PLS 245 Plants, Genes and Agriculture

Location TBD, Spring, T/Th, 2:00 pm; 3 units

Description of Course

In this course, students will learn about the origins of agriculture and crops, be introduced to the scientific concepts of plant biology and genomics, and understand how this knowledge has created modern industrial agriculture and engineered crops. The materials presented will provide a plant science background and perspective to understand today’s news and controversies about the food and products we consume based on a foundation of crop biology, genetics, and biotechnology.

Course Prerequisite or Co-requisites:

There are no prerequisites for this course.

Instructors and Contact Information

Eliot M Herman       Rod Wing       David Galbraith
Professor           Professor       Professor
University of Arizona University of Arizona University of Arizona
School of Plant Sciences School of Plant Sciences School of Plant Sciences
Rm. 249             Rm 253         Rm 341
1657 E. Helen St.   1657 E. Helen St.   1657 E. Helen St.
Tucson, AZ 85721-0240 Tucson, AZ 85721-0240 Tucson, AZ 85721-0240
520/626-1641         520/626-9595   520/621-9153

Office Hours TBD

Office to be assigned in Marley/Forbes and/or Bio5 for set hours to be established for open door and/or prior appointment.

Course Format and Teaching Methods

Lecture supplemented with extracurricular reading assignments and video viewing.

Video assignments from science-oriented programs will either be available from the primary producer, such as PBS, or through the UA library and D2L links. A full list of videos and a schedule of assigned viewing dates will be posted on D2L.

Students will be encouraged to engage with the instructors in each lecture, to create a dialogue posing and discussing relevant questions. The instructors will generally initiate these discussions by posing questions to the class, and will invite volunteer comments and discussion during the course of the lectures. Participation will be highly encouraged.
Course Objectives

1. To appreciate the concepts and applications of scientific enquiry through understanding how the biology of plants has enabled the development of agriculture.
2. To learn about the historic developments of agriculture and its successes in feeding, clothing and housing an ever-growing global population.
3. To provide students with a comprehensive overview of the science of plant biology, including basics of plant anatomy, growth and development, and physiology.

Expected Learning Outcomes

After successfully completing this course, students will have the ability to:
1. Demonstrate an understanding of agricultural production as a global challenge for the 21st Century, by being able to argue coherently about topics of interest in oral and written form,
2. Define the scientific concepts underpinning agricultural production in terms of basic plant biology, physiology, genetics and breeding, in the context of an ever-increasing world population,
3. Develop an enhanced understanding of the scientific method, particularly as it applies to plant biology and agricultural production,
4. Understand how biotechnology can increasingly assist in improving agricultural production,
5. Identify and demonstrate an understanding of the major problems/constraints related to future food security,
6. Develop and evaluate novel approaches to increase food and energy production and minimize food insecurity,
7. Relate food security issues to their own life and experience and to that of communities, to integrate this knowledge with that of other courses, and to utilize this information in the development of career goals, through critical analysis of pertinent articles and books both in popular communication media and the scientific literature.

Students will take a 30-minute pretest on the first day of class. The questions will be designed to assess the knowledge base of the students concerning basic plant biology, plant growth and relationship to the environment, crop agriculture, and biotechnology. This pre-test is not part of the student’s grade, and student names will not be recorded. A key for the pre-test will be posted on D2L.

Each subsequent test will include an evaluation of mastery of sets of knowledge queried in the pretest, thereby serving as a means to benchmark overall learning progress.

Writing assignments will require the students to focus on a specific aspect of the course content, and will allow assessment of the abilities of the students to synthesize and reformulate information in their own voice.

TCE evaluation will provide a means for the students to provide feedback concerning their perception of the learning experience provided by the course.

Assignments and Examinations: Schedule/Due Dates

In-class Tests. This course will have four in-class tests, evenly spaced during the semester, each comprising 100 points. Make-up exams will be provided in accordance with University policy of excused absence due to illness or other circumstances.

Short Essay. All students will be required to submit a short essay at the end of Week Ten, which will constitute 20% of the total grade. The instructors will outline expectations during Week One and these will be posted to D2L, including examples of titles and abstracts. Students will email the title and a short (200 word) abstract of their proposed essays to the instructors by COB Friday of Week Six for approval. Students with disapproved abstracts will discuss and remedy
this situation during Week Seven office hours. All submissions shall be prepared in MS Word and emailed to the instructors by the due dates/times, to allow the instructors to use tracking and comment functions of MS Word. Late submissions will be subject to a graduated loss of points, as detailed in the writing requirement section that follows. Essays that are more than five business days (M-F) late will receive no credit, unless the student has provided prior absence justification as outlined under University policies.

The instructors will provide a list of books/journal articles to serve as potential subject matter for the essay. All suggested books/articles will be readily available as paperback, Kindle editions, or as PDFs.

Writing Assignments. Each student will prepare two five-page double-spaced essays based on their selections of a number of books/journal articles that will provide an in-depth examination of topics that transcend the entire course material. Students may include figures and references as part of this essay. All essays will include, in addition, a cover page with title, student name, and summary. All essays will be prepared on MS Word and emailed to the instructors as .doc, .docx or PDF files by COB on due date. Late (>24 h) essays are subject to loss of credit, unless dispensation has been approved in advance in accordance with university policy. The books/journal article list will be posted on the first the day of classes to give each student four weeks to make their selection and outline their concept for the essay. All books/journal articles will be suitable for students having no prior scientific background, and will require only the reading ability required for university admission. All students will complete their essay following the concept presentation to the instructors for critique and after individual feedback from the instructors on the selection of subject, on the presentation, and on expectations.

General Considerations.

There will be no opportunities for additional or alternative credit.

Class participation will not be graded, although all students are encouraged to participate in class discussions. Class attendance is expected, any material presented in class is considered as appropriate material for tests and examinations.

Students are permitted to use computers and tablets to take notes during lectures but no computers or tablets will be allowed during exams.

(Once course is approved, exact dates will be entered below for midterms and all assignments).

Required Texts or Readings


All students will be required to complete two essays based on reading book(s)/journal articles from a selection provided by the instructors.

Additional reading

The instructors will post a list of general interest books and articles from the popular press and scientific articles for the general public, for example, Scientific American, that will further enhance discussion of subjects of the course subsections. These materials will serve as resources for student essays.

Required or Special Materials

No special materials are required.

Required Extracurricular Activities

Students will be expected to engage in extracurricular activities that will encompass reading and study of the textbook, supplementary assigned materials and viewing of assigned videos available in online access through D2L.
All students will complete a short essay on a topic derived from this course that will require additional reading and library research with the ability to prepare an essay using MS Word on a personal computer.

Final Examination
Although the emphasis of this test will be on material presented since test three, the instructors reserve the option of revisiting other material from the entire semester. The date and time of the final exam, along with links to the Final Exam Regulations, is found at: https://www.registrar.arizona.edu/courses/final-examination-regulations-and-information, and Final Exam Schedule, http://www.registrar.arizona.edu/schedules/finals.htm

Grading Scale and Policies
There is no specific pre-determined grade distribution for this course. All grades will initially be calculated on standard A-E system with each grade in descending 10% order from 100%. The grade cut-offs will be at or below 90% (A), 80% (B), 70% (C), and 60% (D). The failing grade of E will be given to students scoring below the D cutoff percentage, or not finishing the course and not officially withdrawing from the course. The instructors reserve the option to curve the final grade distribution.

All tests will be in the short answer and/or multiple-choice format that will have specific correct answers. A key will be posted on D2L after all students have completed exams, including any make-up tests. The instructors reserve the option to consider alternate answers to questions that may be correct.

The course has a total of 600 points distributed as follows:

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<tr>
<th>Points Possible</th>
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<td>Four examinations</td>
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<td>Writing assignments</td>
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Total Points: 600

Requests for incomplete (I) or withdrawal (W) must be made in accordance with University policies, which are available at http://catalog.arizona.edu/policy/grades-and-grading-system#incomplete and http://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal respectively.

Dispute of Grade Policy: Students will have the opportunity to discuss any questions about test/assignment grades individually by appointment with the instructors. Students are requested to provide specific detail about answer and assignment grading questions.

Honors Credit
For honors credit, an additional discussion hour per week will be arranged for participating students. For this discussion, the instructors will post on D2L reading material to be discussed that will enhance aspects of the class room discussion. The reading assignments and participation is required and considered part of the final grade. For honors students the reading, discussion, and participation will explore some subjects in greater depth and difficulty than in class. Book(s) to be used for honors discussion will be posted on D2L for the first day of class. These books will be supplemented with additional materials posted to D2L in advance of class discussion. The key goal of the discussions and the writing assignments is for the honors student to develop a synthesis of knowledge and create the understanding that derives from linking disparate knowledge facts into a train of thought and to be convey this conceptually to the instructors and to fellow students.

Honors credit is available by completing a substantially enhanced writing project. These projects will be developed on an individual basis by contract with the instructor by appointment in the first three weeks of the semester. A substantial writing project will encompass the detailed
synthesis and individual perspective that addresses a significant question in the context of the course that extends well beyond the essay requirement. Such projects will require substantial additional research and citations indicating that student has pursued an in-depth analysis of the stated problems. It is expected such writing projects will be 6-10 single pages in length, exclusive of figures and references. The honors assignment will be presented instead of the standard writing assignments and is due on the same dates as the standard assignment. A substantial reference list is required (minimum of 10 references) for which it will be assumed that student has carefully read and will be able to answer the instructors’ questions about the reference content.

The instructors will individually discuss the results of this research and writing project (30 min scheduled conference) with each student as part of the honors grade evaluation during the week of lecture 27-29. There may be one or more guest lectures during the semester and the faculty presenting those lectures may also serve as additional evaluators of the honors writing project.

**Absence and Class Participation Policy**

The UA’s policy concerning Class Attendance, Participation, and Administrative Drops is available at [http://catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop](http://catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop)

The UA policy regarding absences for any sincerely held religious belief, observance or practice will be accommodated where reasonable: [http://policy.arizona.edu/human-resources/religious-accommodation-policy](http://policy.arizona.edu/human-resources/religious-accommodation-policy).

Absences preapproved by the UA Dean of Students (or dean’s designee) will be honored. See [http://policy.arizona.edu/employmenthuman-resources/attendance](http://policy.arizona.edu/employmenthuman-resources/attendance).

Participating in the course and attending lectures and other course events are vital to the learning process. As such, attendance is expected at all lectures and discussion section meetings. All materials presented in class or discussion sections will be potentially used as test/exam questions. Students who miss class due to illness or emergency are required to bring documentation from their health-care provider or other relevant, professional third parties. Failure to submit third-party documentation will result in unexcused absences.

**Makeup Policy for Students Who Register Late**

Students who register after the semester has started are requested to consult with the instructors at office hours as soon as possible to be given guidance and recommendations on actions needed to make up for missed class time.

**Course Communications**

Students may request individual time with the instructors either at scheduled office hours or at other times to be arranged. The instructors’ emails will be available to students for short inquiries or to arrange individual meetings.
**Scheduled Topics/Activities**

The proposed schedule is based on a 30 class-day semester. Lectures will involve 100 minute class periods, offered T-Th.

**Chapter titles and authors:** of Plants, Genes and Agriculture: Sustainability through biotechnology annotated into a lecture schedule to utilize the entire content of the proposed textbook.

<table>
<thead>
<tr>
<th>Lecture</th>
<th>Date</th>
<th>Topic</th>
<th>Reading Assignments</th>
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| 1       | Thursday January 10, 2019 | **Welcome to the Course.**

The Human Population and its Need for Food In the 21st Century: The human population will grow to about 12 billion, from its present 7 billion, during the lifetime of today’s students. Meeting the needs of this population will tax global resources, impact the environment, and demand new technical solutions.

Pre-Test: The last 30 minutes of Lecture 1 will involve a pre-test that will address prior knowledge of plants and agriculture. | Chapter 1. |
| 2       | Tuesday January 15  | **The Human Population and its Need for Food in the 21st Century (continued).**

The Development and Organization of Agricultural Production: Agriculture is multicultural and has been independently invented by diverse cultures. Necessity has resulted in many parallel inventions and sometimes very different perspectives. Crop development is Human-managed selection to alter yield, nutrition, taste, and performance to enhance utility that is different from natural selection of fitness. | Chapter 1. |
| 3       | Thursday January 17 | **The Development and Organization of Agricultural Production (continued).**                                                                                                                                | Chapter 2. |
| 4       | Tuesday January 22  | **The Origins of Agriculture and our Food Crops:** A few hundred plants encompass essentially all of agriculture and only a much smaller number encompass the vast majority of agriculture. Almost all extent crops are pre-industrial with only a few crops being developed over the past 300 years.

Plants in Human Nutrition, Diet and Health: Plants are autotrophic, capable of converting inorganic inputs into organic materials that sustains animal and human life. Animals have nutritional requirements that can be met with a | Chapter 3. |
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<th>Day</th>
<th>Topic</th>
<th>Chapter</th>
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<tr>
<td>Thursday</td>
<td>January 24</td>
<td>varied plant diet. The proteins, essential amino acids, essential lipids, vitamins, and carbohydrates provide the necessary nutrients for the human diet.</td>
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<tr>
<td>Tuesday</td>
<td>January 29</td>
<td><strong>EXAMINATION ONE</strong></td>
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<td>Thursday</td>
<td>January 31</td>
<td><strong>Food Safety:</strong> There are bacteria and fungi that can produce toxins that can contaminate food. Food plants may produce bioactive materials including cyanide producing compounds, drugs such as alkaloids, allergens, and anti-nutritional. Consider how the Amazonian peoples developed Cassava that produces lethal levels of cyanide if not carefully processed. Pre-historic agriculture needed to recognize the cause of food safety issues and to develop solutions and this continues today in scientific laboratories and regulated by agencies such as the US Food and Drug Administration.</td>
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<td>Tuesday</td>
<td>February 5</td>
<td><strong>Genes, Genomics and Molecular Biology:</strong> What is DNA? How genetics results from genomes to be bred into crops. Examples to be discussed the origin of Maize and Wheat as two crops that have been extensively manipulated by people. How genes function to produce biological materials.</td>
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<td>Thursday</td>
<td>February 7</td>
<td><strong>Growth and Development: from Zygote to Flower:</strong> What is a plant? Its constituent parts and ontogeny. The plant life-cycle.</td>
<td>7</td>
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<tr>
<td>Tuesday</td>
<td>February 12</td>
<td><strong>Converting Solar Energy into Crop Production:</strong> How plants use light, water, and carbon dioxide to produce sugars and biomass. From the origins of photosynthesis about 2 billion years ago that created the Earth’s oxygen containing atmosphere to today’s scientific goals to improve photosynthesis.</td>
<td>8</td>
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<td>Tuesday</td>
<td>February 12</td>
<td><strong>WRITING ASSIGNMENT #1: DUE.</strong> These assignments will be returned to the individual student by COB on the day of Lecture 11. Students have the opportunity to revise the writing assignment due COB day of Lecture 13.</td>
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<td>Thursday</td>
<td>February 14</td>
<td><strong>Plant Breeding and Crop Improvement:</strong> Historic and modern plant breeding to improve traits including food quality, yield, and resistance to biotic and abiotic stress. The development of hybrids and the Green Revolution.</td>
<td>9</td>
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<tr>
<td>Tuesday</td>
<td>February 19</td>
<td><strong>The Use of Biodiversity in Crop Relatives for Breeding.</strong> Discussion of wild ancestors of modern</td>
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<td>Thursday February 21</td>
<td>EXAMINATION TWO</td>
<td>crops and introgressing desirable traits. Collections of seeds from centers of origin. Preservation of germplasm globally, exemplified by the seed collection at Svalbard as an international cooperative activity that is outlined in the textbook.</td>
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<tr>
<td>12 Tuesday February 26</td>
<td>Sexual and Vegetative Plant Propagation.</td>
<td>Some crops have been developed to are propagated by seed while others are vegetatively, clonally, propagated. The historic development of clonal propagation and current industrial cloning of plants from orchids to pines.</td>
<td>Chapter 11.</td>
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<td>13 Thursday February 28</td>
<td>Inventions in Agriculture: How New Crop Varieties and other Farm Technologies are Developed, and How they reach Farmers.</td>
<td>How historic and current big industrial agriculture over thousands of years has used both biological crop development and machines to increase production and decrease labor input.</td>
<td>Chapter 12.</td>
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<td>Tuesday March 5</td>
<td>SPRING RECESS</td>
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<td>Thursday March 7</td>
<td>SPRING RECESS</td>
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<td>14 Tuesday March 12</td>
<td>Soil Ecosystems, Plant Nutrition and Nutrient Cycling.</td>
<td>Soil as a living ecosystem and how agriculture uses, diminishes, and requires replenishment of resources. The cycles of nitrogen and phosphorus in the soil and the role of microbes. The finite resources of phosphorus and its impact on agriculture.</td>
<td>Chapter 13.</td>
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<tr>
<td>17 Thursday March 21</td>
<td>Biotic Challenges: Diseases.</td>
<td>Plant diseases can destroy crops and has caused historic famine, the Irish potato famine as an example. The role of plant genotypes in disease. Disease has exterminated plants such as the American Chestnut. Current disease challenges of many crops including banana, coffee, citrus, cassava, and cacao may result in commercial extinction. Breeding and genetic engineering approaches to mitigate disease and current work to restore lost plants such as the American Chestnut.</td>
<td>Chapter 15.</td>
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<td>Tuesday March 26</td>
<td>EXAMINATION THREE</td>
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<td>Date</td>
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<td>18</td>
<td>Thursday</td>
<td>Biotic Challenges: Pests. Insects have been historic and current challenges to crop production in some instances directly consuming and destroying crops and in other instances as vectors for disease. This module will discuss the types of insect challenges and effects on global crops with current developments to control insects.</td>
<td>Chapter 16.</td>
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<td>19</td>
<td>Tuesday</td>
<td>Abiotic Challenges: Water, Soils and Salinity. Diminishing water resources and quality has broadly affected agriculture. Many crops are tender to water quality challenges. Other plants have increased tolerance for water availability and quality. What can these plants teach us about how to breed or engineer crops to cope with human-caused changes to the agricultural environment?</td>
<td>Chapter 17.</td>
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<td>20</td>
<td>Thursday</td>
<td>Traits that Benefit Farmers and Industry. An overview of modern plant biotechnology that enhances crop production. In addition to the broad deployment of insecticidal and herbicide resistant traits other emerging industry traits will be discussed including traits that are directed at reducing the massive food waste and traits that help minimize the impact of weather and climate stress.</td>
<td>Chapter 18.</td>
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<tr>
<td>21</td>
<td>Tuesday</td>
<td>Traits that Benefit the Food Industry and the Consumer. New and emerging products that benefit consumer health and nutrition are appearing in the global commodity stream. High oleic soybean oil to heart health, biofortification with vitamins, essential amino acids and lipids, crops that impede the production of aflatoxin or carcinogens will be discussed.</td>
<td>Chapter 19.</td>
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<td>Tuesday</td>
<td>Writing assignment #2 due COB April 9. These assignments will be returned to the individual student by COB day of Lecture 25. Students have the opportunity to revise the writing assignment due COB day of Lecture 27.</td>
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<tr>
<td>22</td>
<td>Thursday</td>
<td>Intensification and Sustainability of Food Production. How much food can be produced? How sustainable is the ever-increasing demand for more food? How does plant biology constrain what can be produced and how this impacts the global environment.</td>
<td>Chapter 20.</td>
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<td>23</td>
<td>Tuesday</td>
<td>Intensification and Sustainability (continued)</td>
<td>Chapter 20.</td>
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<td>24</td>
<td>Thursday</td>
<td>Plants as Pharmaceutical Factories. Plants have been recognized as a natural source of drugs and medicine since distant prehistoric times. Diverse cultures have used plants for medicine and ritual.</td>
<td>Chapter 21.</td>
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Technology has now enabled engineering plants to produce pharmaceuticals to immunize against disease, produce new drugs such as Taxol for cancer, and to create more effective and cost variants of drugs.

Plants as Chemical Factories. Plants have a diverse capacity to produce chemical substances some of which can substitute for nonrenewable petroleum-derived materials. There are large emerging industries that are producing renewable fuels, plastics, and chemicals from crops.

*During the last two lectures the instructors will engage the class with new illustrative materials that provide a synthesis of the semester’s presentations. For a general education class, this course has the broad goal of providing the scientific perspective necessary to understand the issues and controversies associated with providing for the human population. The instructors will pose questions to the class and create discussion of fact chains to examine how the biology and science of plants has enabled today’s and tomorrow’s population, and how this will impact the lives the students over the next decades.

These Socratic discussions will provide the instructors and students an opportunity to create knowledge space to bring the class and its content into a broader understanding and evaluation. These two discussion days will provide the broader impact and summary wrap up that for general education classes creates the long-term perspective that the students can carry forward into their lives as consumers and informed citizens.

**Bibliography**
The required text will be available. Disclosure, although one of the instructors is a coauthor of the text book (i.e., Eliot Herman) all payments to Dr. Herman have been waived and therefore he receives no financial benefit from the purchase of this text. Each student will be required to acquire one additional book for their required essay to meet the writing requirement. All writing assignment books will be easily available in both electronic and paperback formats.

**Classroom Behavior Policy**
To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, reading a newspaper, making phone calls, web surfing, etc.). Students are welcome to use laptops and tablets for note taking during class. No electronic devices will be permitted to be used during tests. A large fraction of class materials will be available prior to the lectures on D2L. Students are welcome to download these materials and use these in class on their devices for annotation.

**Threatening Behavior Policy**
The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any
member of the University community, including to oneself. See http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students.

Notification of Objectionable Materials
This course encompasses subjects including food, agriculture, biotechnology that is often in the news and has many opinions. There may be topics or opinions expressed by others in the class that may be deemed offensive by some students. This is part of a university education. Students are expected to make-up their own minds on how they feel about different topics, but it is expected that they will do so after listening to information from differing viewpoints.

Accessibility and Accommodations
Our goal in this classroom is that learning experiences be as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, please let me know immediately so that we can discuss options. You are also welcome to contact the Disability Resource Center (520-621-3268) to establish reasonable accommodations. For additional information on the Disability Resource Center and reasonable accommodations, please visit http://drc.arizona.edu.

If you have reasonable accommodations, 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.

Please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable.

Code of Academic Integrity
Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of individual independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog. See http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity.

The University Libraries have some excellent tips for avoiding plagiarism, available at http://www.library.arizona.edu/help/tutorials/plagiarism/index.html.

Selling class notes and/or other course materials to other students or to a third party for resale is not permitted without the instructors express written consent. Violations to this and other course rules are subject to the Code of Academic Integrity and may result in course sanctions. Additionally, students who use D2L or UA e-mail to sell or buy these copyrighted materials are subject to Code of Conduct Violations for misuse of student e-mail addresses. This conduct may also constitute copyright infringement.

UA Nondiscrimination and Anti-Harassment Policy
The University is committed to creating and maintaining an environment free of discrimination; see http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy

Our classroom is a place where everyone is encouraged to express well-formed opinions and their reasons for those opinions. We also want to create a tolerant and open environment where such opinions can be expressed without resorting to bullying or discrimination of others.

Additional Resources for Students
UA Academic policies and procedures are available at http://catalog.arizona.edu/policies.

Student Assistance and Advocacy information is available at http://deanofstudents.arizona.edu/student-assistance/students/student-assistance
Confidentiality of Student Records
http://www.registrar.arizona.edu/ferpa/default.htm

Subject to Change Statement
Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructors. All course materials will be posted on D2L and important notices emailed to the class notifying all to look at D2L.