

**Department of Biology, University of Nebraska at Kearney  
Fall 2018**

**COURSE OBJECTIVES AND SYLLABUS FOR  
Biology 830\_05 – Sustainable Agriculture**

**Course Prefix:** BIOL 830  
**Section:** 5  
Online  
**Course Title:** Sustainable Agriculture  
**Credit Hours:** 3  
**Prerequisites:** None  
**Professor:** **Muhammad Saleem, PhD**  
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**Department Chair:** **Dr. Julie Shaffer**  
BHS 335B  
**Phone:** (308) 865-8661  
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**Course description:** basic concepts in food production, sustainable agriculture, biotechnology, genetic engineering, plant health, soil science, and climate change, etc. How can we use biotechnological approaches to develop a sustainable agriculture?

**Students' learning objectives:**

In BIOL 830\_05, following key concepts will be covered and will contribute to students learning (as taken from Maarten J. Chrispeels and Paul Gepts, 2017):

- the development, physiology, and nutrition of plants
- human nutrition and food safety
- photosynthesis and energy transformations
- genetics, molecular biology, and genomics, approaches used in modern crop breeding
- crop domestication and plant breeding
- soil ecosystems
- the biotic (animal pests, diseases, and weeds) and abiotic (drought, flooding, temperature extremes, and soil degradation) stresses that limit crop production
- technological advances and how new innovations (equipment, chemical products, and improved plant varieties) reach farmers and eventually affect what we eat
- plants as sources of pharmaceuticals and specialty chemicals

Although publicized in the controversies surrounding "genetically modified organisms" (GMOs), the

applications of modern biotechnology to agriculture extend far beyond GMOs, and include crop improvements that rely on knowledge of the plant's genomes and its analysis by bioinformatics. This unifying theme of the text is stressed in coverage of a number of issues that will be discussed throughout this course, including:

- how crop plant breeders look for specific traits to solve practical problems
- genetic engineering of crops as a useful way to supplement conventional plant breeding
- the vital contributions of developing countries and their smallhold farmers, and the unique challenges facing them

Challenging and controversial topics such as the safety of pesticides and GMOs, the increasing demand for animal products and the stresses this puts on agricultural output, organic farming and foods, and patenting new crop varieties are will be studied in a balanced way for a broader learning.

**Text book:**

Plants, Genes, and Agriculture; Sustainability through Biotechnology. First Edition (2017), Edited by Maarten J. Chrispeels and Paul Gepts

There might be some other lectures may include related documentaries, selected/suggested by Dr. Saleem or students.

**Contents and syllabus:**

**Lecture Schedule**

Week	Date	Topics	Deadlines
1	08/20	<b>Chapter 1. The Human Population and Its Food Supply in the 21st Century</b>	
		1.1 Hunger and Malnutrition Persist in a World of Plenty	
		1.3 By How Much Does the Food Supply Need to Increase to Satisfy Future Demand?	
		1.4 Agriculture Must Become More Sustainable in the Future	
		1.5 An Uncertain Climate Presents Challenges to Food Production	
		1.6 Urbanization and Rising Living Standards Are Changing the Demand for Agricultural Products and the Way They Are Brought to Market	
		BOX 1.1 Food Deserts in America	
		1.7 Government Policies Play Pivotal Roles in Global Food Production	
		1.8 Agricultural Research Is Vital If We Are to Maintain a Secure Food Supply	
		BOX 1.2 International Agricultural Research Institutes of the CGIAR Consortium	
		1.9 Can Other Agricultural Methods and Policies Contribute to Feeding the Population?	
		1.10 Biotechnology Is Crucial for the Future of Food Production	
2	08/27	<b>Chapter 2. A Changing Global Food System: One Hundred Centuries of Agriculture</b>	
<i>I will upload a PowerPoint lecture as an alternative for this chapter.</i>			
3	09/3	<b>Chapter 3. Plants in Human Nutrition, Diet, and Health</b>	

- 3.2 Carbohydrates Are the Principal Source of Energy in the Human Diet
- 3.3 Fats Are a Source of Energy, Structural Components, and Essential Nutrients
- 3.4 Diets High in Energy Are Linked to Major Diseases
- 3.6 Vitamins Are Small Molecules That Plants Can Make, but Humans and Other Animals Generally Cannot
- 3.8 Plants Produce Bioactive Molecules that Can Affect Human Health
- 3.9 The Consequences of Nutritional Deficiencies Can Be Severe and Long Lasting
- 3.10 Millions of Healthy Vegetarians and Vegans Are Living Proof that Animal Products Are Not a Necessary Component of the Human Diet
- 3.11 Are Organically Grown Plants and Products from Animals Fed with Organic Feed Worth the Additional Price?
- 3.12 The Intestinal Microbiome Significantly Influences Health

**4**                      **09/10**                      **Chapter 4. Genes, Genomics, and Molecular Biology: The Basis of Modern Crop Improvement**

- 4.1 Traits Are Inherited from One Generation to the Next
- 4.2 Genetic Information Is Replicated and Passed to New Cells during Cell Division
- BOX 4.2 Chromosomes, Chromatids, and Meiosis
- 4.3 Genes Are Made of DNA
- 4.4 Gene Expression Involves RNA Synthesis Followed by Protein Synthesis
- 4.5 Gene Expression Is a Highly Regulated Process
- 4.6 Mutations Are Changes in Genes
- 4.7 Much of the Genome's DNA Does Not Code for Proteins
- 4.8 DNA Can Be Manipulated in the Laboratory Using Tools from Nature
- 4.9 Creating GE Plants Depends on the Application of Naturally Occurring Horizontal Gene Transfer
- BOX 4.3 Selectable Markers
- 4.10 Genome Sequencing and Bioinformatics Are Important Tools for Plant Biologists and Plant Breeders
- 4.11 Gene Editing Technologies Allow Us to Make Targeted Changes in an Organism's DNA

**5**                      **09/17**                      **Chapter 5. Growth and Development: From Fertilized Egg Cell to Flowering Plant**

- 5.1 The Plant Body Is Made Up of Cells, Tissues, and Organs
- BOX 5.1 The Structures of a Living Plant Cell
- BOX 5.2 Plant Tissue Systems and Cell Types
- BOX 5.3 Plant Hormones
- 5.4 In the First Stage of Development, Fertilized Egg Cells Develop into Embryos
- 5.5 Deposition of Food Reserves in Seeds Is an Important Aspect of Crop Yield
- 5.6 Maturation, Quiescence, and Dormancy Are Important Aspects of Seed Development
- 5.7 Formation of the Vegetative Body Is the Second Stage of Plant Development
- 5.8 Secondary Growth Produces New Vascular Tissues and Results in the Formation of Wood
- 5.9 Reproduction Involves the Formation of Flowers with Male and Female Organs
- 5.10 Fruits Help Plants Disperse Their Seeds
- 5.11 Developmental Mutants Are an Important Source of Variability to Create New Crop Varieties

**6**                      **9/24**                      **Chapter 6. Converting Solar Energy into Crop Production**

- BOX 6.1 Efficiency of Food Production from Solar Energy to People
- 6.1 Photosynthetic Membranes Convert Light Energy to Chemical Energy
- 6.2 In Photosynthetic Carbon Metabolism, Chemical Energy Is Used to Convert CO<sub>2</sub> to Carbohydrates
- 6.4 Plants Gain CO<sub>2</sub> at the Cost of Water Loss
- 6.5 Plants Make a Dynamic Trade-off of Photosynthetic Efficiency for Photoprotection
- 6.7 How Efficiently Can Photosynthesis Convert Solar Energy into Biomass?

- 6.8 Opportunities Exist for Improving the Efficiency of Photosynthesis
- 6.9 Global Climate Change Interacts with Global Photosynthesis

**7**                      **10/01**                      **Chapter 7. The Domestication of Our Food Crops**

- 7.1 Wheat Was Domesticated in the Near East
- 7.2 Rice Was Domesticated in Asia and Western Africa
- 7.3 Maize and Beans Were Domesticated in the Americas
- 7.4 Domestication Is Accelerated Evolution Involving Relatively Few Genes
- 7.5 Crop Evolution Was Marked by Genetic Bottlenecks That Decreased Diversity
- BOX 7.1 Genetic Uniformity and the Irish Potato Famine
- 7.6 Hybridization Plays a Role in the Appearance of New Crops, the Modification of Existing Crops, and the Development of Some Troublesome Weeds
- 7.7 Polyploidy Led to New Crops and New Traits
- 7.8 Sequencing Crop Plant Genomes Provides Insights into Plant Evolution

**8**                      10/08                      **MID-TERM EXAM**

**9**                      **10/15**                      **Chapter 8. From Classical Plant Breeding to Molecular Crop Improvement**

- 8.1 Plant Breeders Have a Long Wish List
- 8.2 Plant Breeding Involves Introduction of Genetic Diversity, Hybridization, and Selection of New Gene Combinations
- BOX 8.1 Who Owns the World's Genetic Resources?
- 8.4 The Breeding Method Chosen Depends on the Pollination System of the Crop
- 8.5 F1 Hybrids Yield Bumper Crops
- 8.6 Backcrossing Comes as Close as Possible to Manipulating Single Genes via Sexual Reproduction
- 8.7 Quantitative Traits Are More Complex to Manipulate Than Qualitative Traits
- 8.8 The Green Revolution Used Classical Plant Breeding Methods to Increase Wheat and Rice Yields
- 8.9 Tissue and Cell Culture Techniques Facilitate Plant Breeding
- 8.10 The Technologies of Gene Cloning and Plant Transformation Are Powerful Tools to Create GE crops
- 8.11 Marker-assisted Breeding Helps Transfer Major Genes
- 8.13 High-Throughput Trait Measurement Facilitates Phenotyping for Crop Breeding

**10**                      **10/22**                      **Chapter 9. Plant Propagation by Seeds and Vegetative Processes**

- 9.1 Commercial Seed Production Is Often Distinct from Crop Production
- BOX 9.1 Where Do the Seeds to Grow Seedless Watermelons Come From?
- 9.2 Seed Certification Programs Guarantee and Preserve Seed Quality
- 9.3 Saving Seeds Securely Is an Important Aspect of Agriculture in Developing Countries
- BOX 9.2 Storing Seed for the Next Season: Challenges Faced By African Farmers
- 9.4 Seed Germination, Seedling Establishment, and Seed Treatments Are Important Agronomic Variables
- 9.5 Enhancing Microbial Biofertilizers in the Soil Is an Important Technology for Crop Production
- 9.6 Seed Banks Preserve Genetic Diversity for the Future
- 9.7 Sterile Tissue Culture Is Used for Micropropagation and the Production of Somatic Embryos
- 9.8 Grafting Is Widely Used in the Fruit Industry to Propagate Superior Varieties
- 9.9 Apomixis Is a Unique Way in which Some Plant Species Reproduce

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**11**                      **10/29**                      **Chapter 10. Innovations in Agriculture: How Farm Technologies Are Developed and How They Reach Farmers**

- 10.1 Biological and Technological Innovations Have Improved Farming Practices since the Early Days of Agriculture
- BOX 10.1 Synergy between Plant Breeding and Technology Development

- BOX 10.2 The Agricultural Services Industry
- 10.2 Innovations in Agriculture Require Substantial Research in Many Fields
- 10.3 Patents Stimulate Invention and Improvements
- 10.4 Farmers Obtain Seeds in Different Ways
- 10.5 Minor Crops and New Production Methods Are Important
- 10.6 Agricultural Technologies and Practices Are Subject to Oversight and Regulation

**12**                      **11/5**                      **Chapter 11. Soil Ecosystems, Plant Nutrition, and Nutrient Cycling**

- 11.1 Soil Ecosystems Are Fundamental to Agriculture
- 11.2 Particles Created by Weathering Are the Medium of Soil Ecosystems
- 11.3 Living Organisms and Their Remains Are Important Components of Soil Ecosystems
- 11.4 Plants Need Six Mineral Elements in Large Amounts and Eight Others in Small Amounts
- 11.5 Productivity May Be Limited by the Availability of Soil Water and Nutrients
- 11.6 Soil Organic Matter Is the Key Determinant of Soil Fertility
- 11.7 Roots Are the Foundation of Soil Food Webs and Soil Adhesion
- 11.8 Phosphorus Is the Rock-Derived Nutrient That Most Commonly Limits Crop Productivity
- BOX 11.2 Terra Preta Do Indio
- 11.9 Nitrogen-fixing Bacteria and Industrial Nitrogen Fixation Drive the Nitrogen Cycle
- 11.10 Mycorrhizae Are Plant-Fungi Mutualisms That Help Plants Acquire Nutrients

**13**                      **11/12**                      **Chapter 12, 13, 14. Biotic Challenges: selected portions**

- 12.2 Weeds Interfere with Crop Plant Growth
- 12.3 Weed Control Is Achieved by Cultural, Mechanical, Biological, and Chemical Practices
- 12.7 Herbicide Resistance and a Lack of New Herbicides Are Challenges to Weed Control
- 13.1 Microbial Infections Diminish Crop Yields, but Plants Fight Back
- 13.9 Resistance to Pathogens Can Be Introduced into Plants by Breeding and Genetic Engineering
- 14.3 Plants Have Chemical Defenses against Pests
- 14.4 Improved Cultural Practices Can Help Control Pests
- 14.5 Integrated Pest Management Can Control Outbreaks
- 14.9 Evolution Keeps Chemists, Plant Breeders, and Molecular Biologists Busy

**14**                      **11/19**                      **Chapter 15. Abiotic Stresses and How They Affect Crop Yield**

- 15.1 Plants Sense Abiotic Stresses and Respond to Them
- 15.2 Plant Growth Depends on an Active Transpiration Stream
- BOX 15.1 The Ogallala Aquifer
- BOX 15.2 Water Potential, Osmosis, and Turgor Pressure
- 15.3 The Molecular Responses to Water Deficit Involve Signals from the Root
- 15.4 Too Much Water Depletes Oxygen in the Roots and Leads to Cell Death
- 15.5 Crops Experience Osmotic Stress and Sodium Toxicity
- 15.6 Plants Sequester Toxic Ions in Vacuoles
- 15.7 Heat Stress During Reproductive Growth Severely Diminishes Crop Yield
- 15.8 Many Crop Plants That Originated in Tropical Regions Are Sensitive to Cold
- 15.9 The Crops That Feed Humanity Are Not Well Adapted to Alkaline or Acidic Soils
- 15.10 Agricultural Practices and Global Climate Change May Exacerbate Abiotic Stresses

**15**                      **11/26**                      **Chapter 16-17:**

- 16.2 Herbicide-tolerant GE Crops Facilitate Weed Management
- 16.3 Genetic Engineering of Insect Resistance Decreases Pesticide Use on Several Major Crops
- 16.4 Alleviating Water-deficit Stress Is an Increasingly Important Goal of Crop Improvement

- 16.5 Common Bean Provides an Example of Protecting against Virus
- 16.6 Uptake and Assimilation of Nitrogen Can Be Enhanced by Genetic Transformation
- 16.7 Phosphate Uptake Can Be Improved by Transgenic and Traditional Approaches
- 16.8 Pod Shatter-resistant Canola Prevents Seed Losses and Increases Yield
- 16.9 Genetically Engineered Forest Trees Are a New Frontier in Biotechnology
- 16.10 Male-sterile Lines and Fertility-restorer Genes Facilitate Hybrid Seed Production

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12/3

**FINAL EXAM**

**6:00-8:00 pm**

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**Grading:** Grades will be assigned using the standard grading scale for the Department of Biology, as follows: A (93-100%), A- (90-92%), B+ (88-89%), B (83-87%), B- (80-82%), C+ (78-79%), C (73-77%), C- (70-72%), D+ (68-69%), D (63-67%), D- (60-62%), and F (below 60%).

#### **Course Policies-**

There will be quizzes, essays, and other assignments that will make up the final grade, in addition, to course exams.

**\*Policy on plagiarism:** Anyone caught plagiarizing any exercise will receive a 0 for that exercise and will be referred to the Biology Department Chair and to the Senior Vice Chancellor for Academic Affairs and Student Affairs for possible expulsion from UNK.

**\*Policy on incomplete:** To be considered for an incomplete in Biology **830\_05:**

1. You must submit the reasons you cannot complete the scheduled work. This must include a copy of your class schedule and description of your responsibilities outside the classroom. This should be done in writing and include confirmation from your employer or doctor when appropriate.
  2. You must specify the assignments you have missed and a schedule of plans to complete them.
  3. You must submit a copy of the above information to the Chair of the Department of Biology and the Dean of Natural and Social Sciences.
  4. Upon completion of items 1-3, your request for an incomplete will be considered.
- Unless your circumstance is quite remarkable, do not consider an incomplete.

\*Tests and quizzes will not be rescheduled without valid reason.

#### **Students with Disabilities or Students Who are Pregnant**

It is the policy of the University of Nebraska at Kearney to provide flexible, individualized, and reasonable accommodations to students with documented disabilities or students who are pregnant. To receive accommodation services for a disability, students must be registered with UNK Disabilities Services. Contact David Brandt, in the Academic Success Office, 163 Memorial Student Affairs Building, 308-865-8214 or by email [brandtdl@unk.edu](mailto:brandtdl@unk.edu) to register. For students needing accommodation due to pregnancy, you need to contact Student Health. (The following link provides information for students and faculty regarding pregnancy rights. <http://www.nwlc.org/resource/pregnant-and-parenting-students-rights-faqs-college-and-graduate-students>) Students with disabilities or students who are pregnant need to provide the proper documentation from Disability Services or Student Health to their faculty members in order to receive academic accommodations. Anyone who feels they were not afforded these rights, should contact the campus Title IX/ADA Officer at 308-865-8655.

Attached is the link to the above statement for your

convenience. <http://www.unk.edu/offices/disabilityservices.aspx?id=13673>

#### **Reporting sexual harassment, violence and assault**

Any students who experience sexual assault, coercion, domestic violence, dating violence, rape, and/or

stalking, is encouraged to seek help and report to concerned authorities immediately. Reporting these incidences enables the University to immediately provide support to the victim student(s), and to take legitimate action to check recurrence of sexual crimes on the campus community. The concerned authorities will keep your identity confidential at the highest level. You should also keep in mind that all university employees are required to report all incidents that involve sexual harassment. In such case, student is encouraged to contact following:

**UNK Police Department**

308.865.8911 or 308.627.4811

Conducts unbiased investigations with respect and dignity. Can assist with changing academic, living, transportation, and working situations

**Title IX Coordinator**

308.865.8655

Takes timely action to investigate sexual harassment/violence and addresses the impact on students.

**UNK Conduct Officer**

308.865.1619

Investigates reports of assault / misconduct while assisting victims and alleged offenders with understanding the Student Code of Conduct.

**Local Domestic Violence, Sexual Assault Advocacy Agency** 308-237-2599

Additional information can be accessed from UNK website:

<https://www.unk.edu/about/compliance/aaeo/respect/resources.php>