University of Ruhuna - Faculty of Technology
Bachelor of Biosystems Technology Honours Degree
Level I (Semester II) Examination
Academic Year 2021/2022
November/December - 2023

Course Unit: BST 1251 - Fundamental Genetics (Theory)
Time allowed: 1 hour and 30 minutes.
Index No: ....

INSTRUCTIONS:
Number of pages: Four (04)
Write your **index number** in the space provided.
Part I -   Answer **all** questions.
Part II -   Answer **one (01)** question only.

Part I

1. **Mark (x) the statements below as True or False. (30 minutes) [100 marks]**

No:	Statement	True	False
1	Genes are composed of DNA sequences that provide instructions for building the key functional protein molecules in cells most of the time.		
2	Homozygous diploid individuals have two different alleles for a particular gene, while heterozygous individuals have two identical alleles.		
3	The law of segregation states that two alleles for each gene segregate during the formation of gametes.		
4	Genetic mutations are always harmful and result in diseases or disorders.		
5	The phenotype of an organism is solely determined by its genotype, and environmental factors have no influence on the expression of genes.		
6	One of the reasons for selecting common garden pea for Mendel's experiments was that it was self-pollinating.		
7	Mendel carried out his experiments using only the trait of seed colour.		
8	Multifactorial disorder is one of the genetic disorder types.		
9	Heart disease and diabetes are single gene disorders.		
10	Model organisms are selected for genetic research based solely on their simplicity and ease of handling.		
11	The use of model organisms in Genetics allows researchers to gain insights into fundamental biological processes that can be applied to more complex organisms, including humans.		
12	Genetic recombination occurs during mitosis, ensuring genetic diversity in somatic cells.		
13	The process of genetic recombination involves the exchange of genetic material between non-homologous chromosomes.		

14	Gene mapping is a technique used to determine the relative positions of genes on a chromosome and the distance between them.		
15	Linkage mapping is based on the principle of genetic recombination, where the frequency of recombination reflects the distance between genes on a chromosome.		
16	Gene therapy involves the modification or introduction of genes into an individual's cells to treat or prevent disease.		
17	Viral vectors are commonly used in gene therapy to deliver therapeutic genes into target cells.		
18	Mutations can occur in both somatic and germ cells.		
19	Silent mutations always lead to changes in the phenotype of an organism.		
20	Mutations are always caused by external factors such as radiation or chemicals.		

2. **Answer the questions a, b, c and d. (30 minutes) [100 marks]**

    a. Hardy-Weinberg equilibrium is valid under following assumptions. Fill in the blanks.

    1. The population is very ....

    2. There is no net .... of individuals into or out of the population.

    3. There is no net ....; that is, the forward and backward rates for alleles are the same.

    4. Mating is at .... for the trait/gene(s) in question.

    5. There is no .... Offspring from all possible matings for the trait/gene are equally likely to survive.

    b. A wildflower, the dwarf lupin (*Lupinus nanus*) normally bears blue flowers. Occasionally, plants with pink flowers are observed in wild populations. Flower colour is controlled at a single locus, with the pink allele completely recessive to the blue allele. In one population of lupins, a scientist found 25 pink flowers and 3291 blue flowers, for a total of 3316 flowers. Assuming the population is under Hardy-Weinberg equilibrium,

    1. Calculate the expected allele frequencies of the population.

2. Calculate the expected genotype frequencies of the population.

c. A series of test crosses reveals that genes A, B, C and D are located on the same chromosome. Using the given distances between genes in Linkage Map Units (LMU), construct a linkage map for A, B, C and D genes.

Gene pair	Map distance
A and B	18 LMU
A and C	37 LMU
A and D	3 LMU
B and C	19 LMU
B and D	21 LMU
C and D	40 LMU

Map:

d. The F2 progenies do not follow the expected phenotypic ratios according to Mendel's Laws under following deviating conditions. Give one example for each deviating condition below.

Deviating condition	Example
Incomplete dominance	
Multiple alleles	

Lethal allele	
Pleiotropy	
Polygenes	

Part II

Answer only one (1) question. (30 minutes) [100 marks]

1) Briefly describe the transcription in the gene expression process.

(100 marks)

2) Write short notes on any **two (2)** of the followings.

    I.   Holliday model in gene recombination

    II.   Different processes of recombination in prokaryotic cells

    III. Groups of genetic diseases

($50 \times 2 = 100$ marks)

@@