Graduate level Course

HOS 6236 Molecular Marker Assisted Plant Breeding

Graduate Level – 3 credit hours
Fall 2019

Instructors:

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Office Hours TBD

Location and time: Tuesday period 2 (8:30-9:20), Fifield 2316
Thursday periods 2-3 (8:30-10:20), Fifield 2316

Prerequisite STA6166 or ALS5932 or equivalent, and AGR5321 or equivalent. Basic understanding of the software R.

Course Description
This course provides theory, methods and procedures required to apply molecular information in plant breeding programs. The course will be based on lectures and multiple hands-on activities that apply what is learned. Frequent evaluations will occur during the semester by topic (see below).

Intended Audience
The course is designed for graduate students working in plant breeding (e.g. agronomy, horticulture, environmental horticulture, and forestry), or any student in biological science who wants to deepen his/her knowledge about the theory and application of molecular breeding.

Course Objectives
The course goal is to familiarize students with the application of molecular information to plant breeding. By the end of the semester students should be able to describe current methods for mapping quantitative trait loci (QTL), Genome-wide association (GWAS), marker-assisted selection (MAS), and Genomic Selection (GS). The course will also review the applications of biotechnology to breeding programs. Students should be able to describe the advantages and disadvantages of the different methods covered in the course. Students should also be able to list the biotechnology methods applied to plant breeding. Ultimately, students should be able to identify what method and what strategy should be applied depending on the species, the breeding goals, the population and the timeframe.

Evaluation

Points	Type	Topic
05	Quizzes	Plant Breeding and Molecular Markers
05	Quizzes	QTL Analysis
05	Paper Discussion	QTL Analysis
10	Partial Project	QTL Analysis
05	Quizzes	GWAS
05	Paper Discussion	GWAS
10	Partial Project	GWAS
05	Quizzes	MAS
05	Paper Discussion	GWAS
10	Partial Project	MAS
05	Quizzes	GS
05	Paper Discussion	GS
10	Partial Project	GS
05	Quizzes	Genetic Engineering in Breeding
10	Take-Home Exam	
100	**TOTAL**	

Letter Grade

A >90 B+ 85 to 89 B 80 to 84 C+ 75 to 79 C 70 to 74 D+ 65 to 69 D 60 to 64 E < 60

UF grading policies: https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx

Evaluation Description

Quizzes

Quizzes will happen in the **first 5 minutes** of the class. There will be no notice of when quizzes are happening and there is no make up of quizzes, so be on time for class.

Paper discussion

There will be one paper assigned every two weeks. One student chosen at random at the beginning of the class will lead the paper discussion, this student will randomly chose as many students as figures appear in the paper to be explained and discussed. All students will have a chance to lead the discussion.

Partial Projects

Partial project will be developed while the class is covering the topic and is due by 5 PM the last day the topic is covered. The project will start during class for every topic. The due day will be communicated the day the data is given to students. For example; the QTL analysis will involve creating a linkage map, mapping the QTLs, and presenting a report of the work. Similar projects will be given to the topics GWAS, and GS.

Take-Home Exam

Take home exam will be due one day after it is given to students. These exams will involve developing strategies for application of the methods and techniques under different scenarios.

Hands-on Activities

Every week during the second period on Thursday students will be handling data to apply what was learn during the week. This means students are required to participate in this activities.

Software

You will need to bring your own laptop. The main software used will be the statistical software R which can be downloaded from www.r-project.org. **and** R-studio http://www.rstudio.com/. It is your responsibility to make sure that your computer has the latest version of R. Prior to the first day of class, please make sure you have removed all old versions of R, and have the most recent version installed.

There are numerous online resources available for R; however, if you would like a traditional textbook, The R Book, is widely available and comprehensive.

Crawley, M. J. (2012). The R book. John Wiley & Sons.

Required and Recommended Literature

This course does not have a required but a recommended textbook, and a series of scientific manuscript that will be assigned for reading and discussion. Additional literature, to deepen student understanding, can also be found below.

Rex Bernardo. 2014. “Essentials of plant breeding”. Stemma press. Woodbury, Minnesota, USA. ISBN 978-0-9720724-2-7

Broman, K W. 2001. “Review of Statistical Methods for QTL Mapping in Experimental Crosses.” *Lab Animal* 30 (7): 44–52. doi:11469113.

Collard, B. C Y, M. Z Z Jahufer, J. B. Brouwer, and E. C K Pang. 2005. “An Introduction to Markers, Quantitative Trait Loci (QTL) Mapping and Marker-Assisted Selection for Crop Improvement: The Basic Concepts.” *Euphytica* 142 (1–2): 169–96. doi:10.1007/s10681-005-1681-5.

Doerge, Rebecca W. 2002. “Multifactorial Genetics mapping and Analysis of Quantitative Trait Loci in Experimental Populations.” *Nature Reviews Genetics* 3 (1): 43–52. doi:10.1038/nrg703.

Holland, Jb. 2004. “Implementation of Molecular Markers for Quantitative Traits in Breeding Programs—challenges and Opportunities.” *New Directions for a Diverse Planet: Proceedings,* 1–13. http://cropscience.org.au/icsc2004/pdf/203_hollandjb.pdf.

Xu, Yunbi, and Jonathan H. Crouch. 2008. “Marker-Assisted Selection in Plant Breeding: From Publications to Practice.” *Crop Science* 48 (2): 391–407. doi:10.2135/cropsci2007.04.0191.

Korte, Arthur, and Ashley Farlow. 2013. “The Advantages and Limitations of Trait Analysis with GWAS: A Review.” *Plant Methods* 9 (1): 29. doi:10.1186/1746-4811-9-29.

Zhu, Chengsong, Michael Gore, Edward S. Buckler, and Jianming Yu. 2008. “Status and Prospects of Association Mapping in Plants.” *The Plant Genome Journal* 1 (1): 5. doi:10.3835/plantgenome2008.02.0089.

Meuwissen, T. H E, B. J. Hayes, and M. E. Goddard. 2001. “Prediction of Total Genetic Value Using Genome-Wide Dense Marker Maps.” *Genetics* 157 (4): 1819–29. doi:11290733.

Heffner, Elliot L., Mark E. Sorrells, and Jean Luc Jannink. 2009. “Genomic Selection for Crop Improvement.” *Crop Science* 49 (1): 1–12. doi:10.2135/cropsci2008.08.0512.

Heslot, Nicolas, Jean-Luc Jannink, and Mark E. Sorrells. 2015. “Perspectives for Genomic Selection Applications and Research in Plants.” *Crop Science* 55 (1): 1. doi:10.2135/cropsci2014.03.0249.

Gelvin Stanton B. 2003. “Agrobacterium-Mediated Plant Transformation: the Biology behind the “Gene-Jockeying” Tool”. Microbiol Mol Biol Rev 67(1):16-37. doi: 10.1128/MMBR.67.1.16-37.2003

Doudna Jennifer, and Emmanuelle Charpentier. 2014. “The new frontier of genome engineering with CRISPR-Cas9.” Science 28 Vol 346, Issue 6213. doi: 10.1126/science.1258096

Fredy Altpeter,a Nathan M. Springer,b Laura E. Bartley,c Ann E. Blechl,d Thomas P. Brutnell,e Vitaly Citovsky,f Liza J. Conrad,g Stanton B. Gelvin,h David P. Jackson,i Albert P. Kausch,j Peggy G. Lemaux,k June I. Medford,l Martha L. Orozco-Cárdenas,m David M. Tricoli,n Joyce Van Eck,o Daniel F. Voytas,p Virginia Walbot,q Kan Wang,r Zhanyuan J. Zhang,s and C. Neal Stewart Jr. 2016. “Advancing Crop Transformation in the Era of Genome Editing”. The Plant Cell 28:1510–1520. doi: https://doi.org/10.1105/tpc.16.00196

Course Schedule and Topics (Tentative).

Topic	Description
Wk 1	Plant Breeding Review
Wk 2	Molecular Markers Review
Wk 3	Linkage Mapping
Wk 4	Quantitative Trait Loci (QTL) Analysis I
Wk 5	Quantitative Trait Loci (QTL) Analysis II
Wk 6	Genome-Wide Analysis (GWAS) I
Wk 7	Genome-Wide Analysis (GWAS) II
Wk 8	Genome-Wide Analysis (GWAS) III
Wk 9	Marker-Assisted Selection (MAS): Traditional Methods I
Wk 10	Marker-Assisted Selection (MAS): Traditional Methods II
Wk 11	Genomic Selection (GS) I
Wk 12	Genomic Selection (GS) II
Wk 13	Genomic Selection (GS) III
Wk 14	Genomic Selection (GS) IV
Wk 15	Genetic Engineering in Plant Breeding: Traditional Methods No class on Thursday Nov 28 (Holiday)
Wk 16	Genetic Engineering in Plant Breeding: Gene-Editing tools No class on Thursday Dec 05 (Reading Days)

Attendance and Make-Up Work

"Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies that can be found at: https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx"

Online Course Evaluation Process

"Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at https://evaluations.ufl.edu. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at https://evaluations.ufl.edu/results/"

Academic Honesty

"UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (http://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to

report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class."

Software Use:

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate.

Services for Students with Disabilities

"Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, www.dso.ufl.edu/drc/) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester."

Campus Helping Resources

Health and Wellness:

U Matter, We Care: If you or a friend is in distress, please contact umatter@ufl.edu or 352 392- 1575 so that a team member can reach out to the student.

Counseling and Wellness Center: http://www.counseling.ufl.edu/cwc/Default.aspx, 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Assault Recovery Services (SARS) Student Health Care Center, 392-1161. University Police Department, 392-1111 (or 9-1-1 for emergencies). http://www.police.ufl.edu/