Applied Plant Breeding (APBI 318)
Winter 2018 TERM 1

Instructor

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Course Location and Times

Lecture/laboratory – MacMillan Building, Rm 342 9:30-11:00, Tuesdays and Thursdays

Course Description

This course will give students working knowledge of small-scale classical (e.g., non-biotechnological) plant breeding and associated issues (e.g., plant reproductive biology). It will use a hands-on, application-oriented approach to enhance student understanding of the techniques and procedures involved in managing seed inventories (i.e., seed production, storage), designing and implementing a simple plant breeding program, and evaluating the impact of selection on breeding populations and desired outcomes. [3-0-0]

Learning Outcomes

Upon successful completion of this course, the students should be able:

- To design and implement a simple plant breeding program;
- To predict the potential for successful plant improvement for a particular breeding objective, given the nature of the plant species and the genetic inheritance of the trait;
- To create and manage plant populations in terms of specific genetic composition;
- To develop genetic hypotheses and apply the appropriate statistical methods for their evaluation
- To process seed for either seed saving or part of a breeding project.

Course Reading List

There is no required text for this course. Instead, students will engage with a course-specific manual, supplemental readings, and the primary literature.

Suggested Library Resources (non-reserved):

<u>Textbooks:</u>

Allard, R.W. 1960. Principles of Plant Breeding, John Wiley and Sons, NY
Chahal, G.S. and Gosal S.S. 2002. Principles and Procedures of Plant Breeding. Biotechnological and conventional approaches. Alpha Science, Pangbourne, UK
Falconer, D.S. 1981. Introduction to Quantitative Genetics. 2nd ed. Longman, NY
Raven, P.H. et al. 1992. Biology of Plants. 5th ed. Worth Publishers
Simmonds, N.W. 1979. Principles of Crop Improvement, Longman, London

<u>Journals</u>

Theoretical and Applied Genetics	Nature Biotechnology
Genome	Plant Cell Reports
Plant Breeding	Molecular and General Genetics
Plant Cell, Tissue and Organ Culture	Can. J. Plant Science
J. American Soc. Hort Science	HortScience
Crop Science	Heredity
Experimental Agriculture	Euphytica

There are also many relevant resource sites on the Internet. However, the credibility of the content must be assessed considering the expertise and agenda of the source.

Course Format:
The course will include lectures, writing assignments, class discussions, computer simulation, a term project, and laboratories.

Activities/labs (support information will be posted on Canvas)
GreenGenes Breeding Simulation, "Two Minute Talks", Pollen viability, Seed viability, Tissue culture, Seed harvest, cleaning, and storage.

Evaluation Procedures:
Students will be evaluated based on their comprehension of course material, participation, and their ability to apply this information in addressing relevant problems in plant breeding and crop improvement.

Critical Thinking/Word problem Assignments (3x written; 1x oral @ 5% each)	20%
GreenGenes Project	20%
Laboratory Reports (4@2.5% each)	10%
Participation	10%
Term Project	40%
Crossword Puzzle (Bonus)	up to 5%
Overall:	100%

Academic Honesty
Academic honesty is a core value of scholarship. Cheating and plagiarism (including both presenting the work of others as your own and self-plagiarism), are serious academic offences that are taken very seriously in Land & Food Systems. By registering for courses at UBC, students have initiated a contract with the university that they will abide by the rules of the institution. It is the student's responsibility to inform themselves of the University regulations. Definitions of Academic Misconduct can be found on the following website:
http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,54,111,959#10894

If you are unsure of whether you're properly citing references, please ask your instructor for clarification before the assignment is submitted. Improper citation will result in academic discipline.

Critical Thinking Assignments

Assignment 1 (written): Topic: My perfect plant.

In under 1000 words, describe your perfect plant, its attributes, phenotypes, capabilities, and uses. Knowing there are genetic engineering tools that allow trans-species genetic exchange, you are free to dream big. If you have seen a particular trait in some other biological organism, it can be included. However, you are bound by all other laws of nature (e.g., no anti-gravity potatoes). Submit a .doc or .docx file via Canvas.

Assignment 2: Topic TBD

Assignment 3: Word problems

Complete the assigned genetic word problems. Complete in sufficient detail to allow me to understand how you answered the problem. Show all calculations, summaries, hypotheses, statistics, and conclusions.

Assignment 4: Two Minute Talk

Each student will present 1 Two Minute Talk. Topics will be chosen by random draw (unless someone feels drawn to a particular topic). You are allowed 1 slide for visual support. This is an oral presentation where eye contact and interaction with the audience is important; it is not reading a speech.

Genegenes Breeding Simulation:

Each student will receive a unique web-based breeding problem designed to emulate an actual breeding program but without the time required to grow populations. You will be asked to determine the genetic control of simply inherited traits, identification of interactions between genes (epistasis) and calculation of co-segregation (linkage) if present. Additional information will be posted on Canvas.

Laboratory Reports:

Following each laboratory exercise, students will submit, via Canvas, a report summarizing their experience as instructed.

Participation:

Each student is expected to contribute to the classroom discussions in a way that demonstrates engagement and curiosity.

Term Project Description

Each student will select a crop species (that is or could be grown at the UBC Farm) and write a paper that details the development of a breeding program for it. Please have your choice of crop ready by October X. I will go through them and check for duplications so that a final decision can be agreed upon by October X. It would be a good idea to have at least one or two alternative crops in mind in case of duplication.

Your term project should include the following sections:

- Title page: Title, name and student number; executive summary of project (~1/2 page); and 6-8 key words (10%).

- Introduction (~1-2 pages) (20%)
    - Economic (e.g., sales, value added), environmental (e.g., ecological services), and/or social (e.g., pedagogy, ritual) importance of growing this crop compared to other similar crops (10%);
    - Environmental requirements for crop production (i.e., feasibility assessment) (5%);
    - Extent of its current cultivation (local, regional, national, and international) (5%);
- Literature review (~1-3 pages) Relevant literature, including the most recent publications (last 5 years) should be consulted and cited as appropriate (20%).
    - Basic botany including family, order, class, genus, species, etc. with scientific and common names; characterization of flower (e.g., perfect), fruit (e.g., capsule), and pollen (e.g., bi-nucleate) (5%).
    - Evolutionary background of the crop and cytogenetic relationship with its related wild/cultivated species (2.5%);
    - If known, the genetic control of important traits (1.5%);
    - Pertinent Canadian and International breeding programs including their locations (1%);
    - Current commercial breeding objectives (5%);
    - Reproduction system (i.e., outcrosser or selfer) and typical breeding methods used on this crop (5%).
- Breeding program description (? pages) (45%)
    - Vision: detail your ideal plant/cultivar profile (10%);
    - Variation: germplasm sources, cultivar/accession lists, and acquisition strategies (5%);
    - Techniques (5%)
    - Crossing techniques
    - Pollination control techniques (i.e., mechanical, spatial, temporal)
    - Description of the selection pressure environment relevant to your ideal cultivar
    - Seed harvest, cleaning, and storage techniques
    - Breeding strategy and selection criteria (15%)
    - General description of recommended breeding strategy (e.g., MS, Pedigree, SSD)
    - Planting design and isolation requirements
    - Year-by-year activities (e.g., when to increase heterozygosity, when to increase homozygosity, and when to select)
    - Seed production requirements (i.e., number of plants per generation required to achieve goals)
    - Cultivar stabilization and stock seed production procedures (10%)
- References (5%)

Course Schedule:

Date (Day),	Topic and Due dates
Week 1: Sept 4	Imagine Day (No Class)
Week 1: Sept 6	Course Introduction, Goals and Critical Thinking Student introductions and statement of goals
Week 2: Sept 11	Lecture: Pre-plant breeding, Plant domestication, Birth of Plant Breeding, Paradigm Shifts and controversies
Week 2: Sept 13	Lecture: Megasporogenesis Microsporogenesis and Pollen
Week 3: Sept 18	Pollen Lab
Week 3: Sept 20	Seed Trials and Cultivar Assessments at UBC Farm Seed cleaning at UBC Farm
Week 4: Sept 25	Seed Trials and Cultivar Assessments at UBC Farm Seed cleaning at UBC Farm
Week 4: Sept 27	Seed Trials and Cultivar Assessments at UBC Farm Seed cleaning at UBC Farm
Week 5: Oct 2	Lecture: Seed Physiology Class discussion Breeding Projects
Week 5: Oct 4	Lecture: Fertilization and Fruit
Week 6: Oct 9	Lecture: Pollination Systems
Week 6: Oct 11	Class discussion Breeding Projects
Week 7: Oct 16	Lecture: Qualitative genetics/Linkage Introduction to GreenGenes
Week 7: Oct 18	Lecture: Chi Square and Non-Normal Segregation, Linkage and Lethality
Week 8: Oct 23	Lecture: Epistasis
Week 8: Oct 25	Discussion: Genetic word problems
Week 9: Oct 30	Class discussion Breeding Projects
Week 9: Nov 1	Lecture: Lecture: Quantitative Genetics I: Population variance, allele frequency, variance and heritability
Week 10: Nov 6	Lecture: Lecture: Quantitative Genetics II: Inbreeding depression and heterosis

Week 10: Nov 8	Lecture: Breeding Self Pollinated Crops: Mass, Pure, Bulk Lecture: Breeding Cross Pollinated Crops (Pedigree, SSD, BC/Recurrent Selection, Hybrid) Class discussion Open Discussion
Week 11: Nov 13	**Out of Town**
Week 11: Nov 15	**Out of Town**
Week 12: Nov 20	Lecture: Genetic Engineering and Marker Assisted Selection Class discussion
Week 12: Nov 22	Lecture: Breeding for Disease Resistance Class discussion
Week 13: Nov 27	Lecture: Conducting Field Trials and Field Plot Technique Class discussion
Week 13: Nov 29	Lecture: Plant Breeding and Sustainability Class discussion Lecture: Food Production in 2168

APBI 318 Grading Rubric for 2-minute Talks

	Excellent	Good	Satisfactory	Unsatisfactory
Presentation and Communication	Clear speaking voice at ease with the audience Dressed for a presentation Makes eye contact with the audience Answers questions very well	Clear speaking voice Dressed for a presentation Answers questions well	Reading from PowerPoint or overhead Speaking too quickly or too slowly	Disorganized Unprepared
Use of Technology	PowerPoint or overheads clear with graphics or other usual visual tools Have a backup incase the technology fails	PowerPoint or overheads clear and easy to read Have a backup incase the technology fails	PowerPoint or overhead use: some spelling and grammar errors; print too small; points not clear	No PowerPoint or overhead use PowerPoint or overhead use that is sloppy i.e., spelling and grammatical errors
Overall Coherence of the Presentation	Presentation is well organized and has a clear introduction, meaningful substance, and concise ending/ conclusion	Presentation is well organized but lacks either a clear introduction, meaningful substance, or concise ending/ conclusion	Presentation has some organization but lacks a clear introduction, meaningful substance, and concise ending/ conclusion	Presentation is disorganized and without structure