האוניברסיטה העברית בירושלים
THE HEBREW UNIVERSITY OF JERUSALEM

The Hebrew University of Jerusalem

Syllabus

Advanced Concepts In Crop Plant Breeding - 73554

Last update 24-03-2025

HU Credits: 2

Degree/Cycle: 2nd degree (Master)

Responsible Department: Genetics & Breeding

Academic year: 0

Semester: 2nd Semester

Teaching Languages: English

Campus: Rehovot

Course/Module Coordinator: Eyal Fridman

Coordinator Email: Eyal.Fridman@huji.mail.ac.il

Coordinator Office Hours: Monday-Wedensday, 14:00-16:00

Teaching Staff:

Dr. Eyal fridman,
Dr. Alexander Goldschmidt

Course/Module description:

The course will introduce students to key concepts in modern commercial breeding within the post-genomic and genome-editing eras. It will focus on methods for designing and utilizing diverse populations and modern biotechnology approaches. The course will cover various plant breeding methods and modern approaches that leverage molecular tools and genome editing, as well as their applications in crops. Principles of quantitative genetics will be taught, including the heritability of agronomic traits and the use of genetic markers, with a focus on non-additive inheritance, such as heterosis (hybrid vigor) and epistasis.
Students will learn about techniques for creating genetic variation, including mutagenesis, genetic editing, and manipulation of recombination for genetic mapping of agriculturally valuable traits. The course will also address planning principles for breeding projects, incorporating computational and molecular tools, as well as various techniques for genetic prediction and their respective advantages and disadvantages.
The complexity of yield in different environments will be explored, emphasizing the importance of understanding whole plant performance and agricultural management. Genetic models for detecting genotype-environment interactions, plasticity, and phenotypic stability will be examined. The course will also involve adaptation experiments and genomics to uncover the molecular basis of changes under adaptation and cultivation.
Additionally, the course will feature guest lectures from plant breeding companies that manage breeding programs

Course/Module aims:

See learning outcomes

Learning outcomes - On successful completion of this module, students should be able to:

Understanding of modern breeding approaches in the context of fundamental knowledge in breeding science. By the end of this course students will be able to:
1. Explain different techniques for creating genetic variation for the benefit of cultivation
2. Know methods for characterizing natural variation
3. Evaluate advantages and disadvantages of the different approaches in modern cultivation to choose an appropriate approach for the project
4. To plan a strategy of a breeding project for a trait or multiple traits
5. Plan a project to map and isolate molecular genetic variation of quantitative traits

Attendance requirements(%):
60

Teaching arrangement and method of instruction: Lectures

Course/Module Content:
2. Quantitative genetics of plants – variance and inheritance estimates, relationship between traits, breeder equation, introduction to genotype-phenotype relationship
3. Genetic basis for single and multi-loci traits - population structure, genetic-quantitative mapping, epistasis, linkage disequilibrium (LD) in genetic mapping and prediction
4. Yield breeding- Yield components, interrelationships between traits, compensation mechanisms, prediction of yield?
The lecture will provide a historical introspect into the development of modern breeding for yield approaches, highlighting the concepts of trait compensation. We will also cover the history of attempts for early yield prediction and breeding for yield trait components in industrial crops.
5. Non-additive inheritance - epistasis, cytonuclear interactions, heterosis (hybrid vigor)
6. Pangenome - Definitions, Test Cases, Identifying useful variants for breeding, success stories
7. Genomic selection - Theoretical basis, useful models for predicting and selecting for traits, test cases in different crops, how to use it
8. Transgenesis in breeding - Technology principles, different techniques, advantages and limitations, regulation, test cases, success versus failure
The lecture will provide a historical overview of the use of transgenic organisms in industrial breeding pipelines, highlighting both success and failure cases and reviewing the current state of the technology application.
9. Genetic editing - The technology, different techniques in genetic editing, and genome editing for new variation.
The lecture will briefly cover the CRISPR technology and then focus on its applications in plant breeding, discussing its potential, pros, and cons.
1. 10. Inter-species variation for gene manipulation, genetic editing to reproduce allelic variation from nature
11. Recombination in modern breeding - basic concepts, measurements of meiotic and mitotic recombination, manipulation of recombination by mutagenesis and genetic editing, uses in breeding and basic research
12. Plasticity and stability in crop breeding - estimates of stability and plasticity, genetic basis for stability and plasticity, genetic manipulations for stability and plasticity, tradeoffs between plasticity and stability - can they be broken?

13. Evolve and resequence (E&R) - principles, use of genomic and computational tools, test cases, use in plant and crop adaptation research
14. Breeding from the field - guest lectures from the seed industry

Required Reading:
Genetics and Analysis of Quantitative Traits (Michael Lynch and Bruce Walsh)

Additional Reading Material:

Grading Scheme:
Written / Oral / Practical Exam 90 %
Attendance / Participation in Field Excursion 10 %

Additional information: