Question 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)**

b) The biologist collects a number of West Coast Leaping Frog tadpoles (baby frogs) and raises them in an aquarium under controlled conditions. A few tadpoles die before reaching adulthood, but most of them develop into healthy adult frogs. Altogether, this lab population is composed of 27 yellow, 23 blue and 9 light green individuals.

i) Compare the allele frequencies in this lab population to the frequencies in the natural population (showing your calculations) and propose an explanation for their similarity or for their difference. **(4 marks)**

ii) What could the biologist do to increase the proportion of light green frogs in his lab population in the next generation? In your answer give a specific description of what the biologist would be doing in terms of artificially manipulating the allele and genotype frequencies and causing Hardy-Weinberg criteria not to be met. **(6 marks)**

c) One night, members of the West Coast Leaping Frogs Fan Club break into the biologist's lab and steal one third of the yellow frogs for their club's pond. If the remaining frogs mate randomly with respect to colour, what will be

i) the allele frequencies in the next generation? **(2 marks)**

ii) the phenotypic frequencies in the next generation? **(3 marks)**

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Question 2

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

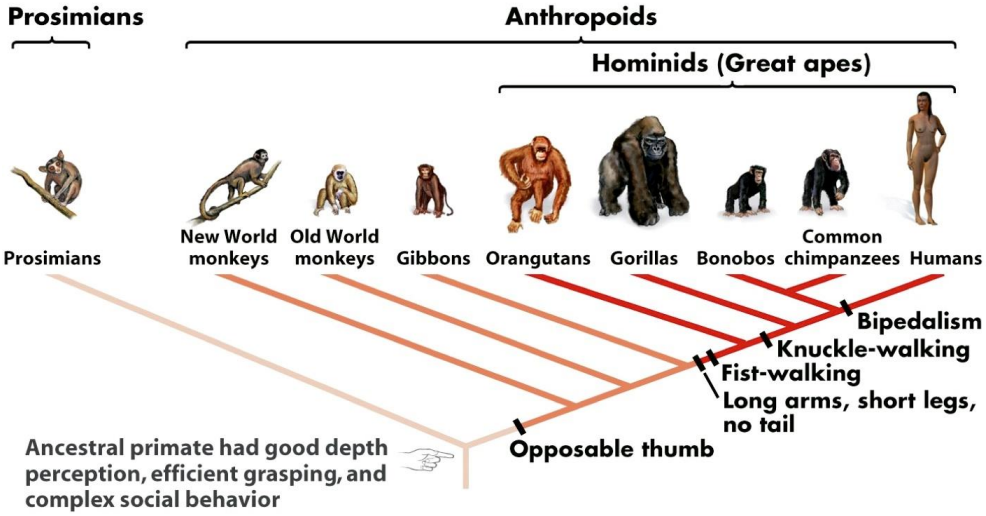

Figure 33-35c Biological Science, 2/e
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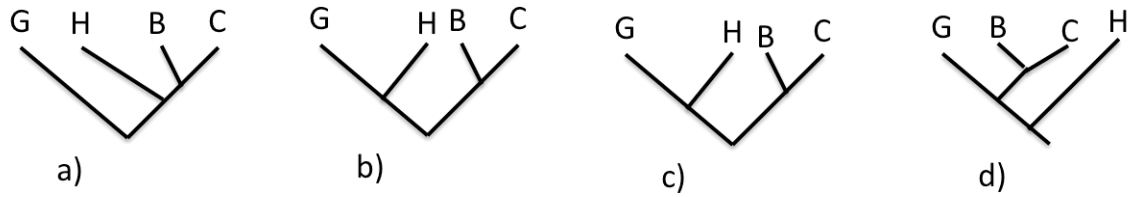
a) How many clades, or monophyletic groups can you identify on the tree (counting also the terminal branches = most recent portion of each lineage)? **(1 mark)**

b) According to the tree, what characteristics did the most recent common ancestor of gorillas, bonobos, chimps and humans have? (Note: this questions assumes that fist-walking, knuckle-walking, and bipedalism are all three different variants of one trait: walking.) **(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)**



f) Primates are not the only animals with opposable thumbs: koalas have two opposable digits (looking like two thumbs). Koalas are the only animals, other than primates, who have opposable thumbs. Koalas are members of the marsupial clade, like kangaroos, wallabies, and other "pouched" mammals. Unlike the babies of placental mammals, marsupial babies are born very "premature" and develop in their mother's pouch.

YOU WILL NOT BE ASKED TO DRAW A PHYLOGENY ON THE EXAM

i) Draw a phylogeny that includes koalas, kangaroos and the placental mammals humans, bonobos and elephants, under the hypothesis that the opposable thumb of primates is homologous to (i.e. inherited from the same common ancestor as) the opposable thumb of koalas. Use the rule of maximum parsimony (smallest number of changes). **(2 marks)**

ii) Now draw a phylogeny that includes koalas, kangaroos and the placental mammals humans, bonobos and elephants, under the hypothesis that the opposable thumb of primates and the opposable thumb of koalas arose independently. Use the rule of maximum parsimony (smallest number of changes). **(2 marks)**

Question 3

A large population of nematode worms live in the soil at Tynehead Park in Surrey, BC. Some of the worms carry the Dpy- mutant allele (Dpy+ is the wild-type). Dpy+ is dominant to Dpy-, and individuals who are homozygous for the mutant allele have a shorter and "fatter" body shape.
Explain, and illustrate with specific examples how and under what circumstances this particular population could be affected by:

a) Genetic drift **(3 marks)**

b) Gene flow **(3 marks)**

c) Selection **(3 marks)**

In the Lake Erie region of Ontario there are two kinds of non-poisonous water snakes. On the shores of the lake most of the snakes have a banded colouration while on the islands in the lake most are not banded. You have been hired by the Ontario government to work on a project designed to protect these 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 they 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) In some snake species, a male will fight with another male for access to a reproductive female. This involves a wrestling match where the snakes raise the front of their bodies off the ground and attempt to topple each other over. They do not bite each other. Rather the winner is the snake that successfully forces the other snake to the ground through strength and dexterity.

i) What is the fitness benefit to the males of engaging in ritual combat? (2 marks)

ii) What is the fitness benefit to the female of mating with the winner of the match? (2 marks)