RQ02018: PRINCIPLES OF PLANT GENETICS AND BREEDING

1. General information

- Term: 5
- Credits: **Total credits 3 (Lecture: 2.5 – Practice: 0.5)**
- **Self-study: 9** credits
- Credit hours for teaching and learning activities: 2 section per week (100 minute per section)
- Self-study: 135 periods (50 minutes each).
- Department conducting the course:
  - Department: Plant Genetics and Breeding
  - Faculty: Agronomy
- Kind of the course:

Foundation □		Fundamental □		Option 1 □		Option 2 □	
Compulsory □	Elective □	Compulsory ☒	Elective □	Compulsory □	Elective □	Compulsory □	Elective □

- Prerequisite course(s): None

2. Course objectives and expected learning outcomes

**** Course objectives*:**

- Knowledge: The course provides students with knowledge in classical and molecular concepts of genetics; basic concepts of Mendelian, quantitative, population, molecular, and evolutionary genetics. Mutagenesis in plant breeding; Application of genetic principles in the improvement of self- and cross-pollinated crops, hybrid cultivars and clonal cultivars;
- Skills: the course provides students with skills in assessment and selection of specific crops.
- Attitude: the course provides students with attitudes in a high sense of responsibility in work and study when given the opportunity.

**** Course expected learning outcomes***

Notation	**Course expected learning outcomes** After successfully completing this course, students are able to	**PLO performance criteria**
Knowledge		
CELO1	Apply crop science knowledge of genetics and breeding in horticulture and landscape design	1.1
CELO2	Apply techniques of assessment and plant breeding to build advanced technical procedures for production of horticulture	2.2
CELO3	Apply crop science knowledge of varieties/cultivars to maintain landscape.	3.4
Skills		
CELO4	Propose a strategy to develop horticultural varieties suitable to Vietnam's conditions.	7.3

Attitude		
CELO5	Perform to improve knowledge and capacity in professional work.	10.2

3. Course description

RQ02018. Principles of Plant Genetics and Breeding (Total credits 3: lecture 2.5 - practice 0.5 - self-study 9)

The course covers classical and molecular concepts of genetics; basic concepts of Mendelian, quantitative, population, molecular, and evolutionary genetics. Mutagenesis in plant breeding; Application of genetic principles to improvement of self- and cross-pollinated crops, hybrid cultivars and clonal cultivars;

4. Teaching and learning & assessment methods

CELOs	CELO1	CELO2	CELO3	CELO4	CELO5
Teaching and learning					
Lecturing	x	x	x	X	
Teaching through practical work	x	x			
Discussion	x	x	x	x	x
Assessment					
Rubric 1. Practical (20%)	x	x	x		
Rubric 2. Mid – term (20%)	x	x			
Rubric 3. Discussion (10%)	x	x	x	x	x
Rubric 4. Fianl exam (50%)	x	x	x	x	

5. Student tasks

- Learning attitude: students must attend all lectures in class and practice.
- Prepare for lectures, self-study: students must read or prepare materials related to the lesson in class under the guidance of the lecturer.
- Practice and work in groups: students complete practical exercises, write individual reports or in groups under the guidance of lecturers.
- Final exam: students must complete final exam in accordance with the regulations of University.

6. Text books and references

**** Text Books/Lecture Notes:***

1. Nguyen Hong Minh. (1999). Genetics. Publishing house of VNUA.
2. Pham Thanh Ho (2007). Genetics.
3. Vu Van Liet, Tran Van Quang, Vu Thi Thu Hien, Nguyen Van Cuong, Nguyen Thanh Tuan, Ngo Thị Hong Tuoi, Pham Thị Ngọc, Nguyen Tuan Anh, Vo Thi Minh Tuyen , (2016). Plant Breeding: annual crops. Publishing house of VNUA.

**** Additional references:***

1. Orton, Thomas J. (2022). Horticultural Plant Breeding. Elservier.
2. Acquaah G. (20012) Principles of plant genetics and breeding. Blackwell Publishing

7. Course outline

Week	Content	Course expected learning outcomes
1-3	**Chapter 1: Molecular genetics**	
	A/ Main contents: (8 hours) **Theory:** (6 hours) 1.1. DNA: The genetic materials 1.1.1. DNA structure: Double helix, antiparallel strands 1.1.2. DNA structure in relation to its function 1.2. DNA replication 1.3. Transcription and translation 1.3.1. Transcription mechanism 1.3.3. Genetic code and Translation 1.4. Control of gene expression 1.4.1 Control of gene transcription in prokaryotes 1.4.2. Control of gene transcription in eukaryotes 1.5. Molecular mechanism of mutation 1.5.1. Types of mutation 1.5.2. Molecular basis of mutation **Seminar/Discussion:** (2 hours) Experiments proving DNA as genetic materials Experiments on DNA replication (hypothesis and testing)	CELO1, 2, 3, 5
	B/ Self-study: (16 hours) - History of DNA discovery - New understandings on replication, transcription and translation (wooble theory) - Similarities and differences in gene expression in prokaryotes and eukaryotes	CELO1, 2, 3, 5
3-5	**Chapter 2: Chromosomes and Mendellian genetics**	
	A/ Main contents: (6 hours) **Theory:** (5 hours) 2.1. Chromosome structure 2.1.1. Chromosome structure of bateria 2.1.2. Chromosome structure of eukaryotes 2.2. Genetic mapping 2.2.1. Map units and recombination frequencies 2.2.2. Crossing-over 2.2.3. Genetic mapping in three point test cross 2.3 Structural and Ploidy variation and application in agriculture 2.4. Monohybrid segregation 2.4.1. Phenotypic ratio in F_2 generation 2.4.2. Principles of segregation 2.5. Dihybrid, trihybrid and multiple gene segregation 2.5.1. Principle of independent assortment 2.5.2. Test cross with unlinked genes 2.5.3. Segregation test by Chi squares 2.6. Deviation from Mendelian segregation – gene interaction **Seminar/discussion:** (1 hours) DNA marker types and application	CELO1, 2, 3, 4, 5

Week	Content	Course expected learning outcomes
	PCR techniques in genetics and agricultural application GMOs **Laboratory practice:** (8 hours) Lesson 1: Mitosis (5 hours) Lesson 2: Meiosis (5 hours) Lesson 3: Assessment of hybrid lines (5 hours)	
	B/ Self-study: (28 hours) - Molecular structure of chromosomes related to gene expression - Linkage, crossing-over and chromosome mapping in eukaryotes - Variation chromosome number and evolution/breeding	CELO1, 2, 3, 5
6-7	**Chapter 3: Quantitatives and Population genetics**	
	A/ Main contents: (5 hours) **Theory:** (4 hours) 3.1. Genetics of population 3.1.1. Allele and genotypic frequency 3.1.2. Random mating and Hardy-Weinberg equilibrium 3.1.3. Significance of Hardy-Weinberg equilibrium 3.2. Factors affecting Hardy-Weinberg equilibrium 3.2.1. Inbreeding 3.2.2. Mutation and migration 3.2.3. Natural selection 3.2.4. Random genetic drift 3.3. Quantitative traits 3.3.1. Phenotypic and genotypic variation 3.3.2. Environmental variation/deviation 3.3.3. Genotype by environment interaction 3.4. Analysis of quantitative traits 3.4.1. Heritability 3.4.1. Genotype by environment interaction 3.4. Artificial selection **Seminar/Discussion:** (1hour) Discussion on the role of natural selection (at gene and phenotype level) in changing allele frequency and evolution; role of artificial selection in breeding. Characteristics of quantitative traits QTLs	CELO1, 2, 3, 5
	B/ Self-study: (10 hours) - Hardy-Weinberg equilibrium and its application Population size in plant breeding	CELO1, 2, 3, 5
8	**Chapter 4: Reporoduction in plants**	
	A/ Main contents: (3 hours) **Theory:** (3 hours) 4.1. Asexual reproduction 4.1.1. Natural asexual reproduction 4.1.2. Artificial asexual reproduction 4.2. Sexual reproduction	CELO1, 2, 3, 5

Week	Content	Course expected learning outcomes
	4.2.1. Characteristics of sexual reproduction 4.2.2. Meiosis and its significance 4.2.3 Breeding system 4.2.4. Self-incompatibility 4.3 Reproduction and genetic structure of population	
	B/ Self-study: (6 hours) - Sexual reproduction is a source of genetic variation. - Reproduction/breeding system, advantages, disadvantages of breeding systems and population genetic structure - Consequences and application of breeding system in crop production and breeding	CELO1, 2, 3, 5
9	**Chapter 5. Breeding Methods in self-pollinated crops**	CELO1, 2, 3, 5
	A/ Main contents: (4 hours) **Theory:** (3 hours) 5.1 Genetic structure of self – pollinated plant poputaion 5.2 Selection methods: 5.2.1 Mass selection 5.2.2 Pure Line Selection 5.3 Selection methods in hybrid generation. 5.3.1 Pedigree Breeding 5.3.2 Bulk Population Breeding 5.3.3 1-seed method 5.3.4 DH 5.4 Backcross Method 5.4.1 Conventional backcross method 5.4.2 Backcross method assisted markers	CELO1, 2, 3, 5
	Seminar/Discussion: (1hour) Breeding methods apply in tomatoes, legumes, flower, fruits etc..	CELO1, 2, 3, 5
	B/ Self-study: (8 hours) - Marker assissted Breeding	CELO1, 2, 3, 5
10-11	**Chapter 5. Breeding Methods in Cross-Pollinated Crops and clonally propagated species**	
	A/ Main contents: (4 hours) **Theory:** (3 hours) 5.1 Genetic structure of cross – pollinated plant poputaion 5.2 Recurrent Selection 5.3 Population genetics of Clonal population 5.4 Breeding Methods for Development of Inbred Lines in Cross-pollinated Crops. (Pedigree, Bulk, Single Seed…) **Seminar/Discussion:** (1hour) Breeding methods apply in onion, cucumber, pumpkin, fruits etc..	CELO1, 2, 3, 5

Week	Content	Course expected learning outcomes
	B/ Self-study: (8 hours) Marker assissted Breeding	CELO1, 2, 3, 5
12	**Chapter 6. Mutation breeding**	CELO1, 2, 3, 5
	A/Main content (3 hours) **Theory:** (2 hours) 6.1 Definition of mutation and its role in breeding 6.2 Mutagenic agents 6.3 Mutagenesis 6.4 Selection methods 6.5 Use of types of mutation. **Seminar/Discussion:** (1hour) The limitations of mutation breeding Achievements of horticultural breeding in Vietnam and the world	CELO1, 2, 3, 5
	B/ Self-study: (6 hours) Marker assissted Breeding	CELO1, 2, 3, 5
13	**Chapter 7. Breeding hybrid cultivars**	CELO1, 2, 3, 5
	A/Main content (4 hours) **Theory:** (3 hours) 7.1 Define and meaning of heterosis in plant breeding 7.2 The concepts of heterosis 7.3 Types of hydrids 7.4 Development of hybrid cultivars	CELO1, 2, 3, 5
	Seminar/Discussion: (1hour) Hybrid cultivars of fruits, flowers etc. Achievements of horticultural breeding in Vietnam and the world	CELO1, 2, 3, 5