

UNIVERSITY OF BRITISH COLUMBIA

Biology 121 Instructor: **Name**
Midterm 2, March, 2016 Stage 1

Name :	_____	_____
	FAMILY NAME	FIRST NAME
Student Number :	_____	

Instructions:

1. Answer all questions in the space provided. The back of the exam will not be marked unless it is an exact replacement for material that is crossed out.
2. Writing can be in pencil or ink, but pencil answers **cannot** be remarked.
3. Answers may be in sentences or point form. Illustrations are acceptable but must be annotated.
4. Students suspected of any of dishonest practices will be immediately dismissed from the examination and will be subject to disciplinary action.
5. Other than **one side of one page** of handwritten summary notes, no other memory devices are permitted.
6. Students may not speak or in any other way communicate with other students while in the examination room.
7. Students may not expose their written paper to other students. The excuse of accidental exposure, forgetfulness, or ignorance will not be accepted.

I have read and fully understand these instructions.

Student signature _____

Mark allocation:

Question	Marks possible	Your mark
1.	15	
2.	7	
3.	9	
4.	13	
5.	3	
Concept Map	1	
Total	48	

1. 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, Gerrit Jansz who emigrated from Holland and married Ariaantje Jacobs in South Africa in 1688. (15 marks total)

- a) A blood test has been developed to determine if individuals are homozygous dominant (VV), heterozygous (Vv) or homozygous recessive (vv). In a population of 100,000 there are 1 VV, 404 Vv and 99595 vv 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)

Frequency of the V allele $p = (1/100,000 + 404/2)/(100,000) = 203/100,000 = .00203$

Or $p = (2 \times 1) + (404/200,000)$
 $= 406/200,000 = 0.00203$

Frequency of the v allele $q = (404/2 + 99595)/100,000 = 99797/100000 = .99797$

Or $q = (404 + 99595 \times 2)/200000 = .99797$

Or $q = 1-p = 1-0.00203 = 0.99797$

		Observed Frequency	Expected Frequency	Expected Number
VV	1	$= 1/100000 = .00001$	$= 0.00203^2 = .000004$	$= 0.000004 \times 100000 = 1$
Vv	404	$= 404/100000 = 0.00404$	$= 2 \times 0.00203 \times 0.99797 = 0.004059$	$= 0.004059 \times 100000 = 406$
vv	99595	$= 99595/100000 = .99595$	$= .99797^2 = .991916$	$= 0.995944 \times 100000 = 99594$

In HWE (1): All the expected numbers are very similar to the observed numbers (2) plus 3 marks for showing all calculations. Accept values that are "close" because of rounding.

- 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)

1 mark for each assumption and 1 mark for each explanation. e.g.

Immigration: immigrants not as likely to have V allele since this is a very rare allele. This would lead to more vv and Vv genotypes.

Selection: While we don't know when the disease Variegated porphyria strikes, individuals with the V allele most likely have lower fitness, and contribute fewer alleles to the gene pool.

Non-random mating: If the disease Variegated porphyria has visible phenotype there may be less mating between V- individuals and vv individuals than expected by chance.

Answer must be clear the V allele (dominant) is disease causing

- c) What type of genetic drift is illustrated in this example? Explain. (2 marks)

Founder effect (1) because the descendants of one couple resulted in a population with allele frequencies different from the original population from which it came. (1)

- 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)

*VP is due to the dominant allele in the **genotype** (1)*

*The development of skin ulcers is an **environmental** effect caused by UV (1).*

Together genotype and environmental influence result in the phenotype of skin ulcers (1).

2. The following photo (Figure 1) appeared in the Vancouver Sun on Apr. 5 2010 along with a story about how the discovery of a new fossil in South Africa (between *Australopithecus* and *Homo habilis* in age) could provide new information about the evolution of humans. (7 marks total)

a) Based on ideas about evolution presented in Biology 121, what is one problem with this representation (i.e. what misconceptions might be promoted by using this representation)? Suggest how you could correct the representation? (3 marks)

EVOLUTION OF HUMAN

This diagram shows the current scientific understanding of the evolution of *Homo sapiens* (modern human) from earlier hominids.

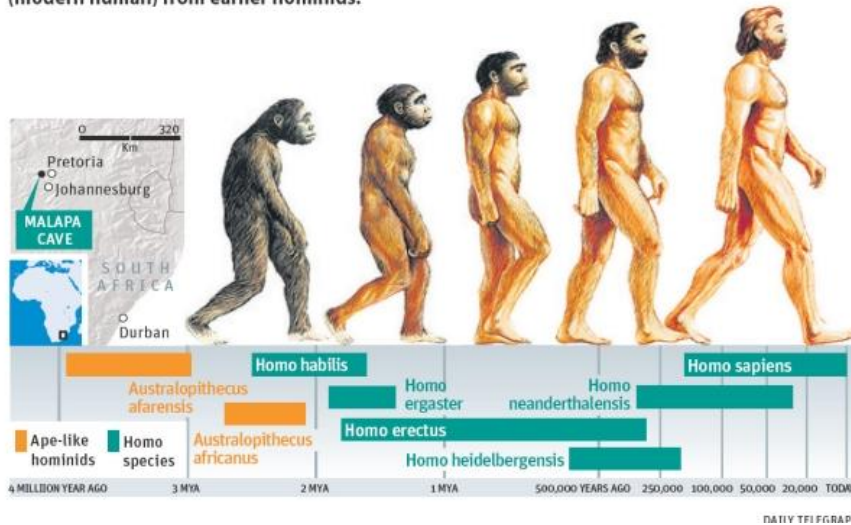


Figure 1 Human evolution

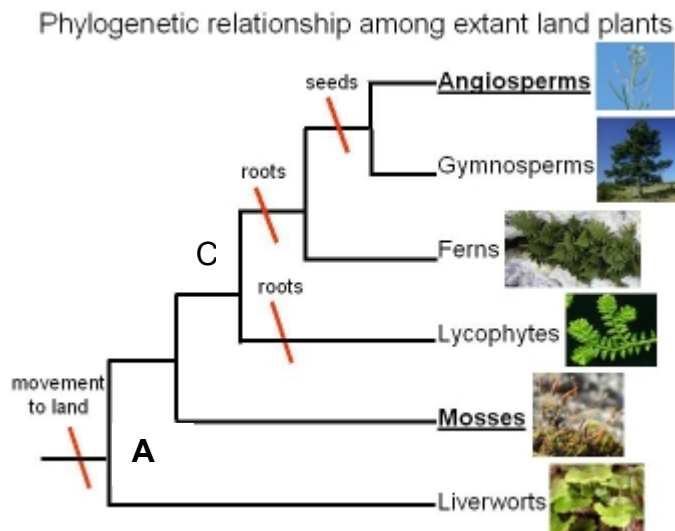
Evolution is not linear (1) – e.g., H. neanderthalensis did not evolve into H sapiens (1).

Correct by having a phylogenetic tree showing a common ancestor and branched evolution (1)

b) Describe one example of natural selection that was discussed in class. Include what was selected for (e.g., which morphological feature) as well as the agent of selection. (4 marks)

Any one of, e.g., finches, mockingbirds, antibiotic or insecticide resistance, etc. Description should include what was selected (2) e.g., beak size and the agent of selection (2) e.g., available food. Must be natural not artificial selection.

3. 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

i and ii 1 mark each Penalty for wrong answers. Right – ½ wrong – so if you check all of them you get 1 mark.

- b) For one of the monophyletic groups you have identified, explain why it is a monophyletic group. (2 marks)

Angiosperms and Gymnosperms are the descendants of E; there are no other descendants of E.

(or Angiosperms, gymnosperms and ferns are the descendants of D; there are no other descendants of D.

- b)What is a synapomorphy for angiosperms and gymnosperms? (1 mark)

seeds

- c)Which group, ferns or gymnosperms diverged first? How do you know? (2 marks)

Ferns because ancestor D is closer to the common ancestor (shorter line) than E.

4. 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)
<i>Morphological</i>	<i>Only small morphological differences (e.g. only banding pattern)</i>	<i>Additional morphological differences (e.g. jaw structure, reproductive structures)</i>
<i>Phylogenetic</i>	<i>Individuals from two populations are a monophyletic group</i>	<i>Individuals from the populations form distinct monophyletic groups</i>
<i>Biological</i>	<i>Individuals from two populations are able to mate and produce viable, fertile offspring</i>	<i>Individuals from two populations unable to mate or produce viable, fertile offspring</i>

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)

many answers are possible; they just have to be logical and biologically possible. e.g., perhaps the environment on the shore or on the island is such that the less common morph is more visible to predators (2)

Banded morphology confers more protection from predators because it acts as camouflage. There are few predators on the islands, so the selection pressure for bands is much lower.

- 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)

Drift – the original population was small and allele frequencies in the released snakes not likely representative of the mainland population and gene flow restricted between island and mainland.

- 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)

any two of: non-random mating, habitat isolation, behavioural isolation e.g. courtship behavior, temporal Isolation, d) mechanical isolation, e) gametic isolation, Postzygotic barriers such as reduced hybrid fertility

5. The cheetah is a large cat and the fastest land animal. It was once widely distributed in Africa and Asia (light pink) but is now very limited in its distribution (see Figure 3) and the total cheetah population in the wild is less than 10,000.

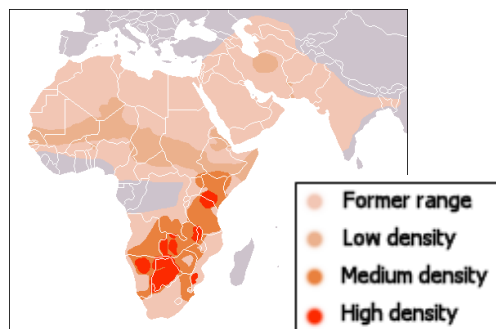


Figure 3. Distribution of cheetahs in Africa and Asia.

Explain how the genetics of cheetahs could be a factor in declining population sizes after its distribution was reduced. (3 marks)

The population of cheetahs has declined and there are now patches of cheetahs in high density, but many areas with low density. These small populations likely have less genetic variation (1) therefore when a change in abiotic conditions occurs, there are fewer different allele combinations (1) in the population that might enable some cheetahs to withstand the new environmental conditions (1). Could get 1 or 2 marks if just answer in more general terms i.e., why genetic variation is important, or discuss problems such as inbreeding depression in small populations.