Evolution Practice Midterm 2 – Evolution

Please **Print** Your Name Neatly (First, Last): ____

Student ID# ____________________________

Instructions

1. Do not take the test booklet apart.
2. You **MUST** put your name or initials at the top of each page.
3. Answer all questions in the space provided.
4. Make sure you have **8** pages (**4** pieces of paper) including the cover page.
5. Writing can be in pencil or permanent ink – **do not use erasable pen**. Please make sure that writing is legible. If it is not legible it can't be graded.
6. Answers can be in sentence form or point form. For point form answers, logical connections should be clear when required.
7. Other than **a one page, double sided, hand written study sheet**, no other memory devices are permitted.
8. Students suspected of any of dishonest practices will be immediately dismissed from the examination and will be subject to disciplinary action.
9. Students may not speak or in any other way communicate with other students while in the examination room.
10. Students may not expose their written paper to other students. The excuse of accidental exposure, forgetfulness, or ignorance will not be accepted.
11. Students are permitted to use non-programmable calculators. Calculators on cell phones are not acceptable.

Question	Marks possible	Score
1.	**9**	
2.	**8**	
3.	**11.5**	
4.	**10**	
Total	**38.5**	
Bonus	**1**	

SPACE FOR ROUGH WORK – WILL NOT BE GRADED

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QUESTION 1. (9 Marks Total)

Grey squirrels were introduced to Stanley Park in 1909 when a small number of squirrels from Eastern Canada were released into the park. Grey squirrels have since become common throughout Vancouver. Squirrels eat seeds, fruits, insects and scavenge from human trash. Squirrels are preyed upon by coyotes, birds, domestic animals and humans. In cities, cars are the major cause of mortality.

Coat coloration is determined by a single gene with two alleles that are incompletely dominant: grey = C^GC^G, black = C^BC^B and brown-black = C^GC^B.

Allele	Initial Frequency in Vancouver	Current Frequency in Vancouver
C^G	0.7	0.370
C^B	0.3	0.630

a. You used historical records to estimate allele frequencies in the initial population in Stanley Park. Would you expect the allele frequencies in the initial population in Stanley Park to be the same as the original population from Eastern Canada? Briefly explain your reasoning with specific reference to evolutionary mechanisms. (**3 marks**)

b. Squirrels with black coats are most abundant in cities; squirrels with grey coats are more abundant in forests (Gibbs et al.). Black squirrels are more easily recognized by humans and stand out against the grey asphalt of roads in comparison to the grey squirrels. In cities, the frequency of black squirrels killed by cars is about 10 times lower than grey squirrels. Could natural selection be the cause for the increase in frequency of the black allele in the Vancouver population? List the criteria and provide an explanation for each. (**6 marks**)

Requirement for Selection	Explanation

QUESTION 2. (8 Marks Total)

a) What are two characteristics in living organisms that appear to be homologies that support the conclusion that all living organisms shared a common ancestor? (**2 marks**)

b) List two vestigial traits discussed in class. (**1 mark**)

c) Explain how vestigial traits are evidence supporting the conclusion that organisms have changed through time. (**2 marks**)

d) For each of the statements in the table below, indicate the type of evidence that it is an example of and the conclusion that it supports. Fill in the circle beside the answer you choose.(**3 marks**)

	Is an example of :	Supports the Conclusion that:
The flagella in eukaryotes (that have flagella) have a common 9+2 arrangement of microtubule bundles.	○ Developmental Homology ○ Extinction ○ Genetic Homology ○ Geographical Relationships ○ Structural Homology ○ Transitional Forms ○ Vestigial Traits ○ An analogous character	○ Organisms are related ○ Organisms have changed through time ○ Neither

	Is an example of :	Supports the Conclusion that:
Silverswords are a group of plants containing ~30 species in three genera (*Agryroxiphium*, *Dubautia* and *Wilkesia*) that are only found on islands in the archipelago of Hawai'i.	○ Developmental Homology ○ Extinction ○ Genetic Homology ○ Geographical Relationships ○ Structural Homology ○ Transitional Forms ○ Vestigial Traits ○ An analogous character	○ Organisms are related ○ Organisms have changed through time ○ Neither
Both bacteria and eukaryotic cells have flagella that are used for swimming. The eukaryotic flagella are all composed filaments of proteins called tubulin and are surrounded by the cell's plasma membrane. Bacterial flagella are formed from different proteins and not surrounded by the cell's plasma membrane.	○ Developmental Homology ○ Extinction ○ Genetic Homology ○ Geographical Relationships ○ Structural Homology ○ Transitional Forms ○ Vestigial Traits ○ An analogous character	○ Organisms are related ○ Organisms have changed through time ○ Neither ○

QUESTION 3. (11.5 Marks Total)

Millipedes are small, slow-moving animals that eat dead leaves Figure 1. Millipedes are eaten by rodents that feed at night (nocturnal predators). Millipedes produce cyanide to deter predators. To signal their toxicity to nocturnal predators, some millipedes are bioluminescent (they glow at night). Brightness of bioluminescence can vary within a population from faint to bright. The millipedes are blind and cannot see this light, but the light is visible to nocturnal predators.

Bioluminescence has a genetic basis. Imagine a simple system where the brightest of the glow is determined by one gene with two alleles G1 and G2. Millipedes that are homozygous for the G1 allele glow faintly. Millipedes that are homozygous for the G2 allele glow brightly. Millipedes that are heterozygous have a mid-level of brightness.

In an **isolated** millipede population of 200 individuals, 18 millipedes glow faintly, 140 millipedes glow brightly, and 42 millipedes glow at a mid-level of brightness.

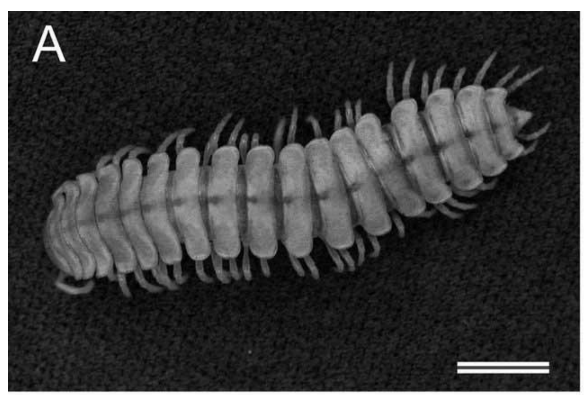

Figure 1. Millipede image from Marek and Moore 2015

Genotype	Phenotype	# individuals	observed genotype frequencies	expected genotype frequencies
G1G1	Low glow	18		
G1G2	Mid-level glow	42		
G2G2	Bright glow	140		

a. What are the observed genotype frequencies for the genotypes in this millipede population? Answer to 2 decimal places. Please show your work and enter your answer in the table provided. (**2 marks**)

b. What are the allele frequencies for the G1 and G2 alleles in this millipede population? Answer to 2 decimal places. (**2 marks**)

c. What are the expected genotype frequencies for the genotypes in this millipede population? Answer to 2 decimal places. Please show your work and enter your answer in the table provided. (**2 marks**)

d. Is this isolated millipede population in Hardy-Weinberg Equilibrium for the G gene? Yes or no. Please circle your choice below. (**0.5 marks**)

Yes **No**

e. Briefly explain your answer to 4d above, referring to specific genotypes. Do not refer to assumptions for this question. (**1.5 marks**)

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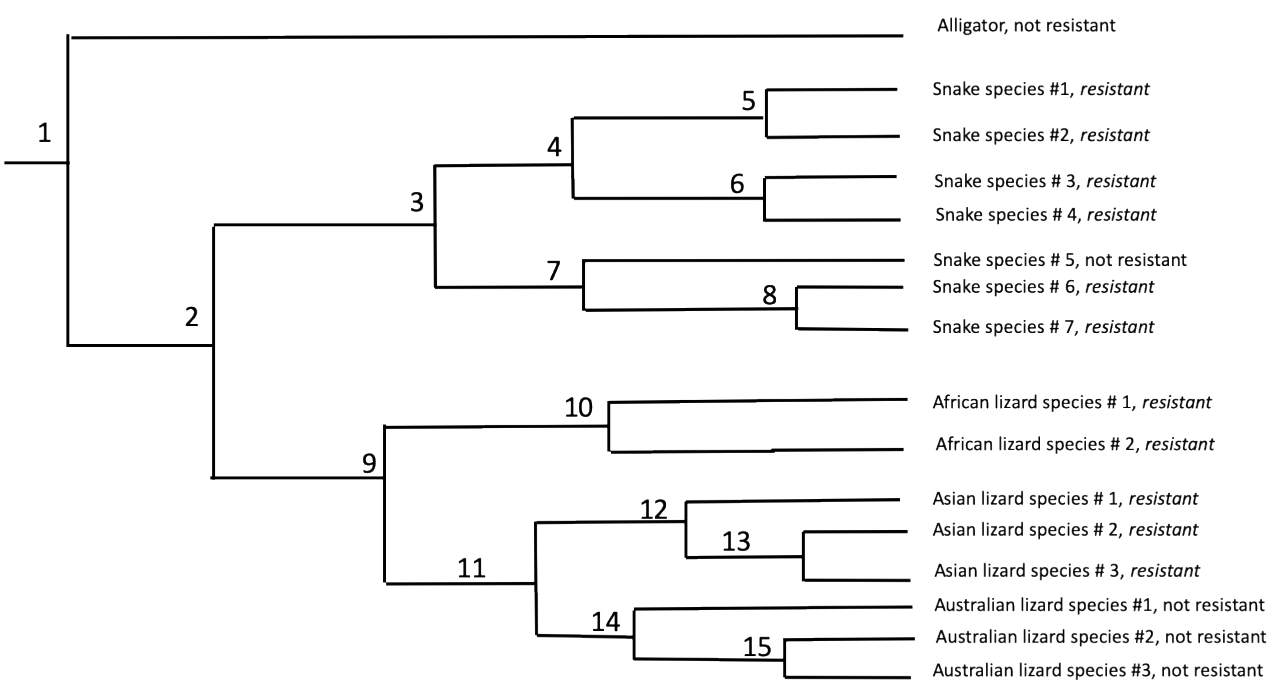
f. Given your answers to parts d and e, choose one evolutionary mechanism that could be responsible for the observed versus the expected genotype frequencies. Clearly state the hypothesis, then evidence, and reasoning to explain why the population is or is not in Hardy-Weinberg (**3.5 marks**)

QUESTION 4. (10 Marks Total)

Many species of toads deter predators by producing toxins that can cause heart failure in predators if the toads are eaten. Some snakes and lizards have evolved a resistance to the toad's toxin. The phylogeny shown in the figure above shows the evolution of toxin resistance in some reptiles. Nodes are labelled with numbers (1-15). The ancestor to the snakes and lizards on this tree was not resistant to toad toxins. **In this system there have been both gains of resistance and losses of resistance to the toxin**.



a) Using the principle of parsimony (the smallest number of changes possible), how many times has toad toxin resistance been gained in this phylogeny? Indicate on the phylogeny with a "G" for gain. **(2 marks)**

b) Using the principle of parsimony (the smallest number of changes possible), how many times has toad toxin resistance been lost based on this phylogeny? Use the letter "X" on the branch to indicate where resistance to toad toxin was lost. (**2 marks**)

c) Is the presence of resistance to toad toxin in both snake species #1 and African lizard species #1 an example of a homology or an analogy (homoplasy)? Explain your reasoning with specific reference to the tree. You answer should show your understanding of both homologies and analogies (homoplasies). (**3 marks**)

d) Which extant taxon/taxa is/are most closely related to snake species #5? **(1 mark)**

e) Are snakes a monophyletic group based on this phylogeny? Explain why or why not with specific reference to the tree. **(2 marks)**