SYLLABUS
PLANT GENETICS AND CROP IMPROVEMENT
Maymester, 2018

Course Number: CSES 5100/6100

Course Title: PLANT GENETICS AND CROP IMPROVEMENT

Credit Hours: 3 Credit hours

Prerequisites: BIOL 1030 (Organismal Biology, the second course of the undergraduate Biology series)

Corequisites: None

Instructor: David Weaver
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Office hours – You can contact me anytime

Date Syllabus Revised: March 1, 2018

Textbook: Due to difficulties in acquiring the text in China, we will not be using a text. However, the on-campus text used in Auburn is *Principles of Plant Genetics and Breeding* by George Acquaah (available in the Bookstore, about $90). We do not go through material in the same order as the book, so be prepared for that. This book is intended as a reference, for reading and further study.

Canvas: The link to enroll yourself in Catalog Canvas for this course is

http://coag.catalog.auburn.edu/courses/agcsesplantgen01

Other references: *Principles of Cultivar Development*, *Vol. 1 Theory and Technique* by W. R. Fehr

Principles of Cultivar Development, *Vol. 2 Crop Species* edited by W. R. Fehr

Breeding Field Crops by J. M. Poehlman and D. Sleper

Principles of Plant Breeding by R. W. Allard

Flower and Vegetable Breeding by Leslie

Principles of Crop Improvement by N.W. Simmonds and J. Smart

Course description:

Principles related to mendelian, population, and molecular genetics of plants including inheritance of qualitative and quantitative traits, and plant transformation. Genetic improvement of crop plants including heritability, role of environment, pedigree selection, recurrent selection, the backcross method, genetic engineering and marker-assisted selection.

In addition to these topics, Dr. Weining Song, a wheat genomicist and professor at NW A&FU will lecture to the class for about 6 days on the topic of "Dawn of Civilization – The Domestication of Plants and Animals". Dr. Song is an expert in this area, having traveled extensively in the Levant. His lectures are highly informative and up to date on the origins of agriculture in the Levant and Far East. Dr. Song's class usually meets four to six days in the afternoon.

Course goals: To help students learn and understand

1) basic principles of mendelian (transmission) genetics
2) basic principles of molecular (functional) genetics
3) historical aspects of crop genetics and improvement
4) why and how crops are improved
5) how crop improvement is affected by the environment
6) how crop improvement is affected by genetics
7) the role of statistics, plant pathology and other disciplines in crop improvement

GRADING POLICY (graduate and undergraduate students CSES 5100/6100)

Two 1-hour exams @ 100 pts	=	200 pts
Final exam @ 100 pts	=	100 pts
Homework	=	100 pts
Total	=	400 pts

The two 1-hour exams will be given approximately 1/3 and 2/3 the way through the four-week teaching period. The final exam will be given after our return to the U.S., during the week following our return, at a mutually agreed upon time.

Grades will be assigned according to a ten-point scale, i. e., divide the total points accumulated by the total possible (and grades will be assigned according to the following percentage:

90 or above	= A
80	= B
70	= C
60	= D
below 60	= F

Each homework assignment will be assigned a due date. There is some flexibility in turning in assignments, but if you do not stay on schedule you can get behind very quickly.

Help sessions will be scheduled as needed, and will be scheduled to accommodate everyone's needs. The purpose of these sessions will be primarily to help with questions regarding homework. I urge you to work together as a group on the homework. Explaining an answer to your fellow students is the best way to gain understanding.

Class attendance is strongly encouraged. You simply cannot do well in this class without regular attendance. There will be no official penalties for poor attendance, other than those you impose upon yourself by missing class.

To do well in this class you need to do four things: Listen to the lectures, read materials assigned in the text and elsewhere, participate in class discussions, and attend class regularly.

Academic dishonesty is an offense that will be reported to the Academic Honesty Committee. This includes copying or otherwise submitting homework that was not done by you or plagiarism of any sort. See

https://sites.auburn.edu/admin/universitypolicies/Policies/AcademicHonestyCode.pdf

Students needing special accommodations should contact Dr. Kelly Haynes, Director of the Program for Students with Disabilities, 1232 Haley Center. If you have a disability that is already recognized by the Program for Students with Disabilities, please see me within the first week of class.

COURSE OUTLINE

DNA – The Genetic Code

- What is genetics?
- DNA - the molecule of heredity
- Structure of DNA
- From DNA to phenotype
- The genetic code
- Genetic mutation
- Effect of environment on phenotype

Transmission Genetics: Heritage from Mendel

- History of Mendel's studies
- Molecular analysis of Mendel's work
- Mendel's experiments in modern context
- Further analysis of Mendel's work
- The testcross
- Extending Mendel's model to two or more genes
- Learning to use rules of probability to predict genetic results
- Genetic segregation in human pedigrees
- Allelic interactions other than dominance
- Interactions between genes – Epistasis
- Qualitative vs. Quantitative traits

Chromosomal Basis of Heredity

- Chromosome number
- Mitosis
- Meiosis
- Variations in chromosome numbers in plants
    - Polyploids
    - Euploids
- Autosomes and sex-chromosomes
- More probability and statistics

Gene Linkage and Genetic Mapping

- Genes are located on chromosomes
- Expression of linkage relationships
- Linkage maps – classical and molecular

Population Genetics

- What is a population?
- Hardy-Weinberg principle
- Using highly polymorphic DNA sequences in DNA typing
- Inbreeding and genetic consequences of self-pollination in plants

Genetics of Complex traits

- The nature of complex (quantitative) traits
- Calculation of variance
- Sources of variation in nature
- Modeling the variance
- Using variances to determine heritability
- Methods of estimating heritability
- Using heritability estimates to predict genetic gain

Genetic Diversity

- Origin of diversity in nature
- Germplasm collection, introduction and storage
- Consequences of insufficient genetic diversity

Parent Selection

- Factors influencing parent selection
- Sources of parental germplasm

Breeding Methods for Self-pollinated Crops

- Mass Selection
- Bulk Method
- Pedigree Method
- Single-Seed Descent
- Early Generation Testing

The Backcross Method

- Backcrossing a dominant trait
- Backcrossing a recessive trait
- Use of genomic-assisted backcrossing

Types of cultivars

- Pure lines
- F_1 hybrids
- Open-pollinated
- Synthetics
- Clonal
- Multilines

Breeding Methods for Cross-pollinated Crops

- Recurrent Selection theory
- Phenotypic Recurrent Selection
- Genotypic Recurrent Selection

Mutation breeding

- Mutagenic agents
- Types of mutations
- Plant material to be treated, other factors

Heterosis

- Genetic basis of heterosis
- Implications on cultivar development

Development of hybrid cultivars

- Evaluation of combining ability
- Prediction of double-cross hybrid performance
- Production of hybrids through the use of cytoplasmic-genetic male-sterility systems

Breeding for pest resistance

- Specific resistance vs. general resistance
- Mechanisms of resistance
- Tolerance
- Use and deployment of resistance genes

Plant transformation and Gentically Modified Organisms in Agriculture

- Role of *A. tumefaciens* in GMO development
- Engineering of plasmids

Molecular Markers and Their Role in Plant Breeding

- Restriction fragment length polymorphisms (RFLP's)
- Amplified fragment length polymorphisms (AFLP’s)
- Simple Sequence Repeats (SSR’s)
- Single Nucleotide Polymorphisms (SNP’s)
- Development of population-specific marker systems
- Use of association mapping in marker systems