UNIVERSITY OF BRITISH COLUMBIA
Biology 121 Practice Midterm 2, Summer 2020

1. (*1 mark; 0.5 each*) Select from the list of words and phrases to complete this sentence.

Note that some words/phrases will be used more than once, some might not be used at all.

non-random mating	random	unpredictable
mutation	smaller	phenotype
fitness	genetic drift	
probability	larger	

_____ occurs when the _____ that two individuals in a population will mate is not the same for all possible pairs of individuals.

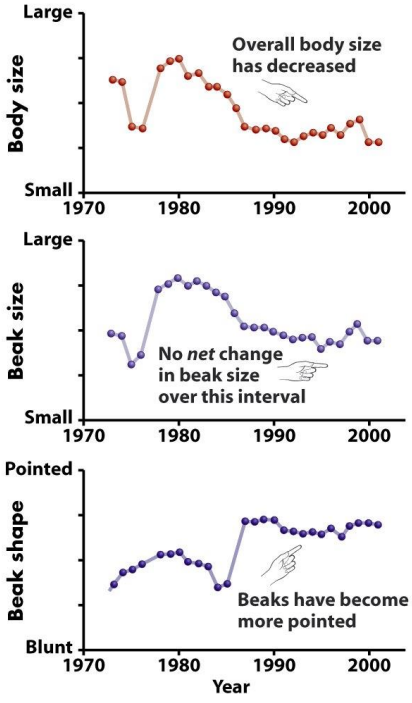
2. Variegated porphyria (VP) is a disease caused by a dominant allele; it affects the nervous system and other organs. This disease is more common in South Africa than elsewhere in the world and its origins there can be traced back to a Dutch man who emigrated from The Netherlands and married a woman in South Africa in 1688. (15 marks total)

a) A blood test has been developed to determine if individuals are homozygous dominant (AA), heterozygous Aa) or homozygous recessive (aa). In a population of 100,000 there are 1 AA, 404 Aa and 99,595 aa individuals. Is this population in HW equilibrium? Justify your answer. Show all your calculations to six decimal places and show all your work. (**6 marks**)

b) List two assumptions of the HW equilibrium that may have been violated in this example and indicate how each violation could account for the results obtained. (4 marks)

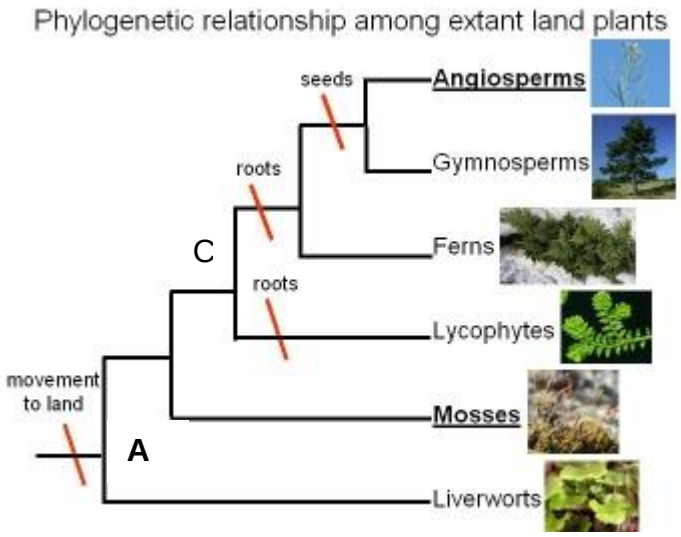
c) What evolutionary mechanism is illustrated in this example (not considering the original origin of the variegated porphyria allele in humans)? Explain (2 marks)

d) Individuals with VP are sensitive to sunlight and develop skin ulcers as a consequence of ultraviolet light exposure. Explain how this illustrates that phenotype is a combination of genotype plus the interaction of genotype with the environment (Phenotype= Genotype + Environment). (3 marks)



3. The medium ground finches on an island in the Galapagos have been studied in detail by Peter and Rosemary Grant over the last 30 years. A summary of changes in their body size, beak size and beak shape are shown to the left. (There was a drought in 1977, and a return to full plant growth by 1983). In chickens, a related species of bird, beak size and shape are determined by known genes. What are the pre-requisites for evolution? Explain how each of these pre-requisites *might* be met based on the data given. **(8 marks)**

4. The following phylogenetic tree shows the relationship among terrestrial plants alive today. (7 marks total)



a) Which of the following groups form monophyletic clades (all members of a monophyletic clade must share a common ancestor)? Circle the correct answer(s). For those that are not a monophyletic clade, explain why not. (4 marks).

i) Angiosperms, Gymnosperms

ii) Angiosperms, Gymnosperms, Ferns

iii) Ferns, Lycophytes

iv) Lycophytes, Mosses

b) The first node by the root is labeled A, label the remaining nodes in order, from B to E. For one of the monophyletic groups you have identified, explain why it is a monophyletic group. (2 marks)

c) What is a synapomorphy (shared derived character) for angiosperms and gymnosperms? (1 mark)

5. In the Lake Erie region of Ontario there are two kinds of non-poisonous water snakes (*Nerodia* spp.). On the shores of the lake most of the snakes have a banded colouration, while on the islands in the lake most snakes are not banded. You have been hired by the Ontario government to work on a project designed to protect these threatened snakes from becoming endangered. (13 marks total)
   a) The first thing you have to do is to determine whether banded and unbanded snakes represent different morphological forms (morphs) of one species or are two separate species. In the table below, indicate what would you expect to observe if these were separate species and what would you expect if they were the same species but with different morphs (6 marks).

Species Concept	Expectations if only one species (1 mark each)	Expectations if two species (1 mark each)

   b) Suppose you determine that these two morphs are in fact one species. What could be causing the difference in distribution of the two morphs? (2 marks)

c) Talking to the locals, you discover that the population on the island was founded by a snake breeder who accidentally released five snakes 25 years ago. Given this new information, what evolutionary factor(s) could be responsible for the difference between the island and the mainland population? Briefly explain your answer (3 marks)

d) Suppose you determine that they are in fact two species. What are two reproductive isolating mechanisms that could be causing them to remain separate species? (2 marks)

6. You are studying an isolated population of a flowering plant species, the Common Silverweed. Two alleles for gene *A* exist in this population (*A1* and *A2*). The function of gene *A* is currently unknown. (**8 marks total**)

a. Explain how a single, large change in population size could possibly result in a random change in the frequencies of *A1* and *A2* in this population. (**2 marks**)

b. Explain how the frequencies of *A1* and *A2* could change randomly between generations, even if there is no change in population size. Assume there are no mutations affecting gene *A*. (**2 marks**)

c. Several years later, you discover a third allele for gene *A* in the population (i.e., *A3*), which was not there previously. Briefly describe two different evolutionary mechanisms that could have possibly resulted in the appearance of the new allele in this population. (**4 marks**)