

CPSC 466: Genomics for Plant Improvement

A current educational gap seems to be functional genomics to characterize genes and their function, and how this information is applied through biotech/molecular breeding to produce genotypes with desirable phenotypes. This course will modify the content of our existing CPSC 466: Plant Genomics course to meet the defined educational gap. The course complements and builds upon topics covered in CPSC 261, CPSC 265, CPSC 352, CPSC 453, CPSC 454, CPSC 467, CPSC 468, CPSC 469, CPSC 563, CPSC 566. The course also integrates the most relevant content from CPSC 452: Genetics of Higher Organisms, and some aspects of CPSC 568: Recombinant DNA Technology Lab. Its intended audience is advanced undergraduate students at the University, such as the Plant Biotechnology and Molecular Biology concentration within the Crop Sciences undergraduate major, as well as graduate students in a number of campus programs.

Anticipated enrollment is 15-20 students.

Two-hour course during the second 8 weeks of fall semester.

Prefer assuming time slot previously held by CPSC 466, MWF 11:00 – 11:50 AM in N120 Turner Computer Lab.

Current Course Catalog Description. An overview of genomics in the context of molecular biology including: basic principles in molecular biology, accessing biological databases; transcriptional, translational, and post-translational gene regulation; regulatory roles of non-protein coding RNA, signal transduction, genome projects and gene annotation, DNA microarray analysis, protein interaction maps, and integrative functional genomics. Same as [IB 477](#). Prerequisite: [CPSC 352](#) or a similar course, or consent of instructor.

Proposed New Course Catalog Description. An overview of applying the methods of genomics to discover variation in genes and their expression, creating new genetic variation, and applying this information to the improvement of economically important plants. Emphasis is on recent advances in genomic science and activities where functional genomics information is used to efficiently create and manipulate desirable phenotypes. Same as [IB 477](#). Prerequisite: [CPSC 352](#) or a similar course, or consent of instructor.

The course would be based on recent literature that illustrates real examples of functional genomics methods and their applications. The content would be structured around discovery of variation in genes and their expression, creating new genetic variation, and evaluation of phenotypes. In addition to reading and discussing journal articles, another goal would be for students to complete exercises in how functional genomics information is converted into application, for example developing markers from sequence data, going from QTL to genes, designing a transgene for a desired phenotype. This would not involve a wet lab, but rather using existing data in online databases or examples from the work of my lab or others who wish to contribute relevant datasets.

I also plan to develop this course from the beginning with the idea that it may be offered online to a variety of curricula and programs. These could include Bioenergy professional masters or continuing education programs, the off-campus graduate program, campus Entrepreneurship program, students at other institutions, or perhaps even interested people from industry. A TA would be necessary to help deliver the online content through existing resources such as Illinois Compass and Elluminate. The TA would also have responsibility for coordinating the technical aspects of engaging other programs. As starting points, the TA could contact Heather Miller, Juerggen Scheffran, guy from CABER Exec committee who is director of Professional Masters program.

Course Outline

Week 1 – Gene discovery.

- Monday - Exploiting the biology of the trait to be improved.
- Wednesday – ESTs and genespace/genome sequencing
- Friday - genome annotation.
- Assignment over weekend-choose a trait. It can be your proposed thesis topic.

Week 2: Assessing genetic variation and architecture in populations.

- Monday –Overview of molecular markers, genotyping methods, and their applications.
- Wednesday - Surveys of nucleotide diversity within coding versus noncoding sequences, extent of LD.
- Friday – Developing useful molecular markers from sequence information.
- Assignment over weekend - develop strategy to discover molecular markers.

Week 3: Genetic mapping for gene discovery.

- Monday - Linkage mapping.
- Wednesday - Association mapping.
- Friday - QTL cloning.
- Assignment over weekend –develop strategy for genetic mapping of your trait and to clone and verify genetic basis of identified QTL.

Week 4: RNA/protein expression variation.

- Monday - Microarrays, sequence-based profiling
- Wednesday - small RNAs.
- Friday – overview of proteomics and metabolomics.
- Assignment over weekend –Design a strategy to profile gene expression changes for your trait.

Week 5: Developing Genetic Networks.

- Monday - Network modeling.
- Wednesday - Regulatory variation.
- Friday - Environmental effects on gene expression.
- Assignment over weekend – design a network from DNA-RNA-PROTEIN-METABOLITE-TRAIT.

Week 6: Functional genomics

- Monday - mutagenized populations, TILLING/eco-TILLING
- Wednesday - transposon/T-DNA reverse genetics
- Friday - enhancer traps/activation/localization tagging.
- Assignment over weekend – Design a strategy to functionally test your trait.

Week 7: Biotechnology product development.

- Transformation technology
- Transgene product development
- Regulatory science
- Assignment over weekend – Design a product development path for your trait.

Week 8: Synthesis. Students write review article on their genomics-direct plant improvement effort.