Plant Biotechnology PLS 424R-524R(3 credits)

This course covers the methods, applications, and implementation of plant biotechnology in agriculture. The topics covered include technical as well as regulatory and policy aspects of aspects of plant biotechnology.

It will be assumed that the students at the senior undergraduate/graduate student level will have a course background in basic genetics, plant physiology/biology, and biochemistry (UA suggested equivalents Chem 241 A/B, Chem 242 a/b and Bioc 462 a/b or Bioc 460). The Fall semester Plant Biochemistry class (PLS/MCB/ECOL/CHEM/BIOC 448A/548A) is highly recommended. The intent is to build on background knowledge by discussing engineering strategies that use genetics and biochemistry knowledge to select or create plant biotechnology traits. This course will discuss some of the societal issues of plant biotechnology, primarily those issues that have a science-based decision process. These include regulatory processes, safety concerns and intellectual property. No prior background will be required for this component of the course.

This is primarily a lecture course. Throughout the course there will be some discussions within the class as a part of the lectures. Students are expected to add to those discussions, although participation is not graded, with a critical examination of various scientific and societal aspects of plant biotechnology. The graduate students will lead a short discussion on a biotechnology-related subject as part of their final grade and will interact with the entire class in those discussions.

Classes will be held on **Tuesday/Thursday 11:00 – 12:15**

Office hours

Office hours are made upon request Mon-Friday 8 am-4 pm. Email to set up an appointment.

Contact information for Instructor

Eliot Herman: 249 Keating/BIO5

Office phone: 626-1641

Email: emherman@email.arizona.edu

Instructor Bio

Eliot M Herman, Dr. Herman is a Professor in the School of Plant Sciences and a member of the Bio5 Institute. Prior to employment at the University of Arizona he was a scientist working with the USDA/ARS for 24 years where his research focused on engineering seeds to improve composition. His research has focused on understanding how protein and oil metabolites are regulated and accumulated and addressing the problem of food allergens. He discovered the protein that is major soybean allergen and produced the first biotech knockout of a major allergen by silencing this allergen for which he was awarded the top USDA annual award in 2004 by the Secretary of Agriculture. As a federal employee Dr. Herman served on a wide

variety of other biotechnology related assignments including serving as NSF program director at the inception of the plant genome programs, as Science Fellow in the US Embassy in Sweden working on plant biotechnology issues in the Nordic and Baltic nations, on the EPA oversight committee that examined the aftermath of the Starlink Bt maize episode especially the question of whether there was an allergenic reaction by consumers. Dr. Herman has served as an evaluation committee member for NIST program that was directed at providing federal support for emerging biotechnology start-ups. Dr. Herman was one of the original full members of the Donald Danforth Plant Science Center in St. Louis during 2002-12, prior to relocating to University of Arizona. At the Danforth Center he was involved in its first start-up spin-off based on technology developed from his research program. Dr. Herman's current research program is supported by grants from NIH, USDA, and the soybean industry.

There will be one or more guest instructors as outlined in the schedule. Information and bios will be posted on D2l in advance of their lecture.

Grading

All students- two exams; undergrad (50% final grade each- or 40% if Grad student option chosen), grad students (40% final each). The tests will be a combination in short answer format. Test questions will be derived from in-class materials and presentations. The university scale will be employed for grading purposes. Dependent on performance, I reserve the right to scale up the scores of individual examinations or the class as a whole. Exams may not be missed except for medical emergencies (Doctor's note required), or for circumstances leading to a University approved absence form. In these cases, make-up exams will be provided. Incomplete grades will only be given under exceptional circumstances, and these require a written agreement between the student and the instructor, specifying the work to be completed and the timeframe.

All students are expected to contribute to class discussion.

Grad students (Optional for undergrads) (20% of final grade)- Each graduate student will make a class presentation- they will produce a 1 page single spaced bullet-point problem/solution paper, three references. They will outline a significant problem and propose a solution. An example by instructor will be given in advance. They will present ONE side to class and have three minutes to outline their paper. The class will have TEN minutes (undergraduate and graduates both) to question this proposal. This will test the graduate student's capacity for critical thinking, development of a proposal, and to be able to defend their ideas. The grade will be based on the idea/concept proposed, the one page write-up, and the student's discussion of the idea with their peers in class. The idea/concept to be presented will be discussed with Dr. Herman no later than April 1, 2015. A title and one-two sentence summary concept is to be sent to Dr. Herman (emherman@email.arizona.edu).

The following is an example of Dr. Herman's presentation in this format, a slide, 3 minutes to present, and in this instance 90 minutes of discussion with global policy makers.

Herman EM (2013) The Challenge To Meet Global Need For Protein Sources For Animal Production. In: 21st Century Borders/Synthetic Biology: Focus on Responsibility & Governance,

convened by the Institute on Science for Global Policy (ISGP) Dec. 4–7, 2012 (copy to be posted on D2L).

Syllabus

An outline of the lecture course is provided under syllabus. Please note the topics are provisional, and I reserve the right to alter this schedule as we progress through the semester. The webpages will be updated regularly and in advance of a lecture to reflect any changes.

Date	Topic
January 15	Introduction Plants Food And Man Plant Biotech and the advance of agriculture Global Food Commerce And Availability The 9 and 12 billion question
January 20	Plant Genomes- Gene structure Biotechnology tools (cloning, protein/nucleic acid tools), omics, big data
January 22	Darwin, Mendel, the genetic glass ceiling of crops Mutation/Insertion Traits Gamma Gardens and insertion libraries Mutation products TILLING populations Utility of plant genomes.
January 27	Plant Tissue Culture Methods and Application to produce clonal plants and bioactive substances
January 29	Plant Transformation Crown Gall to Agro Insertion sites, stability Plant Transformation Biolistics and other methods Insertion sites, stability
February 3	Vectors and design, Directed modification of genomes, gene expression, suppression, RNAi, Gene Editing. Marker free problem and solutions.
February 5	Biotechnology goals, designing traits, tissue and cellular location of trait. Expression of regulation.
February 10	Production traits- Herbicide Production Traits-no till Global adoption of no-till technology Policy, safety of herbicide use Gene flow, weed resistance
February 12	Production Traits- Animals – Insect Pest Resistance
February 17	Controlling ripening and bruising injury

February 19	Production Traits- Abiotic Stress- Freezing and drought stress
February 24	Production Traits – Virus Cross-Protection- Dr. Judy Brown
February 26	Phytoremediation, CO2 scrubbing- the biotechnology of plants improving the environment.
March 3	Cellulosic biofuels, biofuels oils, bioplastics
March 5	1st exam
March 10	Protein Enhancement and Protein Products to produce enhanced food, feed, and industrial enzymes.
March 12	Carotenoids (Golden Rice) Gates Bio-fortification produces Improving human health Dr. Monica Schmidt
March 24	Food Oils Heart-healthy soybean oil- Specialty oils
March 26	Allergy and Risk Food allergy WHO decision tree Altering food allergens Allergen risk of plant modification
March 31	Vaccines/Bioactives such as hormones and antibodies Production, effectiveness, issues Human vaccines Production animal vaccines Using plant biotechnology for immunizing wild populations Antibodies- Mzapp Ebola treatment Growth and other hormones Humanizing proteins

April 2	Consumer products- quality and appearance Post-harvest- control of ripening, browning and injury Flowers- the “holy grail” of the true blue rose
April 7	Animal feed traits- the need to double animal feed by 2050 Phytase and other digestive enzymes Anti-nutritional proteins and substances Amino acid enhancement
April 14	Characterization of traits, GRAS concept Omics, Substantial Equivalence, Collateral traits Risk/Regulation/Policy (US and EU as primary paradigms). Geneflow issues, APHIS, BL1-5IP/Owning Life/Policy, Labeling. Stacking traits.
April 16	Feeding 9 Billion and then 12 billion International Programs; Gates, Rockefeller, FAO, AID the broader goals of plant biotechnology
April 21	Rice and biotechnology Dr. Rod Wing
April 23	The other green-Algal biotechnology
April 28	Presentations
April 30	Presentations and/or wrap-up
May 5	Exam #2- course evaluation

Lecture Materials

All slides used in class will be posted on D2L no later than the day of the lecture.

Assigned Readings:

Primary Text

Plant Biotechnology and Agriculture- ed. A. Altman and Paul Hasegawa. Academic Press, 2012. Many of the individual chapters were written by the leaders in the individual plant biotechnology fields. –RECOMMENDED

For many subjects selected review and perspective papers will be suggested. Some of these papers will contain lecture figures. All of these papers will be accessible through UA library access. References will be given as part of the posted lectures.

Other Reading

In addition to the textbook, there are two other reading books. These books provide background context. They are not technical and should be easy and enjoyable reading. Throughout this course these books will provide background information in the larger and often less technical context. These two books should be read in the FIRST THREE weeks of this course.

Robert Paarlberg, Food Politics, 2nd Edition, 2013, Oxford Univ Press (paperback, kindle)

Nina Federoff, Mendel in the kitchen, 2006, John Henry Press (paperback, kindle)

Suggested Reading

Throughout this course a number of other books, articles and web resources will be posted with lecture materials. These will serve to elaborate on various points and provide more information on subjects of interest. Dr. Herman will use some materials from these books in lectures.

Robert Paalberg, forward by Normal Borlaug and Jimmy Carter, 2008, Starved For Science. This is an important book that discussions the consequences for people in need of the collision of science and politics of biotechnology. This book is an important reminder that the technology development and policy debates occur a world away from those who most need the assistance.

Peter Laufer, 2012, Organic, A journalist's quest to discover the truth behind food labeling. (hardcover, kindle) This book is not about GMOs, but rather it is an exploration about what labels mean and the problems with labeling in the context of certifiable organic foods. An object lesson, and a well presented one, of the issues with labels.

Dan Charles, Lords of harvest, 2001, Basic books, (paperback, kindle)- This is one of the best historical descriptions of the development of transgenic plant technology.

Jonathan Gressel, 2008, Genetic Glass Ceilings. Trangenics for crop diversity. (Hardcover only)- A unique perspective that examines the synergy of conventional breeding and transgenics.

Pamela Ronald and Raoul Adamchak, 2012, Tomorrow's Table, Organic Farming, Genetics, and the Future of Food. (paperback, kindle)-Dr. Ronald is a UC Davis professor and National Academy member who works on the biotechnology of rice. She is married to an organic farmer, Raoul Adamchak. The interactions and synergy of these two worlds is a unique contribution.

Additional Information

The University of Arizona Code of Academic Integrity applies to PLS 424-524. All students should abide by this Code.

As a courtesy to others, please switch off your phones during the class period. Electronic devices can be used for course work only during class hours.

Policies, Codes, and Conduct Statements:

General UA Codes and Conduct Information:
http://deanofstudents.arizona.edu/policiesandcodes.

Behavior inappropriate for the classroom:
http://deanofstudents.arizona.edu/examplesofdisruptivebehavior

Threats of physical harm to any member of the University community: http://web.arizona.edu/~policy/threatening.pdf

UA Code of Academic Integrity: http://deanofstudents.arizona.edu/codeofacademicintegrity

Special Needs and Accommodations Statement:

Students who need special accommodations or services should contact the Disability Resources Center, 1224 East Lowell Street, Tucson, AZ 85721, (520) 621-3268, FAX (520) 621-9423, email: uadrc@email.arizona.edu, http://drc.arizona.edu/. You must register and request that the Center or DRC send me official notification of your accommodations needs as soon as possible. Please plan to meet with me by appointment or during office hours to discuss accommodations and how my course requirements and activities may impact your ability to fully participate. *The need for accommodations must be documented by the appropriate office*.