



**JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY
SCHOOL OF AGRICULTURAL AND FOOD SCIENCES**

**FOURTH YEAR SECOND SEMESTER UNIVERSITY EXAMINATION FOR THE
DEGREE OF BACHELOR OF SCIENCE IN AGRICULTURAL EXTENSION
EDUCATION**

**2020/2021 ACADEMIC YEAR
REGULAR**

COURSE CODE: AHT 3224

COURSE TITLE: Principles of Plant Breeding

EXAM VENUE: **STREAM: BSc. Agricultural Extension
Education**

DATE: **EXAM SESSION:**

TIME: 2 HOURS

Instructions:

- 1. Answer ALL questions in section A and ANY other 2 Questions in section B.**
- 2. Candidates are advised not to write on question paper.**
- 3. Candidates must hand in their answer booklets to the invigilator while in the examination room.**

SECTION A [30 MARKS]

Answer ALL questions from this Section

1. Define or Explain the following terminologies
 - (a) Genotype x environment interaction [1 MARK]
 - (b) Phenotype [1 MARK]
 - (c) Marker-assisted selection [1 MARK]
 - (d) Selection intensity [1 MARK]
 - (e) Embryo rescue [1 MARK]
 - (f) Allele [1 MARK]
 - (g) Wide-cross [1 MARK]
 - (h) Quantitative trait locus (QTL) [1 MARK]
 - (i) Open-pollinated cultivar [1 MARK]
 - (j) General combining ability (GCA) [1 MARK]

2. Distinguish between the following:
 - (a) Molecular marker vs Morphological marker [2 MARKS]
 - (b) Heterosis vs Inbreeding depression [2 MARKS]
 - (c) Natural selection vs Artificial selection [2 MARKS]
 - (d) Interspecific hybridization vs Intergeneric hybridization [2 MARKS]
 - (e) Traditional breeding vs Genetic engineering [2 MARKS]

3. Although natural selection played a major role in shaping the genetic make-up of the crop species we have today, not all traits are subject to influence of forces of nature such as weather, diseases, volcanic eruptions, tsunamis, etc. Think out of the box; and list any FOUR traits that you believe can only be selected by a plant breeder and NOT by natural selection [2 MARKS]

4. Explain why knowledge on the origin of crop species, their history and evolution are important for success of any breeding program [3 MARKS]

5. There are often several factors that influence the decision of breeders when it comes to setting objectives for their research programs. LIST and DESCRIBE any FIVE of these considerations that breeders must take into account. **[5 MARKS]**

SECTION B (40 MARKS)

Answer ANY TWO questions in this section

- 6a. Plant disease resistance can be classified into two types: (i) inhibition of infection, and (ii) inhibition of growth after infection. Explain each of these mechanisms, and give examples whenever necessary **[10 MARKS]**

- 6b. While visiting India, Prof. Akinyi Onyango, an internationally well-respected plant breeder working for Jaramogi Oginga Odinga University of Science and Technology, stumbled into a strange plant species during one of her evening walks. Because it was already getting late in the evening, she hurriedly studied the plant, and concluded that it reproduces through self-pollination. She brought back to Kenya a single seed of the plant which she later planted under controlled conditions in one of the greenhouses at Bondo. Although the seed germinated, Prof. Akinyi noticed that no seeds were produced by the plant. As an experienced plant breeder, she immediately suspected self-incompatibility as the likely culprit. Give FIVE possible explanations for the observed self-incompatibility in the plant. **[10 MARKS]**

- 7a. Describe any FIVE advantages of using molecular markers in plant breeding programs **[5 MARKS]**

- 7b. From a breeding point of view, distinguish (i) early generation selection, (ii) intermediate generation selection, and (iii) advanced generation selection. **[15 MARKS]**

- 8a. After graduating from the School of Agricultural and Food Sciences, Jaramogi Oginga Odinga University of Science and Technology with a Class One Bachelor's Degree in Agricultural Extension and Education, the Kenya Breweries Limited (KBL) offered you a job as

a sorghum breeder at their Kisumu Research Station. Your task is to develop varieties with broad adaptation to the Nyanza Region. The fungal disease downy mildew disease (caused by *Peronoscleropora sorghi*) is one of the major constraints to sorghum productivity in the region. Through careful screening of approximately 5,000 sorghum accessions, you managed to identify an old landrace of sorghum with excellent resistance against the downy mildew disease. Genetic analysis showed you that the resistance is controlled by a single dominant gene (RR). Diagrammatically, outline a breeding scheme that you will use for transferring the resistance genes from the landrace into the susceptible (rr) 'Serena' that is being used for malting. Note that you want to transfer ONLY the resistance gene while ensuring that at least 96% of the genetic background is that of the cultivar 'Serena'. **[15 MARKS]**

8b. Explain why the breeding program will involve more resources (time and money) if the resistance to downy mildew in the landrace is controlled by a single recessive gene (rr) instead of a single dominant gene (RR). **[5 MARKS]**