Examination Candidate Number: _____________

Desk Number: _____________

UNIVERSITY OF YORK
BSc Stage 1 Degree Examinations 2017-18

Department:

BIOLOGY

Title of Exam:

Genetics and Evolution

Time allowed: 1 hour and 30 minutes
Total marks available for this paper: 50

● Answer all questions in the spaces provided on the examination paper
● The marks available for each question are indicated on the paper
● A calculator will be provided

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DO NOT WRITE ON THIS BOOKLET BEFORE THE EXAM BEGINS
DO NOT TURN OVER THIS PAGE UNTIL INSTRUCTED TO DO SO BY AN INVIGILATOR
1. Explain how you would use a mutagenesis screen to identify cell division cycle mutants in *Schizosaccharomyces pombe.* (5 marks)

2. In budding yeast, *Saccharomyces cerevisiae,* the *tub2* mutant arrests during cell division with the bud not separated from the mother cell. A double mutant of *tub2;stu1* completes cell division. *tub2;stu1* mutants were transformed with a library of plasmids containing genes from budding yeast, and cells resembling the original *tub2* mutant were identified.

   a) What type of genetic modifier is the *stu1* mutation? (1 mark)

   b) Provide an explanation for your answer (1 mark)

   c) How was the wild-type copy of *STU1* gene isolated? (3 marks)
3. Wild-type *Drosophila* have red eyes. Seven white eyed mutants were identified by mutagenesis. The mutants were crossed to each other and to a red eyed wild-type strain (WT). The eye colour of the progeny was recorded and presented in the table below.

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<tr>
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<th>mutant a</th>
<th>mutant b</th>
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a) Why were all the mutant lines crossed to the wild type line? (1 mark)

b) Write down the complementation groups you have identified. (3 marks)

c) How many genes have been identified with roles in production of red eyes? (1 mark)
4. Two different pink-flowered mutants were identified in a mutagenesis screen. Each of these mutants was self-pollinated and produced pink-flowered progeny. The two pink mutants were then crossed to each other. The F1 progeny from this cross produced red flowers. Wild-type flowers from this species are also red. The F1 progeny were then self-pollinated. F2 generation produced a ratio of 9 red flowered plants to 7 pink flowered mutants.

   a) Provide an explanation for the 9:7 ratio in the F2 generation.

   (2 marks)

   c) Outline a possible biosynthetic pathway that leads to the production of wild-type red pigment. Provide an explanation for your answer.

   (3 marks)

5. Define the following concepts:

   i) synteny (1 mark)

   ii) pseudogene (1 mark)

   iii) transposon (1 mark)
iv) heritability (1 mark)

v) Regression towards the mean (1 mark)

6. Explain how comparative genomics provided evidence for the origin of chloroplasts. (4 marks)

7. What evidence supports the evolution of the olfactory receptor gene family and what was the impact of this evolution on the sense of smell in vertebrates? (4 marks)
8. Describe the genetic evidence that confirms modern humans encountered their most recent ancestors. (3 marks)

9. In a population of sheep, an allele B for white wool is dominant over allele b, for black wool. You count the sheep in this population and find that of a total 800 sheep, 792 are white and 8 are black.

   (a) Assuming that the population is in Hardy-Weinberg equilibrium, what is the frequency of the allele b? (1 mark)

   (b) Assuming that the population is in Hardy-Weinberg equilibrium, calculate the number of sheep homozygous for the dominant allele B in the population? (2 marks)
(c) You genotype the sheep population and discover that the true frequency of allele \( b \) does not match what you found for question (a): the sheep are not in Hardy-Weinberg equilibrium. List two possible reasons why.  

(2 marks)

(d) The true frequency of allele \( b \) was found to be 0.2. Knowing that there are 8 black sheep in this population of 800, how many heterozygous sheep are there?  

(2 marks)

10. (a) Give a recognised definition for the word species:  

(1 mark)
(b) What is allopatric speciation? Give an example in nature. (2 marks)

11. (a) Explain what is meant by genetic drift. (1 mark)

(b) Two alleles, a and A have no known phenotypic effect. The frequency of allele a in the population is 0.3. Assuming neither of these alleles offers selective advantage, is allele a more likely to be fixed in or lost from this population? (1 mark)

(c) What effect does population size have on the number of generations it takes for allele a to become fixed or lost due to genetic drift? (2 marks).