BIO 201: Genetics and Evolution
First Mid-Semester Examination, September 11, 2018
Total Marks: 30

Please write genotypes/reasoning where ever necessary

1. With the help of a schematic, describe the different possible types of dominance relationships between two alleles at a locus. (4 marks)
2. Sickle cell anaemia is the result of a type of mutation in the gene that codes for part of the haemoglobin molecule. Recall that haemoglobin carries oxygen in your red bloods cells. The mutation causes the red blood cells to become stiff and sickle-shaped when they release their oxygen. The sickle cells tend to get stuck in blood vessels, causing pain and increased risk of stroke, blindness, damage to the heart and lungs, and other conditions.
   (a) Analyze the nucleotide strands below to determine what amino acid is changed and what type of mutation occurred. (1 mark)
   Normal haemoglobin DNA C A C G T G G A C T G A G G A C T C C T C
   Sickle cell haemoglobin mRNA G U G C A C C U G A C U C C U G U G G A G
   (b) Assume that you have a protein that is 34 amino acids long. A deletion happens in the 86th nucleotide base position in the gene. If this mutated gene is expressed, how many of the 34 amino acids will be of the correct type? (1 mark)
3. In the garden pea, tall is dominant to short and red flower colour is dominant to white. Pure-breeding tall red plants are crossed with pure-breeding short white plants, and the F1 are crossed with each other to produce an F2. What proportion of F2 plants have the same genotype as the F1 plants? State your assumption (s). (2 marks)
4. Chinchilla coat colour in mice is due to a recessive allele (c^{ch}) and the normally pigmented coat, called agouti, is due to the dominant allele. Mice heterozygous for chinchilla coat colour are mated to homozygous chinchilla (c^{ch} / c^{ch}) mice, and the resulting progeny include both agouti and chinchilla phenotypes. If one takes one of the agouti progeny and mates it to one of its chinchilla sibs, what is the expected genotypic ratio among their offspring? (2 marks)
5. Assume that two different albino strains of mice give pigmented progeny when crossed with pigmented strains. In both cases, the F2 segregates three pigmented to one albino. When albino strain I is crossed to albino strain II, however, all progeny are pigmented. (a) Explain these results with appropriate genotypes (2 marks). (b) Clearly describe a cross (or crosses) that could be made to test your hypothesis (2 marks)
6. In poultry, in individual with XX chromosomes is a male while an individual with XY chromosomes is a female. Assume that Plain feather character is dominant to striped feathers and is controlled by a X-linked locus. Similarly, Yellow leg is dominant to red leg and is also controlled by a different X-linked locus. These two loci assort independently. When a plain feathered, yellow legged hen is crossed to a pure breeding striped feathered, red legged rooster, what are the expected genotype and phenotype frequencies of the F2 progeny? (4 marks)

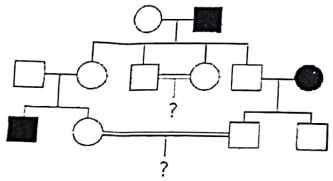
7. A pure breeding red flowered plant is crossed with a pure breeding white flowered plant. The resulting F1 is selfed. In the F2 progeny, red, white and pink flowered plants occur in the ratio 3:7:6. (a) Explain the inheritance pattern of this character. (3 marks). (b) If the F1 progeny are subjected to a test cross, what would be the expected phenotypic ratio? (1 mark).

8. The accompanying pedigree is for a trait of interest. The trait is not necessarily uncommon in the population, but individual I-1 is homozygous normal.

   (a) What is the probable mode of inheritance? Why? (1 mark).

   (b) What is the probability that the child of the brother-sister mating between II-3 and II-4 will show the trait phenotypically? (1 mark)

   (c) What is the probability that a child of the first-cousin marriage (III-2 and III-3) will carry the gene for the trait? (2 marks)



9. Mallet M et al (2011, BMC Evolutionary Biology 11:156) allowed accumulation of mutations on the X chromosomes of *Drosophila melanogaster*. They then compared the fitness of the females from mutation accumulation lines and the control populations under two conditions: (a) When both the X chromosomes in a female were identical- called "homozygous females" and (b) When one X chromosome was from the mutation accumulation line (or the control line) and the other X chromosome was chosen at random from the control population- called "heterozygous females". The results are summarised in the graph below. The solid line represents the correlation of fitness between homozygous and heterozygous females of control populations. The dashed line represents the correlation of fitness between homozygous and heterozygous females of mutation accumulation populations. Interpret the graph in terms of the nature of mutations (harmful? beneficial? dominant? recessive? etc). Explain your reasons. (4 marks)