## Applied Plant Sciences – Plant Breeding/Molecular Genetics Track

### M.S.

**Applied Plant Sciences M.S. Program Requirements**

<table>
<thead>
<tr>
<th>M.S. Requirements</th>
<th>Plant Breeding/Molecular Genetics Track</th>
<th>Credits</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Course</strong></td>
<td><strong>Title</strong></td>
<td><strong>Credits</strong></td>
<td><strong>Semester</strong></td>
</tr>
<tr>
<td>APSC 8123</td>
<td>Research Ethics in the Plant and Environmental Sciences</td>
<td>0.5</td>
<td>Spring</td>
</tr>
<tr>
<td>Agro 5311</td>
<td>Research Methods in Crop Improvement and Production</td>
<td>1</td>
<td>Summer (register in Fall)</td>
</tr>
<tr>
<td>Agro/Hort 8270</td>
<td>Graduate Seminar</td>
<td>1</td>
<td>Fall &amp; Spring</td>
</tr>
<tr>
<td>Stat 5021 or NR 5021</td>
<td>Statistical Analysis or Statistics for Agriculture and Natural Resource Professionals</td>
<td>4</td>
<td>Fall &amp; Spring or Fall</td>
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</table>

<table>
<thead>
<tr>
<th>Area</th>
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</thead>
<tbody>
<tr>
<td>Genetics Area</td>
<td>See list</td>
<td>&gt; 3</td>
</tr>
<tr>
<td>Molecular Genetics Area</td>
<td>See list</td>
<td>&gt; 3</td>
</tr>
<tr>
<td>Plant Breeding Area</td>
<td>See list</td>
<td>&gt; 3</td>
</tr>
<tr>
<td>Additional Courses</td>
<td>Determined by student/committee - See Other Suggested Courses</td>
<td></td>
</tr>
</tbody>
</table>

**Total Course Credits (Plan A)**: > 20

**Total Course Credits (Plan B)**: > 30

| APSC 8777 | Thesis Credits (Plan A only) | 10 |

**Plan A** requires a minimum of 20 coursework credits and 10 thesis credits. The final examination is oral.

**Plan B** requires 30 major credits. The final examination is oral. A capstone project, which is determined in consultation with the student’s adviser, is 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 1 semester must be completed before filing a Degree Program Form.

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)
or NR 5021 Statistics for Agriculture and Natural Resource Professionals (3 cr), Fall

M.S. Plan A degree: The minimum 20 credits of coursework must include the program-wide required courses and students must complete additional courses from the list below including at least one course from each of the three areas (Genetics, Molecular Genetics, Plant Breeding):

**Genetics**
EEB 5042 - Quantitative Genetics, 3 cr., Fall  
GCD 8131 - Advanced Genetics and Genomics, 3 cr., Spring

**Molecular Genetics**
GCD 4034 - Molecular Genetics, 3 cr., Spring  
AGRO 8241 - Chromosomal & Mol. Genetics of Plant Improv., 3 cr., Spring (odd years)

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

Additional courses determined by student/committee including those listed below. (Courses other than those listed below can be substituted with agreement of the adviser, advisory committee, and DGS.)

**OTHER SUGGESTED COURSES**

**Agroecology**
SAGR 8010 - Colloquium in Sustainable Agriculture, 2 cr., Fall  
AGRO 5321 - Ecology of Agricultural Systems (3 cr)

**Biochemistry**
PBIO 5601 – Topics in Plant Biochemistry (3 cr)  
BIOC 5401 - Advanced Metabolism and its Regulation, 3 cr., Fall  
BIOC 8001 - Biochemistry: Structure, Catalysis, and Metabolism, 3 cr., Fall  
BIOC 8002 - Molecular Biology and Regulation of Biological Processes, 3 cr., Fall

**Biotechnology/Genetics/Genomics**
HORT 4071W - Applications of Plant Biotechnology to Crop Improvement, 4 cr., Fall  
HORT 5058 - Plant Cytogenetics (2 cr)  
HORT 5059 - Plant Cytogenetics Lab (1 cr)  
AGRO 5431 – Applied Plant Genomics and Bioinformatics (3 cr)  
PBIO 5516 - Plant Cell Biology, 3 cr., Spring (odd years)  
PLPA 5301 - Plant Genomics, 3 cr., Fall

**Computational Biology/Bioinformatics**
BIOL 5485 - Bioinformatics, 3 cr., Fall (even years)  
BIOC 5361 - Microbial Genomics and Bioinformatics, 3 cr., Fall and Spring  
CSCI 4041 - Algorithms and Data Structures, 4 cr., Fall and Spring  
CSCI 5461 - Functional Genomics, Systems Biology and Bioinformatics, 3 cr., Spring  
CSCI 5481 - Computational techniques for genomics, 3 cr., Fall  
CSCI 3003/5980 - Introduction to Computing in Biology, 3 cr., Spring

**Evolution**
AGRO / HORT 8023 - Evolution of Crop Plants, 2 cr., Spring (odd years)  
EEB 5221 - Molecular Evolution, 3 cr. Spring (odd years)  
PBIO 5309 - Molecular Ecology and Ecological Genomics, 3 cr., Fall (even years)

**Physiology**
PBIO 5412 - Plant Physiology, 3 cr., Fall  
HORT 8044 - Manipulation of Plant Growth and Reproduction, 2 cr., Spring (even years)
PBIO 5516 - Plant Cell Biology (3 cr)

**Plant Pathology**
- PLPA 5103/8103 - Plant-Microbe Interactions, 3 cr., Spring
- PLPA 5202 - Field Plant Pathology 2 cr
- PLPA 5444 - Ecol, Epidem, and Evolutionary Biology of Plant-Microbe Interactions, 3 cr., Fall
- PLPA 5480 - Principles of Plant Pathology, 3 cr., Fall
- PLPA 5660 - Plant Disease Resistance and Applications, 3 cr
- PLPA 8104 - Plant Virology, 2 cr., Spring
- PLPA 8105 - Plant Bacteriology, 2 cr., Spring

**Statistics**
- AGRO 5121 - Applied Experimental Design, 4 cr., Spring
- NR 5021 Statistics for Agriculture and Natural Resource Professionals (3 cr), Fall
- ANSC 5200 - Statistical Genetics and Genomics, 4 cr., Fall
- STAT 5041 - Bayesian Decision Making
- STAT 5201 - Sampling Methodology in Finite Populations
- STAT 5302 - Applied Regression Analysis, 4 cr., Fall & Spring
- STAT 5303 - Designing Experiments
- STAT 5401 - Applied Multivariate Methods, 3 cr., Fall & Spring
- STAT 5421 - Analysis of Categorical Data
- STAT 5601 - Nonparametric Methods, 3 cr., Fall
- STAT 5421 - Analysis of categorical Data, 3 cr., Fall
- ENT 5126 - Spatial and Temporal Analysis of Ecological Data
- ESPM 5211 - Survey, Measurement, and Modeling for Environmental Analysis
- FR 5131 - Geographical Information Systems (GIS) for Natural Resources
- FW 8051 - Statistical Modeling of Ecological Data
- GIS 5555 - Basic Spatial Analysis

M.S. Plan B degree: Students must complete the course requirements of the MS Plan A (above) plus additional courses for a minimum of 30 course credits.
### Applied Plant Sciences – Plant Breeding/Molecular Genetics Track
#### Ph.D.

**Applied Plant Sciences PhD Program Requirements**

<table>
<thead>
<tr>
<th>Ph.D. Requirements</th>
<th>Plant Breeding/Molecular Genetics Track</th>
<th>Credits</th>
<th>Semester</th>
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<tr>
<td><strong>Course</strong></td>
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<tr>
<td>APSC 8123*</td>
<td>Research Ethics in the Plant and Environmental Sciences (unless taken in M.S. at U of M)</td>
<td>0.5</td>
<td>Spring</td>
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<tr>
<td>Agro 5311*</td>
<td>Research Methods in Crop Improvement and Production</td>
<td>1</td>
<td>Summer (register in Fall)</td>
</tr>
<tr>
<td>Agro/Hort 8270*</td>
<td>Graduate Seminar</td>
<td>1</td>
<td>Fall &amp; Spring</td>
</tr>
<tr>
<td>Stat 5021 or NR 5021*</td>
<td>Statistical Analysis or Statistics for Agriculture and Natural Resource Professionals</td>
<td>4, 3</td>
<td>Fall &amp; Spring or Fall</td>
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<tr>
<td>Grad 8101</td>
<td>Teaching in Higher Education</td>
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<tr>
<td>Agro/Hort 8280 or SAGR 8010</td>
<td>Current Topics in Applied Plant Sciences Colloquium in Sustainable Agriculture</td>
<td>1, 2</td>
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<tr>
<td>Genetics Area</td>
<td>See list</td>
<td>&gt; 3</td>
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<tr>
<td><strong>Total Course Credits</strong></td>
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</tr>
<tr>
<td>APSC 8888</td>
<td>Thesis Credits</td>
<td>24</td>
<td></td>
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</table>

*Not required if already completed as part of M.S. program.

30 course credits are required in the major.

24 thesis credits are required.

This program may be completed with a minor in another field.

Successful completion and defense of a thesis is required for completion of the Ph.D. degree (see [http://policy.umn.edu/education/doctoralcompletion](http://policy.umn.edu/education/doctoralcompletion)).

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 (below), the requirements for their respective specialization, and present one graduate seminar (AGRO 8270) as part of their PhD program (in addition to AGRO 8270 if taken as part of a M.S. program); 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. Credits from graduate coursework at the UMN or from another institution, completed prior to admission to the PhD program, may be used subject to limitations in University policy (http://policy.umn.edu/education/gradcreditdegree)

**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) unless taken in M.S. program at University of Minnesota
- GRAD 8101 - Teaching in Higher Education (3.0 cr)
- SAGR 8010 - Colloquium in Sustainable Agriculture (2.0 cr) or AGRO/HORT 8280 - Current Topics in Applied Plant Sciences (1 cr)
- STAT 5021 - Statistical Analysis (4.0 cr) or
  - NR 5021 Statistics for Agriculture and Natural Resource Professionals (3 cr)

Note: AGRO 5311 and STAT 5021 are not required if previously included in a M.S. program.

Students must complete 30 credits including the program-wide required courses and at least one course from each of the three areas (Genetics, Molecular Genetics, Plant Breeding):

**Genetics**
- EEB 5042 - Quantitative Genetics, 3 cr., Fall
- GCD 8131 - Advanced Genetics and Genomics, 3 cr., Spring

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