

UNIVERSITY OF SWAZILAND

FINAL EXAMINATION PAPER: DECEMBER 2011

TITLE OF PAPER: GENETICS

COURSE CODE: B303

TIME ALLOWED: THREE HOURS

- INSTRUCTIONS:**
- 1. THIS PAPER IS DIVIDED INTO TWO SECTIONS**
 - 2. ANSWER QUESTION 1 (COMPULSORY) IN SECTION A AND ANY THREE OTHER QUESTIONS IN SECTION B**
 - 3. EACH QUESTION CARRIES TWENTY FIVE (25) MARKS**
 - 4. ILLUSTRATE YOUR ANSWER WITH LARGE AND CLEARLY LABELLED DIAGRAMS WHERE APPROPRIATE**

SPECIAL REQUIREMENTS: CANDIDATES MAY BRING CALCULATORS

THIS PAPER SHOULD NOT BE OPENED UNTIL PERMISSION HAS BEEN GRANTED BY THE INVIGILATORS

SECTION A (COMPULSORY)

Question 1

- (a) A Sample of normal double-stranded DNA was found to have a guanine content of 18%. What is the expected proportion of Adenine? (4 marks)
- (b) Explain the relation between the terms allele, locus, genotype and phenotype. (4 marks)
- (c) Explain the principle of independent assortment, highlighting how it is related to the principle of equal segregation. (4 marks)
- (c) A plant of genotype $A/A;b/b$ is crossed with $a/a;B/B$. The resulting F1 was then test-crossed.
- (i) Determine the percentage of $a/a;b/b$ recombinants in the progeny if alleles are not linked. (4 marks)
- (ii) Determine the percentage of $a/a;b/b$ in the progeny if alleles are linked on the same chromosome and are 20 m.u apart. (3 marks)
- (d) A couple are both heterozygous for two autosomal recessive diseases: cystic fibrosis (CF) and phenylketonuria (PKU). What is the probability that their first child will have either CF or PKU? (6 marks)

[Total 25 marks]

SECTION B (ANSWER ANY THREE QUESTIONS FROM THIS SECTION)

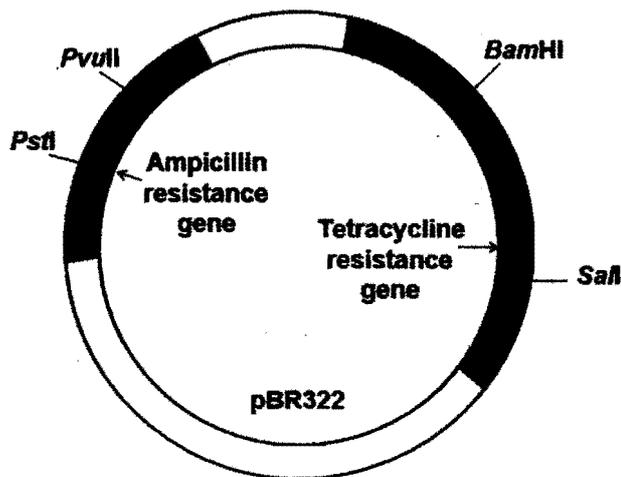
Question 2

- (a) Differentiate between broad sense and narrow sense heritability. (5 marks)
- (b) In a population of mice, there are two alleles of the *A* locus (*A* and *a*). Tests showed that in this population there are 384 mice of genotype *A/A*, 210 of *A/a*, and 260 of *a/a*. Determine the frequencies of the two alleles in the population. (5 marks)
- (c) Discuss the factors that perturb the Hardy-Weinberg equilibrium status of a population of species. (15 marks)

[Total = 25 marks]

Question 3

- (a) Explain the effect on DNA replication of mutations that destroy each of the following activities in DNA polymerase I:
- (i) 3' → 5' exonuclease activity, (4 marks)
 - (ii) 5' → 3' exonuclease activity, (4 marks)
 - (iii) 5' → 3' polymerase activity. (4 marks)
- (b) An ampicillin-resistant, tetracycline-resistant plasmid, **pBR322**, is cleaved with *Pst*I, which cleaves within the ampicillin gene. The cut plasmid is ligated with *Pst*I-digested *Drosophila* DNA to prepare a genomic library and a mixture is used to transform *E.coli* K12 competent cells.

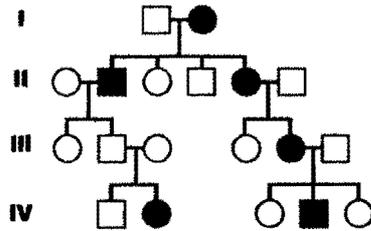


- (i) Explain why the above plasmid is a suitable cloning vector. (2 marks)
- (ii) State, with reasons, the antibiotic that should be added to the medium to select bacterial cells that have incorporated a plasmid. (5 marks)
- (ii) Explain the growth pattern that should be selected to obtain plasmids containing *Drosophila* DNA inserts. (4 marks)
- (iii) Explain the presence of colonies that are resistant to both antibiotics. (2 marks)

[Total = 25 marks]

Question 4

- (a) The pedigree below shows the inheritance of ataxia, a rare neurological disorder characterized by uncoordinated movements.



- (i) Deduce the likely mode of inheritance shown here. (6 marks)
 (ii) Explain the case of individual IV-2. (4 marks)
- (b) Allele *A* is epistatic to allele *B*. Indicate and explain whether each of the following statements is true or false. (15 marks)
- (i) Alleles *A* and *B* are at the same locus.
 - (ii) Alleles *A* and *B* are at different loci.
 - (iii) Alleles *A* and *B* are always located on the same chromosome.
 - (iv) Alleles *A* and *B* may be located on different, homologous chromosomes.
 - (v) Alleles *A* and *B* may be located on different, non-homologous chromosomes.

[Total = 25 marks]

Question 5

- (a) Explain the following terms:
- (i) Co-dominance, (2 marks)
 - (ii) Dominant epistasis, (2 marks)
 - (iii) Anueploidy, (2 marks)
 - (iv) Nullisomy, (2 marks)
 - (v) Trisomy, (2 marks)
 - (vi) Familial Down Syndrome. (2 marks)
- (b) Hemophilia is a congenital recessive X-linked defect in blood clotting factors. Nothando is a female who has hemophilia. She marries Thando, a male who has normal blood clotting. What proportion of their children is expected to have hemophilia? (5 marks)
- (c) Bob has XXY chromosomes (Klinefelter Syndrome) and is colorblind. His mother and father have normal color vision, but his maternal grandfather is colorblind. Assume that Bob's chromosome abnormality arose from nondisjunction in meiosis. In which parent and in which meiotic division did nondisjunction occur? Explain your answer. (8 marks)

[Total = 25 marks]

Question 6

- (a) (i) Explain, using examples, what is meant by dosage compensation. (4 marks)
(ii) Explain why tortoiseshell cats are almost always female and why they have a patchy distribution of orange and black fur. (4 marks)
(iii) A *Drosophila* male carrying a recessive X-linked mutation for yellow body is mated to a homozygous wild-type female with gray body. All the daughters of this mating have uniformly gray bodies. Why aren't their bodies a mosaic of yellow and gray patches? (4 marks)
- (b) (i) A woman with type AB blood gave birth to a baby with type B blood. Two different men claim to be the father. One has type A blood, the other type O blood. Is this information sufficient to serve as genetic evidence in resolving this issue? Explain your answer, giving details of any missing information. (7 marks)
(ii) A woman with type A blood gave birth to a baby, with type O blood. The woman stated that a man with type AB blood was the father of the baby. Is there any merit to her statement? Justify your answer. (6 marks)

[Total 25 marks]

END OF QUESTION PAPER