Twin Cities Campus
Animal Sciences M.S.
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Animal Science, 305 Haecker Hall, 1364 Eckles Avenue, Saint Paul, MN 55108 (612-624-3491; fax: 612-625-5789)
Email: ansci@umn.edu
Website: http://www.ansci.umn.edu/GraduateProgram/index.htm

- Program Type: Master's
- Requirements for this program are current for Fall 2014
- 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.

Students in the animal sciences M.S. concentrate on one of the animal sciences subdisciplines: genetics, growth biology, nutrition, physiology, or production systems. Students have the option of tailoring their individual programs to include study in more than one subdiscipline and to emphasize basic or applied science.

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.

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.

Plan B: Plan B requires 24 major credits and 6 credits outside the major. The final exam is written and oral. A capstone project is required.

Capstone Project: The Plan B project requires approximately 120 hours to complete. The nature and extent of the project is agreed upon in advance by the student and faculty adviser.
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.

Plan A requires a minimum of 14 semester credits in the major and 6 credits in a designated minor or related field outside the major. Selection of courses to fulfill this requirement and development of the thesis project are primarily the responsibility of the student and faculty adviser. Students also must register for a minimum of 10 thesis credits.

Plan B requires a minimum of 30 credits, which must include 14 or more credits in the major area and at least 6 credits in one or more related fields outside the major. The balance of credits is chosen by agreement between the adviser and student. In addition to coursework, students must complete the Plan B Capstone Project, which requires approximately 120 hours. The nature and extent of the project is agreed upon in advance by the student and faculty adviser.
Twin Cities Campus
Animal Sciences Minor
Animal Science
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Animal Science, 305 Haecker Hall, 1364 Eckles Avenue, Saint Paul, MN 55108 (612-624-3491; fax: 612-625-5789)
Email: ansci@umn.edu
Website: http://www.ansci.umn.edu/GraduateProgram/index.htm

• Program Type: Graduate minor related to major
• Requirements for this program are current for Fall 2014
• 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.

Students pursuing a minor in animal sciences concentrate on one of the animal sciences subdisciplines: genetics, growth biology, nutrition, physiology, or production systems. Students have the option of tailoring their program to include study in more than one subdiscipline and to emphasize basic or applied science.

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.

Requirements are designed to fit the student's needs. A master's minor requires 6 credits in areas not closely related to the major; no more than 2 of these credits may be in research or special problems. A doctoral minor requires 12 credits in areas not closely related to the major; no more than 3 of these credits may be in research or special problems.
Twin Cities Campus
Animal Sciences Ph.D.
Animal Science
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Animal Science, 305 Haecker Hall, 1364 Eckles Avenue, Saint Paul, MN 55108 (612-624-3491; fax: 612-625-5789)
Email: ansci@umn.edu
Website: http://www.ansci.umn.edu/GraduateProgram/index.htm

- Program Type: Doctorate
- Requirements for this program are current for Fall 2014
- Length of program in credits: 72
- 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.

Students in the Ph.D. program concentrate on one of the animal sciences subdisciplines: genetics, growth biology, nutrition, physiology, or production systems. Students have the option of tailoring their program to include study in more than one subdiscipline and to emphasize basic or applied science.

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 in agriculture or a biological field with training in biology, chemistry, physics, and mathematics is required.

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
40 credits are required in the major.
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.

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.

The Ph.D. degree is granted chiefly in recognition of the candidate's achievements and knowledge in a specific field. Students must register for a minimum of 24 thesis credits. Appropriate graduate level courses taken at another university may be approved for transfer. Coursework completed under an M.S. program can be counted towards the Ph.D. degree. The student is expected to maintain a B average or better in all coursework.
Twin Cities Campus

Applied Economics M.S.

Applied Economics
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Applied Economics Graduate Program, 231 Ruttan Hall, 1994 Buford Avenue, Saint Paul, MN 55108-6040 (612-625-3777; fax: 612-625-6245)
Email: apecdgs@umn.edu
Website: http://www.catalogs.umn.edu/grad/programs/g004.html

- Program Type: Master's
- Requirements for this program are current for Fall 2014
- 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.

The M.S. degree in applied economics prepares students for employment opportunities in the public and private sector and for further graduate study. This rigorous but flexible program includes core coursework in economic theory and quantitative methods and offers opportunities for specialized coursework and research in all the fields of study offered by the program.

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:
The following coursework is considered the minimum preparation for the M.S. program: micro and macroeconomic theory at the intermediate undergraduate level, statistics, two semesters of calculus, and introductory linear algebra. Additional coursework in economics, statistics, and math is highly desirable and recommended, especially for students who intend to apply for the doctoral program after completion of the M.S. degree.

Special Application Requirements:
Applicants must submit scores from the General Test of the GRE, three letters of recommendation from persons familiar with the applicant's scholarship and research potential, a complete set of college or university transcripts, and a clearly written statement of academic and career interests, goals, and objectives. For complete application instructions, visit the website: http://www.apecgrad.umn.edu/Admissions/index.htm. Students should apply by the December deadline to ensure priority consideration for admissions and funding.

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, 0 credits outside the major, and 10 thesis credits. The final exam is oral.

**Plan B:** Plan B requires 14 major credits and 0 credits outside the major. The final exam is oral. A capstone project is required.

**Capstone Project:** A project that demonstrates familiarity with the theoretical and empirical tools of economics. The Plan B project requires between 4 and 6 project credits (APEC 8793).

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.

M.S. students are required to complete graduate-level courses in microeconomic theory, macroeconomic theory, and econometrics or statistics. Students are also required to participate in two 1-credit M.S. seminars. Both Plan A and Plan B require at least 30 credits, of which at least 14 credits must be in the major field. The major field must include a minimum of 9 credits in applied economics (excluding thesis and special topics, independent study, and the M.S. seminar). Plan A requires 10 thesis credits. Plan B requires a 4- to 6-credit project.

For more information about program requirements, refer to the department’s Graduate Program Student Handbook: http://www.apecgrad.umn.edu/prod/groups/cfans/@pub/@cfans/@apec/documents/asset/cfans_asset_352638.pdf.
Twin Cities Campus
Applied Economics Minor
Applied Economics
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Applied Economics Graduate Program, 231 Ruttan Hall, 1994 Buford Avenue, Saint Paul, MN 55108-6040 (612-625-3777; fax: 612-625-6245)
Email: apecdgs@umn.edu
Website: http://www.catalogs.umn.edu/grad/programs/g004.html

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2014
- Length of program in credits (Masters): 9
- Length of program in credits (Doctorate): 15
- 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.

Graduate study in applied economics requires an operational knowledge of economic theory and modern methods of quantitative analysis, as well as practical application in specialized fields of inquiry, which include consumer behavior and household economics; health economics; labor economics; policy analysis; production and marketing economics; resource and environmental economics; and trade and development economics.

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

Prerequisites for Admission
Special Application Requirements:
Courses for the minor must be approved by the director of graduate studies in the Applied Economics Graduate Program.

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.

M.S. students must complete at least 9 credits of 5xxx or 8xxx courses in applied economics. Ph.D. students must complete at least 15 credits of 5xxx or 8xxx courses in applied economics. Courses for the minor must be approved by the director of graduate studies. All courses in the minor must be taken A-F and completed with a GPA of 3.00 or higher.
Twin Cities Campus
Applied Economics Ph.D.
Applied Economics
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Applied Economics Graduate Program, 231 Ruttan Hall, 1994 Buford Avenue, Saint Paul, MN 55108-6040 (612-625-3777; fax: 612-625-6245)
Email: apecdgs@umn.edu
Website: http://www.catalogs.umn.edu/grad/programs/g004.html

- Program Type: Doctorate
- Requirements for this program are current for Fall 2014
- 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.

The Ph.D. degree program in applied economics prepares students for careers in academia, government, and the private sector. This rigorous program includes core coursework in economic theory, quantitative methods, and two fields of specialization selected from the following: consumer behavior and household economics; production and marketing economics; trade and development economics; natural resource and environmental economics; health economics; labor economics; and policy analysis.

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 minimum preferred undergraduate GPA for admittance to the program is a B average (3.00/4.00). Most admitted students will have a higher GPA.

Other requirements to be completed before admission:
Applicants for the Ph.D. degree should have completed an M.S. degree in economics, agricultural economics, or a related field; or have equivalent coursework and research experience. Applicants without a master's degree are, except in a few special cases, considered for admission into the M.S. program.

Prior training should include micro- and macro-economic theory at the master's level, multivariate calculus, differential equations and linear algebra, and mathematical statistics. Students lacking background in economics or quantitative methods may be required to complete additional coursework before entering the program.

Special Application Requirements:
Applicants must submit scores from the General Test of the GRE, three letters of recommendation from persons familiar with the applicant's scholarship and research potential, a complete set of college or university transcripts, and a clearly written statement of academic and career interests, goals, and objectives. For complete application instructions, visit the website: http://www.apecgrad.umn.edu/Admissions/index.htm. Students should apply by the December deadline to ensure priority consideration for admissions and funding.

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
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 towards program requirements is not permitted.

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

Most students take at least 40 credits of coursework and must take 24 thesis credits. Required courses in microeconomic theory, macroeconomic theory and applied econometrics and at least two-thirds of the remaining credits included in the PhD degree program are to be completed on the A-F grade basis. The student must pass a written preliminary exam in microeconomic theory and at least one field examination in one of the seven Ph.D. fields offered by the Applied Economics Graduate Program. In addition, there is a requirement for a qualifying paper written in the second year of the program.

After passing the written preliminary examinations, the student must take a preliminary oral exam. This exam can be on coursework, a thesis prospectus, or some combination. It is administered by a committee of four persons, to include three from the Applied Economics Graduate Program and one other graduate faculty from outside the program. At the conclusion of the thesis research, students complete a final oral examination, which consists of a public seminar (in which the candidate presents the thesis) and a closed meeting between the candidate and the appointed examining committee.

For more details, please see the Graduate Program Handbook weblink:
http://www.apecgrad.umn.edu/ServicesandResources/index.htm
**Twin Cities Campus**

**Applied Plant Sciences M.S.**  
*Agronomy & Plant Genetics, Horticultural Science*  
*College of Food, Agricultural and Natural Resource Sciences*

Link to a list of faculty for this program.

**Contact Information:**  
Department of Agronomy and Plant Genetics, 411 Borlaug Hall, 1991 Upper Buford Circle, St. Paul, MN 55108-6026 (612-625-4742; fax: 612-625-1268)  
Email: apsc@umn.edu  
Website: [http://www.appliedplantsciences.umn.edu](http://www.appliedplantsciences.umn.edu)

- Program Type: Master's  
- Requirements for this program are current for Fall 2014  
- 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.

Applied plant sciences is an interdisciplinary program for educating students to become professional scientists well grounded in the applied disciplines of agronomy/agroecology, horticulture, and plant breeding/molecular genetics. Graduates of the program are able to provide innovative leadership and contribute to problem solving within their disciplines in the public or private sector and within society at large. The program develops the quantitative and qualitative research skills necessary to conduct high quality research and scholarship. Students gain broad familiarity with all of the disciplines within the program and gain in-depth knowledge within their area of expertise. The program's graduate faculty is drawn primarily from the Department of Agronomy and Plant Genetics and the Department of Horticultural Science; but also from the Departments of Plant Biology; Plant Pathology; Soil, Water, and Climate; Landscape Architecture; and related departments. Students choose from among four specialization tracks: agronomy/agroecology, applied plant sciences, horticulture, or plant breeding/plant molecular genetics.

**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 entering the program should have a foundation in the physical and biological sciences, preferably with some emphasis in plant science. A minimum of 10 credits of math and physics, 12 credits of chemistry and biochemistry, and 15 credits of biological and/or agricultural sciences are recommended for admission. In addition, students should have completed a B.S. or B.A. degree in agriculture, biology, or other related life science. Students with a B.S. or B.A. degree outside these areas may be admitted with the requirement that they take the prerequisite courses noted above at the undergraduate level in addition to their graduate coursework.

**Special Application Requirements:**  
Applicants must submit scores from the General (Aptitude) Test of the GRE; three letters of recommendation from persons familiar with their scholarship and research potential; a complete set of transcripts; and a clearly written personal statement of career interests, goals, and objectives as part of the online application. Students should apply by December 5 for admission into fall semester of the following year. Students should apply by October 1 for admission into spring semester of the following year.

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: 550

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 20 major credits, up to null credits outside the major, and 10 thesis credits. The final exam is oral.

**Plan B:** Plan B requires 30 major credits and up to null credits outside the major. The final exam is written and oral. A capstone project is required.

**Capstone Project:** Determined in consultation with advisor.

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.

The M.S. is offered under Plan A (with thesis) and Plan B (with project). Plan A requires a minimum of 20 course credits and 10 thesis credits; Plan B requires a minimum of 30 course credits. Students are required to complete the courses in the common curriculum and the requirements for their specialization, and to present one graduate seminar. Additional course requirements are flexible and are determined in consultation with the student's adviser(s) and advisory committee. Required core courses are counted toward the required credits.

**Required courses**
All APS graduate students are required to take a group of core courses

- AGRO 5311 - Research Methods in Crop Improvement and Production (1.0 cr)
- AGRO 8270 - Graduate Seminar (1.0 cr)
- APSC 8123 - Research Ethics in the Plant and Environmental Sciences (0.5 cr)
- STAT 5021 - Statistical Analysis (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.

**Agronomy and Agroecology**

Students conduct research to increase their knowledge of cropping systems and weed science, including alternative approaches and management strategies. Emphasis is on improving production efficiency and profitability in an environmentally sound approach that benefits society. Mechanisms of crop physiology and ecology underlying plant responses to the environment are a particular emphasis of this track.

M.S. Plan A degree: In addition to the 6.5 credits in program-wide required courses, students must complete two agroecology/agronomy courses:

- AGRO 4005 - Applied Crop Physiology and Development (4 cr)
- AGRO 4505 - Integrated Weed Management (3 cr)
- AGRO 4401 - Plant Genetics and Breeding (4 cr)
- SAGR 8010 - Sustainable Agriculture Colloquium (2 cr)
- AGRO 5321 - Ecology of Agricultural Systems (3 cr)
- AGRO 5999 - Special Topics: Agro-ecosystems Analysis Summer Field Course (3 cr);

A course in plant biology such as:

- PBIO 5516 - Plant Cell Biology (3 cr)
- PBIO 5412 - Plant Physiology (3 cr)
At least one other course from the following suggested courses:

- BIOL 5407 - Ecology (3 cr)
- EEB 4068 - Plant Physiological Ecology (3 cr)
- EEB 4069 - Ecosystem Ecology (3 cr)
- EEB 5053 - Ecology: Theory and Concepts (4 cr)
- HORT 5071 - Restoration and Reclamation Ecology (3 cr)
- ESPM 5108 - Ecology of Managed Systems (4 cr)
- ESPM 5345 - Sustainable Land Use Planning and Policy (3 cr)

Courses listed within the agroecology/agronomy, plant biology, and ecology groups are provided as a guide for students and faculty. Other courses can be substituted with agreement of the adviser, advisory committee, and DGS.

**Required courses**

- **AGRO 5311** - Research Methods in Crop Improvement and Production (1.0 cr)
- **AGRO 8270** - Graduate Seminar (1.0 cr)
- **APSC 8123** - Research Ethics in the Plant and Environmental Sciences (0.5 cr)
- **STAT 5021** - Statistical Analysis (4.0 cr)

**Horticulture**

Students conduct research related to fruits, vegetables, potatoes, flowers, ornamental trees and shrubs, or turf; on the physiology, production, environmental impact of cropping systems; and use of horticultural crops. Research areas include the effect of horticultural commodities on human health, hormonal, and stress physiology; flower development and flowering physiology; integrated pest management; post harvest physiology; and cropping system strategies. Students get a broad range of experiences in the field, greenhouse, and/or laboratory using genetic, molecular, biochemical, and ecological tools to answer research questions.

In addition to the 6.5 credits in program-wide required courses, students must complete at least 14 course credits from the following courses:

**Area 1 - Cross Commodity Horticulture**

- HORT 4071W - Applications of Biotechnology to Plant Improvement (4 cr)
- AGRO 4505 - Integrated Weed Management (4 cr)
- HORT 4461 - Horticultural Marketing
- HORT 5007 - Advanced Plant Propagation (3 cr) (Sp even yrs)
- HORT 5023 - Public Garden Management (2 cr)
- STAT 5302 - Applied Regression Analysis (4 cr)
- AGRO 5321 - Ecology of Agricultural Systems (3 cr)
- MKTG 6051 - Marketing Research (4 cr)
- MKTG 6055 - Buyer Behavior (4 cr)
- MBA 6210 - Marketing Management (3 cr)
- SAGR 8010 - Colloquium in Sustainable Agriculture (2 cr)
- HORT 8044 - Manipulation of Plant Growth and Reproduction (2 cr), Spring (even yrs)

**Area 2 - Commodity-based Horticulture**

- HORT 4061 - Turfgrass Management (4 cr)
- HORT 4062 - Turfgrass Weed and Disease Science (3 cr), Fall (odd yrs)
- HORT 4063 - Turfgrass Science (3 cr)
- HORT 4141W - Plant Production I (4 cr)
- HORT 5031 - Organic Viticulture and Fruit Production (3 cr), Fall (odd yrs)
- HORT 5032 - Organic Vegetable Production (3 cr), Spring (odd yrs)
- HORT 5051 - Plant Production II (4 cr)
- HORT 5071 - Restoration and Reclamation Ecology (3 cr)

**Required Courses**

- **AGRO 5311** - Research Methods in Crop Improvement and Production (1.0 cr)
- **AGRO 8270** - Graduate Seminar (1.0 cr)
- **APSC 8123** - Research Ethics in the Plant and Environmental Sciences (0.5 cr)
- **STAT 5021** - Statistical Analysis (4.0 cr)

**Plant Breeding and Plant Molecular Genetics**

This track allows students to select from genetic research projects ranging from applied plant breeding projects emphasizing breeding procedures and methodologies to molecular genetic projects doing biotechnology, genetic engineering, and genomic research in agronomic and horticultural crops. These research projects give students the opportunity to integrate the latest developments in the laboratory with applied applications in the field to reach the overarching goal of developing new germplasm that will improve the sustainability of our food/feed/fiber/fuel systems.
In addition to the 6.5 credits in program-wide required courses, students must complete at least 14 course credits from the following courses:

AGRO/HORT 8280 - Current Topics in Applied Plant Sciences (1 cr)
or AGRO 8010 - Colloquium in Sustainable Agriculture (2 cr)
Molecular Genetics Area (3 cr)
Genetics Area (3 cr)
Plant Breeding Area (3 cr)
Additional courses determined by student/committee (6 cr).

**Required courses**

AGRO 5311 - Research Methods in Crop Improvement and Production (1.0 cr)
AGRO 8270 - Graduate Seminar (1.0 cr)
APSC 8123 - Research Ethics in the Plant and Environmental Sciences (0.5 cr)
STAT 5021 - Statistical Analysis (4.0 cr)
Twin Cities Campus

Applied Plant Sciences Minor
Agronomy & Plant Genetics, Horticultural Science
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Agronomy and Plant Genetics, 411 Borlaug Hall, 1991 Upper Buford Circle, St. Paul, MN 55108-6026 (612-625-4742; fax: 612-625-1268)
Email: apsc@umn.edu
Website: http://www.appliedplantsciences.umn.edu

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2014
- 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.

Applied plant sciences is an interdisciplinary program for educating students to become professional scientists well grounded in the applied disciplines of agronomy/agroecology, horticulture, and plant breeding/molecular genetics. Graduates of the program are able to provide innovative leadership and contribute to problem solving within their disciplines in the public or private sector and within society at large. The program develops the quantitative and qualitative research skills necessary to conduct high quality research and scholarship. Students gain broad familiarity with all of the disciplines within the program and gain in-depth knowledge within their area of expertise. The program's graduate faculty is drawn primarily from the Department of Agronomy and Plant Genetics and the Department of Horticultural Science; but also from the Departments of Plant Biology; Plant Pathology; Soil, Water, and Climate; Landscape Architecture; and related departments. Students choose from among four specialization tracks: agronomy/agroecology, applied plant sciences, horticulture, or plant breeding/plant molecular genetics.

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 entering the program should have a foundation in the physical and biological sciences, preferably with some emphasis in plant science. A minimum of 10 credits of math and physics, 12 credits of chemistry and biochemistry, and 15 credits of biological and/or agricultural sciences are recommended for admission. In addition, students should have completed a B.S. or B.A. degree in agriculture, biology, or other related life science. Students with a B.S. or B.A. degree outside these areas may be admitted with the requirement that they take the prerequisite courses noted above at the undergraduate level in addition to their graduate coursework.

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.

Coursework is determined upon consultation with the Director of Graduate Studies.
Twin Cities Campus

Applied Plant Sciences Ph.D.
Agronomy & Plant Genetics, Horticultural Science
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Agronomy and Plant Genetics, 411 Borlaug Hall, 1991 Upper Buford Circle, St. Paul, MN 55108-6026 (612-625-4742; fax: 612-625-1268)
Email: apsc@umn.edu
Website: http://www.appliedplantsciences.umn.edu

- Program Type: Doctorate
- Requirements for this program are current for Fall 2014
- 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.

Applied plant sciences is an interdisciplinary program for educating students to become professional scientists well grounded in the applied disciplines of agronomy/agroecology, horticulture, and plant breeding/molecular genetics. Graduates of the program are able to provide innovative leadership and contribute to problem solving within their disciplines in the public or private sector and within society at large. The program develops the quantitative and qualitative research skills necessary to conduct high quality research and scholarship. Students gain broad familiarity with all of the disciplines within the program and gain in-depth knowledge within their area of expertise. The program's graduate faculty is drawn primarily from the Department of Agronomy and Plant Genetics and the Department of Horticultural Science; but also from the Departments of Ecology, Evolution, and Behavior; Plant Biology; Plant Pathology; Soil, Water, and Climate; and related departments. Students choose from among four specialization tracks: agronomy/agroecology, applied plant sciences, horticulture, or plant breeding/plant molecular genetics. Student choose from among four specialization tracks: agronomy/agroecology, applied plant sciences, horticulture, or plant breeding/molecular genetics.

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 entering the program should have a foundation in the physical and biological sciences, preferably with some emphasis in plant science. A minimum of 10 credits of math and physics, 12 credits of chemistry and biochemistry, and 15 credits of biological and/or agricultural sciences are recommended for admission. In addition, students should have completed a B.S. or B.A. degree in agriculture, biology, or other related life science. Students with a B.S. or B.A. degree outside these areas may be admitted with the requirement that they take the prerequisite courses noted above at the undergraduate level in addition to their graduate coursework.

Special Application Requirements:
Applicants must submit scores from the General (Aptitude) Test of the GRE; three letters of recommendation from persons familiar with their scholarship and research potential; a complete set of official transcripts; and a clearly written personal statement of career interests, goals, and objectives as part of the online application. Students should apply by December 1 for admission into fall semester of the following year. Students should apply by October 1 for admission into spring semester of the following year.

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
Program Requirements

30 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 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 semester must be completed before filing a Degree Program Form.

Ph.D. students are required to complete the courses in the common curriculum, the requirements for their respective specialization, and present one graduate seminar; 24 thesis credits are also required. Additional course requirements are flexible and are determined in consultation with the student's adviser(s) and advisory committee. Required core courses are counted toward the required 30 credits.

Program Sub-plans

A sub-plan is not required for this program.

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

Agronomy and Agroecology

Students conduct research to increase their knowledge of cropping systems and weed science, including alternative approaches and management strategies. Emphasis is on improving production efficiency and profitability in an environmentally sound approach that benefits society. Mechanisms of crop physiology and ecology underlying plant responses to the environment are a particular emphasis of this track.

Two agroecology/agronomy courses:
AGRO 4005 - Applied Crop Physiology and Development (4 cr)
AGRO 4401 - Plant Genetics and Breeding (4 cr)
AGRO 4505 - Integrated Weed Management (3 cr)
SAGR 8010 - Sustainable Agriculture Colloquium (2 cr)
AGRO 5321 - Ecology of Agricultural Systems (3 cr)
AGRO 5999 - Special Topics: Agro-ecosystem Analysis Summer Field Course (3 cr)

A course in plant biology such as:
PBIO 5412 - Plant Physiology (3 cr)
PBIO 5416 - Plant Morphology, Development, and Evolution (4 cr)

Ecology courses such as the following:
BIOL 5407 - Ecology (3 cr)
EEB 4068 - Plant Physiological Ecology (3 cr)
EEB 4609 - Ecosystem Ecology (3 cr)
EEB 5053 - Ecology: Theory and Concepts (4 cr)
HORT 5071 - Restoration and Reclamation Ecology (3 cr)
ESPM 5108 - Ecology of Managed Systems (4 cr)
ESPM 5245 - Sustainable Land Use Planning and Policy (3 cr)

Required courses
AGRO 5311 - Research Methods in Crop Improvement and Production (1.0 cr)
AGRO 8270 - Graduate Seminar (1.0 cr)
APSC 8123 - Research Ethics in the Plant and Environmental Sciences (0.5 cr)
GRAD 8101 - Teaching in Higher Education (3.0 cr)
SAGR 8010 - Colloquium in Sustainable Agriculture (2.0 cr)
STAT 5021 - Statistical Analysis (4.0 cr)

Horticulture
Students conduct research related to fruits, vegetables, potatoes, flowers, ornamental trees and shrubs, or turf; and on the physiology, production, environmental impact of cropping systems, and use of horticultural crops. Research areas include the effect of horticultural commodities on human health, hormonal, and stress physiology; flower development and flowering physiology; integrated pest management; post harvest physiology; and cropping system strategies. Students get a broad range of experiences in the field, greenhouse, and/or laboratory using genetic, molecular, biochemical, and ecological tools to answer research questions.

Specialization courses:
Area 1 - Cross Commodity Horticulture
HORT 4071W - Applications of Biotechnology to Plant Improvement (4 cr)
AGRO 4505 - Integrated Weed Management (4 cr)
HORT 4461 - Horticultural Marketing
HORT 5007 - Advanced Plant Propagation (3 cr), Spring (even yrs)
AGRO 5021 - Introduction to Plant Breeding (3 cr)
HORT 5023 - Public Garden Management (2 cr)
STAT 5302 - Applied Regression Analysis (4 cr)
AGRO 5321 - Ecology of Agricultural Systems (3 cr)
MKTG 6051 - Marketing Research (4 cr)
MKTG 6055 - Buyer Behavior (4 cr)
MBA 6210 - Marketing Management (3 cr)
SAGR 8010 - Colloquium in Sustainable Agriculture (2 cr)
HORT 8023 - Evolution of Crop Plants (3 cr)
HORT 8044 - Manipulation of Plant Growth and Reproduction (2 cr), Spring (even yrs)
AGRO 8305 - Physiological Ecology of Plants in Natural and Managed Ecosystems (4 cr)
AGRO 8605 - Advanced Management of Agroecosystems (3 cr)

Area 2 - Commodity-based Horticulture
HORT 4061 - Turfgrass Management (4 cr)
HORT 4062 - Turfgrass Weed and Disease Science (3 cr), Fall (odd yrs)
HORT 4063 - Turfgrass Science (3 cr)
HORT 4141W - Plant Production I (4 cr)
HORT 5031 - Organic Viticulture and Fruit Production (3 cr), Fall (odd yrs)
HORT 5032 - Organic Vegetable Production (3 cr) Spring (odd yrs)
HORT 5051 - Plant Production II (4 cr)
HORT 5071 - Restoration and Reclamation Ecology (3 cr)

Required courses
AGRO 5311 - Research Methods in Crop Improvement and Production (1.0 cr)
APSC 8123 - Research Ethics in the Plant and Environmental Sciences (0.5 cr)
GRAD 8101 - Teaching in Higher Education (3.0 cr)
HORT 8270 - Graduate Seminar (1.0 cr)
SAGR 8010 - Colloquium in Sustainable Agriculture (2.0 cr)
STAT 5021 - Statistical Analysis (4.0 cr)

Plant Breeding and Plant Molecular Genetics
This track allows students to select from genetic research projects ranging from applied plant breeding projects emphasizing breeding procedures and methodologies to molecular genetic projects doing biotechnology, genetic engineering, and genomic research in agronomic and horticultural crops. These research projects give students the opportunity to integrate the latest developments in the laboratory with applied applications in the field to reach the overarching goal of developing new germplasm that will improve the sustainability of our food/feed/fiber/fuel systems.

Molecular Genetics Area (3 cr)
Genetics Area (3 cr)
Plant Breeding Area (3 cr)
Additional courses determined by student/advisory committee (12 credits) from these suggested areas and course:

Genetics area:
EEB 5042 - Quantitative Genetics (3 cr), Fall
GCD 8131 - Advanced Genetics and Genomics (3 cr), Spring
Molecular Genetics area:
GCD 4034 - Molecular Genetics, (3 cr), Spring
AGRO 8241 - Chromosomal and Molecular Genetics of Plant Improvement (3 cr), Spring (odd years)

Plant Breeding area:
AGRO/HORT 8201 - Advanced Plant Breeding (3 cr), Fall (odd years)
AGRO 8202 - Breeding for Quantitative Traits in Plants (3 cr), Spring (even years)

Required courses
AGRO 5311 - Research Methods in Crop Improvement and Production (1.0 cr)
AGRO 8270 - Graduate Seminar (1.0 cr)
APSC 8123 - Research Ethics in the Plant and Environmental Sciences (0.5 cr)
GRAD 8101 - Teaching in Higher Education (3.0 cr)
SAGR 8010 - Colloquium in Sustainable Agriculture (2.0 cr)
STAT 5021 - Statistical Analysis (4.0 cr)
Twin Cities Campus

Bioproducts and Biosystems Science, Eng and Mgmt M.S.

Bioproducts and Biosystems Engineering

College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Bioproducts and Biosystems Engineering, Biosystems and Agricultural Engineering Building, 1390 Eckles Avenue, St. Paul, MN 55108 (612-625-7733; fax: 612-624-3005)
Email: bbe@umn.edu
Website: http://www.bbe.umn.edu

- Program Type: Master's
- Requirements for this program are current for Fall 2014
- 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.

The master of science degree in the bioproducts and biosystems science engineering and management (BBSEM) graduate program provides a strong foundation in the basic sciences, engineering, and management in support of the renewable bio-resources utilization, environmental quality, and national security while improving our global competitiveness. The areas of specialization include bioproducts science and engineering, biosystems science and engineering, and bioproducts marketing and management.

Bioproducts science and engineering specialization focuses on the fundamental science and engineering of the various manufacturing processes used in sustainable conversion of biomass into bio-based industrial and consumer products and their effective end-use applications. Bioproducts include "green" materials, chemicals and energy derived from bio-resources including biofuels, bioenergy, biocomposites, bio-based plastics, adhesives, pulp and paper, building materials, and more.

Biosystems science and engineering specialization is designed for students who seek to develop a strong foundation in physical sciences and engineering principles which are applied to important problems involving biological systems. Potential areas of interest include water and soil management and protection; livestock environment; food engineering and value-added processing; machinery systems design; grain quality; safety, health, and risk management; renewable energy systems; and waste management.

Bioproducts marketing and management specialization is designed for graduate students who seek to build on a strong diverse background encompassing liberal arts, basic sciences, communications and product development, and marketing and management of bioproducts.

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 seeking a master's degree should have a bachelor's degree in engineering, mathematics, the physical or biological sciences, or a related field from a recognized U.S or international university. Applicants should have a performance level on previous academic work required for a degree of at least a 3.0 GPA (on a 4.0 grading scale).

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, 6 credits outside the major, and 10 thesis credits. The final exam is oral.

Plan B: Plan B requires 20 major credits and 10 credits outside the major. The final exam is oral. A capstone project is required.

Capstone Project: Students complete a smaller project or projects that involve a total of about 120 hours of work, and write a Plan B paper on their project.

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.

All master's level students must take BBE 8001 - Seminar I (1 cr) and BBE 8002 - Seminar II (1 cr). All master's level students must take BBE 8013 - Parameter Estimation (3 cr) unless they can demonstrate to the BBE 8013 instructor that they have already mastered the course material or have justified the selection of a suitable alternative.

Degree programs are expected to include mostly 5xxx and 8xxx courses. The graduate degree program may contain no more than 9 credits of 4xxx level coursework. If a master's degree program includes more than 4 credits of special problems or advanced problems courses, students and their advisers are asked to include a letter of explanation when the degree program is submitted for approval.
Bioproducts and Biosystems Science, Engineering and Management Minor

Bioproducts and Biosystems Engineering

College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Bioproducts and Biosystems Engineering, Biosystems and Agricultural Engineering Building, 1390 Eckles Avenue, St. Paul, MN 55108 (612-625-7733; fax: 612-624-3005)
Email: bbe@umn.edu
Website: http://www.bbe.umn.edu

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2014
- 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 bioproducts and biosystems science engineering and management (BBSEM) graduate program provides a strong foundation in the basic sciences, engineering, and management in support of the renewable bio-resources utilization, environmental quality, and national security while improving our global competitiveness. The areas of specialization include bioproducts science and engineering, biosystems science and engineering, and bioproducts marketing and management.

Bioproducts science and engineering specialization focuses on the fundamental science and engineering of the various manufacturing processes used in the sustainable conversion of biomass into bio-based industrial and consumer products and their effective end-use applications. Bioproducts include "green" materials, chemicals and energy derived from bio-resources including biofuels, bioenergy, biocomposites, bio-based plastics, adhesives, pulp and paper, building materials, and more. Biosystems science and engineering specialization is designed for students who seek to develop a strong foundation in physical sciences and engineering principles which are applied to important problems involving biological systems. Potential areas of interest include water and soil management and protection; livestock environment; food engineering and value-added processing; machinery systems design; grain quality; safety, health, and risk management; renewable energy systems; and waste management. Bioproducts marketing and management specialization is designed for graduate students who seek to build on a strong diverse background encompassing liberal arts, basic sciences, communications and product development, and marketing and management of bioproducts.

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 student must be in good standing in their degree program to apply for this minor.

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.

For master's students, a minor consists of at least 6 credits of BBE courses numbered 4xxx or higher. For doctoral students, a minor consists of at least 12 credits of BBE courses numbered 4xxx or higher.
Twin Cities Campus
Bioproducts and Biosystems Science, Engineering and Management Ph.D.
Bioproducts and Biosystems Engineering
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Bioproducts and Biosystems Engineering, Biosystems and Agricultural Engineering Building, 1390 Eckles Avenue, St. Paul, MN 55108 (612-625-7733; fax: 612-624-3005)
Email: bbe@umn.edu
Website: http://www.bbe.umn.edu

- Program Type: Doctorate
- Requirements for this program are current for Fall 2014
- Length of program in credits: 69
- 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 Ph.D. degree offered by the bioproducts and biosystems science engineering and management (BBSEM) graduate program provides a strong foundation in the basic sciences, engineering, and management in support of the renewable bio-resources utilization, environmental quality, and national security while improving our global competitiveness. The areas of specialization include bioproducts science and engineering, biosystems science and engineering, and bioproducts marketing and management.

Bioproducts science and engineering specialization focuses on the fundamental science and engineering of the various manufacturing processes used in the sustainable conversion of biomass into bio-based industrial and consumer products and their effective end-use applications. Bioproducts include "green" materials, chemicals and energy derived from bio-resources including biofuels, bioenergy, biocomposites, bio-based plastics, adhesives, pulp and paper, building materials, and more.

Biosystems science and engineering specialization is designed for students who seek to develop a strong foundation in physical sciences and engineering principles which are applied to important problems involving biological systems. Potential areas of interest include water and soil management and protection; livestock environment; food engineering and value-added processing; machinery systems design; grain quality; safety, health, and risk management; renewable energy systems; and waste management.

Bioproducts marketing and management specialization is designed for graduate students who seek to build on a strong diverse background encompassing liberal arts, basic sciences, communications and product development, and marketing and management of bioproducts.

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 3.20.

Students seeking the Ph.D. should have a bachelor's degree in engineering, mathematics, the physical or biological sciences, or a related field from a recognized U.S. or international university.

Students seeking the Ph.D. should have a master's degree in engineering, mathematics, the physical or biological sciences, or a related field from a recognized U.S. or international university.

Special Application Requirements:
Students seeking the Ph.D. should also have a master's degree in engineering, mathematics, the physical or biological sciences, or a related field from a recognized U.S. or international university. Applicants should have a performance level on previous academic work required for a degree of at least a 3.2 GPA (on a 4.0 grading scale). Students expecting to pursue a Ph.D. normally complete a master of science Plan A degree before starting their Ph.D. programs. Exceptional students who want to go straight to the Ph.D. from the bachelor's level may be admitted subject to conditions agreed upon by the adviser, the director of graduate studies, and the graduate program coordinator.
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

33 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 3 semesters must be completed before filing a Degree Program Form.

All Ph.D. degree programs must include BBE 8001 - Seminar I (1 cr), BBE 8002 - Seminar II (1 cr). Any of these courses taken at the master's level count toward the Ph.D. and do not have to be retaken.

The Ph.D. in bioproducts and biosystems science engineering and management requires extended study and intense intellectual effort conducting cutting-edge research and advancing the forefront of knowledge in the subject matter area. Students develop skills that enable them to define problems or research questions, plan research, conduct independent research and/or lead research efforts, analyze data, and effectively communicate research results to a variety of audiences. All Ph.D. degree programs must include a minimum of 45 graduate course credits beyond the B.S. degree and a minimum of 24 doctoral thesis credits (BBE 8888). A minimum of 12 course credits must be in a minor field or in a supporting program. Ph.D. degree programs should contain a minimum of 9 course credits in a concentrated area of scientific or mathematical theoretical development that is related to the student’s research, and may contain up to 3 credits of enrichment courses.
Twin Cities Campus
Conservation Biology M.S.
Fisheries, Wildlife, and Conservation Biology
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Fisheries, Wildlife, and Conservation Biology, 135 B Skok Hall, 2003 Upper Buford Circle, St. Paul, MN 55108 (612-624-7751)
Email: consbio@umn.edu
Website: http://www.consbio.umn.edu

- Program Type: Master's
- Requirements for this program are current for Fall 2014
- 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.

The Conservation Biology (CB) Program has two complementary objectives leading to a unique multidisciplinary program. The first is to provide students with sound graduate training in the biological sciences relevant to the global conservation of plants, animals, and ecosystems. The second objective promotes the study of social, political, and economic sciences that relate to recognition and solution of conservation problems. Students may select a named track, fisheries and aquatic biology, which offers an aquatic specialization. Students may also pursue a joint degree in law and conservation biology through the joint law degree program. The overall goal of the program is to prepare students to develop solutions or approaches to address problems that are scientifically and environmentally sound and likely to be acted upon or implemented within their social and political context.

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 B.S./B.A. degree in biology or a closely related field is preferred. Applicants with a baccalaureate degree in another field are accepted, but may be required to take selected courses in biology.

Special Application Requirements:
A statement of career goals and three letters of recommendation evaluating the applicant's potential for graduate study are required. Scores less than five years old from the General Test of the GRE are required. TOEFL is required for applicants who speak English as a second language. Applicants to the joint law degree program must also apply to the Law School. Application deadline is December 15. Typically, students only are admitted for fall semester.

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).
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. A capstone project is required.

**Capstone Project:** Plan B master's students must demonstrate familiarity with the tools of research or scholarship in their major field, the ability to work independently, and the ability to present the results of their investigation effectively, by completing at least one Plan B project. The Plan B project should involve a combined total of approximately 120 hours (the equivalent of three full-time weeks) of work. The advisory committee specifies both the nature and extent of the options available to satisfy this requirement, subject to approval by the DGS. The Plan B project must be satisfied independent of the courses in the student's program.

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.

Students must complete a minimum of 30 credits in the biological and social aspects of conservation biology. For Plan A students, 10 of these credits are thesis credits; for Plan B students, 10 of these credits are for electives.

**Joint- or Dual-degree Coursework:** Joint Degree in Conservation Biology and Law
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.

**Fisheries and Aquatic Biology**

Three-quarters of the global ecosystem is water and most is a global commons. Many biologists and economists argue that freshwater is one of the most critical global resources and that the functional integrity and biodiversity within freshwater and marine ecosystems are highly threatened. The Fisheries and Aquatic Biology (FAB) track is available for M.S., Ph.D., and joint degree students wishing to emphasize this concentration within a CB major. The track name can be indicated on the student's transcript (this is optional) and may be useful to the graduate for obtaining jobs with many federal and state agencies where such expertise is specified in job announcements or hiring criteria. The track designation clearly indicates that the student has specialized coursework and research or project experience leading to expertise in fisheries or aquatic biology. Combined with a typical undergraduate degree in biology or natural resource science, careful selection of courses in the graduate program will satisfy the educational requirements for professional certification by the American Fisheries Society.

Students in the track must be advised or co-advised by a faculty member affiliated with the track. Requests for admission to the track may be made during the application process or at any time after the student is admitted to the CB graduate program. Students in the track must meet all requirements for the M.S. in CB.

Students who designate this track will be expected to work closely with their Student Advisory Committee (SAC) to develop an appropriate course of study. The track coordinator will review each student's academic program to examine how track expectations are met and forward it with a recommendation to the DGS for approval.

In addition to course requirements for the conservation biology major, students in the FAB track will take at least two 3 cr courses from the following list:

- EEB 5601 - Limnology (3 cr)
- ENT 5361 - Aquatic Insects (3 cr)
- FW 4136 - Ichthyology (4 cr)
- FW 4401 - Fish Physiology and Behavior (4 cr)
- FW 5003 - Human Dimensions of Biological Conservation (3 cr)
- FW 5601 - Fisheries Population Analysis (3 cr)
- OR FW 5051 Analysis of Populations - (4 cr)
- FW 5604 - Fisheries Ecology and Management (3 cr)
- FW 8448 - Fishery Science (3 cr)
- FW 8459 - Stream and River Ecology (3 cr)
FW 8465 - Fish Habitats and Restoration (3 cr)
ESPM 5061 - Water Quality and Natural Resource (3 cr)
ESPM 5575 - Wetlands Conservation (3 cr)
EPSM 5111 Hydrology and Water Quality Field Methods (3 cr)
EEB 5605 Limnology Laboratory (2 cr)
EEB 8601 Introduction to Stream Restoration (3 cr)
EEB 8602 Stream Restoration Practice (2 cr)
FR 5114 Hydrology and Watershed Management (3 cr)
FR 5153 Forest and Wetland Hydrology (3 cr)

Other advanced courses or colloquia on fisheries or aquatic biology that are not listed here may also satisfy needs of students in the track. In addition, master's students are required to enroll for at least one semester of FW 8200 - Seminar for 1 credit.
**Twin Cities Campus**

**Conservation Biology Minor**

*Fisheries, Wildlife, and Conservation Biology*

*College of Food, Agricultural and Natural Resource Sciences*

Link to a [list of faculty](#) for this program.

**Contact Information:**
Department of Fisheries, Wildlife, and Conservation Biology, 135 B Skok Hall, 2003 Upper Buford Circle, St. Paul, MN 55108 (612-624-7751)
Email: consbio@umn.edu
Website: [http://www.consbio.umn.edu](http://www.consbio.umn.edu)

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2014
- Length of program in credits (Masters): 7
- 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 Conservation Biology (CB) Program has two complementary objectives leading to a unique multidisciplinary program. The first is to provide students with sound graduate training in the biological sciences relevant to the global conservation of plants, animals, and ecosystems. The second objective promotes the study of social, political, and economic sciences that relate to recognition and solution of conservation problems. Students may select a named track, fisheries and aquatic biology, which offers an aquatic specialization. Students may also pursue a joint degree in law and conservation biology through the joint law degree program. The overall goal of the program is to prepare students to develop solutions or approaches to address problems that are scientifically and environmentally sound and likely to be acted upon or implemented within their social and political context.

**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.

A master's minor may be earned by completing the two required courses for a major, plus participating in one semester of the conservation biology seminar. A doctoral minor may be earned by completing the two required courses for a major, participating in one semester of the conservation biology seminar, and completing 6 elective credits. Electives are determined in consultation with the director of graduate studies and the student's advisory committee.
Twin Cities Campus

Conservation Biology Ph.D.
Fisheries, Wildlife, and Conservation Biology
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Fisheries, Wildlife, and Conservation Biology, 135 B Skok Hall, 2003 Upper Buford Circle, St. Paul, MN 55108 (612-624-7751)
Email: consbio@umn.edu
Website: http://www.consbio.umn.edu

- Program Type: Doctorate
- Requirements for this program are current for Fall 2014
- 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.

The Conservation Biology (CB) Program has two complementary objectives leading to a unique multidisciplinary program. The first is to provide students with sound graduate training in the biological sciences relevant to the global conservation of plants, animals, and ecosystems. The second objective promotes the study of social, political, and economic sciences that relate to recognition and solution of conservation problems. Students may select a named track, fisheries and aquatic biology, which offers an aquatic specialization. Students may also pursue a joint degree in law and conservation biology through the joint law degree program. The overall goal of the program is to prepare students to develop solutions or approaches to address problems that are scientifically and environmentally sound and likely to be acted upon or implemented within their social and political context.

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.

Other requirements to be completed before admission:
A B.S./B.A. degree in biology or a closely related field is preferred. Applicants with a baccalaureate degree in another field are accepted, but these individuals may be required to take selected courses in biology. In general, Ph.D. applicants holding a baccalaureate degree are first expected to complete a master's degree.

Special Application Requirements:
A statement of career goals and three letters of recommendation evaluating the applicant's potential for graduate study are required. Letters of recommendation should be sent directly to the Conservation Biology Program Office. Scores less than five years old from the General Test of the GRE are required. TOEFL is required for applicants who speak English as a second language. Applicants to the joint law degree program must also apply to the Law School. Application deadline is January 1. Typically, students are admitted only for fall semester.

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
Program Requirements
12 credits are required in the major.
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.

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.

Ph.D. students complete 48 credits, 24 credits in courses and 24 thesis credits. Students are expected to show competency in both the biological and social sciences. With their advisory committee, students develop a program that emphasizes the ecological and social aspects of conservation biology. Dissertation research may require proficiency in supporting areas (e.g., statistics, computing, communications).

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

Fisheries and Aquatic Biology
Three-quarters of the global ecosystem is water and most is a global commons. Many biologists and economists argue that freshwater is one of the most critical global resources and that the functional integrity and biodiversity within freshwater and marine ecosystems are highly threatened. The Fisheries and Aquatic Biology (FAB) track is available for M.S., Ph.D., and joint degree students wishing to emphasize this concentration within a CB major. The track name can be indicated on the student's transcript (this is optional) and may be useful to the graduate for obtaining jobs with many federal and state agencies where such expertise is specified in job announcements or hiring criteria. The track designation clearly indicates that the student has specialized coursework and research or project experience leading to expertise in fisheries or aquatic biology. Combined with a typical undergraduate degree in biology or natural resource science, careful selection of courses in the graduate program will satisfy the educational requirements for professional certification by the American Fisheries Society.

Students in the track must be advised or co-advised by a faculty member affiliated with the track. Request for admission to the track may be made during the application process or any time after the student is admitted to the CB graduate program. Students in the track must meet all requirements for the Ph.D. in CB.

Students who designate this track will be expected to work closely with their Student Advisory Committee (SAC) to develop an appropriate course of study. The track coordinator will review each student's academic program to examine how track expectations are met and forward it with a recommendation to the DGS for approval.

In addition to course requirements for the conservation biology major, students in the FAB track must take at least three courses from the following list:
EEB 5601 - Limnology (3 cr)
ENT 5361 - Aquatic Insects (3 cr)
FW 4136 - Ichthyology (4 cr)
FW 4401 - Fish Physiology and Behavior (4 cr)
FW 5003 - Human Dimensions of Biological Conservation (3 cr)
FW 5601 - Fisheries Population Analysis (3 cr)
OR FW 5051 Analysis of Populations - (4 cr)
FW 5604 - Fisheries Ecology and Management (3 cr)
FW 8448 - Fishery Science (3 cr)
FW 8459 - Stream and River Ecology (3 cr)
FW 8465 - Fish Habitats and Restoration (3 cr)
ESPM 5061 - Water Quality and Natural Resource (3 cr)
ESPM 5575 - Wetlands Conservation (3 cr)
EPSPM 5111 Hydrology and Water Quality Field Methods (3 cr)
EEB 5605 Limnology Laboratory (2 cr)
EEB 8601 Introduction to Stream Restoration (3 cr)
EEB 8602 Stream Restoration Practice (2 cr)
FR 5114 Hydrology and Watershed Management (3 cr)
FR 5153 Forest and Wetland Hydrology (3 cr)

Other advanced courses or colloquia on fisheries or aquatic biology that are not listed here may also satisfy needs of students in the track. In addition, doctoral students are required to enroll for at least two semesters of FW 8200 - Seminar for 1 credit per semester.
Twin Cities Campus
Entomology M.S.
Entomology
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Entomology, 1980 Folwell Avenue, 219 Hodson Hall, St. Paul, MN 55108 (612-624-3636; fax: 612-625-5299)
Email: entodept@umn.edu
Website: http://www.entomology.umn.edu

- Program Type: Master's
- Requirements for this program are current for Fall 2014
- 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.

Entomology centers on the study of insects and includes specializations in ecology, behavior, molecular biology, microbiology, neurobiology, physiology, population dynamics, systematics, and taxonomy. Specialized or applied areas include apiculture, biological control, cell culture, insect conservation, insect-vector relations, integrated pest management, and modeling. Research programs are active in aquatic systems, forest systems, crop and animal agriculture, human health, and natural and urban environments.

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:
A bachelor's degree with a major in a biological science is a prerequisite. Preference is given to students with a broad background in the basic sciences. Admission depends primarily on applicant's undergraduate record, letters of recommendation, and the statement of interest from the applicant.

Special Application Requirements:
Applicants must submit a complete set of official transcripts and a clearly written statement of career interests, goals, and objectives. Three letters of recommendation are required from persons well acquainted with the student's academic record, and should be either uploaded or sent directly to the department.

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

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

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 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 24 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 3.00 is required for students to remain in good standing.

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

Students must present one graduate seminar (ENT 8300) and must take Scientific Communication and Ethics (ENT 8061). Students must also pass two written examination questions. The core curriculum courses are: ENT 5021 - Insect Taxonomy and Phylogeny, ENT 5011 - Insect Structure and Function, and either ENT 5042 - Insect Ecology or ENT 5045 - Insect Population Dynamics.

Plan B students must take 6 credits of ENT 5910 - Special Problems in Entomology as part of the 20 credits of required entomology courses. For both plans: All courses are flexible and are determined in consultation with the adviser and other members of the student's advisory committee. Plan A is recommended for students contemplating a career in entomological research.

Requirements for the M.S., supplemental to general Graduate Education requirements, include a minimum of 14 course credits in entomology including a core curriculum of fundamental entomology courses and 1 credit of graduate seminar. Additional requirements include 6 credits from other programs to make a total of at least 20 course credits for Plan A or at least 30 course credits for Plan B students (must take 6 credits of ENT 5910). These courses are flexible and are determined in consultation with the adviser and other members of the student's advisory committee. Plan A is recommended for students contemplating a career in entomological research.

Course Group 0
All students must take: Seminar (ENT 8300, 1 cr.)
Twin Cities Campus
Entomology Minor
Entomology
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Entomology, 1980 Folwell Ave, 219 Hodson Hall, St. Paul, MN 55108 (612-624-3636; fax: 612-625-5299)
Email: entodept@umn.edu
Website: http://www.entomology.umn.edu

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2014
- 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.

Entomology centers on the study of insects and includes specializations in ecology, behavior, molecular biology, microbiology, neurobiology, physiology, population dynamics, systematics, and taxonomy. Specialized or applied areas include apiculture, biological control, cell culture, insect conservation, insect-vector relations, integrated pest management, and modeling. Research programs are active in aquatic systems, forest systems, crop and animal agriculture, human health, and natural and urban environments.

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.

The master's minor requires a minimum of 6 credits in 4xxx, 5xxx, or 8xxx entomology courses. The doctoral minor requires a minimum of 12 credits in 4xxx, 5xxx, or 8xxx entomology courses.
Twin Cities Campus

Entomology Ph.D.

Entomology
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Entomology, 1980 Folwell Avenue, 219 Hodson Hall, St. Paul, MN 55108 (612-624-3636; fax: 612-625-5299)
Email: entodept@umn.edu
Website: http://www.entomology.umn.edu

- Program Type: Doctorate
- Requirements for this program are current for Fall 2014
- Length of program in credits: 51
- 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.

Entomology centers on the study of insects and includes specializations in ecology, behavior, molecular biology, microbiology, neurobiology, physiology, population dynamics, systematics, and taxonomy. Specialized or applied areas include apiculture, biological control, cell culture, insect conservation, insect-vector relations, integrated pest management, and modeling. Research programs are active in aquatic systems, forest systems, crop and animal agriculture, human health, and natural and urban environments.

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 3.50 GPA (on a 4.00 scale) for prior graduate work is preferred for admission.

Other requirements to be completed before admission:
A bachelor's degree with a major in a biological science is a prerequisite. Preference is given to students with a broad background in the basic sciences. Admission depends primarily on applicant's undergraduate record, letters of recommendation, and the statement of interest from the applicant.

Special Application Requirements:
Applicants must submit a complete set of official transcripts and a clearly written statement of career interests, goals, and objectives.
Three letters of recommendation are required from persons well acquainted with the student's academic record, and should be either uploaded or sent directly to the department.

Applicants must submit their test score(s) from the following:
- GRE
- TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based – Reading Score: 19
  - Paper Based - Total Score: 550

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

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
15 credits are required in the major.
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.

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

At least 3 semesters must be completed before filing a Degree Program Form.

Students must present two graduate seminars (ENT 8300) and must take Scientific Communication and Ethics (ENT 8061). Students also must pass three written examination questions (or a total of four if the student has received an M.S. degree in entomology from the U of MN). The core curriculum courses are: ENT 5021 - Insect Taxonomy and Phylogeny, ENT 5011 - Insect Structure and Function, and either ENT 5042 - Insect Ecology or ENT 5045 - Insect Population Dynamics.

Ph.D. requirements include a minimum of 15 course credits in entomology, including a core curriculum of fundamental entomology courses and 2 credits of graduate seminar. Additional requirements include 12 credits from other programs, and are determined in consultation with the adviser and other members of the student's advisory committee.
Twin Cities Campus
Food Science M.S.
Food Science & Nutrition
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Food Science and Nutrition, 225 Food Science and Nutrition Building, 1334 Eckles Avenue, Saint Paul, MN 55108 (612-624-6753; fax: 612-625-5272)
Email: fsgrad@umn.edu
Website: http://fscn.cfans.umn.edu/graduate_programs/foodsciencegraduate/index.htm

- Program Type: Master's
- Requirements for this program are current for Fall 2014
- 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.

Food science applies scientific principles to the manufacture, distribution, marketing, and consumer aspects of food. Food scientists apply the basic principles and techniques of many disciplines, including chemistry, physics, microbiology, and nutrition, to food processing and preservation, new product development, and food marketing. Food scientists are concerned with the theoretical and practical aspects of the food chain, from the production of raw materials to the use of food products by consumers. Students may emphasize the chemistry, engineering, microbiology, nutrition, or technology of food products.

Students may spend a maximum of five (5) years in this degree program.

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.

Applicants to the program need a bachelor's degree, or its international equivalent, in any field.

Other requirements to be completed before admission:
The minimum requirements are general chemistry with laboratory, organic chemistry with laboratory, physics with laboratory, biology with laboratory, and calculus. If preparation appears inadequate, certain additional courses may be required after admission.

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.

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Information current as of September 19, 2014
Program Requirements

Plan A: Plan A requires 20 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 equivalent to 120 hours of work or three full weeks of research and writing. It should consist of one of the following options, which are intended to familiarize the candidate with the tools of research or scholarship in the field and serve to demonstrate the ability to work independently: 1) The candidate may prepare one paper equivalent to 120 hours of work in one advanced course, over and above the normal course requirement as approved by the instructor in consultation with the adviser. This course must be from the major field of interest. 2) The candidate may prepare one paper equivalent to the requirement of 120 hours in some related field or course as approved in consultation with the instructor and the adviser. 3) The student may do an equivalent amount of library or laboratory research and write a research report to satisfy the requirement as approved by the adviser. This may take the form of a research proposal.

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. offers both Plan A (with thesis) and Plan B (without thesis) options. Both options require at least 20 course credits in the major. Plan A also requires at least 10 thesis credits. Plan B also requires at least an additional 10 graduate credits in approved courses and a Plan B paper. The minor may be chosen from fields such as biochemistry, chemistry, chemical engineering, microbiology, nutrition, and statistics. All students also are expected to participate as teaching assistants during their graduate careers.
Twin Cities Campus

Food Science Minor

Food Science & Nutrition

College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Food Science and Nutrition, 225 Food Science and Nutrition Building, 1334 Eckles Avenue, Saint Paul, MN 55108 (612-624-6753; fax: 612-625-5272)
Email: fsgrad@umn.edu
Website: http://fscn.cfans.umn.edu/education/foodsciencegraduate/index.htm

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2014
- Length of program in credits (Masters): 10
- 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.

Food science applies scientific principles to the manufacture, distribution, marketing, and consumer aspects of food. Food scientists apply the basic principles and techniques of many disciplines, including chemistry, physics, microbiology, and nutrition, to food processing and preservation, new product development, and food marketing. Food scientists are concerned with the theoretical and practical aspects of the food chain, from the production of raw materials to the use of food products by consumers. Students may emphasize the chemistry, engineering, microbiology, nutrition, or technology of food products.

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.

For a master's minor, the following courses must be taken: FSCN 4111 and 4121, and BAE 4744. The minor must be approved by the food science director of graduate studies.

For a Ph.D. minor, students must take FSCN 4111 and 4121, BAE 4744, and one additional food science graduate-level course totaling 12 credits. The minor must be approved by the Food Science Director of Graduate Studies.
Twin Cities Campus
Food Science Ph.D.
Food Science & Nutrition
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Food Science and Nutrition, 225 Food Science and Nutrition Building, 1334 Eckles Avenue, Saint Paul, MN 55108 (612-624-6753; fax: 612-625-5272)
Email: fsgrad@umn.edu
Website: http://fscn.cfans.umn.edu/graduate_programs/foodsciencegraduate/index.htm

- Program Type: Doctorate
- Requirements for this program are current for Fall 2014
- Length of program in credits: 60
- 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.

Food science applies scientific principles to the manufacture, distribution, marketing, and consumer aspects of food. Food scientists apply the basic principles and techniques of many disciplines, including chemistry, physics, microbiology, and nutrition, to food processing and preservation, new product development, and food marketing. Food scientists are concerned with the theoretical and practical aspects of the food chain, from the production of raw materials to the use of food products by consumers. Students may emphasize the chemistry, engineering, microbiology, nutrition, or technology of food products.

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.

Applicants to the program need a bachelor's degree in any field or its international equivalent along with demonstrated research ability such as a MS degree or publications.

Other requirements to be completed before admission:
The minimum requirements are general chemistry with laboratory, organic chemistry with laboratory, physics with laboratory, biology with laboratory, and calculus. If preparation appears inadequate, certain additional courses may be required after admission. Graduate Record Examination (GRE) General Test scores, and the TOEFL (for international students) are also required.

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
24 credits are required in the major.
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.

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.

The number of credits required varies depending on preparation (such a M.S. in food science) and the research undertaken. Of these, at least 12 credits must be in the minor or related fields and 24 credits must be doctoral thesis credits. The student and the adviser, with the approval of the graduate studies committee, determine coursework in the major. All students also must participate as teaching assistants during their graduate career.
Land and Atmospheric Science M.S.

College of Food, Agricultural and Natural Resource Sciences

Twin Cities Campus

Land and Atmospheric Science M.S.

Soil, Water, & Climate

Contact Information:
Email: laas@umn.edu
Website: http://www.laas.umn.edu

- Program Type: Master's
- Requirements for this program are current for Fall 2014
- 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.

Land and Atmospheric Science (LAAS) is a science-based interdisciplinary program focused on the fundamentals of Earth system processes related to land and atmosphere and their coupled interactions. Students have the option to develop a program based on one of the more traditional areas in atmospheric science or soil science or to design their own interdisciplinary course of study bridging the two disciplines. The Land and Atmospheric Science Graduate Program has no formal tracks or emphasis areas, but instead allows students to design a curriculum that addresses their interests within the scope of the program. This multidisciplinary program encompasses aspects of chemistry, physics, biology, atmospheric sciences, and geology.

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 3.20.

B.S. degree in a related field of science, or a graduate or professional degree.

Required prerequisites

Basic Sciences
Students are expected to have taken a minimum of four of the following courses (or their equivalent).
- MATH 1271 - Calculus I [MATH] (4.0 cr)
- or MATH 1142 - Short Calculus [MATH] (4.0 cr)
- or MATH 2243 - Linear Algebra and Differential Equations (4.0 cr)
- PHYS 1101W - Introductory College Physics I [PHYS, WI] (4.0 cr)
- PHYS 1102W - Introductory College Physics II [PHYS, WI] (4.0 cr)
- or ESPM 3131 - Environmental Physics (3.0 cr)
- or CHEM 1061 - Chemical Principles I [PHYS] (3.0 cr)
- or CHEM 1065 - Chemical Principles I Laboratory [PHYS] (1.0 cr)
- or CHEM 1062 - Chemical Principles II [PHYS] (3.0 cr)
- or CHEM 1066 - Chemical Principles II Laboratory [PHYS] (1.0 cr)
- or STAT 3011 - Introduction to Statistical Analysis [MATH] (4.0 cr)

Environmental Sciences
Students are expected to have taken a minimum of two of the following (or similar) courses:
Take 2 - 6 course(s) from the following:
- ESPM 1011 - Issues in the Environment [ENV] (3.0 cr)
- ESPM 1425 - The Atmosphere [PHYS, ENV] (4.0 cr)
- SOIL 2125 - Basic Soil Science [PHYS, ENV] (4.0 cr)
- ESCI 1001 - Earth and Its Environments [PHYS, ENV] (4.0 cr)
ESPM 3612W - Soil and Environmental Biology [WI] (3.0 cr)
or MICB 3301 - Biology of Microorganisms (5.0 cr)
• BIOL 3407 - Ecology (3.0 cr)

Other requirements to be completed before admission:
Student course admission prerequisites are as shown below. Students who are admitted with deficiencies would be provided with a list of courses they are required to take before the completion of their degree. This list would be developed by the directors of graduate studies in consultation with the student's faculty adviser.

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 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 20 major credits and 10 credits outside the major. The final exam is oral. A capstone project is required.

Capstone Project: The Plan B project typically consists of a technical paper of a topic and length acceptable to the student's advisory committee.

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.

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

All M.S. students must complete a minimum of 30 credits: 14 credits in the major area (which includes one seminar - 1 cr, and teaching experience), and a minimum of 6 credits in a minor or related field.

Plan A students: all must take a minimum of 10 thesis credits. Plan A students in the soil science concentration must take three out of the four core courses in soil science. Plan A students in the climatology concentration must take two or more courses in climatology or atmospheric sciences (approved by the student's advisory committee) and two of the four core courses in soil science.

Plan B students: all must complete 20 major and 10 outside coursework credits. Students must complete a Plan B paper and fulfill the 30-credit minimum by taking 10 credits of coursework or a special project to replace the 10 thesis credits. Plan B students in the soil science concentration must take all four core courses in soil science. Plan B students in the climatology concentration must take three or more courses in climatology or atmospheric sciences (approved by the student's advisory committee) and two of the four core courses in soil science.

Core Courses
Take exactly 3 course(s) totaling exactly 5 credit(s) from the following:
• LAAS 5050 - Integrated Topics in Land & Atmospheric Science (3.0 cr)
• LAAS 8128 - Land and Atmospheric Science Seminar (1.5 cr)
• SOIL 8123 - Research Ethics in the Plant and Environmental Sciences (0.5 cr)
Major credits
Choose at least 9 additional credits within the LAAS major. (You will need 15 for Plan B).

Outside the major
Choose at least 6 credits from outside the major. These can be courses for a minor or from a related field. (You will need 10 credits for Plan B).

Thesis credits
Register for at least 10 credits of LAAS 8777 for Plan A.
Land and Atmospheric Science Minor

Soil, Water, & Climate

College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Soil, Water, and Climate, 439 Borlaug Hall, 1911 Upper Buford Circle, St. Paul, MN 55108 (612-625-5251; fax: 612-625-2208)
Email: laas@umn.edu
Website: http://www.laas.umn.edu

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2014
- Length of program in credits (Masters): 9
- 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.

Land and Atmospheric Science (LAAS) is a science-based interdisciplinary program focused on the fundamentals of Earth system processes related to land and atmosphere and their coupled interactions. Students have the option to develop a program based on one of the more traditional areas in atmospheric science or soil science or to design their own interdisciplinary course of study bridging the two disciplines. The Land and Atmospheric Science Graduate Program has no formal tracks or emphasis areas, but instead allows students to design a curriculum that addresses their interests within the scope of the program. This multidisciplinary program encompasses aspects of chemistry, physics, biology, atmospheric sciences, and geology.

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 3.20.

B.S. degree in a related science field.

Special Application Requirements:
All courses for use in the minor must be taken using the A-F grading system, unless approved by the Graduate Advisory Committee, or if they are offered on an S-N basis only. Courses for use in the minor must be selected with the consultation of the land and atmospheric science graduate faculty member serving as the minor adviser and approved by the director of graduate studies.

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 minor in LAAS for doctoral students requires a minimum of 12 graduate-level credits of regular coursework (not special problems) in land and atmospheric science. The minor in LAAS for master's students requires a minimum of 9 graduate-level credits in LAAS.

All students seeking a minor in LAAS must take LAAS 5050 - Integrated Topics in Land and Atmospheric Science (3 cr). The remaining 9 or 6 credits for the doctoral or master's minor, respectively, must come from other graduate-level LAAS courses.

Integrated Topics
All students are required to take the following course.
Take 1 or more course(s) totaling exactly 3 credit(s) from the following:
- LAAS 5050 - Integrated Topics in Land & Atmospheric Science (3.0 cr)

Other LAAS courses
Take 6 credits for M.S. minor or 9 credits for Ph.D. minor from the following options, or others approved by the DGS and the LAAS graduate faculty member serving as the minor adviser.
LAAS 5426 - Atmospheric Processes II: Radiation, Composition, and Climate (3.0 cr)
or LAAS 5515 - Soil Formation: Earth Surface Processes and Biogeochemistry (3.0 cr)
or LAAS 8128 - Land and Atmospheric Science Seminar (1.5 cr)
or LAAS 5051 - Thesis Proposal Writing for Land & Atmospheric Science (2.0 cr)
or LAAS 5425 - Atmospheric Processes I: Thermodynamics and Dynamics of the Atmosphere (3.0 cr)
Land and Atmospheric Science Ph.D.

Twin Cities Campus

Soil, Water, & Climate

College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Email: laas@umn.edu
Website: http://www.laas.umn.edu

- Program Type: Doctorate
- Requirements for this program are current for Fall 2014
- Length of program in credits: 62
- 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.

Land and Atmospheric Science (LAAS) is a science-based interdisciplinary program focused on the fundamentals of Earth system processes related to land and atmosphere and their coupled interactions. Students have the option to develop a program based on one of the more traditional areas in atmospheric science or soil science or to design their own interdisciplinary course of study bridging the two disciplines. The Land and Atmospheric Science Graduate Program has no formal tracks or emphasis areas, but instead allows students to design a curriculum that addresses their interests within the scope of the program. This multidisciplinary program encompasses aspects of chemistry, physics, biology, atmospheric sciences, and geology.

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 3.20.

Applicants to the LAAS Ph.D. program are expected to have an M.S. degree or equivalent in a related field of science.

Required prerequisites

Basic Sciences
Students are expected to have taken a minimum of four of the following courses (or their equivalent):
- MATH 1271 - Calculus I [MATH] (4.0 cr)
- or MATH 1142 - Short Calculus [MATH] (4.0 cr)
- or MATH 2243 - Linear Algebra and Differential Equations (4.0 cr)
- PHYS 1101W - Introductory College Physics I [PHYS, WI] (4.0 cr)
- PHYS 1102W - Introductory College Physics II [PHYS, WI] (4.0 cr)
- or ESPM 3131 - Environmental Physics (3.0 cr)
- or CHEM 1061 - Chemical Principles I [PHYS] (3.0 cr)
- CHEM 1065 - Chemical Principles I Laboratory [PHYS] (1.0 cr)
- CHEM 1062 - Chemical Principles II [PHYS] (3.0 cr)
- CHEM 1066 - Chemical Principles II Laboratory [PHYS] (1.0 cr)
- or STAT 3011 - Introduction to Statistical Analysis [MATH] (4.0 cr)

Environmental Sciences
Students are expected to have taken a minimum of two of the following (or similar) courses:
Take 2 - 6 course(s) from the following:
- ESPM 1011 - Issues in the Environment [ENV] (3.0 cr)
- ESPM 1425 - The Atmosphere [PHYS, ENV] (4.0 cr)
- SOIL 2125 - Basic Soil Science [PHYS, ENV] (4.0 cr)
- ESCI 1001 - Earth and Its Environments [PHYS, ENV] (4.0 cr)
ESPM 3612W - Soil and Environmental Biology [WI] (3.0 cr)
or MICB 3301 - Biology of Microorganisms (5.0 cr)

BIOL 3407 - Ecology (3.0 cr)

Other requirements to be completed before admission:
Students with a B.S. degree and outstanding scholarship can request direct admission to the LAAS Ph.D. program. Each request will be considered on a case-by-case basis by the Graduate Advisory Committee. Evidence of outstanding scholarship may include: peer-reviewed publications, a pre-doctoral fellowship, a National Science Foundation Ph.D. Fellowship, high GPA/GRE scores, or strong previous research experience. Current M.S. candidates who exhibit outstanding scholarship may request transfer to a Ph.D. degree program after completion of their first two semesters of coursework.

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
- 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
26 credits are required in the major.
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 towards program requirements is not permitted.

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.

Students must take two seminars (1 credit each), 2 credits of teaching experience, a minimum of 12 credits in a minor or supporting program, and 24 thesis credits. Students in the soil science concentration must take all four core area courses in soil science. Students in the climatology concentration must take a minimum of two courses in climatology or atmospheric sciences (approved by the student's advisory committee) and two of the four core area course in soil science.

Core Courses
Take exactly 5 course(s) totaling exactly 10 credit(s) from the following:
- LAAS 5050 - Integrated Topics in Land & Atmospheric Science (3.0 cr)
- LAAS 8128 - Land and Atmospheric Science Seminar (1.5 cr)
- SOIL 8123 - Research Ethics in the Plant and Environmental Sciences (0.5 cr)
- LAAS 5051 - Thesis Proposal Writing for Land & Atmospheric Science (2.0 cr)
- GRAD 8101 - Teaching in Higher Education (3.0 cr)

LAAS and Related Courses
Choose courses relevant to particular area of research with consent of adviser.
Take 4 or more course(s) totaling 16 or more credit(s) from the following:
- LAAS 5311 - Soil Chemistry and Mineralogy (3.0 cr)
- LAAS 5425 - Atmospheric Processes I: Thermodynamics and Dynamics of the Atmosphere (3.0 cr)
- AGRO 5121 - Applied Experimental Design (4.0 cr)
- AGRO 5321 - Ecology of Agricultural Systems (3.0 cr)
ar CE 4502 - Water and Wastewater Treatment (3.0 cr)
ar CE 4562 - Environmental Remediation Technology (3.0 cr)
ar CE 5180 - Special Topics (1.0 - 4.0 cr)
ar CE 5541 - Environmental Water Chemistry (3.0 cr)
ar CE 5542 - Experimental Methods in Environmental Engineering (3.0 cr)
ar CE 8503 - Environmental Mass Transport (4.0 cr)
ar CE 8506 - Stochastic Hydrology (4.0 cr)
ar CE 8521 - The Atmospheric Boundary Layer (4.0 cr)
ar CE 8542 - Chemistry of Organic Pollutants in Environmental Systems (3.0 cr)
ar CE 8561 - Analysis and Modeling of Aquatic Environments I (3.0 cr)
ar CE 8562 - Analysis and Modeling of Aquatic Environments II (3.0 cr)
ar EEB 4068 - Plant Physiological Ecology (3.0 cr)
ar EEB 4611 - Biogeochemical Processes (3.0 cr)
ar EEB 5053 - Ecology: Theory and Concepts (4.0 cr)
ar EEB 5146 - Science and Policy of Global Environmental Change (3.0 cr)
ar EEB 5601 - Limnology (3.0 cr)
ar EEB 5605 - Limnology Laboratory (2.0 cr)
ar ESCI 5205 - Fluid Mechanics in Earth and Environmental Sciences (3.0 cr)
ar ESPM 5061 - Water Quality and Natural Resources (3.0 cr)
ar ESPM 5111 - Hydrology and Water Quality Field Methods (3.0 cr)
ar ESPM 5402 - Biometeorology (3.0 cr)
ar ESPM 5601 - Principles of Waste Management (3.0 cr)
ar BBE 5608 - Environmental and Industrial Microbiol (3.0 cr)
ar FNRM 5262 - Remote Sensing of Natural Resources and Environment (3.0 cr)
ar FW 8459 - Stream and River Ecology (3.0 cr)
ar GEOG 5401 - Geography of Environmental Systems and Global Change (4.0 cr)
ar GEOG 5421 - Introduction to Atmospheric Science (3.0 cr)
ar GEOG 5423 - Climate Models and Modeling (3.0 cr)
ar GEOG 5426 - Climatic Variations (3.0 cr)
ar GEOG 8270 - Seminar: Climatology (3.0 cr)
ar LAAS 5426 - Atmospheric Processes II: Radiation, Composition, and Climate (3.0 cr)
ar LAAS 5515 - Soil Formation: Earth Surface Processes and Biogeochemistry (3.0 cr)
ar MICB 4111 - Microbial Physiology and Diversity (3.0 cr)
ar PBIO 5412 - Plant Physiology (3.0 cr)
ar PUBH 6100 - Topics: Environmental Health (0.5 - 4.0 cr)
ar PUBH 6190 - Environmental Chemistry (3.0 cr)
ar PUBH 6191 - Air Pollution (3.0 cr)
ar SOIL 4505 - Soil Geography: Soil Variability on Planet Earth (2.0 cr)
ar SOIL 5232 - Vadose Zone Hydrology (3.0 cr)
ar SOIL 5555 - Wetland Soils (3.0 cr)
ar SOIL 5611 - Soil Biology and Fertility (3.0 cr)
ar SOIL 8252 - Advanced Soil Physics (2.0 cr)
ar SOIL 8510 - Advanced Topics in Pedology (2.0 - 4.0 cr)
ar SOIL 8541 - Aquatic and Soil Chemistry (3.0 cr)
ar STAT 5021 - Statistical Analysis (4.0 cr)
ar STAT 5302 - Applied Regression Analysis (4.0 cr)
ar STAT 5303 - Designing Experiments (4.0 cr)

Outside the major
Choose 12 credits of minor or related field coursework.

Thesis credits
10 completions allowed; no grade associated; maximum 18 credits per semester or summer; 24 credits required. Take 24 or more credit(s) from the following:
• LAAS 8888 - Thesis Credit: Doctoral (1.0 - 24.0 cr)
Twin Cities Campus

Natural Resources Science and Management M.S.
Bioproducts and Biosystems Engineering, Fisheries, Wildlife, and Conservation Biology, Forest Resources
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Forest Resources, 116d Green Hall, 1530 Cleveland Avenue N., St. Paul MN 55108 (612-624-7683; fax: 612-625-5212)
Email: nrsm@umn.edu
Website: http://www.nrsm.umn.edu

- Program Type: Master's
- Requirements for this program are current for Fall 2014
- 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.


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:
Most admitted students have earned degrees in natural resource-related majors. Applicants with exceptional academic records but no related background are eligible; if admitted, they may complete the prerequisites for advanced courses during the early stages of their graduate program. These prerequisites will vary depending upon the student's track and major adviser.

Applicants will not be admitted unless a member of the program faculty agrees to advise them ahead of time. This decision depends on admissibility (the applicant's overall credentials), mutual research interests, and the faculty member's ability to take on a new student. Some faculty members will not advise students unless they have funding for the student. Applicants are encouraged to review faculty profiles on the program website and begin making contacts prior to and during the application process.

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 20 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 up to null credits outside the major. The final exam is oral. A capstone project is required.

**Capstone Project:** Plan B project(s) is(are) designed in consultation with the student's adviser and committee. It(They) must develop and demonstrate competence in the student's track.

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.

The M.S. is offered under Plan A (with thesis) and Plan B (without thesis). Plan A requires at least 20 coursework credits and Plan B requires at least 30 coursework credits. Plan A students must also register for 10 thesis credits. Plan A students usually design a program to support their specific thesis project. In consultation with faculty members, Plan B students design a program that develops competence in at least one track. Students present a seminar on the thesis or the Plan B project. Specific requirements vary by track and research project; prospective students should contact the director of graduate studies or a prospective faculty advisor for specific information. Students must also receive training in the ethical conduct of research and present a formal seminar to faculty and peers. This presentation is separate from the final exam seminar.

**Joint- or Dual-degree Coursework:** Law, Health and the Life Sciences 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.

**Assessment, Monitoring, and Geospatial Analysis**

Addresses measurements and related technology applications and resource analysis. Graduate students in this track may choose to specialize in topics such as: geographic information systems (GIS); remote sensing; geospatial analysis; survey design (including forest inventory and monitoring), measurement, modeling; and biometrics. Studies typically focus on landscape, region, or global levels.

**Economics, Policy, Management, and Society**

For students interested in focusing on how society values and makes decisions about the use, management, and protection of natural and environmental resources. Graduate students in this track can specialize in areas such as: economics, policy, administration and management, planning, operations research, conflict resolution, human dimensions, and land use planning. Studies might consider choices, impacts, and tradeoffs in protecting, restoring, developing, and allocating natural and environmental resources. The research conducted by students in this track may address a wide range of issues and problems from local to international in scope.

**Forest Hydrology and Watershed Management**

Brings together the integrally related areas of earth sciences, soils, and water resources management with an applied focus on wildland ecosystems, which may include the interface of forests with grasslands, wetlands, and agriculture. Graduate students in this track may specialize in areas such as: forest hydrology, water quality, and watershed management. Research would focus on forest, riparian, and wetland ecosystems.

**Forest Products**

For students who wish to specialize in areas such as: wood and fiber as raw materials; deterioration of wood; wood mechanics and structural design; wood moisture interactions and drying; processing and performance of composites; economics of manufacturing systems; technology and processing of solid wood products; marketing, design and production of housing components; and energy-efficient building construction.

**Forests: Biology, Ecology, Conservation, and Management**
Focuses on forest resources and allows students to choose from specializations in the following areas: forest biology, ecology, ecophysiology; genetics and tree improvement; tree physiology; reproductive biology and forest regeneration; forest growth and vegetation dynamics; timber harvesting, silviculture, and sustainable forest management; landscape ecology, restoration, and management; conservation of biodiversity and wildlife habitat management; forest health; disturbance (including fire) ecology; urban and community forestry; and agroforestry. Research normally focuses on forest and related ecosystems.

**Paper Science and Engineering**
Specializes in areas such as: the chemistry and biotechnology of lignocellulosic materials; material science of paper and fiber products; paper recycling; energy and manufacturing efficiency in the pulp and paper-making process; novel and environmentally friendly pulping and bleaching, transport processes through porous media, surface and colloid science of papermaking; chemical engineering applications in pulp and paper processes; and statistical process control.

**Recreation Resources, Tourism, and Environmental Education**
Focuses on the use and management of natural resources for recreation and tourism. Graduate students in this track may specialize in areas such recreational land management, resource-based tourism, planning for recreation and tourism, and the human dimensions of natural resource uses. Additionally, students may focus on environmental education and leadership for effective communication with diverse publics about natural resources.

**Wildlife Ecology and Management**
For students interested in working with leaders in ecology, physiology, evolution, genetics, statistics, computer science, forestry, natural resource policy, and the social sciences as they relate to wildlife; ecology and management; and conservation biology.
Twin Cities Campus

Natural Resources Science and Management Minor
Bioproducts and Biosystems Engineering, Fisheries, Wildlife, and Conservation Biology, Forest Resources
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Forest Resources, 116d Green Hall, 1530 Cleveland Avenue N., St. Paul MN 55108 (612-624-7683; fax 612-625-5212)
Email: nrsm@umn.edu
Website: http://www.nrsm.umn.edu

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2014
- 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.


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.

Students majoring in other programs who wish to declare a minor in Natural Resources Science and Management must file a proposal with the NRSM program office. Master's students must complete a minimum of eight credits of NRSM-related coursework. Doctoral students must complete a minimum of twelve credits of NRSM-related coursework.

Because the NRSM program is multidisciplinary, we do not require specific courses for completion of the minor. Rather, the student should work in consultation with his or her major advisor(s) and with the NRSM faculty member who will serve on the student's examination committee as the representative of the program minor. (It is a University of MN requirement that students declaring a minor have a representative of the minor program on the committee.) The proposed coursework will then be reviewed by NRSM's director of graduate studies, and must be approved before the student can submit the degree program for approval. It is expected that courses students take to fulfill the NRSM minor are taught by NRSM faculty members. The minor proposal form is available on the NRSM website.
Twin Cities Campus
Natural Resources Science and Management Ph.D.
Bioproducts and Biosystems Engineering, Fisheries, Wildlife, and Conservation Biology, Forest Resources
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Forest Resources, 116d Green Hall, 1530 Cleveland Avenue N., St. Paul MN 55108 (612-624-7683; fax: 612-625-5212)
Email: nrsm@umn.edu
Website: http://www.nrsm.umn.edu

• Program Type: Doctorate
• Requirements for this program are current for Fall 2014
• Length of program in credits: 59 to 72
• 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.


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:
Most admitted students have earned degrees in natural resource-related majors. Applicants with exceptional academic records but no related background are eligible; if admitted, they may complete the prerequisites for advanced courses during the early stages of their graduate program. These prerequisites will vary depending upon the student's chosen track and major adviser.

Applicants will not be admitted unless a member of the program faculty agrees to advise the student ahead of time. This decision depends on admissibility (the applicant's overall credentials), mutual research interests, and the faculty member's ability to take on a new student. Some faculty members will not advise students unless they have funding for the student. Applicants are encouraged to review faculty profiles on the program website and begin making contacts prior to and during the application process.

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
35 to 48 credits are required in the major.
0 credits are required outside the major.
24 thesis credits are required.

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

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

This program may not 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.

The University of Minnesota requires at least 48 credits for a doctoral degree, 24 of which must be thesis credits. The NRSM graduate program will typically expect to see 40 to 48 course credits. If a student enters the program with a relevant master's degree, relevant credits from the prior degree can be transferred in to apply toward the doctoral degree pending advisor, committee, graduate program, and college approval. Normally, a student who enters the doctoral program with a master's degree will complete 30-40 additional credits in the major program. There are no minor courses required, but students have the option of formally declaring a minor.

Course selection and thesis proposals are developed by each student in consultation with the faculty adviser and are approved by the Natural Resources Science and Management Graduate Studies Committee. Students must also receive training in the ethical conduct of research and present a formal seminar to faculty and peers. This presentation is separate from the final exam seminar.

Joint- or Dual-degree Coursework: Law, Health and the Life Sciences
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.

Assessment, Monitoring, and Geospatial Analysis
Addresses measurements and related technology applications and resource analysis. Graduate students in this track may choose to specialize in topics such as: geographic information systems (GIS); remote sensing; geospatial analysis; survey design (including forest inventory and monitoring), measurement, modeling; and biometrics. Studies typically focus on landscape, region, or global levels.

Economics, Policy, Management, and Society
For students interested in focusing on how society values and makes decisions about the use, management, and protection of natural and environmental resources. Graduate students in this track can specialize in areas such as: economics, policy, administration and management, planning, operations research, conflict resolution, human dimensions, and land use planning. Studies might consider choices, impacts, and tradeoffs in protecting, restoring, developing, and allocating natural and environmental resources. The research conducted by students in this track may address a wide range of issues and problems from local to international in scope.

Forest Hydrology and Watershed Management
Brings together the integrally related areas of earth sciences, soils, and water resources management with an applied focus on wildland ecosystems, which may include the interface of forests with grasslands, wetlands, and agriculture. Graduate students in this track may specialize in areas such as: forest hydrology, water quality, and watershed management. Research would focus on forest, riparian, and wetland ecosystems.

Forest Products
For students who wish to specialize in areas such as: wood and fiber as raw materials; deterioration of wood; wood mechanics and structural design; wood moisture interactions and drying; processing and performance of composites; economics of manufacturing systems; technology and processing of solid wood products; marketing, design and production of housing components; and energy-efficient building construction.
Forests: Biology, Ecology, Conservation, and Management
Focuses on forest resources and allows students to choose from specializations in the following areas: forest biology, ecology, ecophysiology; genetics and tree improvement; tree physiology; reproductive biology and forest regeneration; forest growth and vegetation dynamics; timber harvesting, silviculture, and sustainable forest management; landscape ecology, restoration, and management; conservation of biodiversity and wildlife habitat management; forest health; disturbance (including fire) ecology; urban and community forestry; and agroforestry. Research normally focuses on forest and related ecosystems.

Paper Science and Engineering
Specializes in areas such as: the chemistry and biotechnology of lignocellulosic materials; material science of paper and fiber products; paper recycling; energy and manufacturing efficiency in the pulp and paper-making process; novel and environmentally friendly pulping and bleaching, transport processes through porous media, surface and colloid science of papermaking; chemical engineering applications in pulp and paper processes; and statistical process control.

Recreation Resources, Tourism, and Environmental Education
Focuses on the use and management of natural resources for recreation and tourism. Graduate students in this track may specialize in areas such recreational land management, resource-based tourism, planning for recreation and tourism, and the human dimensions of natural resource uses. Additionally, students may focus on environmental education and leadership for effective communication with diverse publics about natural resources.

Wildlife Ecology and Management
For students interested in working with leaders in ecology, physiology, evolution, genetics, statistics, computer science, forestry, natural resource policy, and the social sciences as they relate to wildlife, ecology and management, and conservation biology.
Twin Cities Campus
Nutrition M.S.
College of Food, Agricultural and Natural Resource Sciences

Contact Information:
Department of Food Science and Nutrition, 225 Food Science and Nutrition Building, 1334 Eckles Avenue, Saint Paul, MN 55108 (612-624-6753; fax: 612-625-5272)
Email: fsgrad@umn.edu
Website: http://fscn.cfans.umn.edu/graduate_programs/nutritiongraduate/index.htm

- Program Type: Master's
- Requirements for this program are current for Fall 2014
- 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.

Nutrition is the study of how nutrients, both essential and nonessential, affect health and all life processes. Consequently, nutrition is an extremely broad field that encompasses physiology, biochemistry, education, public health, and public policy. The nutrition graduate program is interdisciplinary. Advisers and financial support may come from any of the departments or schools in which nutrition graduate faculty reside, including the Department of Food Science and Nutrition (College of Food, Agricultural and Natural Resource Sciences); Division of Epidemiology (School of Public Health); Departments of Medicine, Surgery, Psychiatry, Lab Medicine and Pathology, and Family Medicine and Community Health (Medical School); Department of Kinesiology and Leisure Studies (College of Education and Human Development); Department of Biochemistry and Molecular Biology (University of Minnesota Duluth); University of Minnesota Extension; Hormel Institute (Austin, Minn.); and V.A. Medical Center and Park Nicollet Institute (Minneapolis, Minn.). Three subspecialty areas are offered in the program: human nutrition, nutritional biochemistry, and public health nutrition. Thesis work can be conducted locally or internationally in the laboratory, clinic, or field.

Students are allowed a maximum of 5 years in the program.

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.

Applicants to the program need a bachelor's degree in any field or its international equivalent.

Other requirements to be completed before admission:
A strong foundation in the biological and physical sciences is required. This background includes college mathematics, the equivalent of one semester of general chemistry, organic chemistry, general biology, biochemistry, physiology, and statistics. For the doctoral program, additional prerequisite courses include calculus and physics. If there is evidence that the applicant has a good background in the sciences, some of the prerequisites can be met after admission. The M.S. program also requires the following nutrition courses, or equivalent, which may be completed after the student's admission to the program: Principles of Nutrition (FSCN 1112), Life Cycle Nutrition (FSCN 3612), and Human Nutrition (FSCN 4612).

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, 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 oral. A capstone project is required.

**Capstone Project:** The Plan B project is a combined total of approximately 120 hours (the equivalent of three full-time weeks) of work. The graduate faculty, including the student’s adviser and DGS, specify both the nature and extent of the course and project work necessary to satisfy this requirement.

This program may not 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 both Plan A (thesis) and Plan B (non-thesis). Plan A requires a minimum of 20 course credits and 10 thesis credits; Plan B requires a minimum of 30 course credits, including a Plan B project.

General requirements include the graduate nutrition core series (four courses), an orientation and presentation skills class, graduate courses statistics, an advanced topics course, and presentation of the thesis or project work. All students also are expected to obtain teaching experience, subject to the policies of the adviser’s department or division.

**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
Nutrition Minor
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Food Science and Nutrition, 225 Food Science and Nutrition Building, 1334 Eckles Avenue, Saint Paul, MN 55108 (612-624-6753; fax: 612-625-5272)
Email: fsgrad@umn.edu
Website: http://fscn.cfans.umn.edu/education/nutritiongraduate/index.htm

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2014
- Length of program in credits (Masters): 6
- Length of program in credits (Doctorate): 13
- 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.

Nutrition is the study of how nutrients, both essential and nonessential, affect health and all life processes. Consequently, nutrition is an extremely broad field that encompasses physiology, biochemistry, education, public health, and public policy. The nutrition graduate program is interdisciplinary. Advisers and financial support may come from any of the departments or schools in which nutrition graduate faculty reside, including the Department of Food Science and Nutrition (College of Food, Agricultural and Natural Resource Sciences); Division of Epidemiology (School of Public Health); Departments of Medicine, Surgery, Psychiatry, Lab Medicine and Pathology, and Family Medicine and Community Health (Medical School); Department of Kinesiology and Leisure Studies (College of Education and Human Development); Department of Biochemistry and Molecular Biology (University of Minnesota Duluth); University of Minnesota Extension; Hormel Institute (Austin, Minn.); V.A. Medical Center and Park Nicollet Institute (Minneapolis, Minn.).

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.

A master's minor requires a minimum of 6 course credits in nutrition, including NUTR 5625 and NUTR 5626. A doctoral minor may be completed by taking NUTR5624, 5625, 5628, 5622, and 8620.
Twin Cities Campus
Nutrition Ph.D.
Food Science & Nutrition
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Food Science and Nutrition, 225 Food Science and Nutrition Building, 1334 Eckles Avenue, Saint Paul, MN 55108 (612-624-6753; fax: 612-625-5272)
Email: fsgrad@umn.edu
Website: http://fscn.cfans.umn.edu/graduate_programs/nutritiongraduate/index.htm

- Program Type: Doctorate
- Requirements for this program are current for Fall 2014
- Length of program in credits: 52
- 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.

Nutrition is the study of how nutrients, both essential and nonessential, affect health and all life processes. Consequently, nutrition is an extremely broad field that encompasses physiology, biochemistry, education, public health, and public policy. The nutrition graduate program is interdisciplinary. Advisers and financial support may come from any of the departments or schools in which nutrition graduate faculty reside, including the Department of Food Science and Nutrition (College of Food, Agricultural and Natural Resource Sciences); Division of Epidemiology (School of Public Health); Departments of Medicine, Surgery, Psychiatry, Lab Medicine and Pathology, and Family Medicine and Community Health (Medical School); Department of Kinesiology and Leisure Studies (College of Education and Human Development); Department of Biochemistry and Molecular Biology (University of Minnesota Duluth); University of Minnesota Extension; Hormel Institute (Austin, Minn.); V.A. Medical Center and Park Nicollet Institute (Minneapolis, Minn.).

Three subspecialty areas are offered in the doctoral degree program: human nutrition, nutritional biochemistry, and public health nutrition. Thesis work may be conducted locally or internationally in the laboratory, clinic, or field.

Students may spend a maximum of 8 years in the program.

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.

Applicants to the program need a bachelor's degree in any field or its international equivalent, along with demonstrated research ability such as a M.S. degree or publications.

Other requirements to be completed before admission:
A strong foundation in the biological and physical sciences is required. This background includes college mathematics, the equivalent of one semester of general chemistry, organic chemistry, general biology, biochemistry, physiology, and statistics. For the doctoral program, additional prerequisite courses include calculus and physics. If there is evidence that the applicant has a good background in the sciences, some of the prerequisites can be met after admission. The Ph.D. program also requires the following nutrition courses, or equivalents, which may be completed after admission to the program: Principles of Nutrition (FSCN 1112), Life Cycle Nutrition (FSCN 3612), and Human Nutrition (FSCN 4612).

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**

16 credits are required in the major.
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.

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.

The Ph.D. offers three areas of specialization: human nutrition, nutritional biochemistry, and public health nutrition. Thesis work may be conducted in the laboratory, clinic, or field, either locally or internationally.

The Ph.D. requires the graduate nutrition core series (four courses), an orientation and presentation skills class, graduate level courses in statistics and two advanced topics courses. All students also are expected to obtain teaching experience, subject to the policies of the adviser's department or division.
Twin Cities Campus
Plant Pathology M.S.
Plant Pathology
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Plant Pathology, 495 Borlaug Hall, 1991 Buford Circle, Saint Paul, MN 55108 (612-625-8200)
Email: plpathgp@umn.edu
Website: http://plpa.cfans.umn.edu

- Program Type: Master's
- Requirements for this program are current for Fall 2014
- 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.

Plant pathology focuses on the biology of plant-microbe interactions, and incorporates research involving biochemical, molecular, genetic, physiological, whole organism, population, and community levels of biological organization. Plant pathology interfaces with all plant science disciplines, and with many other fields including food sciences, veterinary medicine, biobased products, and ecology. Areas of concentration include molecular plant pathology (offered as a special emphasis), plant disease management, biological control of plant disease, forest pathology and microbial degradation of wood, microbial ecology, population biology, plant-microbe interactions, disease resistance, host-parasite coevolution, plant microbe mutualisms, and virology. Students have opportunities for laboratory and field research locally, as well as nationally and internationally. The course of study varies with the requirements for the area of concentration and interests of the student. Students who choose the emphasis in molecular plant pathology enhance their ability to design and use molecular approaches to investigate plant disease, increase basic knowledge, and develop new strategies for disease control.

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.

Master's degree applicants must have a sound college background in the basic biological and physical sciences and mathematics.

Other requirements to be completed before admission:
Applicants must have completed 35 semester credits in biology with at least one course in each of the following areas: botany, zoology, genetics, plant physiology, and microbiology. Applicants must also have completed at least one course each in inorganic chemistry, organic chemistry, biochemistry, and physics. If deficiencies exist in the prerequisites, students must correct them during the first year of the graduate program. These courses cannot be counted as part of the degree program. All students accepted into the department with a B.S. degree are admitted into the M.S. program. After a minimum of two semesters, students who qualify may elect to change their degree status to the Ph.D. program. Criteria for the change include scholastic standing, potential for success in completing a Ph.D., and writing competency.

Special Application Requirements:
GRE scores are required for all students and TOEFL or IELTS scores are required for international students. A clearly written statement of career interests as well as three letters of recommendation are required of all students. Students may apply at any time; however, submission of all application materials by December 10 will ensure priority consideration for fellowships and research assistantships for the next academic year. Students can be admitted any semester.

Applicants must submit their test score(s) from the following:
- GRE
  - General Test - Verbal Reasoning: 153
  - General Test - Quantitative Reasoning: 148
  - General Test - Analytical Writing: 4.5

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Information current as of September 19, 2014
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

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

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 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. A capstone project is required.

**Capstone Project:** The Plan B option also requires one to three projects totaling ca. 120 hours. The content and procedures for completing the project(s) are to be determined and approved by the student's major adviser and the director of graduate studies.

This program may be completed with a minor.

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

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

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

Regular attendance at weekly plant pathology seminars is expected. Internships are encouraged as part of the graduate experience and financial support is available on a competitive basis for international or domestic internships.

### Required Coursework

**PLPA 5480:** Principles of Plant Disease (3 cr) must be completed if student lacks an introductory Plant Pathology course.

- **PLPA 8104:** Plant Virology (2.0 cr)
- **PLPA 8105:** Plant Bacteriology (2.0 cr)
- **PLPA 8123:** Research Ethics in Plant and Environmental Sciences (0.5 cr)
- **PLPA 8200:** Seminar (1.0 cr)

Students must enroll for 1 credit in PLPA 8090 Advanced Procedures and Research in Plant Pathology, Topic: Teaching Experience. Students must enroll in a seminar or workshop on teaching methods.

All students are required to enroll in a minimum of four of the following courses, chosen in consultation with the director of graduate studies, adviser, and graduate advisory committee.

Take 4 or more course(s) from the following:

- **PLPA 5003:** Diseases of Forest and Shade Trees (3.0 cr)
- **PLPA 5202:** Field Plant Pathology (2.0 cr)
- **PLPA 5203:** Introduction to Fungal Biology (3.0 cr)
- **PLPA 5300:** Current Topics in Molecular Plant Pathology (1.0 - 2.0 cr)
- **PLPA 5301:** Plant Genomics (3.0 cr)
- **PLPA 5444:** Ecology, Epidemiology, and Evolutionary Biology of Plant-Microbe Interactions (3.0 cr)
- **PLPA 5660:** Plant Disease Resistance and Applications (3.0 cr)
- **PLPA 8103:** Plant-Microbe Interactions (3.0 cr)

### M.S. in Plant Pathology, Molecular Option (Plan A only)

#### Molecular Option Requirements

M.S. students wishing to emphasize molecular plant pathology must complete the following course requirements in addition to the Plan A master's program requirements:

**BIOC 4125:** Laboratory in Molecular Biology and Biotechnology, or equivalent.
PLPA 8103 - Plant-Microbe Interactions (3.0 cr)

**Suggested courses for the 6 supporting field credits**

Note: Students who wish to complete a designated minor (which is certified on the transcript, unlike the related-fields option, which is not) must complete 6 or more credits in a single field. A designated minor must be approved by the director of graduate studies in the minor field.

Take 6 or more credit(s) from the following:

- AGRO 8241 - Chromosomal and Molecular Genetics of Plant Improvement (3.0 cr)
- BIOC 5361 - Microbial Genomics and Bioinformatics (3.0 cr)
- EEB 5221 - Molecular Evolution (3.0 cr)
- GCD 5036 - Molecular Cell Biology (3.0 cr)
Twin Cities Campus
Plant Pathology Minor
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Plant Pathology Graduate Program, 495 Borlaug Hall, 1991 Buford Circle, Saint Paul, MN 55108 (612-625-8200)
Email: pipathgp@umn.edu
Website: http://plpa.cfans.umn.edu

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2014
- 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.

Plant pathology focuses on the biology of plant-microbe interactions, and incorporates research involving biochemical, molecular, genetic, physiological, whole organism, population, and community levels of biological organization. Plant pathology interfaces with all plant science disciplines, and with many other fields including food sciences, veterinary medicine, biobased products, and ecology. Areas of concentration include molecular plant pathology (offered as a special emphasis), plant disease management, biological control of plant disease, forest pathology and microbial degradation of wood, microbial ecology, population biology, plant-microbe interactions, disease resistance, host-parasite coevolution, plant microbe mutualisms, and virology. Students have opportunities for laboratory and field research locally as well as nationally and internationally. The course of study varies with the requirements for the area of concentration and interests of the student. Students who choose the emphasis in molecular plant pathology enhance their ability to design and use molecular approaches to investigate plant disease, increase basic knowledge, and develop new strategies for disease control.

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.
Twin Cities Campus

Plant Pathology Ph.D.

College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Plant Pathology Graduate Program, 495 Borlaug Hall, 1991 Buford Circle, Saint Paul, MN 55108 (612-625-8200)
Email: pipathpg@umn.edu
Website: http://plpa.cfans.umn.edu

- Program Type: Doctorate
- Requirements for this program are current for Fall 2014
- Length of program in credits: 53
- 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.

Plant pathology focuses on the biology of plant-microbe interactions, and incorporates research involving biochemical, molecular, genetic, physiological, whole organism, population, and community levels of biological organization. Plant pathology interfaces with all plant science disciplines, and with food sciences, veterinary medicine, biobased products, and ecology. Areas of concentration include molecular plant pathology (offered as a special emphasis), plant disease management, biological control of plant disease, forest pathology and microbial degradation of wood, microbial ecology, population biology, plant-microbe interactions, disease resistance, host-parasite coevolution, plant microbe mutualisms, and virology. Students have opportunities for laboratory and field research locally as well as nationally and internationally. The course of study varies with the requirements of the area of concentration and interests of the student. Students who choose the emphasis in molecular plant pathology enhance their ability to design and use molecular approaches to investigate plant disease, increase basic knowledge, and develop new strategies for disease control.

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 sound college background in the basic biological and physical sciences and mathematics.

Ph.D. applicants must satisfy all the prerequisites for the master's degree program in plant pathology or have a master's degree in plant pathology or in a field of natural science.

Other requirements to be completed before admission:
Applicants must have completed 35 semester credits in biology with at least one course in each of the following areas: botany, zoology, genetics, plant physiology, and microbiology. Applicants must also have completed at least one course each in inorganic chemistry, organic chemistry, biochemistry, and physics. If deficiencies exist in the prerequisites, they must be corrected during the first year of the graduate program. Applicants should note that these courses cannot be counted as part of the degree program. All students accepted into the department with only a B.S. degree are admitted into the M.S. degree program. A minimum of two semesters, students who qualify may elect to change their degree status to the Ph.D. program. Criteria for the change include scholastic standing, potential for success in completing a Ph.D., and writing competency.

Special Application Requirements:
GRE scores are required for all students and TOEFL or IELTS scores are required for international students. A clearly written statement of career interests as well as three letters of recommendation are required of all students. Students may apply at any time; however, submission of all application materials by December 10 will ensure priority consideration for fellowships and research assistantships for the next academic year. Students can be admitted any semester.

Applicants must submit their test score(s) from the following:
- GRE
  - General Test - Verbal Reasoning: 153

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Information current as of September 19, 2014
General Test - Quantitative Reasoning: 148  
General Test - Analytical Writing: 4.5  

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  

The preferred English language test is Test of English as Foreign Language.  
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  
17 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 towards program requirements is not permitted.  

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

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

Course requirements include enrollment in a supervised teaching or extension teaching experience. Degree programs are determined by the student and the student's advisory committee, with approval of the director of graduate studies. Regular attendance at weekly plant pathology seminars is expected. Internships are encouraged as part of the graduate experience and financial support is available on a competitive basis for international or domestic internships.  

A detailed overview of course offerings and requirements, including additional details on the molecular plant pathology emphasis, is available on the plant pathology program website.  

Required Coursework  
All Ph.D. students must take the following courses (if not taken previously):  
PLPA 5444 - Ecology, Epidemiology, and Evolutionary Biology of Plant-Microbe Interactions (3.0 cr)  
PLPA 5480 - Principles of Plant Pathology (3.0 cr)  
PLPA 8103 - Plant-Microbe Interactions (3.0 cr)  
PLPA 8123 - Research Ethics in Plant and Environmental Sciences (0.5 cr)  
two semesters of PLPA 8200 - Plant Pathology Seminar (2 credits total, including credits taken during a PLPA M.S. program at the University of Minnesota)  
one full semester in-classroom teaching experience  
PLPA 8005 - Supervised Classroom or Extension Teaching Experience (2.0 cr)  
or GRAD 8101 - Teaching in Higher Education (3.0 cr)  
PLPA 8104 - Plant Virology (2.0 cr)  
or PLPA 8105 - Plant Bacteriology (2.0 cr)  

Ph.D. in Plant Pathology, Molecular Option  

Molecular Option Requirements  
Ph.D. students wishing to emphasize molecular plant pathology must complete the following course requirements in addition to the standard Ph.D. program requirements.  
BIOC 4125 - Laboratory in Molecular Biology and Biotechnology or equivalent  
PLPA 5301 - Plant Genomics (3.0 cr)  
PLPA 5300 - Current Topics in Molecular Plant Pathology (two semesters required) 2 credits total
Suggested courses for the 12 supporting field credits:
Take 12 or more credit(s) from the following:
• AGRO 8241 - Chromosomal and Molecular Genetics of Plant Improvement (3.0 cr)
• ANSC 5200 - Statistical Genetics and Genomics (4.0 cr)
• BIOL 5961 - Microbial Genomics and Bioinformatics (3.0 cr)
• CSCI 5481 - Computational Techniques for Genomics (3.0 cr)
• EEB 5221 - Molecular Evolution (3.0 cr)
• GCD 5036 - Molecular Cell Biology (3.0 cr)
• GCD 8131 - Advanced Genetics and Genomics (3.0 cr)
• MICA 8002 - Structure, Function, and Genetics of Bacteria and Viruses (4.0 cr)
Twin Cities Campus

Risk Analysis for Introduced Species and Genotypes Minor

Fisheries, Wildlife, and Conservation Biology
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Fisheries, Wildlife, and Conservation Biology, 115 Northern Forest Station, 1992 Folwell Avenue, St. Paul, MN 55108-1034 (612-625-0890; fax: 612-626-7080)
Email: isgigert@umn.edu
Website: http://isg-igert.umn.edu

- Program Type: Graduate free-standing minor
- Requirements for this program are current for Fall 2014
- Length of program in credits (Masters): 6
- Length of program in credits (Doctorate): 13
- 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 in risk analysis for introduced species and genotypes is available to master's (M.A. and M.S.) and doctoral students. The minor provides an interdisciplinary curriculum that addresses all phases of risk analysis pertaining to the introduction of exotic species and novel genotypes. The curriculum is based on collaborative learning and includes a survey course, discussions, a problem solving practicum, and a cooperative learning practicum. The minor complements major programs in applied economics; applied plant sciences; conservation biology; ecology, evolution, and behavior; entomology; natural resources science and management; plant biological sciences; and water resources science.

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.

The master's minor requires 6 graduate credits from the core curriculum; the doctoral minor requires 13 graduate credits. Master's students must take ISG 5010 (3 credits), ISG 5020 (1 credit), and ISG 8001 (1 credit; taken twice for credit).

The doctoral minor requires at least 13 credits, including the master's courses, plus ISG 8021 (3 credits), ISG 8031 (1 credit), and a 3-credit course in quantitative modeling or a decision analysis course offered by another program.
Twin Cities Campus
Sustainable Agriculture Systems Minor
Agronomy & Plant Genetics
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Director of Graduate Studies, Sustainable Agriculture Systems Minor, 411 Borlaug Hall, 1991 Buford Circle, St. Paul, MN 55108 (612-625-3754; fax: 612-625-1268)
Email: sheaf001@umn.edu
Website: http://www.misa.umn.edu/StudentPrograms/GraduateMinor/index.htm

- Program Type: Graduate free-standing minor
- Requirements for this program are current for Fall 2014
- 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 minor in sustainable agriculture systems offers master's (M.A. and M.S.) and doctoral students an interdisciplinary curriculum that considers the biological, sociological, and economic aspects of agriculture. The minor emphasizes a holistic perspective to designing farming and food systems and solving problems in agriculture. The importance of yield and profitability are balanced by considerations of the environment and the health and social well-being of producers, consumers, and communities. The minor complements major programs in ecology, conservation biology, forestry, sociology, geography, political science, and public affairs, as well as majors in the College of Food, Agricultural and Natural Resource Sciences.

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:
Admission is contingent upon prior admission to a master's or doctoral degree-granting program.

Special Application Requirements:
Contact the director of graduate studies in sustainable agriculture systems for an Intent to Enroll Form. Students are admitted each semester.

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.

The master's minor requires 6 graduate credits from the core curriculum; the doctoral minor requires 12 graduate credits. All students must take SAGR 8010 and 8020. The other core course is AGRO 5321 - Ecology of Agricultural Systems (cross listed with ENT 5321). A unique component of the minor is an on-site internship with growers, grassroots organizations, or public agencies working in sustainable agriculture.