

UNIVERSITY OF BRITISH COLUMBIA

Biology 121 Section 226, Practice Final 2014

Name: _____ Student number: _____
(Please print)

Instructions:

1. Answer all questions in the space provided.
2. All writing must be in **INK**.
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** for summary notes and **one side of the same page for concept maps**, 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.
8. Make sure you have **12** pages including this cover page.

I have read and fully understand these instructions.

Student signature _____

Mark allocation:

Question	Marks possible	Your mark
1.	15	
2.	9	
3.	4	
4.	10	
5.	14	
6.	7	
7.	7	
8.	9	
9.	25	
11.	2	
Total	102	
Concept Map	1	
Total	103	

1. West Coast Leaping Frogs are endemic of Magic Island's West Coast and can have light green, yellow, or blue abdomens. Abdomen colour is controlled by a protein coded by a gene called "C". This gene has two alleles, C_B (for "colour blue") and C_Y (for "colour yellow"). Frogs that are heterozygous C_B/C_Y are light green, due to the mixture of blue and yellow pigments.

a) A field biologist conducts a study on Magic Island and finds that a population of West Coast Leaping Frogs living in a forested area is composed of 820 yellow individuals, 313 blue, and 78 light green individuals.

i) What are the respective frequencies of the C_B and C_Y alleles in this population? Show your calculations for full marks. **(2 marks)**

ii) Is the population described above in Hardy-Weinberg equilibrium? Show all your reasoning and your calculations for full marks. **(4 marks)**

iii) Propose a hypothesis that explains the low proportion of light green frogs in this population. Be precise and very specific. **(4 marks)**

2. (9 marks) Consider a diploid ($2n$) plant. An F1 plant with the genotype $Aa Bb$ was produced by crossing two pure-breeding parents with the genotypes $aaBB$ and $AAbb$. From previous experiments you have determined that alleles of the A and B genes do not assort independently (i.e. they are linked, on the same chromosome).
- a) Draw the chromosomes with these genes as they would appear in metaphase I of meiosis in one of the F1 plants if:
- Crossing over did not occur (2 marks)
 - Crossing over occurred once (2 marks)
 - How many different gametes are possible if crossing over occurs once? (1 mark)

4. (10 marks) A black female mouse with normal ears is crossed with a brown male with small ears. All the F1 are black with normal ears. All the F1 are self-crossed (5 crosses) and the following F2 are obtained:
- 62 black females with normal ears
 - 18 brown females with normal ears
 - 31 black males with normal ears
 - 30 black males with small ears
 - 10 brown males with normal ears
 - 9 brown males with small ears

How are the traits black and brown fur and small and normal ears inherited?

Support your answer by showing the genotypes of the original parents, F1 and the F2 (be sure to define your alleles). Show the F1 x F1 cross in a Punnett square.

5. (14 marks) Two species of fish that live around Caribbean reefs have a unique type of interaction. The Caribbean cleaning gobies (*Elacatinus evelynae*) eat parasites (gnathiids) found on the skin of the longfin damselfish (*Stegastes diencaeus*).

- What type of interaction is occurring between these two species? (1 mark)
- Explain specifically how each member benefits or is harmed in this interaction. (2 marks)

Karen Cheney and Isabelle Côte studied two aspects of this interaction. First they counted the number of parasites (gnathiids) on longfin damselfish in areas with or without cleaner fish. The results are shown in Figure 1.

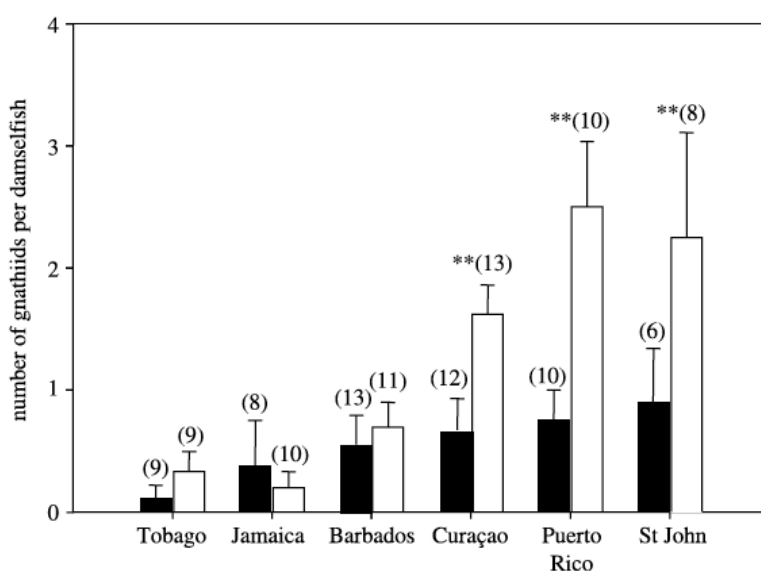


Figure 1. The number of gnathiids (parasites) per damselfish found at various locations in the Caribbean. Black bars indicate parasite numbers on damselfish in areas with cleaner fish. Open (white) bars indicate parasite numbers on damselfish in areas without cleaner fish. The numbers in brackets indicate the sample size. The stars (**) indicate where the number of parasites on damselfish significantly differed between treatments (cleaner fish present, cleaner fish absent).

- Describe the results shown in Figure 1 above. (2 marks)
- What can you conclude from this graph about the effect of cleaner fish on the number of parasites found on damselfish. (2 marks)

In some situations, the cleaner fish also feed on scales, mucus and tissue from damselfish (rather than on the parasites). Cheney and Côte wanted to determine if the cleaner fish diet changed depending on the number of parasites present on damselfish.

They counted the number of parasites on longfin damselfish and determined what material was being eaten by the cleaner fish. The results are shown in Figure 2. The letters indicate different locations. The dots indicate the % scales, mucus and tissue from damselfish ingested given the average number of parasites on the damselfish. The horizontal bars indicate the variation in parasite numbers on damselfish. The vertical bars indicate the variation in scales, mucus and tissue from the damselfish ingested by the cleaner fish. If bars do not overlap, the values can be considered significantly different.

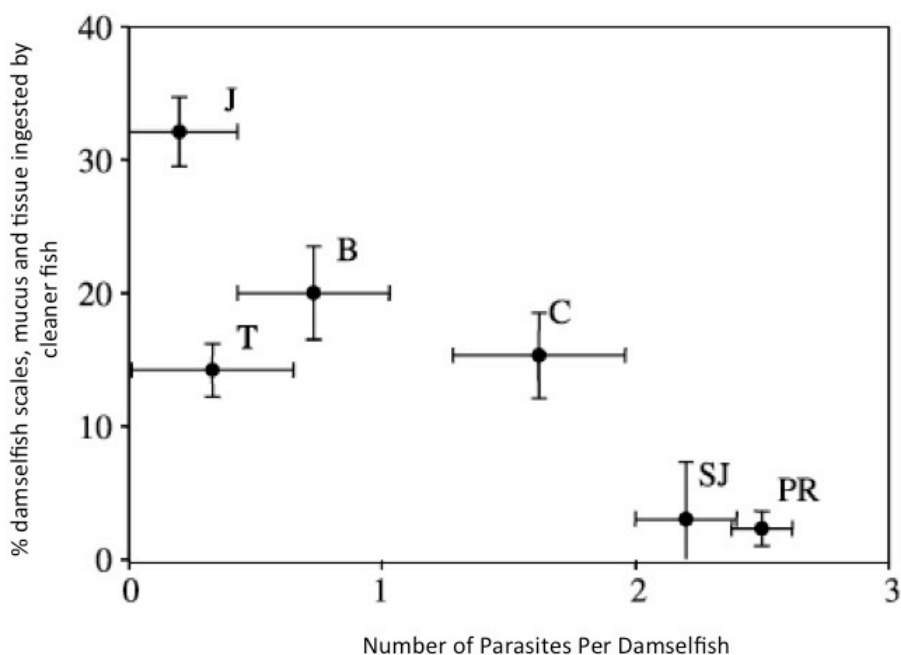
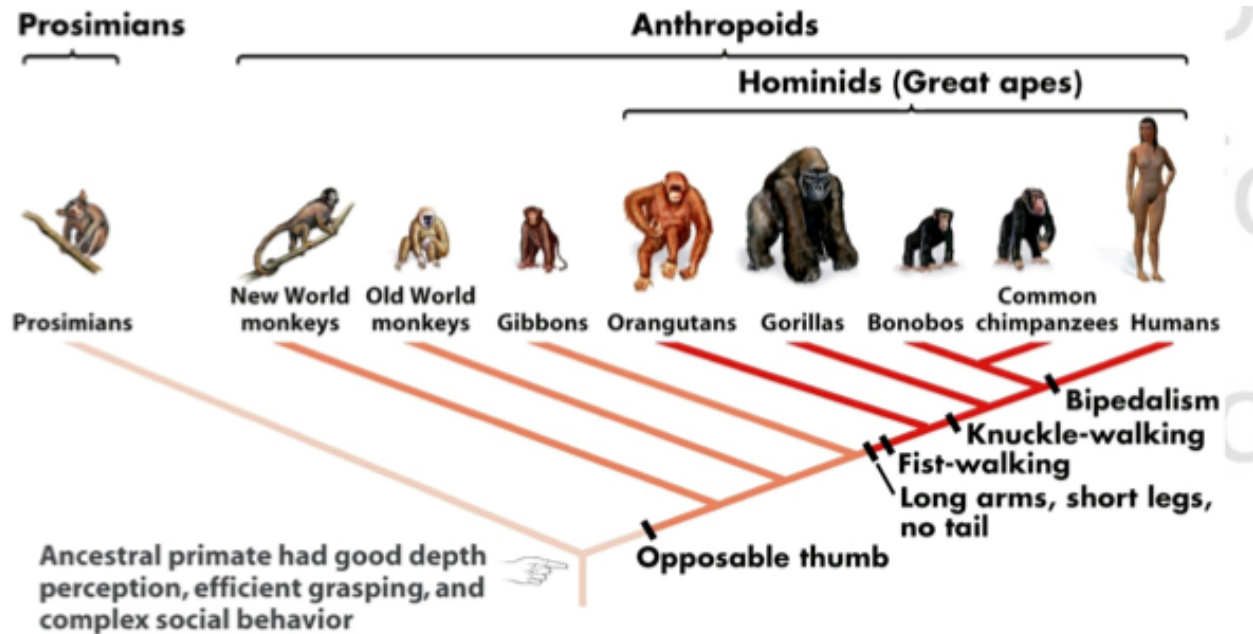


Figure 2. The % of damselfish material ingested when compared with the number of parasites on the damselfish.

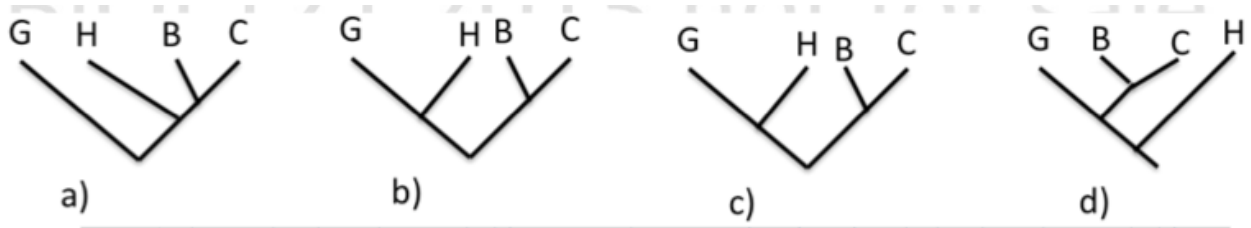
- e) How would you describe the type of interaction where the cleaner fish eats more scales, mucus and tissue from the damselfish than parasites? (1 mark)
- f) Explain specifically how each member benefits or is harmed in the interaction described in e). (2 marks)
- g) Describe the results shown in Figure 2 above. (2 marks)
- h) How do parasite numbers on damselfish change the interaction between cleaner fish and damselfish? (2 marks)

6. The phylogenetic tree shown below represents the current view on the genealogical relationships among the primates alive today.

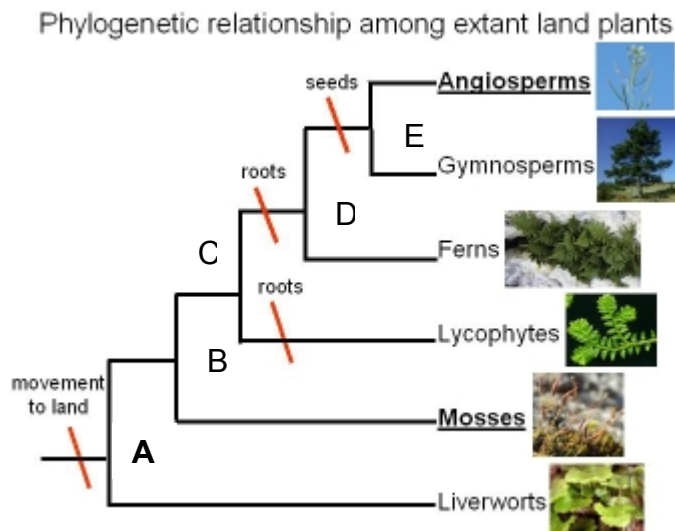


- a) How many clades, or monophyletic groups can you identify on the tree (counting also the “tips of the branches”)? (1 mark)
- b) According to the tree, what characteristics did the most recent common ancestor of gorillas, bonobos, chimps and humans had? (2 marks)
- c) On the tree, circle the most recent common ancestor of all Great Apes. (1 mark)
- d) A previous BIOL121 student stated: “This tree cannot be true because it shows that chimps and bonobos are more evolved than humans.” Do you agree or disagree with this statement? If you agree, justify your answer using evidence from the tree. If you disagree, explain where the previous student went wrong. (3 marks)

e) Consider each of the trees below and explain for each one whether or not it shows the same genealogical relationships among gorillas (G), bonobos (B), chimps (C) and humans (H) as the tree above (on the previous page). **(6 marks)**



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



- a) Which of the following groups form monophyletic clades (circle the number)? (2 marks)

- Angiosperms, Gymnosperms
- Angiosperms, Gymnosperms, Ferns
- Ferns, Lycophytes
- Lycophytes, Mosses

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

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

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

8. (9 marks) 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 4) and the total cheetah population in the wild is less than 10,000..

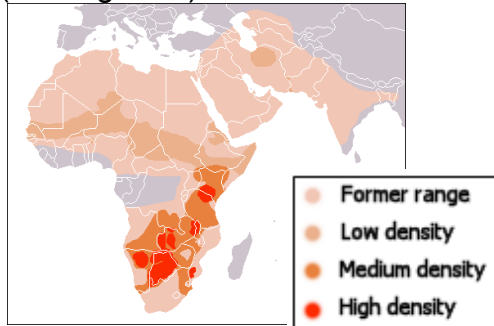


Figure 4. Distribution of cheetahs in Africa and Asia.

- a) List one abiotic factor that could have caused this change in distribution and explain how it has affected the distribution of cheetahs (3 marks)
- b) Explain how the genetics of cheetahs could be a factor in declining population sizes after its distribution was reduced. (3 marks)
- c) List one biotic factor that could have caused this change in distribution and explain how it has affected the distribution of cheetahs. (3 marks)
9. (25 marks) In the Lake Erie region of Ontario there are two kinds of non-poisonous water snakes (*Nerodia*). 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.
- 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. What would you do to determine if they were one species with two morphs or two species? (2 marks)
- 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) 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)
- d) Your next task is to count the snakes in a 3 ha area along the shore and in a similar-sized area on one of the islands. What method would you use to count them? Why would you use this method? What is one drawback of using this method? (3 marks)
- e) You were provided the following graph completed by previous summer students of the finite rate of increase in population growth (λ) of the banded snakes (on the shore).

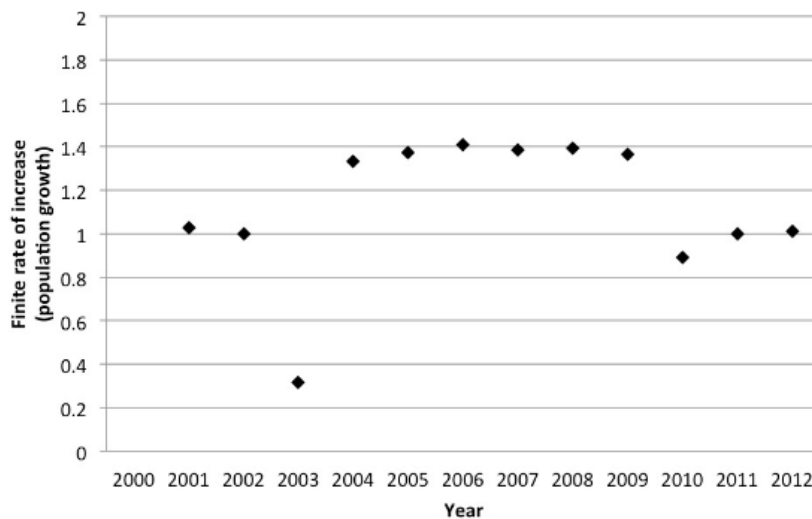


Figure 5 Finite rate of increase of Banded snakes along the shores of Lake Erie.

- i) In what time periods did the banded-snake population size:
 Stay the same
 Increase
 Decrease
 Be very specific and explain your reasoning for each. (6 marks)

ii) What is one factor that could be important in the population decline in one of the periods you chose above. Is this factor density-dependent or density independent? Explain. (2 marks)

iii) Based on the graph above, is this species threatened? Explain. (2 marks)

f) A similar species of snake has slithered in from Florida. You are concerned that this new species may become invasive and upset the balance between the original species. What are two things you would you have to consider to determine if the new species is a threat? For each, indicate why it is important. (4 marks)

10. What did you learn in this course that has been the most interesting or valuable to you? Explain. (2 marks)