
- CSPH 5533 - Introduction to Therapeutic Horticulture (2.0 cr)
- CSPH 5535 - Reiki Healing (1.0 cr)
- CSPH 5536 - Advanced Reiki Healing: Level II (1.0 cr)
- CSPH 5541 - Emotional Healing and Happiness: Eastern and Western Approaches to Transforming the Mind (2.0 cr)
- CSPH 5555 - Introduction to Body and Movement-based Therapies (2.0 cr)
- CSPH 5561 - Overview of the Creative Arts in Health and Healing (2.0 cr)
- CSPH 5601 - Music, Health and Healing (2.0 cr)
- CSPH 5605 - Movement and Music for Well-being and Healing (2.0 cr)
- CSPH 5631 - Healing Imagery I (2.0 cr)
- CSPH 5641 - Animals in Health Care: The Healing Dimensions of Human/Animal Relationships (3.0 cr)
- CSPH 5642 - Nature Heals: An Introduction to Nature-Based Therapeutics (3.0 cr)
- CSPH 5643 - Horse as Teacher: Intro to Nature-Based Therapeutics Equine-Assisted Activities & Therapies (EAAT) (3.0 cr)
- CSPH 5701 - Fundamentals of Health Coaching I (4.0 cr)
- CSPH 5706 - Lifestyle Medicine (2.0 cr)
- CSPH 5708 - Mind-Body Science and the Art of Transformation (1.0 cr)
- CSPH 5711 - Optimal Healing Environments (3.0 cr)
- CSPH 5712 - Supervised Health Coaching Skills Advancement (1.0 - 2.0 cr)
- CSPH 5713 - Health Coaching for Health Professionals (2.0 cr)
- CSPH 5805 - Wellbeing in the Workplace (3.0 cr)
- CSPH 5806 - Wellbeing and Resiliency for Health Professionals (1.0 cr)
- CSPH 5807 - Mindfulness in the Workplace: Pause, Practice, Perform (2.0 cr)
- CSPH 5905 - Food Matters: Cook Like Your Life Depends On It (1.0 cr)
- CSPH 6000 - Integrative Therapies and Healing Practices Topics (1.0 - 4.0 cr)
- CSPH 8101 - Critiquing and Synthesizing Complementary and Alternative Healing Practices (CAHP) Research (2.0 cr)
- CSPH 8191 - Independent Study in Integrative Therapies and Healing Practices (1.0 - 6.0 cr)
Doctoral

Required Course
All students take the Introduction to Integrative Therapies and Healing Practices course.

CSPH 5101 - Introduction to Integrative Healing Practices (3.0 cr)

Elective Options
Take 2 or more course(s) totaling 9 or more credit(s) from the following:

- CSPH 5000 - Explorations in Integrative Therapies and Healing Practices (1.0 - 4.0 cr)
- CSPH 5102 - Art of Healing: Self as Healer (1.0 cr)
- CSPH 5111 - Ways of Thinking about Health (2.0 cr)
- CSPH 5115 - Cultural Awareness, Knowledge and Health (3.0 cr)
- CSPH 5118 - Whole Person, Whole Community: The Reciprocity of Wellbeing (3.0 cr)
- CSPH 5121 - Whole Systems Healing: Health and the Environment (2.0 cr)
- CSPH 5201 - Spirituality and Resilience (2.0 cr)
- CSPH 5211 - Peacemaking and Spirituality: A Journey Toward Healing and Strength (2.0 - 3.0 cr)
- CSPH 5212 - Peacebuilding Through Mindfulness: Transformative Dialogue in the Global Community (3.0 cr)
- CSPH 5215 - Forgiveness and Healing: A Journey Toward Wholeness (3.0 cr)
- CSPH 5225 - Meditation: Integrating Body and Mind (2.0 cr)
- CSPH 5226 - Advanced Meditation: Body, Brain, Mind, and Universe (1.0 cr)
- CSPH 5311 - Introduction to Traditional Chinese Medicine (2.0 cr)
- CSPH 5313 - Acupressure (1.0 cr)
- CSPH 5315 - Traditional Tibetan Medicine: Ethics, Spirituality, and Healing (2.0 cr)
- CSPH 5317 - Yoga: Ethics, Spirituality, and Healing (2.0 cr)
- CSPH 5318 - Tibetan Medicine, Ayurveda, and Yoga in India (4.0 cr)
- CSPH 5319 - Yoga and Ayurveda in India (4.0 cr)
- CSPH 5331 - Foundations of Shamanism and Shamanic Healing (2.0 cr)
- CSPH 5392 - Global Healing Traditions: Amazonia Plant Spirit Medicine (2.0 cr)
- CSPH 5341 - Overview of Indigenous Hawaiian Healing (2.0 cr)
- CSPH 5343 - Ayurvedic Medicine: The Science of Self-healing (2.0 cr)
- CSPH 5401 - People, Plants, and Drugs: Introduction to Ethnopharmacology (3.0 cr)
- CSPH 5421 - Botanical Medicines in Integrative Healthcare (3.0 cr)
- CSPH 5423 - Botanical Medicines: Foundations and Practical Applications (1.0 cr)
- CSPH 5431 - Functional Nutrition: An Expanded View of Nutrition, Chronic Disease, and Optimal Health (2.0 cr)
- CSPH 5503 - Aromatherapy Fundamentals (1.0 cr)
- CSPH 5511 - Interdisciplinary Palliative Care: An Experiential Course in a Community Setting (2.0 cr)
- CSPH 5512 - Spiritual Aspects of Palliative Care (2.0 cr)
- CSPH 5513 - Living Well, Dying Well: Empowering Patient Communication at the End of Life (2.0 cr)
- CSPH 5521 - Therapeutic Landscapes (3.0 cr)
- CSPH 5522 - Therapeutic Horticulture (3.0 cr)
- CSPH 5523 - Applications in Therapeutic Horticulture (2.0 cr)
- CSPH 5531 - Introduction to Traditional Chinese Medicine (2.0 cr)
- CSPH 5535 - Reiki Healing (1.0 cr)
- CSPH 5536 - Advanced Reiki Healing: Level II (1.0 cr)
- CSPH 5541 - Emotional Healing and Happiness: Eastern and Western Approaches to Transforming the Mind (2.0 cr)
- CSPH 5555 - Introduction to Body and Movement-based Therapies (2.0 cr)
- CSPH 5561 - Overview of the Creative Arts in Health and Healing (2.0 cr)
- CSPH 5560 - Music, Health and Healing (2.0 cr)
- CSPH 5565 - Movement and Music for Well-being and Healing (2.0 cr)
- CSPH 5631 - Healing Imagery I (2.0 cr)
- CSPH 5641 - Animals in Health Care: The Healing Dimensions of Human/Animal Relationships (3.0 cr)
- CSPH 5642 - Nature Heals: An Introduction to Nature-Based Therapeutics (3.0 cr)
- CSPH 5643 - Horse as Teacher: Intro to Nature-Based Therapeutics Equine-Assisted Activities & Therapies (EAAT) (3.0 cr)
- CSPH 5701 - Fundamentals of Health Coaching I (4.0 cr)
- CSPH 5706 - Lifestyle Medicine (2.0 cr)
- CSPH 5708 - Mind-Body Science and the Art of Transformation (1.0 cr)
- CSPH 5711 - Optimal Healing Environments (3.0 cr)
- CSPH 5712 - Supervised Health Coaching Skills Advancement (1.0 - 2.0 cr)
- CSPH 5713 - Health Coaching for Health Professionals (2.0 cr)
- CSPH 5805 - Wellbeing in the Workplace (3.0 cr)
- CSPH 5806 - Wellbeing and Resiliency for Health Professionals (1.0 cr)
- CSPH 5807 - Mindfulness in the Workplace: Pause, Practice, Perform (2.0 cr)
- CSPH 5905 - Food Matters: Cook Like Your Life Depends On It (1.0 cr)
- CSPH 6000 - Integrative Therapies and Healing Practices Topics (1.0 - 4.0 cr)
- CSPH 8101 - Critiquing and Synthesizing Complementary and Alternative Healing Practices (CAHP) Research (2.0 cr)
- CSPH 8191 - Independent Study in Integrative Therapies and Healing Practices (1.0 - 6.0 cr)
Twin Cities Campus
Integrative Therapies and Healing Practices Postbaccalaureate Certificate
Spirituality and Healing, Earl E Bakken Center for Graduate School

Link to a list of faculty for this program.

Contact Information:
Earl E. Bakken Center for Spirituality & Healing, Mayo Memorial Building, Room C591, MMC 505, 420 Delaware Street SE, Minneapolis, MN 55455 (612-624-9459; fax: 612-626-5280).
Website: http://www.csh.umn.edu

- Program Type: Post-baccalaureate credit certificate/licensure/endorsement
- Requirements for this program are current for Fall 2018
- Length of program in credits: 12 to 20
- This program does not require summer semesters for timely completion.
- Degree: Integrative Thyps & Healing Practices PBacc Cert

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

The integrative therapies and healing practices certificate is an interdisciplinary program designed to expose students to a global range of integrative, complementary, cross-cultural and spiritual healing practices. Courses enhance the preparation of students in health sciences and other disciplines by developing knowledge and skills in the emerging field of integrative health care. Specifically, the certificate provides students with a theoretical basis for applying integrative therapies and healing practices; prepares students to research integrative therapies and healing practices; and prepares students to work collaboratively with other health professionals and patients in a multicultural, pluralistic healthcare system. The curriculum for the 12-credit certificate includes a core introductory course that provides the theoretical foundation for the program, as well as a course in self care. Students choose additional courses offered by the Earl E. Bakken Center for Spirituality & Healing in clinical applications, spirituality, or cross-cultural health and healing. The program draws upon the rich expertise of University and community-based faculty who encourage and challenge students to discover new ways of care-giving, and to cultivate diverse skills that will transform their life’s work, experiences and relationships with others.

The certificate is also available with a health coaching track. Students who pursue the certificate with the health coaching track complete a total of 20 credits, including the core introductory course.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)
- primarily online (at least 80% of the instruction for the program is online with short, intensive periods of face-to-face coursework)
- partially online (between 50% to 80% of instruction is online)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

The certificate requires applicants to have a bachelor's or higher degree in a healthcare or healthcare-related field.

Other requirements to be completed before admission:
This field of study is designed for the healthcare professional, those currently enrolled in a graduate health professions program, board-certified chaplains with at least three years in a healthcare setting, and those with a non-healthcare bachelor's degree with direct work experience in health related areas. Such fields include nursing, social work, psychology, medicine, nutrition, pharmacy, chiropractic, naturopathy, and licensed acupuncture.

The certificate's Health Coaching track requires an applicant interview prior to admission.

Special Application Requirements:
In addition to the University's online application, applicants submit a personal statement describing their goals for obtaining the certificate and their professional qualifications. The statement should address your interest in integrative therapies and short- and long-term professional goals after completing the program. Two letters of recommendation are required, preferably one from an academic source and one from an employer/supervisor. A current C.V. or resume is also required. All items are uploaded directly into the University's online application.

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Information current as of August 31, 2018
Applicants to the Health Coaching track are required to provide three letters of recommendation and a three-to-five page personal statement focusing on what led to the applicant's interest in Health Coaching as a professional activity, including a description of interest in and experience with holistic integrative health and healing. A current C.V. or resume is also required. All items are uploaded directly into the University’s online application. Selected Health Coaching track applicants will be chosen for admissions interviews.

The application deadline is March 15 for entrance into program the following fall semester.

International applicants must submit score(s) from one of the following tests:

- **TOEFL**
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
  - Paper Based - Total Score: 550

- **IELTS**
  - Total Score: 6.5

- **MELAB**
  - Final score: 80

The preferred English language test is Test of English as Foreign Language

Key to test abbreviations (TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

### Program Requirements

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 2.80 is required for students to remain in good standing.

At least 1 semesters must be completed before filing a Degree Program Form.

### Required Course

Students pursuing either the general certificate or the certificate with health coaching track must complete this course.

**CSPH 5101 - Introduction to Integrative Healing Practices (3.0 cr)**

### Certificate Options

#### General Certificate

#### Self Care Course Requirement

General certificate students complete one of the two following courses for at least one credit:

- **CSPH 5102 - Art of Healing: Self as Healer (1.0 cr)**
- or **CSPH 5806 - Wellbeing and Resiliency for Health Professionals (1.0 cr)**

#### Electives

Students are encouraged to choose electives, in consultation with their faculty advisor, from CSPH courses consistent with their academic training and professional goals. Up to 3 credits of CSPH courses at the 4xxx-level may be applied to the certificate.

Take 3 or more course(s) totaling 8 or more credit(s) from the following:

- **CSPH 4311 - Foundations of Hatha Yoga: Alignment & Movement Principles (3.0 cr)**
- **CSPH 4312 - Hatha Yoga Philosophy, Lifestyle, & Ethics (3.0 cr)**
- **CSPH 4313 - Hatha Yoga Teaching Principles & Methodology (2.0 cr)**
- **CSPH 5000 - Explorations in Integrative Therapies and Healing Practices (1.0 - 4.0 cr)**
- **CSPH 5102 - Art of Healing: Self as Healer (1.0 cr)**
- **CSPH 5111 - Ways of Thinking about Health (2.0 cr)**
- **CSPH 5115 - Cultural Awareness, Knowledge and Health (3.0 cr)**
- **CSPH 5118 - Whole Person, Whole Community: The Reciprocity of Wellbeing (3.0 cr)**
- **CSPH 5121 - Whole Systems Healing: Health and the Environment (2.0 cr)**
- **CSPH 5201 - Spirituality and Resilience (2.0 cr)**
- **CSPH 5211 - Peacemaking and Spirituality: A Journey Toward Healing and Strength (2.0 - 3.0 cr)**
- **CSPH 5212 - Peacebuilding Through Mindfulness: Transformative Dialogue in the Global Community (3.0 cr)**
- **CSPH 5215 - Forgiveness and Healing: A Journey Toward Wholeness (3.0 cr)**
- **CSPH 5225 - Meditation: Integrating Body and Mind (2.0 cr)**
- **CSPH 5226 - Advanced Meditation: Body, Brain, Mind, and Universe (1.0 cr)**

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Information current as of August 31, 2018
• CSPH 5311 - Introduction to Traditional Chinese Medicine (2.0 cr)
• CSPH 5313 - Acupressure (1.0 cr)
• CSPH 5315 - Traditional Tibetan Medicine: Ethics, Spirituality, and Healing (2.0 cr)
• CSPH 5317 - Yoga: Ethics, Spirituality, and Healing (2.0 cr)
• CSPH 5318 - Tibetan Medicine, Ayurveda, and Yoga in India (4.0 cr)
• CSPH 5319 - Yoga and Ayurveda in India (4.0 cr)
• CSPH 5331 - Foundations of Shamanism and Shamanic Healing (2.0 cr)
• CSPH 5332 - Global Healing Traditions: Amazonia Plant Spirit Medicine (2.0 cr)
• CSPH 5341 - Overview of Indigenous Hawaiian Healing (2.0 cr)
• CSPH 5343 - Ayurveda Medicine: The Science of Self-healing (2.0 cr)
• CSPH 5401 - People, Plants, and Drugs: Introduction to Ethnopharmacology (3.0 cr)
• CSPH 5421 - Botanical Medicines in Integrative Healthcare (3.0 cr)
• CSPH 5423 - Botanical Medicines: Foundations and Practical Applications (1.0 cr)
• CSPH 5431 - Functional Nutrition: An Expanded View of Nutrition, Chronic Disease, and Optimal Health (2.0 cr)
• CSPH 5503 - Aromatherapy Fundamentals (1.0 cr)
• CSPH 5511 - Interdisciplinary Palliative Care: An Experiential Course in a Community Setting (2.0 cr)
• CSPH 5512 - Spiritual Aspects of Palliative Care (2.0 cr)
• CSPH 5513 - Living Well, Dying Well: Empowering Patient Communication at the End of Life (2.0 cr)
• CSPH 5521 - Therapeutic Landscapes (3.0 cr)
• CSPH 5522 - Therapeutic Horticulture (3.0 cr)
• CSPH 5523 - Applications in Therapeutic Horticulture (2.0 cr)
• CSPH 5533 - Introduction to Energy Healing (2.0 cr)
• CSPH 5535 - Reiki Healing (1.0 cr)
• CSPH 5536 - Advanced Reiki Healing: Level II (1.0 cr)
• CSPH 5541 - Emotional Healing and Happiness: Eastern and Western Approaches to Transforming the Mind (2.0 cr)
• CSPH 5555 - Introduction to Body and Movement-based Therapies (2.0 cr)
• CSPH 5561 - Overview of the Creative Arts in Health and Healing (2.0 cr)
• CSPH 5601 - Music, Health and Healing (2.0 cr)
• CSPH 5605 - Movement and Music for Well-being and Healing (2.0 cr)
• CSPH 5631 - Healing Imagery I (2.0 cr)
• CSPH 5641 - Animals in Health Care: The Healing Dimensions of Human/Animal Relationships (3.0 cr)
• CSPH 5642 - Nature Heals: An Introduction to Nature-Based Therapeutics (3.0 cr)
• CSPH 5643 - Horse as Teacher: Intro to Nature-Based Therapeutics Equine-Assisted Activities & Therapies (EAAT) (3.0 cr)
• CSPH 5701 - Fundamentals of Health Coaching I (4.0 cr)
• CSPH 5706 - Lifestyle Medicine (2.0 cr)
• CSPH 5708 - Mind-Body Science and the Art of Transformation (1.0 cr)
• CSPH 5711 - Optimal Healing Environments (3.0 cr)
• CSPH 5712 - Supervised Health Coaching Skills Advancement (1.0 - 2.0 cr)
• CSPH 5713 - Health Coaching for Health Professionals (2.0 cr)
• CSPH 5805 - Wellbeing in the Workplace (3.0 cr)
• CSPH 5806 - Wellbeing and Resiliency for Health Professionals (1.0 cr)
• CSPH 5807 - Mindfulness in the Workplace: Pause, Practice, Perform (2.0 cr)
• CSPH 5905 - Food Matters: Cook Like Your Life Depends On It (1.0 cr)
• CSPH 6000 - Integrative Therapies and Healing Practices Topics (1.0 - 4.0 cr)
• CSPH 8101 - Critiquing and Synthesizing Complementary and Alternative Healing Practices (CAHP) Research (2.0 cr)
• CSPH 8191 - Independent Study in Integrative Therapies and Healing Practices (1.0 - 6.0 cr)

-OR-

Health Coaching Track

Coursework for the certificate with the health coaching track is detailed in sub-plan requirements.

Program Sub-plans

A sub-plan is not required for this program.
Students may not complete the program with more than one sub-plan.

Health Coaching

Health coaching is an emerging method of partnering with clients to achieve their overall goals. It is practiced from a holistic perspective that views each person as intrinsically whole and the ultimate expert in his or her healing journey. Health coaching is being offered in a wide range of venues including hospitals, clinics, community health and fitness facilities, corporations, educational institutions, and private practices. The Earl E. Bakken Center for Spirituality & Healing is a pioneer in the field of health coaching, working to advance education, research and care model innovation.

University of Minnesota health coaching programs have program approval from the National Consortium for Credentialing Health and
Wellness Coaches (www.ncchwc.org), and were permanently accredited in 2017.

In addition to the required CSPH 5101 introduction course, students complete the health coaching track course requirements for a minimum of 20 credits. Students are strongly encouraged to confer with their faculty advisor concerning the specific sequence in which the track coursework must be taken. A minimum GPA of 3.0 must be maintained for all required track coursework.

Coursework may be completed in a minimum of four semesters or may be spread over a variable amount of time up to a maximum of four years.

**Health Coaching track requirements**
- CSPH 5701 - Fundamentals of Health Coaching I (4.0 cr)
- CSPH 5702 - Fundamentals of Health Coaching II (4.0 cr)
- CSPH 5703 - Advanced Health Coaching Practicum (3.0 cr)
- CSPH 5704 - Business of Health Coaching (2.0 cr)
- CSPH 5705 - Health Coaching Professional Internship (2.0 cr)
- CSPH 5706 - Lifestyle Medicine (2.0 cr)
Twin Cities Campus
Molecular, Cellular, Developmental Biology and Genetics M.S.
Genetics, Cell Biology, and Development TCBS, Genetics, Cell Biology, and Development TMED
Graduate School

Link to a list of faculty for this program.

Contact Information:
MCDB&G Graduate Program, 6-160 Jackson Hall, 321 Church Street SE, University of Minnesota, Minneapolis, MN, 55455 (612-624-7470, fax: 612-626-6140)
Email: mcdbg@umn.edu OR gcgrad@umn.edu
Website: http://mcdbq.umn.edu OR http://cbs.umn.edu/genetic-counseling/home

- Program Type: Master's
- Requirements for this program are current for Fall 2018
- Length of program in credits: 30 to 55
- This program requires summer semesters for timely completion.
- Degree: Master of Science

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

The MCDB&G MS degree can be earned in one of three ways:

1. The MS with a genetic counseling track: This full-time program is designed to provide students with the academic foundation and clinical expertise necessary to enter the profession of genetic counseling. The curriculum integrates selected coursework with firsthand experience in the diagnostic medical genetics laboratories and supervised work in clinical settings with patients and families. The clinical component involves work in multiple clinical settings throughout the Twin Cities, the Mayo clinic in Rochester, St. Cloud and other centers. The MS with a genetic counseling track is accredited by the Accreditation Council for Genetic Counseling, and all graduates are eligible to apply to the American Board of Genetic Counseling for active candidate status and to sit for board certification.

2. The joint JD/MS-MCDB&G program: This program, offered in conjunction with the joint degree program in law, science, and technology, is unique in the nation and enables students to combine a JD degree with the MCDB&G MS degree. Students entering this program must be admitted to both MCDB&G and the Law School.

3. Eligible MCDB&G PhD students, who leave before they have completed their doctoral degree, may be offered the option to complete the MS. Eligibility to complete the MS is determined by the student's advisor and the MCDB&G director of graduate studies. MCDB&G does not offer a free-standing MS degree program in research.

Program Delivery
This program is available:
• via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
For genetic counseling admissions information go to http://cbs.umn.edu/genetic-counseling/admissions

For JD/MS admissions info - http://cbs.umn.edu/academics/departments/gcd/graduate/prospective

Other requirements to be completed before admission:
Applications to the MS with the genetic counseling track are stronger if the applicant has interacted with a practicing genetic counselor--in the clinical setting, or in another capacity such as personal interviews--that affords the applicant a real-life understanding of the profession. The application deadline date is December 15, and admission is for fall semester only.

Successful applicants to the joint JD/MS program must have previous research experience in an academic or industrial setting, in addition to any course-related laboratory experience. Demonstrated familiarity with and aptitude for basic science research is important prior to embarking on this dual degree program. The application deadline date is December 1, and admission is for fall semester only. Entry into the joint JD/MS program requires separate admittance to both the Law School and MCDB&G.

Applicants must submit their test score(s) from the following:
• GRE
International applicants must submit score(s) from one of the following tests:

• TOEFL
• IELTS

Key to test abbreviations (GRE, TOEFL, IELTS).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements

Plan A: Plan A requires 20 major credits, 0 credits outside the major, and 10 thesis credits. The final exam is written and oral.

Plan B: Plan B requires 30 to 55 major credits and 0 credits outside the major. The final exam is written and oral.

This program may not be completed with a minor.

Use of 4xxx courses towards program requirements is not permitted.

A minimum GPA of 3.0 is required for students to remain in good standing.

Plan A

Take the following courses for at least 17 credits. Non-GCD coursework, selected in consultation with the advisor, may be applied to this requirement. MCDG 8900 can be taken for one credit four times (over four semesters). MCDG 8950 can be taken for one credit twice (over two semesters).

- GCD 8131 - Advanced Molecular Genetics and Genomics (3.0 cr)
- GCD 8151 - Cellular Biochemistry and Cell Biology (2.0 - 4.0 cr)
- GCD 8161 - Advanced Cell Biology and Development (3.0 cr)
- GCD 8171 - Literature Analysis (1.0 - 2.0 cr)
- BIOC 8401 - Ethics, Public Policy, and Careers in Molecular and Cellular Biology (1.0 cr)
- MCDG 8900 - Student Research Seminar (1.0 cr)
- MCDG 8950 - Teaching Practicum (1.0 cr)

Required Coursework

Take at least one of the following courses for three credits:

- GCD 5005 - Computer Programming for Biology (3.0 cr)
- or GCD 8920 - Special Topics (1.0 - 4.0 cr)

Plan A thesis credits

10 thesis credits are required.

Take 10 or more credit(s) from the following:

- MCDG 8777 - Thesis Credits: Master's (1.0 - 18.0 cr)

Plan B

Take at least 27 credits of coursework from the following list. Non-GCD courses, selected in consultation with the advisor, can be applied to this requirement. MCDG 8900 can be taken for one credit four times (over four semesters). MCDG 8950 can be taken for one credit twice (over two semesters).

- GCD 8131 - Advanced Molecular Genetics and Genomics (3.0 cr)
- GCD 8151 - Cellular Biochemistry and Cell Biology (2.0 - 4.0 cr)
- GCD 8161 - Advanced Cell Biology and Development (3.0 cr)
- GCD 8171 - Literature Analysis (1.0 - 2.0 cr)
- BIOC 8401 - Ethics, Public Policy, and Careers in Molecular and Cellular Biology (1.0 cr)
- MCDG 8900 - Student Research Seminar (1.0 cr)
- MCDG 8950 - Teaching Practicum (1.0 cr)

Required Coursework

Take at least one of the following courses for three credits:

- GCD 8920 - Special Topics (1.0 - 4.0 cr)
- or GCD 5005 - Computer Programming for Biology (3.0 cr)

Joint- or Dual-degree Coursework: JD/MS-MCDB&G (Joint Degree Program in Law, Science and Technology) Student may take a total of 12 credits in common among the academic programs.
Program Sub-plans
A sub-plan is not required for this program.
Students may not complete the program with more than one sub-plan.

Genetic Counseling
This sub-plan is limited to students completing the program under Plan B.

The MS with genetic counseling track is designed to be completed in 4 semesters and the interim summer. Most of the coursework is taken the first year, with more time during the second year dedicated to clinical experience. Students will be placed in laboratory and clinical observation experiences during the first year, five clinical genetic counseling internships during the second year, and will complete a minimum of 800 hours of direct patient contact. Students will be placed in laboratory and clinical observation experiences during the first year, five clinical genetic counseling internships during the second year, and will complete a minimum of 800 hours of direct patient contact. Students must earn a passing grade in their five clinical internship rotations and present a completed log of at least 50 clinical cases before the final oral examination.

Only under exceptional circumstances will the course of study be varied to meet the needs of a student with many of the courses already completed or with extensive clinical laboratory experience.

Plan B projects that qualify for the genetic counseling track include those that study a genetic counseling problem and add to the existing genetic counseling literature; produce materials that add to the profession, such as teaching materials or ways of evaluating the service; or produce educational materials needed by patient populations or the general public.

First Year
Students will observe in a clinical setting one day per week, and gain experience in the clinical laboratories one day per week. An elective course of the student's choice is an option.
Credit requirement for these courses are: GCD 6110 (6.0 crs); GCD 8994 (2.0 crs, S/N only). Register for GCD 8993 for 2.0 crs twice (over two semesters), S/N only.

GCD 8911 - Introduction to Genetic Counseling Skills and Practice (3.0 cr)
GCD 8912 - Genetic Counseling in Practice (4.0 cr)
GCD 8073 - Genetics & Genomics in Human Health (3.0 cr)
GCD 6110 - Science of Medical Practice (3.0 - 6.0 cr)
PSY 5137 - Introduction to Behavioral Genetics (3.0 cr)
GCD 8993 - Directed Studies (1.0 - 5.0 cr)
GCD 8994 - Research (1.0 - 5.0 cr)

Summer
During the summer between the first and second year of the program, students will begin their first clinical internship rotation with patient responsibilities. This 10-week rotation includes the expectation that students will spend between 2-3 days per week in the clinic. The students time in the clinic, which is set by the clinical supervisor, may exceed the 20-hour minimum.

GCD 8001 - Genetic Counseling Clinical Internship I (3.0 cr)

Second Year
Students will complete internships in a clinical setting 2-3 days per week for 15 weeks. An elective course of the student's choice is an option.

Register for GCD 8994 for 2.0 crs twice (over two semesters), S/N only.

GCD 8002 - Genetic Counseling Clinical Internship II (5.0 cr)
GCD 8003 - Genetic Counseling Clinical Internship III (5.0 cr)
GCD 8913 - Psychosocial Issues in Genetic Counseling I (3.0 cr)
GCD 8914 - Ethical and Legal Issues in Genetic Counseling (3.0 cr)
GCD 8915 - Psychosocial Issues in Genetic Counseling II (3.0 cr)
GCD 8994 - Research (1.0 - 5.0 cr)
Twin Cities Campus
Molecular, Cellular, Developmental Biology and Genetics Minor

Genetics, Cell Biology, and Development TCBS; Genetics, Cell Biology, and Development TMED

Graduate School

Link to a list of faculty for this program.

Contact Information:
MCDB&G Graduate Program, 6-160 Jackson Hall, 321 Church Street SE, University of Minnesota, Minneapolis, MN 55455 (612-624-7470, fax: 612-626-6140).
Email: mcdbg@umn.edu
Website: http://mcdbg.umn.edu

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2018
- Length of program in credits (Masters): 12
- Length of program in credits (Doctorate): 12
- This program does not require summer semesters for timely completion.

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

This program provides scientific training in the basic life sciences, with emphasis on the molecular basis of genetics, development, and cell biology. Areas of specialization include membranes, receptors, membrane transport, cell interactions, macromolecular structure, extracellular matrix, cytoskeleton, cell motility, regulation of gene expression, neuroscience, developmental mechanisms, human genetics, plant cell and molecular biology, genetic mechanisms, and genomics.

The program is interdisciplinary and involves faculty from several departments in the College of Biological Sciences, the Medical School, and the College of Food, Agricultural and Natural Resource Sciences. Institutes for human genetics, plant molecular genetics, biological process technology, Genome Engineering, Stem Cell research and a center for developmental biology provide opportunities for graduate study.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
Use of 4xxx courses towards program requirements is not permitted.

Courses taken for the minor must be graded A-F. A minimum GPA of 3.0 for these courses is required.

Required Coursework (9 credits)
Take the following courses for 9 credits. With approval of the director of the MCDB&G director of graduate studies, other courses may be substituted.

- GCD 8151 - Cellular Biochemistry and Cell Biology (2.0 - 4.0 cr)
- GCD 8131 - Advanced Molecular Genetics and Genomics (3.0 cr)
- GCD 8161 - Advanced Cell Biology and Development (3.0 cr)

Electives (3 credits)
Choose at least one of the following courses. GCD 8920 Special Topics: Computational Genomics must be taken for 3 credits.

- GCD 8920 - Special Topics (1.0 - 4.0 cr)
- GCD 5005 - Computer Programming for Biology (3.0 cr)

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Program Sub-plans

Students are required to complete one of the following sub-plans.
Students may not complete the program with more than one sub-plan.

Masters

Doctoral
Twin Cities Campus
Molecular, Cellular, Developmental Biology and Genetics Ph.D.
Genetics, Cell Biology, and Development TCBS, Genetics, Cell Biology, and Development TMED
Graduate School

Link to a list of faculty for this program.

Contact Information:
MCDB&G Graduate Program, 6-160 Jackson Hall, 321 Church Street SE, University of Minnesota, Minneapolis, MN  55455 (612-624-7470, fax: 612-626-6140)
Email: mcdbg@umn.edu
Website: http://mcdbg.umn.edu

- Program Type: Doctorate
- Requirements for this program are current for Fall 2018
- Length of program in credits: 48
- This program does not require summer semesters for timely completion.
- Degree: Doctor of Philosophy

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

This program provides scientific training in the basic life sciences, with emphasis on the molecular basis of genetics, development, and cell biology. Areas of specialization include membranes, receptors, membrane transport, cell interactions, macromolecular structure, extracellular matrix, cytoskeleton, cell motility, regulation of gene expression, neuroscience, developmental mechanisms, human genetics, plant cell and molecular biology, genetic mechanisms, and genomics.

The program is interdisciplinary and involves faculty from several departments in the College of Biological Sciences, the Medical School, and the College of Food, Agricultural and Natural Resource Sciences. Institutes for human genetics, plant molecular genetics, biological process technology, genome engineering, stem cell research and a center for developmental biology provide opportunities for graduate study.

PhD students are admitted to MCDB&G under the auspices of Molecular, Cellular and Structural Biology (MCSB), a first year program administered by the MCDB&G and the Biochemistry, Molecular Biology and Biophysics (BMBB) graduate programs. After the first year, students select either MCDB&G or BMBB to complete their degree. MCDB&G does NOT have a freestanding master's program.

The MCDB&G PhD is also part of two joint degree programs: The Joint Degree Program in Law, Health, and Life Sciences; and the MD/PhD program.

The Joint Degree Program in Law, Health, and Life Sciences is unique in the nation and enables students to combine a JD degree with a PhD or MS degree. Students entering this program must be admitted to both the MCDB&G program and the Law School. Admission qualifications for MS and PhD students are identical; only the student's career objectives distinguish the degree that they pursue.

The MD/PhD program emphasizes integration of the two major components of training--medicine and research--to ensure excellence in both. The program features a special curriculum that facilitates the transition from Medical School to the first year of formal graduate training, and the transition from graduate training back to Medical School.

Program Delivery
This program is available:
• via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.50.

Applications from students with an undergraduate or master's degree in the biological, chemical, or physical sciences are preferred.

Other requirements to be completed before admission:
Recommended academic preparation includes coursework in molecular biology, genetics, biology, and biochemistry.

Successful applicants must have previous research experience in an academic or industrial setting in addition to any course-related laboratory experiences. It is important to demonstrate familiarity with and aptitude for basic science research prior to embarking on a
Special Application Requirements:
Applicants must submit three letters of recommendation from persons familiar with their academic and research capabilities. A statement of interests and goals, a complete set of transcripts, and scores from the General Test of the GRE are required. We will accept copies of the transcripts and GRE scores. The GRE Subject Test in biochemistry, cell and molecular biology, biology, or chemistry is strongly recommended, but not required. The deadline for receipt of completed applications is December 1. Graduate studies begin fall semester only.

Entry into the J.D./Ph.D. program requires separate admittance to both the Law School and the MCDB&G Graduate Program. Entry into the M.D./Ph.D. program requires separate admittance to both the Medical School and the MCDB&G Graduate Program.

Applicants must submit their test score(s) from the following:
- GRE
  - General Test - Verbal Reasoning: 550
  - General Test - Quantitative Reasoning: 600
  - General Test - Analytical Writing: 3.5

International applicants must submit score(s) from one of the following tests:
- TOEFL
  - Internet Based - Total Score: 107
  - Internet Based - Writing Score: 25
  - Internet Based - Reading Score: 25
  - Paper Based - Total Score: 625

Key to test abbreviations (GRE, TOEFL).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
24 credits are required in the major.
0 credits are required outside the major.
24 thesis credits are required.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 3.0 is required for students to remain in good standing.

At least 2 semesters must be completed before filing a Degree Program Form.

Required Coursework (24 credits)
Take all of the following courses for at least 21 credits. MCDG 8900 can be taken for one credit four times (over four semesters). MCDG 8950 and MCDG 8920 each can be taken for one credit twice (over two semesters).

- GCD 8151 - Cellular Biochemistry and Cell Biology (2.0 - 4.0 cr)
- GCD 8131 - Advanced Molecular Genetics and Genomics (3.0 cr)
- GCD 8161 - Advanced Cell Biology and Development (3.0 cr)
- GCD 8171 - Literature Analysis (1.0 - 2.0 cr)
- BIOC 8401 - Ethics, Public Policy, and Careers in Molecular and Cellular Biology (1.0 cr)
- MCDG 8920 - Special Topics (1.0 - 4.0 cr)
- MCDG 8900 - Student Research Seminar (1.0 cr)
- MCDG 8950 - Teaching Practicum (1.0 cr)

Take at least one of the following courses for 3 credits to complete the 24-credit course requirement.
- GCD 5005 - Computer Programming for Biology (3.0 cr)
- or GCD 8920 - Special Topics (1.0 - 4.0 cr)

Electives
Students may take additional elective credits if necessary. Select courses from the following list, or in consultation with the advisor and director of graduate studies.

Take 0 or more credit(s) from the following:
• BIOC 8001 - Biochemistry: Structure, Catalysis, and Metabolism (3.0 cr)
• BIOC 8002 - Molecular Biology and Regulation of Biological Processes (3.0 cr)
• BIOC 5309 - Biocatalysis and Biodegradation (3.0 cr)
• BIOC 5352 - Biotechnology and Bioengineering for Biochemists (3.0 cr)
• BIOC 5361 - Microbial Genomics and Bioinformatics (3.0 cr)
• BIOC 5444 - Muscle (3.0 cr)
• BIOC 5527 - Introduction to Modern Structural Biology (4.0 cr)
• BIOC 5528 - Spectroscopy and Kinetics (4.0 cr)
• CSCI 5461 - Functional Genomics, Systems Biology, and Bioinformatics (3.0 cr)
• CSCI 5980 - Special Topics in Computer Science (1.0 - 3.0 cr)
• CSCI 8980 - Special Advanced Topics in Computer Science (1.0 - 3.0 cr)
• GCD 8008 - Mammalian Gene Transfer and Genome Engineering (2.0 cr)
• GCD 8073 - Genetics & Genomics in Human Health (3.0 cr)
• GRAD 8101 - Teaching in Higher Education (3.0 cr)
• GRAD 8200 - Teaching and Learning Topics in Higher Education (1.0 cr)
• MICA 8002 - Structure, Function, and Genetics of Bacteria and Viruses (4.0 cr)
• MICA 8003 - Immunity and Immunopathology (4.0 cr)
• MICA 8004 - Cellular and Cancer Biology (4.0 cr)
• MATH 8540 - Topics in Mathematical Biology (1.0 - 3.0 cr)
• NSC 8211 - Developmental Neurobiology (3.0 cr)
• OBIO 8012 - Basic Concepts in Skeletal Biology (2.0 cr)
• PHCL 5111 - Pharmacogenomics (3.0 cr)
• PUBH 6450 - Biostatistics I (4.0 cr)
• SCB 8181 - Stem Cell Biology (3.0 cr)
• STAT 5021 - Statistical Analysis (4.0 cr)
• BIOC 5535 - Introduction to Modern Structural Biology -- Diffraction (2.0 cr)
• BIOC 5536 - Introduction to Modern Structural Biology - Nuclear Magnetic Resonance (2.0 cr)

**Thesis Credits**
Take at least 24 doctoral thesis credits.
MCDG 8888 - Thesis Credit: Doctoral (1.0 - 24.0 cr)

**Joint- or Dual-degree Coursework:** Joint Degree Program in Law, Science and Technology (JD/PhD). Medical Scientist Training Program (MD/PhD) Student may take a total of 12 credits in common among the academic programs.
Twin Cities Campus
Water Resources Science M.S.
Water Resources Center
Graduate School

Link to a list of faculty for this program.

Contact Information:
Water Resources Science, University of Minnesota, 193 McNeal Hall, 1985 Buford Avenue, St. Paul MN 55108 (612-624-7456)
Email: wrs@umn.edu
Website: http://wrs.umn.edu

- Program Type: Master's
- Requirements for this program are current for Fall 2018
- Length of program in credits: 30 to 32
- This program does not require summer semesters for timely completion.
- University of Minnesota, Duluth
- Degree: Master of Science

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

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 interest: aquatic biology, environmental chemistry, hydrologic science, limnology, water management technology, water policy, water quality, and watershed science and management. A Limnology and Oceanography track is also offered. 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.

Students in the program develop the breadth of scientific knowledge appropriate to understand the complicated aquatic ecosystems and watersheds on which they will work, as well as social dimensions of the topic, including the public policy and legal frameworks in which water resources are protected and managed.

The program involves faculty from the following departments on the Twin Cities campus: Applied Economics; Bioproducts and Biosystems Engineering; Civil Engineering; Earth Sciences; Ecology, Evolution, and Behavior; Entomology; Environmental and Occupational Health; Fisheries, Wildlife, and Conservation Biology; Forest Resources; Geography; Horticultural Science; Plant Biology; and Soil, Water, and Climate. It also involves faculty from the following departments on the Duluth campus: Biology; Chemical Engineering; Chemistry; Civil Engineering; Geography; Geological Sciences; and Physics; as well as the Large Lakes Observatory and the Natural Resources Research Institute in Duluth.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

The program is flexible enough to accommodate students from a variety of backgrounds. Normally students have a bachelor's degree in physical, biological, or environmental science or engineering.

Other requirements to be completed before admission:
Recommended academic preparation includes one year (or two semesters) each of calculus, physics, and chemistry, and one biology course.

Availability of funding and willingness of a member of the graduate faculty to serve as an advisor are important criteria for admission to the program.
Special Application Requirements:
Applicants must submit three letters of recommendation via the University of Minnesota's ApplyYourself website. 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.

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 General Test. Students may be admitted any semester but are strongly encouraged to submit their application by December 15 for fall semester admission. More specific application instructions can be found on the program website: wrs.umn.edu/admissions/admissions-info.

Applicants must submit their test score(s) from the following:
• GRE

International applicants must submit score(s) from one of the following tests:
• TOEFL
  - Internet Based - Total Score: 79
  - Paper Based - Total Score: 550
• IELTS
  - Total Score: 6.5
• MELAB
  - Final score: 80

The preferred English language test is Test of English as Foreign Language

Key to test abbreviations(GRE, TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
Plan A: Plan A requires 22 major credits, 0 credits outside the major, and 10 thesis credits. The final exam is oral.

Plan B: Plan B requires 30 major credits and 0 credits outside the major. The final exam is oral. A capstone project is required.

Capstone Project: The Plan B project is defined by the faculty advisor. The Plan B option is well suited to students who have little undergraduate course work in water resources science and thus need more coursework to gain the combination of depth and breadth needed in this field. Plan B projects involve field, laboratory, or computer work and the analysis, synthesis, or interpretation of data.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 3.00 is required for students to remain in good standing.

At least 1 semesters must be completed before filing a Degree Program Form.

Credits from a minor may count toward the total credits of your master's degree, with adviser approval.

All course credits must be at the post-baccalaureate level, taken for graduate credits, and assessed at the graduate tuition rate. Masters students may request to transfer 40% of their coursework from another accredited graduate program.

Students with WRS-equivalent core courses taken as undergraduates may substitute other classes to meet program requirements, with advisor approval.

Water Resources Seminar
WRS 8100 - Interdisciplinary Seminar in Water Resources (0.5 cr)

Water Resources Ethics
WRS 8581 - Research and Professional Ethics in Water Resources and Environmental Science (0.5 cr)

Hydrology Core
Take at least 3 credits from the following:
BBE 8513 - Hydrologic Modeling of Small Watersheds (3.0 cr)
or CEGE 4501 - Hydrologic Design (4.0 cr)
or ESCI 4702 - General Hydrogeology (4.0 cr)
or FNRM 5114 - Hydrology and Watershed Management (3.0 cr)
or FNRM 5153 - Forest Hydrology & Watershed Biogeochemistry (3.0 cr)

Environmental/Water Chemistry Core
Take at least 3 credits from the following:
CEGE 5541 - Environmental Water Chemistry (3.0 cr)
or ESCI 4401 - Aqueous Environmental Geochemistry (3.0 cr)
or LAAS 5311 - Soil Chemistry and Mineralogy (3.0 cr)
or PUBH 6190 - Environmental Chemistry (3.0 cr)

Limnology Core
EEB 5601 - Limnology (3.0 cr)

Water Resources Policy Core
WRS 5101 - Water Policy (3.0 cr)

WRS Electives
Plan A students need at least 9 credits from the following list and Plan B students need at least 17 credits.
APEC 5651 - Economics of Natural Resource and Environmental Policy (3.0 cr)
or BBE 5523 - Ecological Engineering Design (3.0 cr)
or BBE 5513 - Watershed Engineering (3.0 cr)
or BBE 5535 - Assessment and Diagnosis of Impaired Waters (3.0 cr)
or BBE 8513 - Hydrologic Modeling of Small Watersheds (3.0 cr)
or PMB 4121 - Microbial Ecology and Applied Microbiology (3.0 cr)
or CEGE 4351 - Groundwater Mechanics (3.0 cr)
or CEGE 4352 - Groundwater Modeling (3.0 cr)
or CEGE 4501 - Hydrologic Design (4.0 cr)
or CEGE 4502 - Water and Wastewater Treatment (3.0 cr)
or CEGE 4511 - Hydraulic Structures (3.0 cr)
or CEGE 4512 - Open Channel Hydraulics (4.0 cr)
or CEGE 5541 - Environmental Water Chemistry (3.0 cr)
or CEGE 4562 - Environmental Remediation Technologies (3.0 cr)
or CEGE 5542 - Experimental Methods in Environmental Engineering (3.0 cr)
or CEGE 5551 - Environmental Microbiology (3.0 cr)
or CEGE 8504 - Theory of Unit Operations (4.0 cr)
or CEGE 8505 - Biological Processes (3.0 cr)
or CEGE 8506 - Stochastic Hydrology (4.0 cr)
or CEGE 8507 - Advanced Methods in Hydrology (4.0 cr)
or CEGE 8511 - Mechanics of Sediment Transport (3.0 cr)
or ESCI 8511 - Mechanics of Sediment Transport (3.0 cr)
or CEGE 8542 - Chemistry of Organic Pollutants in Environmental Systems (3.0 cr)
or CEGE 8572 - Computational Environmental Fluid Dynamics (4.0 cr)
or CEGE 8601 - Introduction to Stream Restoration (3.0 cr)
or EEB 8601 - Introduction to Stream Restoration (3.0 cr)
or CEGE 8602 - Stream Restoration Practice (2.0 cr)
or ESCI 8602 - Stream Restoration Practice (2.0 cr)
or CONS 8004 - Economic and Social Aspects of Conservation Biology (3.0 cr)
or EEB 4611 - Biogeochemical Processes (3.0 cr)
or EEB 5601 - Limnology (3.0 cr)
or ENT 5081 - Insects, Aquatic Habitats, and Pollution (3.0 cr)
or ENT 5361 - Aquatic Insects (4.0 cr)
or ESCI 4401 - Aqueous Environmental Geochemistry (3.0 cr)
or ESCI 4402 - Biogeochemical Cycles in the Ocean (3.0 cr)
or ESCI 4702 - General Hydrogeology (4.0 cr)
or ESCI 5705 - Limnogeology and Paleoenvironment (3.0 cr)
or ESCI 5971 - Field Hydrogeology (2.0 cr)
or ESPM 4216 - Contaminant Hydrology (3.0 cr)
or ESPM 5061 - Water Quality and Natural Resources (3.0 cr)
or ESPM 5111 - Hydrology and Water Quality Field Methods (3.0 cr)
or ESPM 5256 - Natural Resource Law and the Management of Public Lands and Waters (3.0 cr)
or ESPM 5402 - Biometeorology (3.0 cr)
or ESPM 5555 - Wetland Soils (3.0 cr)
or SOIL 5555 - Wetland Soils (3.0 cr)
or ESPM 5575 - Wetlands (3.0 cr)
or ESPM 5581 - Principles of Waste Management (3.0 cr)
or ESPM 5703 - Agroforestry in Watershed Management (3.0 cr)
or FNRM 5114 - Hydrology and Watershed Management (3.0 cr)
or FNRM 5153 - Forest Hydrology & Watershed Biogeochemistry (3.0 cr)
or FW 4136 - Ichthyology (4.0 cr)
or FW 5604W - Fisheries Ecology and Management [WI] (3.0 cr)
or FW 8459 - Fish Habitats and Restoration (3.0 cr)
or GEOG 5426 - Climatic Variations (3.0 cr)
or HORT 5071 - Ecological Restoration (4.0 cr)
or LAAS 5311 - Soil Chemistry and Mineralogy (3.0 cr)
or PUBH 6190 - Environmental Chemistry (3.0 cr)
or SOIL 5232 - Vadose Zone Hydrology (3.0 cr)
or ESPM 5295 - GIS in Environmental Science and Management (4.0 cr)
or FNRM 5131 - Geographical Information Systems (GIS) for Natural Resources (4.0 cr)
or FNRM 5262 - Remote Sensing and Geospatial Analysis of Natural Resources and Environment (3.0 cr)
or FW 5459 - Stream and River Ecology (3.0 cr)
or STAT 5021 - Statistical Analysis (4.0 cr)
or WRS 5150 - Watershed Specialist Training (2.0 cr)

Plan A Option:
Take 10 or more credit(s) from the following:
•WRS 8777 - Thesis Credits: Master's (1.0 - 18.0 cr)

Plan B Option
Select additional courses in consultation with your advisor to complete the Plan B option.

Program Sub-plans
A sub-plan is not required for this program.
Students may not complete the program with more than one sub-plan.

Limnology and Oceanography
The science of inland waters, or "limnology," includes the study of streams, lakes, ponds, and wetlands. While Lake Superior falls into this category, the style of research, particularly the nature of sampling and the scale of the processes investigated, makes the study of Lake Superior and other Great Lakes more akin to oceanography than to classical limnology.

A program that focuses on the study of both limnology and oceanography strengthens understanding of both systems, through comparative studies and by fostering interaction between groups that focus more strongly on one or the other system. Limnology and oceanography are by necessity interdisciplinary fields, with major components contributed by biological, geological, physical and chemical sciences. Such interdisciplinary fields in the modern research university require mechanisms to ensure cross-fertilization of ideas, approaches, methods, techniques, and knowledge. The limnology and oceanography track in WRS provides just such a much-needed mechanism. The goal of the program is to produce scientists with strong technical skills in aquatic science and a broad understanding of limnology and oceanography.

Students with WRS-equivalent coursework taken as undergraduates may substitute other classes to meet minimum credit requirements.

The faculty advisor must be a member of the limnology and oceanography track faculty.

Water Resources Seminar
WRS 8100 - Interdisciplinary Seminar in Water Resources (0.5 cr)

Water Resources Ethics
WRS 8581 - Research and Professional Ethics in Water Resources and Environmental Science (0.5 cr)

Hydrology Core for Limnology/Oceanography Students
Take at least 3 credits from the following:
BBE 8513 - Hydrologic Modeling of Small Watersheds (3.0 cr)
or FNRM 5114 - Hydrology and Watershed Management (3.0 cr)

Environmental/Water Chemistry Core for Limnology/Oceanography Students
Take at least 3 credits from the following:
CEGE 5541 - Environmental Water Chemistry (3.0 cr)
or ESCI 4401 - Aqueous Environmental Geochemistry (3.0 cr)
or LAAS 5311 - Soil Chemistry and Mineralogy (3.0 cr)
or PUBH 6190 - Environmental Chemistry (3.0 cr)
or EEB 4611 - Biogeochemical Processes (3.0 cr)

Limnology Core
EEB 5601 - Limnology (3.0 cr)

Water Resources Policy Core
WRS 5101 - Water Policy (3.0 cr)

WRS Electives
Plan A students need at least 9 credits from the following list and Plan B students need at least 17 credits. Electives must be selected under the guidance of your L&O committee. Choose from the following:

APEC 5651 - Economics of Natural Resource and Environmental Policy (3.0 cr)
or BBE 5523 - Ecological Engineering Design (3.0 cr)
or BBE 5513 - Watershed Engineering (3.0 cr)
or BBE 5535 - Assessment and Diagnosis of Impaired Waters (3.0 cr)
or BBE 8601 - Introduction to Stream Restoration (3.0 cr)
or PMB 4121 - Microbial Ecology and Applied Microbiology (3.0 cr)
or CEGE 4351 - Groundwater Mechanics (3.0 cr)
or CEGE 4352 - Groundwater Modeling (3.0 cr)
or CEGE 4501 - Hydrologic Design (4.0 cr)
or CEGE 4502 - Water and Wastewater Treatment (3.0 cr)
or CEGE 4511 - Hydraulic Structures (3.0 cr)
or CEGE 4512 - Open Channel Hydraulics (4.0 cr)
or CEGE 5541 - Environmental Water Chemistry (3.0 cr)
or CEGE 4562 - Environmental Remediation Technologies (3.0 cr)
or CEGE 5542 - Experimental Methods in Environmental Engineering (3.0 cr)
or CEGE 5551 - Environmental Microbiology (3.0 cr)
or CEGE 8504 - Theory of Unit Operations (4.0 cr)
or CEGE 8505 - Biological Processes (3.0 cr)
or CEGE 8506 - Stochastic Hydrology (4.0 cr)
or CEGE 8507 - Advanced Methods in Hydrology (4.0 cr)
or CEGE 8511 - Mechanics of Sediment Transport (3.0 cr)
or ESCI 8511 - Mechanics of Sediment Transport (3.0 cr)
or CEGE 8542 - Chemistry of Organic Pollutants in Environmental Systems (3.0 cr)
or CEGE 8572 - Computational Environmental Fluid Dynamics (4.0 cr)
or CEGE 8601 - Introduction to Stream Restoration (3.0 cr)
or EEB 8601 - Introduction to Stream Restoration (3.0 cr)
or CEGE 8602 - Stream Restoration Practice (2.0 cr)
or EEB 8602 - Stream Restoration Practice (2.0 cr)
or CEGE 8602 - Stream Restoration Practice (2.0 cr)
or CONS 8004 - Economic and Social Aspects of Conservation Biology (3.0 cr)
or EEB 4611 - Biogeochemical Processes (3.0 cr)
or EEB 5601 - Limnology (3.0 cr)
or ENT 5081 - Insects, Aquatic Habitats, and Pollution (3.0 cr)
or ENT 5361 - Aquatic Insects (4.0 cr)
or ESCI 4401 - Aqueous Environmental Geochemistry (3.0 cr)
or ESCI 4402 - Biogeochemical Cycles in the Ocean (3.0 cr)
or ESCI 4702 - General Hydrogeology (4.0 cr)
or ESCI 5705 - Limnogeology and Paleoenvironment (3.0 cr)
or ESCI 5971 - Field Hydrogeology (2.0 cr)
or ESPM 4216 - Contaminant Hydrology (3.0 cr)
or ESPM 5061 - Water Quality and Natural Resources (3.0 cr)
or ESPM 5111 - Hydrology and Water Quality Field Methods (3.0 cr)
or ESPM 5256 - Natural Resource Law and the Management of Public Lands and Waters (3.0 cr)
or ESPM 5402 - Biometeorology (3.0 cr)
or ESPM 5555 - Wetland Soils (3.0 cr)
or SOIL 5555 - Wetland Soils (3.0 cr)
or ESPM 5575 - Wetlands (3.0 cr)
or ESPM 5601 - Principles of Waste Management (3.0 cr)
or ESPM 5703 - Agroforestry in Watershed Management (3.0 cr)
or FNRM 5114 - Hydrology and Watershed Management (3.0 cr)
or FNRM 5153 - Forest Hydrology & Watershed Biogeochemistry (3.0 cr)
or FW 4136 - Ichthyology (4.0 cr)
or FW 5604W - Fisheries Ecology and Management [WI] (3.0 cr)
or FW 8459 - Stream and River Ecology (3.0 cr)
or FW 8465 - Fish Habitats and Restoration (3.0 cr)
or GEOG 5426 - Climatic Variations (3.0 cr)
or HORT 5071 - Ecological Restoration (4.0 cr)
or LAAS 5311 - Soil Chemistry and Mineralogy (3.0 cr)
or PUBH 6190 - Environmental Chemistry (3.0 cr)
or SOIL 5232 - Vadose Zone Hydrology (3.0 cr)
or WRS 5150 - Watershed Specialist Training (2.0 cr)
or ESPM 5295 - GIS in Environmental Science and Management (4.0 cr)
or FNRM 5131 - Geographical Information Systems (GIS) for Natural Resources (4.0 cr)
or FNRM 5262 - Remote Sensing and Geospatial Analysis of Natural Resources and Environment (3.0 cr)
or FW 5459 - Stream and River Ecology (3.0 cr)
or STAT 5021 - Statistical Analysis (4.0 cr)

Plan A Option:
Take 10 or more credit(s) from the following:
• WRS 8777 - Thesis Credits: Master's (1.0 - 18.0 cr)

Plan B Option
Select additional courses in consultation with your advisor to compete the Plan B option.
**Twin Cities Campus**

**Water Resources Science Minor**

_Water Resources Center_  
_Graduate School_

Link to a list of faculty for this program.

**Contact Information:**
Water Resources Science, 193 McNeal Hall, 1985 Buford Avenue, St. Paul MN 55108 (612-624-7456; fax: 612-625-1263)  
Email: [wrs@umn.edu](mailto:wrs@umn.edu)  
Website: [http://wrs.umn.edu](http://wrs.umn.edu)

- Program Type: Graduate minor related to major  
- Requirements for this program are current for Fall 2018  
- Length of program in credits (Masters): 9  
- Length of program in credits (Doctorate): 12  
- This program does not require summer semesters for timely completion.  
- University of Minnesota Duluth

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

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 interest: aquatic biology, environmental chemistry, hydrologic science, limnology, water management technology, water policy, water quality, and watershed science and management. A Limnology and Oceanography track is also offered. 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.

Students in the program develop the breadth of scientific knowledge appropriate to understand the complicated aquatic ecosystems and watersheds on which they will work, as well as social dimensions of the topic, including the public policy and legal frameworks in which water resources are protected and managed.

The program involves faculty from the following departments on the Twin Cities campus: Applied Economics; Bioproducts and Biosystems Engineering; Civil Engineering; Earth Sciences; Ecology, Evolution, and Behavior; Entomology; Environmental and Occupational Health; Fisheries, Wildlife, and Conservation Biology; Forest Resources; Geography; Horticultural Science; Plant Biology; and Soil, Water, and Climate. It also involves faculty from the following departments on the Duluth campus: Biology; Chemical Engineering; Chemistry; Civil Engineering; Geography; Geological Sciences; and Physics; as well as the Large Lakes Observatory and the Natural Resources Research Institute in Duluth.

**Program Delivery**

This program is available:  
- via classroom (the majority of instruction is face-to-face)

**Prerequisites for Admission**

The preferred undergraduate GPA for admittance to the program is 3.00.

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

**Program Requirements**

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

**Required Course**

_WRS 5101 - Water Policy (3.0 cr)_

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Information current as of August 31, 2018
Electives
Master's students must take at least 6 credits, and doctoral students must take at least 9 credits from the following list of electives.

Take 6 - 9 credit(s) from the following:

- BBE 8513 - Hydrologic Modeling of Small Watersheds (3.0 cr)
- CEGE 4501 - Hydrologic Design (4.0 cr)
- CEGE 5541 - Environmental Water Chemistry (3.0 cr)
- EEB 5601 - Limnology (3.0 cr)
- ESCI 4401 - Aqueous Environmental Geochemistry (3.0 cr)
- ESCI 4702 - General Hydrogeology (4.0 cr)
- FNRM 5114 - Hydrology and Watershed Management (3.0 cr)
- FNRM 5153 - Forest Hydrology & Watershed Biogeochemistry (3.0 cr)
- LAAS 5311 - Soil Chemistry and Mineralogy (3.0 cr)
- PUBH 6190 - Environmental Chemistry (3.0 cr)

Program Sub-plans
Students are required to complete one of the following sub-plans.
Students may not complete the program with more than one sub-plan.

Master's

Doctoral
Twin Cities Campus
Water Resources Science PhD
Water Resources Center
Graduate School

Link to a list of faculty for this program.

Contact Information:
Water Resources Science, 193 McNeal Hall, 1985 Buford Avenue, St. Paul MN 55108 (612-624-7456)
Email: wrs@umn.edu
Website: http://wrs.umn.edu

- Program Type: Doctorate
- Requirements for this program are current for Fall 2018
- Length of program in credits: 48
- This program does not require summer semesters for timely completion.
- The Water Resources Science PhD is an All-University program delivered on the Twin Cities and Duluth Campuses. The University of Minnesota Twin Cities is the degree granting authority for the Water Resources Science PhD program in Duluth.
- Degree: Doctor of Philosophy

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

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: aquatic biology, environmental chemistry, hydrologic science, limnology, water management technology, water policy, water quality, and watershed science and management. A limnology and oceanography track is also available. 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.

Students in the program develop the breadth of scientific knowledge appropriate to understand the complicated aquatic ecosystems and watersheds on which they will work, as well as social dimensions of the topic, including the public policy and legal frameworks in which water resources are protected and managed.

The program involves faculty from the following departments on the Twin Cities campus: Applied Economics; Bioproducts and Biosystems Engineering; Civil Engineering; Earth Sciences; Ecology, Evolution, and Behavior; Entomology; Environmental and Occupational Health; Fisheries, Wildlife, and Conservation Biology; Forest Resources; Geography; Horticultural Science; Plant Biology; and Soil, Water, and Climate. It also involves faculty from the following departments on the Duluth campus: Biology; Chemical Engineering; Chemistry; Civil Engineering Geography; Geological Sciences; Physics; as well as the Large Lakes Observatory and the Natural Resources Research Institute in Duluth.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

The program is flexible enough to accommodate students from a variety of backgrounds. Normally students have a master's degree in physical, biological, or environmental science or engineering.

Other requirements to be completed before admission:
Recommended academic preparation includes one year (or two semesters) each of calculus, physics, and chemistry, and one biology course at the undergraduate level.

Availability of funding and willingness of a member of the graduate faculty to serve as an advisor are important criteria for admission to
Special Application Requirements:
Applicants must submit three letters of recommendation via the University of Minnesota's ApplyYourself website. 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.

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. Students may be admitted any semester but are strongly encouraged to submit their application by December 15 for fall semester admission. More specific application instruction can be found on the program website: wrs.umn.edu/admissions/admissions-info.

Applicants must submit their test score(s) from the following:
- GRE

International applicants must submit score(s) from one of the following tests:
- TOEFL
  - Internet Based - Total Score: 79
  - Paper Based - Total Score: 550
- IELTS
  - Total Score: 6.5
- MELAB
  - Final score: 80

The preferred English language test is Test of English as Foreign Language

Key to test abbreviations (GRE, TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
24 credits are required in the major.
24 thesis credits are required.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 3.00 is required for students to remain in good standing.

At least 2 semesters must be completed before filing a Degree Program Form.

Water Resources Seminar
Students must take WRS 8100 for 0.5 credits.
WRS 8100 - Interdisciplinary Seminar in Water Resources (0.5 cr)

Water Resources Ethics
WRS 8581 - Research and Professional Ethics in Water Resources and Environmental Science (0.5 cr)

Hydrology Core
Take at least 3 credits from the following:
BBE 8513 - Hydrologic Modeling of Small Watersheds (3.0 cr)
or CEGE 4501 - Hydrologic Design (4.0 cr)
or ESCI 4702 - General Hydrogeology (4.0 cr)
or FNRM 5114 - Hydrology and Watershed Management (3.0 cr)
or FNRM 5153 - Forest Hydrology & Watershed Biogeochemistry (3.0 cr)

Environmental/Water Chemistry Core
Take at least 3 credits from the following:
CEGE 5541 - Environmental Water Chemistry (3.0 cr)
or ESCI 4401 - Aqueous Environmental Geochemistry (3.0 cr)
or LAAS 5311 - Soil Chemistry and Mineralogy (3.0 cr)
or PUBH 6190 - Environmental Chemistry (3.0 cr)

Limnology Core
EEB 5601 - Limnology (3.0 cr)

Water Resources Policy Core
WRS 5101 - Water Policy (3.0 cr)

WRS Electives
Approved electives to fulfill the required 24 course credits, choose from the following:
APEC 5651 - Economics of Natural Resource and Environmental Policy (3.0 cr)
or BBE 5523 - Ecological Engineering Design (3.0 cr)
or BBE 5513 - Watershed Engineering (3.0 cr)
or BBE 5535 - Assessment and Diagnosis of Impaired Waters (3.0 cr)
or BBE 5513 - Hydrologic Modeling of Small Watersheds (3.0 cr)
or PMB 4121 - Microbial Ecology and Applied Microbiology (3.0 cr)
or CEGE 4351 - Groundwater Mechanics (3.0 cr)
or CEGE 4352 - Groundwater Modeling (3.0 cr)
or CEGE 4501 - Hydrologic Design (4.0 cr)
or CEGE 4502 - Water and Wastewater Treatment (3.0 cr)
or CEGE 4511 - Hydraulic Structures (3.0 cr)
or CEGE 4512 - Open Channel Hydraulics (4.0 cr)
or CEGE 4562 - Environmental Remediation Technologies (3.0 cr)
or CEGE 5541 - Environmental Water Chemistry (3.0 cr)
or CEGE 5542 - Experimental Methods in Environmental Engineering (3.0 cr)
or CEGE 5551 - Environmental Microbiology (3.0 cr)
or CEGE 8504 - Theory of Unit Operations (4.0 cr)
or CEGE 8505 - Biological Processes (3.0 cr)
or CEGE 8506 - Stochastic Hydrology (4.0 cr)
or CEGE 8507 - Advanced Methods in Hydrology (4.0 cr)
or CEGE 8511 - Mechanics of Sediment Transport (3.0 cr)
or ESCI 8511 - Mechanics of Sediment Transport (3.0 cr)
or CEGE 8542 - Chemistry of Organic Pollutants in Environmental Systems (3.0 cr)
or CEGE 8572 - Computational Environmental Fluid Dynamics (4.0 cr)
or CEGE 8601 - Introduction to Stream Restoration (3.0 cr)
or EEB 8601 - Introduction to Stream Restoration (3.0 cr)
or ESCI 8601 - Introduction to Stream Restoration (3.0 cr)
or CEGE 8602 - Stream Restoration Practice (2.0 cr)
or EEB 8602 - Stream Restoration Practice (2.0 cr)
or ESCI 8602 - Stream Restoration Practice (2.0 cr)
or CONS 8004 - Economic and Social Aspects of Conservation Biology (3.0 cr)
or EEB 4611 - Biogeochemical Processes (3.0 cr)
or EEB 5601 - Limnology (3.0 cr)
or ENT 5081 - Insects, Aquatic Habitats, and Pollution (3.0 cr)
or ENT 5361 - Aquatic Insects (4.0 cr)
or ESCI 4401 - Aqueous Environmental Geochemistry (3.0 cr)
or ESCI 4402 - Biogeochemical Cycles in the Ocean (3.0 cr)
or ESCI 4702 - General Hydrogeology (4.0 cr)
or ESCI 5705 - Limnogeology and Paleoenvironment (3.0 cr)
or ESCI 5971 - Field Hydrogeology (2.0 cr)
or ESPM 4216 - Contaminant Hydrology (3.0 cr)
or ESPM 5061 - Water Quality and Natural Resources (3.0 cr)
or ESPM 5111 - Hydrology and Water Quality Field Methods (3.0 cr)
or ESPM 5256 - Natural Resource Law and the Management of Public Lands and Waters (3.0 cr)
or ESPM 5402 - Biometeorology (3.0 cr)
or ESPM 5555 - Wetland Soils (3.0 cr)
or SOIL 5555 - Wetland Soils (3.0 cr)
or ESPM 5575 - Wetlands (3.0 cr)
or ESPM 5601 - Principles of Waste Management (3.0 cr)
or ESPM 5703 - Agroforestry in Watershed Management (3.0 cr)
or FNRM 5114 - Hydrology and Watershed Management (3.0 cr)
or FNRM 5153 - Forest Hydrology & Watershed Biogeochemistry (3.0 cr)
or FW 4136 - Ichthyology (4.0 cr)
or FW 5604W - Fisheries Ecology and Management [WI] (3.0 cr)
or FW 8459 - Stream and River Ecology (3.0 cr)
or FW 8465 - Fish Habitats and Restoration (3.0 cr)
or GEOG 5426 - Climatic Variations (3.0 cr)
or HORT 5071 - Ecological Restoration (4.0 cr)
or LAAS 5311 - Soil Chemistry and Mineralogy (3.0 cr)
or PUBH 6190 - Environmental Chemistry (3.0 cr)
or SOIL 5232 - Vadose Zone Hydrology (3.0 cr)
or ESPM 5295 - GIS in Environmental Science and Management (4.0 cr)
or FNRM 5131 - Geographical Information Systems (GIS) for Natural Resources (4.0 cr)
or FW 5459 - Stream and River Ecology (3.0 cr)
or FNRM 5262 - Remote Sensing and Geospatial Analysis of Natural Resources and Environment (3.0 cr)
or STAT 5021 - Statistical Analysis (4.0 cr)
or WRS 5150 - Watershed Specialist Training (2.0 cr)
or FW 5459 - Stream and River Ecology (3.0 cr)
or FNRM 5262 - Remote Sensing and Geospatial Analysis of Natural Resources and Environment (3.0 cr)
or STAT 5021 - Statistical Analysis (4.0 cr)
or WRS 5150 - Watershed Specialist Training (2.0 cr)

Thesis Requirement
All doctoral students must take 24 doctoral thesis credits.
WRS 8888 - Thesis Credit: Doctoral (1.0 - 24.0 cr)

Program Sub-plans
A sub-plan is not required for this program.
Students may not complete the program with more than one sub-plan.

Limnology and Oceanography
The science of inland waters, or "limnology," includes the study of streams, lakes, ponds, and wetlands. While Lake Superior falls into this category, the style of research, particularly the nature of sampling and the scale of the processes investigated, makes study of Lake Superior and other Great Lakes more akin to oceanography than to classical limnology. A program that focuses on the study of both limnology and oceanography strengthens understanding of both systems, through comparative studies and by fostering interaction between groups that focus more strongly on one or the other system. Limnology and oceanography are by necessity interdisciplinary fields, with major components contributed by biological, geological, physical, and chemical sciences.

This track within the cross-campus interdisciplinary WRS program provides comprehensive training in limnology and oceanography. As is the case for the WRS graduate program as a whole, the L&O program includes a set of core courses plus electives in the subfield of limnology and oceanography.

The goal of the program is to produce scientists with strong technical skills in aquatic science and a broad understanding of limnology and oceanography. Faculty on both Twin Cities and Duluth campuses participate in the limnology and oceanography track.

PhD students pursuing the limnology and oceanography track must have at least two members of the limnology and oceanography faculty on their committee, including the advisor.

Water Resources Seminar
Students must take WRS 8100 for 0.5 credits.
WRS 8100 - Interdisciplinary Seminar in Water Resources (0.5 cr)

Water Resources Ethics
WRS 8581 - Research and Professional Ethics in Water Resources and Environmental Science (0.5 cr)

Hydrology Core for Limnology/Oceanography Students
Take 3 or more credit(s) from the following:
  • BBE 8513 - Hydrologic Modeling of Small Watersheds (3.0 cr)
  • FNRM 5114 - Hydrology and Watershed Management (3.0 cr)

Environmental/Water Chemistry Core for Limnology/Oceanography Students
Take at least 3 credits from the following:
  • CEGE 5541 - Environmental Water Chemistry (3.0 cr)
  • ESCI 4401 - Aqueous Environmental Geochemistry (3.0 cr)
  • LAAS 5311 - Soil Chemistry and Mineralogy (3.0 cr)
  • PUBH 6190 - Environmental Chemistry (3.0 cr)
  • EEB 4611 - Biogeochemical Processes (3.0 cr)

Limnology Core
  • EEB 5601 - Limnology (3.0 cr)

Water Resources Policy Core
WRS 5101 - Water Policy (3.0 cr)

WRS Electives
Approved electives to fulfill the required 24 course credits must be chosen in consultation with your L&O committee. Choose from the following:
APEC 5651 - Economics of Natural Resource and Environmental Policy (3.0 cr)
or BBE 5523 - Ecological Engineering Design (3.0 cr)
or BBE 5513 - Watershed Engineering (3.0 cr)
or BBE 5535 - Assessment and Diagnosis of Impaired Waters (3.0 cr)
or BBE 8513 - Hydrologic Modeling of Small Watersheds (3.0 cr)
or PMB 4121 - Microbial Ecology and Applied Microbiology (3.0 cr)
or CEGE 4351 - Groundwater Mechanics (3.0 cr)
or CEGE 4352 - Groundwater Modeling (3.0 cr)
or CEGE 4501 - Hydrologic Design (4.0 cr)
or CEGE 4502 - Water and Wastewater Treatment (3.0 cr)
or CEGE 4511 - Hydraulic Structures (3.0 cr)
or CEGE 4512 - Open Channel Hydraulics (4.0 cr)
or CEGE 4562 - Environmental Remediation Technologies (3.0 cr)
or CEGE 5541 - Environmental Water Chemistry (3.0 cr)
or CEGE 5542 - Experimental Methods in Environmental Engineering (3.0 cr)
or CEGE 5551 - Environmental Microbiology (3.0 cr)
or CEGE 8504 - Theory of Unit Operations (4.0 cr)
or CEGE 8505 - Biological Processes (3.0 cr)
or CEGE 8506 - Stochastic Hydrology (4.0 cr)
or CEGE 8507 - Advanced Methods in Hydrology (4.0 cr)
or CEGE 8511 - Mechanics of Sediment Transport (3.0 cr)
or ESCI 8511 - Mechanisms of Sediment Transport (3.0 cr)
or CEGE 8542 - Chemistry of Organic Pollutants in Environmental Systems (3.0 cr)
or CEGE 8572 - Computational Environmental Fluid Dynamics (4.0 cr)
or CEGE 8601 - Introduction to Stream Restoration (3.0 cr)
or EEB 8601 - Introduction to Stream Restoration (3.0 cr)
or EISCI 8601 - Introduction to Stream Restoration (3.0 cr)
or CEGE 8602 - Stream Restoration Practice (2.0 cr)
or EEB 8602 - Stream Restoration Practice (2.0 cr)
or ESCI 8602 - Stream Restoration Practice (2.0 cr)
or CONS 8004 - Economic and Social Aspects of Conservation Biology (3.0 cr)
or EEB 4611 - Biogeochemical Processes (3.0 cr)
or EEB 5601 - Limnology (3.0 cr)
or ENT 5081 - Insects, Aquatic Habitats, and Pollution (3.0 cr)
or ENT 5361 - Aquatic Insects (4.0 cr)
or ESCI 4401 - Aqueous Environmental Geochemistry (3.0 cr)
or ESCI 4402 - Biogeochemical Cycles in the Ocean (3.0 cr)
or ESCI 4702 - General Hydrogeology (4.0 cr)
or ESCI 5705 - Limnogeology and Paleoecosystem (3.0 cr)
or ESCI 5971 - Field Hydrogeology (2.0 cr)
or ESPM 4216 - Contaminant Hydrology (3.0 cr)
or ESPM 5061 - Water Quality and Natural Resources (3.0 cr)
or ESPM 5111 - Hydrology and Water Quality Field Methods (3.0 cr)
or ESPM 5256 - Natural Resource Law and the Management of Public Lands and Waters (3.0 cr)
or ESPM 5402 - Biometeorology (3.0 cr)
or ESPM 5555 - Wetland Soils (3.0 cr)
or SOIL 5555 - Wetland Soils (3.0 cr)
or ESPM 5556 - Wetlands (3.0 cr)
or ESPM 5601 - Principles of Waste Management (3.0 cr)
or ESPM 5703 - Agroforestry in Watershed Management (3.0 cr)
or FNRM 5114 - Hydrology and Watershed Management (3.0 cr)
or FNRM 5153 - Forest Hydrology & Watershed Biogeochemistry (3.0 cr)
or FW 4136 - Ichthyology (4.0 cr)
or FW 5604W - Fisheries Ecology and Management [WI] (3.0 cr)
or FW 8459 - Stream and River Ecology (3.0 cr)
or FW 8465 - Fish Habitat and Restoration (3.0 cr)
or GEOG 5426 - Climatic Variations (3.0 cr)
or HORT 5071 - Ecological Restoration (4.0 cr)
or LAAS 5311 - Soil Chemistry and Mineralogy (3.0 cr)
or PUBH 6190 - Environmental Chemistry (3.0 cr)
or SOIL 5232 - Vadose Zone Hydrology (3.0 cr)
or WRS 5150 - Watershed Specialist Training (2.0 cr)
or ESPM 5295 - GIS in Environmental Science and Management (4.0 cr)
or FNRM 5131 - Geographical Information Systems (GIS) for Natural Resources (4.0 cr)
or FNRM 5262 - Remote Sensing and Geospatial Analysis of Natural Resources and Environment (3.0 cr)
or FW 5459 - Stream and River Ecology (3.0 cr)
or STAT 5021 - Statistical Analysis (4.0 cr)

**Thesis Requirement**
All doctoral students must take 24 doctoral thesis credits.
WRS 8888 - Thesis Credit: Doctoral (1.0 - 24.0 cr)