

UNIVERSITY OF BRITISH COLUMBIA
Biology 121 Midterm 2, 2022

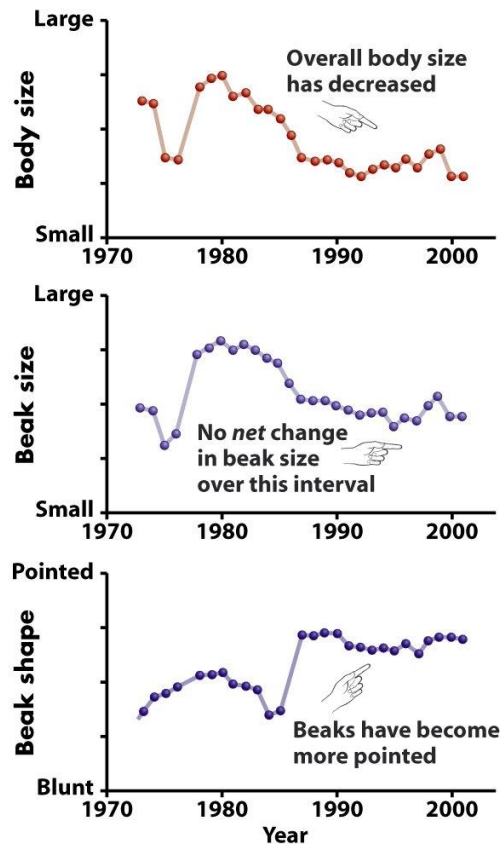
You may once again bring a study sheet that is a **SINGLE** 8.5 x 11 inch piece of paper with **HAND-WRITTEN/DRAWN** notes (printed tablet notes fine) on **BOTH** sides of the paper. Your study sheet must be **UNIQUE** to you. Please **DO NOT** include copy/pasted textbook figures, class slides, homework questions, etc. on your study sheet.

Why no copy/pasted notes? Because the act of creating the study sheet, of decided what to include and compiling it all onto your document is a form of studying. You are processing the information you've been given as you create your study sheet: deciding what is most important, condensing your notes, drawing pictures. When you copy and paste, you're not getting that same benefit of studying as you create.

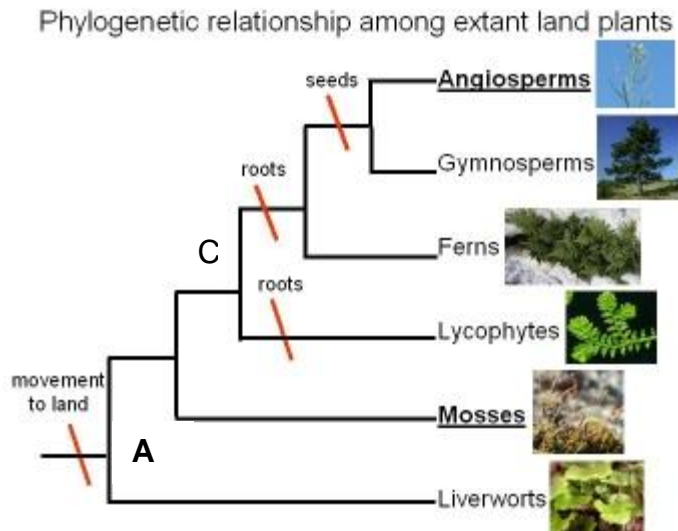
NOTE: This practice midterm is not exactly the same length as what you will see in the midterm. I have added an additional phylogenetics question at the end for extra practice.

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 below. (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 by natural selection? 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).
- Angiosperms, Gymnosperms
 - Angiosperms, Gymnosperms, Ferns
 - Ferns, Lycophytes
 - 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. British Columbia is home to two subspecies of Saw-whet owls: the Common Northern Saw-whet owl (*Aegolius acadicus acadicus*) and the Haida Gwaii Saw-whet owl (*Aegolius acadicus brooksi*). Some researchers believe that the two subspecies should be classified as two different species. The table below shows key characteristics of the two subspecies:

	Common Northern Saw-When Owl	Haida Gwaii Saw-Whet Owl
Population size	1900	200,000
Feather colour	Light brown	Dark brown
Body length	18-21 cm	17.5-22 cm
Body weight	65-151 g	75-145 g
Diet	~80% mice, rest other small mammals or birds	Marine invertebrates (e.g., crabs, snails)
Behaviour	Migratory	Not migratory
DNA, and phylogeny built using DNA	<p>Scale bar for phylogeny: — = a single nucleotide difference</p>	

Q5.1 Does the phylogenetic species concept support the argument that these two owls are separate species? Briefly explain your answer, using information from the table above (2 sentences maximum). (2 marks)

Q5.2 Using information from table above, identify one other species concept that would support the argument that these two owls are separate species. Briefly explain your answer, using information from the table above (2 sentences maximum). (2 marks)

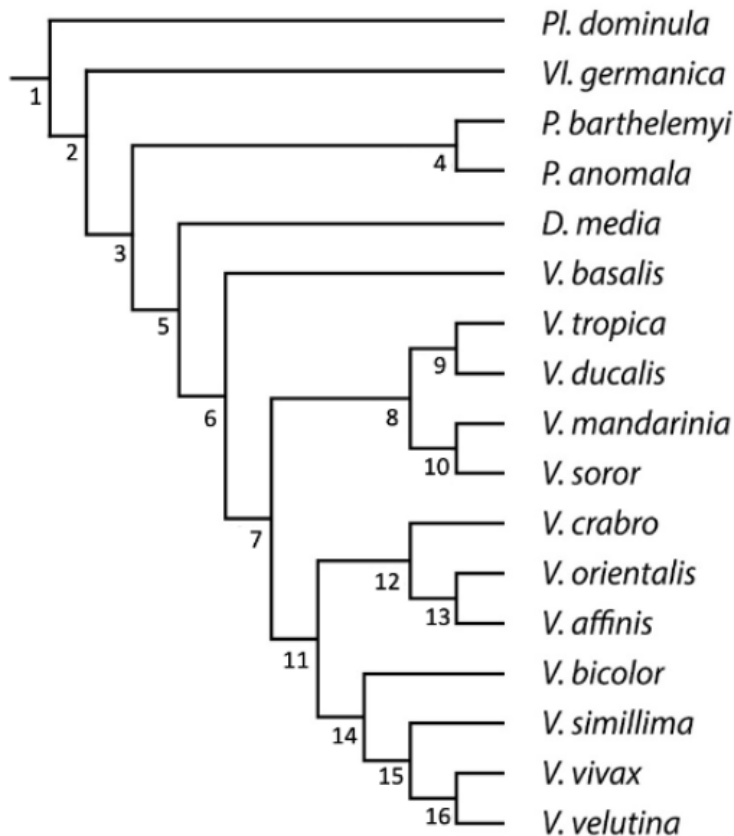
6. You are studying an isolated population of a flowering plant species, the Common Silverweed. Two alleles for gene *A* exist in this population (*A1* and *A2*). The function of gene *A* is currently unknown. **(8 marks total)**
- a. Explain how a single, large change in population size could possibly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

Q3 Phylogenetic Tree

Below is a phylogenetic tree showing the evolutionary relationships among hornets. (repeated in the sub-questions, where needed)



Q3.2 If *P. barthelemyi*, *P. anomala* and their common ancestor had a mutation that changed their appearance, would this be an example of a homologous trait or convergent evolution? Explain your answer (2 sentences maximum). (2 marks).

Q3.3 Hornets are venomous. Your friend gets stung by a *V. mandarinia* and needs antivenom. Antivenom for *V. basalis* and *V. affinis* is available. Which antivenom do you think your friend should receive? Explain your answer, make specific reference to the phylogeny. 2 sentences maximum. (2 marks)