Applied Plant Breeding (APBI 318)
Winter 2022 TERM 1/Online and Flipped

Instructor
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Course Format and Times
This course uses a flipped format meaning students are required to watch pre-recorded mini-lectures ahead of synchronous meetings and come prepared to discuss the topics covered in the recordings.

Synchronous meetings are held Tuesdays and Thursdays at 9:30-11:00 Vancouver Time

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, genetics). It will use an application-oriented approach to enhance student understanding of the techniques and procedures involved in reproductive biology (i.e., anatomy, morphology, fertilization, genetics), in implementing a simple plant breeding program, and in evaluating the impact of selection on breeding populations and desired outcomes.

Learning Outcomes
Upon successful completion of this course, the students should be able to:
- Design and implement a simple plant breeding program;
- 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;
- Create and manage plant populations in terms of specific genetic composition;
- Develop genetic hypotheses and apply the appropriate statistical methods for their evaluation;
- 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 and resources (posted on Canvas), supplemental readings, and the primary literature.

Suggested Library Resources (non-reserved):
Textbooks:
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

Journals

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 video recorded mini-lectures, synchronous discussions (recorded and posted), writing assignments, computer simulation, term project, and at-home laboratories.

Activities/labs (support information will be posted on Canvas)
GreenGenes Breeding Simulation, "2-minute Talks", and Seed harvest, cleaning, and viability testing.

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 (1x written and 3x word problems @ 5% each)	20%
GreenGenes Project	20%
Laboratory Reports (2@2.5% each)	5%
2-min Talks	15%
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.

Assignment 1: 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, please note 1) it must maintain the essence of a plant (e.g., no walking plants with legs) and 2) you are bound by all laws of nature (e.g., no anti-gravity potatoes 😉).

Assignments 2, 3 and 4: Genetic 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.

Greengenes 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:
My Seed Diary Parts I and II. See Assignment in Canvas for details.

2 min Talks:
See Assignment in Canvas for details.

Term Project Description
Each student will select a crop (that is or could be grown at in SW British Columbia) and write a paper that details the development of a breeding program for it. We will brainstorm ideas as a group but plan to have your choice of crop and breeding objective ready by October 18.

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),	Discussion Topic	Mini-lectures to Watch Before Synchronous Discussion
Week 1: Sept 6	Imagine Day (No Class)	
Week 1: Sept 8	Course Introduction, Goals and Critical Thinking Student introductions, goals, and favorite plant	Course Logistics
Week 2: Sept 13	Impacts of domestication and plant breeding	Introduction to Plant Breeding Important Historical Events
Week 2: Sept 15	Flowers and the female gametophyte	Flower Structure Megasporogenesis
Week 3: Sept 20	The male gametophyte and the cool world of pollen Assignment 1 Due: Topic: My perfect plant	Microsporogensis Pollen Overview Microspore Embryogenesis
Week 3: Sept 22	Sex, fertilization, and the consequences…. Discuss your perfect plants	Fertilization Seeds
Week 4: Sept 27	Fruit diversity and breeding	Fruit Types Seed Dispersal
Week 4: Sept 29	Seeds and early growth	Seed Physiology Seed Testing
Week 5: Oct 4	Practical seed cleaning	My Seed Diary Part I
Week 5: Oct 6	Class discussion Breeding Projects	
Week 6: Oct 11	Breeders work with natural breeding systems, until they don't….	Natural Breeding Systems Self Incompatibility Overview
Week 6: Oct 13		Self Incompatibility Morph and Dev Mech Self Incompatibility Genetic Mech Variants in the Reproductive Process

Week 7: **Oct 18**	Mendel and his genetics When things don't work out, linkage? Genetic Word Problem- Qualitative Inheritance Due	Introduction to Qualitative Inheritance Mendelian Genetics Chi Square Analysis Linkage and Recombination Three Point Test Cross Detecting Linkage
Week 7: **Oct 20**	When things really don't work out, lethality, epistasis, modifiers, oh my….	Altered Ratios Lethality Altered Ratios Epistasis Altered Ratios Modifiers
Week 8: **Oct 25**	Introduction to Greengenes Genetic Word Problems- Linkage and Epistasis Due	Greengenes Document Mastering Mendel's Magic
Week 8: **Oct 27**	Class discussion Breeding Projects	
Week 9: **Nov 1**	Dissecting complex traits, the quantitative way…. Greengenes Due	Introduction to Quantitative Inheritance Quantitative Distributions Number of Genes Formula Allelic Contributions
Week 9: **Nov 3**	Alleles are the basis of populations	Allelic Frequency Hardy Weinberg Equilibrium Population Equilibrium Effect of Selection on Allelic Frequency
Week 10: **Nov 8**	Populations are made up of individuals that breeders select…. And… The royals come to plants…	Variance Overview Genotypic Variance Model of Genotypic Variance Number of Genes Formula Heritability and Selection Pressure Inbreeding Depression Heterosis and Hybrid Vigour
Week 10: **Nov 10**	No Class- Winter Break	
Week 11: **Nov 15**	Breeding strategies for Self-Pollinated Crops	Breeding Schemes Overview Breeding Schemes Mass Selection Breeding Schemes Pure Line Breeding Schemes Bulk Method

Week 11: **Nov 17**	Breeding strategies for Cross Pollinated Crops	Breeding Schemes Pedigree Selection Breeding Schemes Single Seed Descent Breeding Schemes Backcross Breeding Combining Ability Recurrent Selection
Week 12: **Nov 22**	Doing the actual work in the field	Field Plot Technique Experimental Design
Week 12: **Nov 24**	Example breeding scenario: Breeding for Disease Resistance	Breeding for Disease Resistance Introduction Disease Development Vertical and Horizontal Resistance Disease Resistance Mechanisms Sources of Resistance Screening Techniques
Week 13: **Nov 29**	Example breeding scenario: Breeding for Disease Resistance (continued) 2 min Talks Due **(Dec 6)**	Breeding Strategies for Resistance Marker Assisted Selection for Resistance Somaclonal Variation Genetic Engineering for Resistance Managing for Disease Resistance
Week 13: **Dec 1**	Catch up day	
Week 14: **Dec 6**	Class wrap-up	2 min Talks