

Cladistic Analysis. The following data come from the mitochondrial loci cytochrome oxidase I, tRNA Lysine, and subunit 8 of ATPase. Gibbons are the designated outgroup. Orangutans, gorillas, bonobos, and humans are the ingroup. Report m, g, and s for each character. Of course, resolve the most parsimonious cladogram first before reporting s. When you are satisfied that the most parsimonious cladogram has been resolved, calculate M, G, S, CI, and RI for that most optimal solution.

locus:	COI		tRNALys	ATPase 8				
position	2664	2670	4028	4410	4414	4415	4417	
Gibbon	C	T	A	T	C	C	C	
Orangutan	C	C	A	A	C	C	C	
Gorilla	C	C	A	A	A	G	T	
Human	A	T	T	A	A	A	T	
Bonobo	A	T	T	A	A	A	T	
m=	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>2</u>	<u>1</u>	M = 8 (1 pt)
g=	<u>2</u>	<u>2</u>	<u>2</u>	<u>4</u>	<u>3</u>	<u>3</u>	<u>3</u>	G = 19 (1 pt)
s=	<u>1</u>	<u>2</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>2</u>	<u>1</u>	S = 9 (1 pt)
								CI = 8/9 = 0.89 (1 pt)
								RI = 10/11 = 0.91 (1 pt)

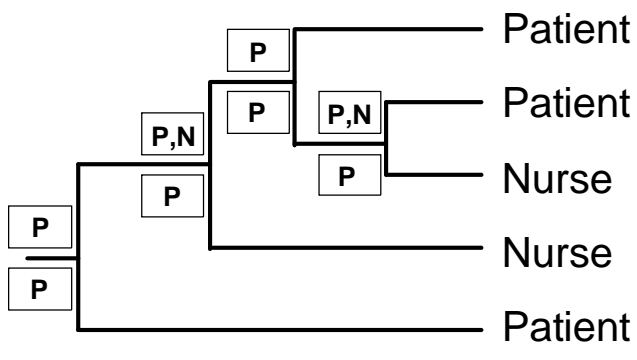
Draw most parsimonious cladogram in this box, and indicate where derived homologies arise (or revert to ancestral states). (5 pts)

Are great apes (orangutans, gorillas, and bonobos) monophyletic? **NO** (1 pt)

State the two reasons the retention index (RI) is a better measure of fit as the parsimony optimality criterion than the consistency index (CI).

1. **CI can never be 0 whereas RI can if a derived state evolves to its maximum** (2 pts)
2. **CI tends to be inflated by characters that are not shared among terminal branches** (2 pts)

In 1998, a Louisiana physician was convicted of infecting his nurse girl friend with HIV taken from one of his HIV-infected patients. The conviction relied on phylogenetic analysis of HIV sequence data. Using the down- and up-pass parsimony approach, reconstruct the ancestral state/source (**P** for patient, **N** for nurse) for each node on the phylogeny to the right in order to determine the direction of infection. Report the down-pass optimization above the branch, and up-pass (final) optimization below the respective branch (use the boxes provided). (4 pts)



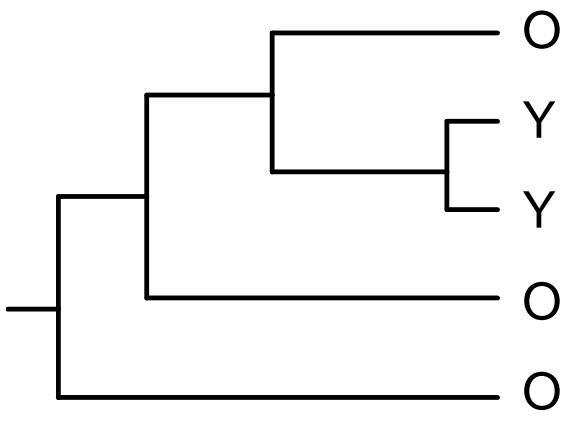
What is the source (ancestral state) for each strain sampled from the Nurse? **The Patient** (1 pt)

Was the patient under the care of the Louisiana doctor the source of the HIV sampled from the nurse (girl friend)? **YES** (1 pt)

To the right, draw the expected phylogeny of an endemic Hawaiian radiation of species (e.g., *Drosophila*, etc.). Simply classify the terminal branches as coming from the old or young islands, where the young island is just the big island of Hawaii. Show two (2) terminal branches of young island endemics (labeled “Y”) and three (3) terminal branches of old island endemics (labeled (“O”).

Answer: any cladogram in which Old (O) would be optimized at the basal-most nodes.

(4 pts)



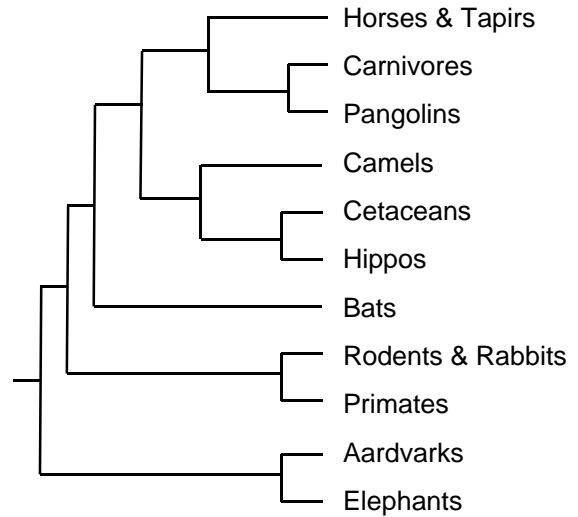
Of the four main terminal branches of primates, prosimians, New World monkeys, Old World Monkeys, and hominids (including apes), the prehensile tail is unique to New World monkeys and indeed reveals the monophyly of New World monkeys. With respect to the prehensile tail and the set of four terminal primate branches indicated above, report the minimum ($m = \underline{1}$), maximum ($g = \underline{1}$), actual ($s = \underline{1}$) number of times this derived state evolved, as well as its consistency ($ci = \underline{1}$) and retention index ($ri = \underline{\text{undefined}}$). (5 pts)

What do traits evolving either by mutation and genetic drift or by sexual selection (i.e., secondary sex traits) share in common? **They are not prone to convergent evolution (also allopatric, arbitrary, etc.)** (2 pts)

What is the signature of a group of species that have diverged (speciated) mostly by sexual selection?

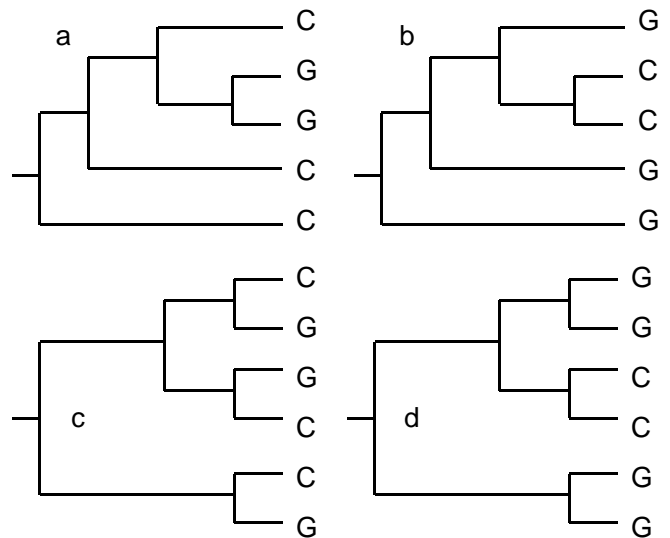
Females are morphological similar but males differ in secondary sex traits (2 pts)

Mammals with high crowned teeth have the ability to graze grass, which is silica-rich and thus abrasive. High crowned teeth in mammals is a derived state and mammals possessing this state include the terminal branches represented by Horses & Tapirs, Camels, Hippos, Rodents & Rabbits, and Elephants. For the character “absence or presence of high crowned teeth”, and according to the phylogeny to the right, report the minimum ($m = \underline{1}$), maximum ($g = \underline{5}$), and actual ($s = \underline{5}$) number of times that high crowned teeth evolved among these mammal lineages as well as the $ci = \underline{0.2}$ and the $ri = \underline{0}$ for this character. (5 pts)



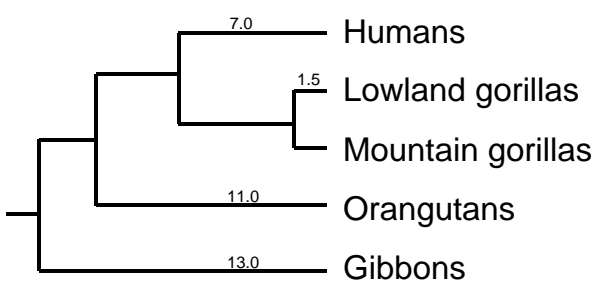
Darwin’s finches are endemic to the Galapagos Islands (600 miles from the coast of Ecuador) and are derived from continental American finches. Of the four simplified phylogenies to the right (a-d), **a** (1 pt) is the expected phylogeny of the Galapagos endemic Geospiza (Darwin’s finches). The terminal branches are classified as coming from the Galapagos (G) or the American Continent (C).

Of these four phylogenies, phylogeny **c** (a, b, c, or d – 1 pt) contrasts strongly to the other three. Why? **It is the only phylogeny in which a single ancestral area cannot be determined (i.e., because of vicariance or rampant dispersal)** (2 pts).



13 pts

Phylogenetic Independent Contrasts. Two hypotheses are used to explain why apes and humans have relatively high levels of uric acid in blood serum. The first explanation involves the maintenance of blood pressure via osmotic potential (elevated salt content of serum is maintained by uric acid). The second hypothesis involves the maintenance of antioxidants. Average levels of uric acid in serum may be inversely related to the levels of the evolutionary intake of foods high in salt or vitamin C. Salt may serve as a substitute for uric acid in the maintenance of high blood pressure, or vitamin C may serve as a substitute for uric acid as an antioxidant. Use the phylogeny to the right to calculate the two missing phylogenetic contrasts below (in boxes – 2 pts each) and then finish graphing the results (lower right-hand graph – 1 pt).

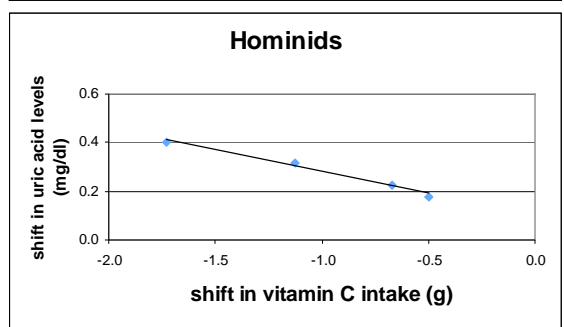
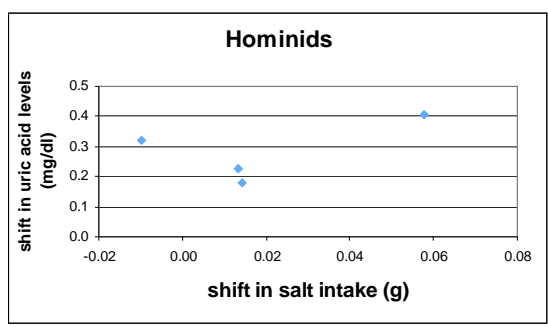
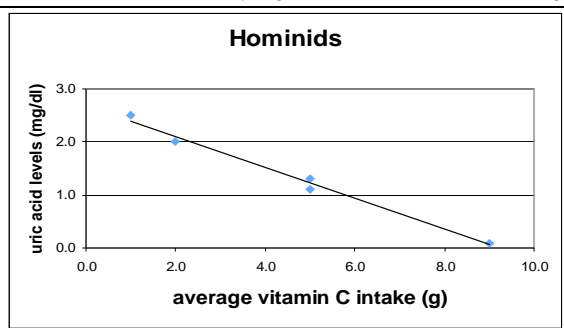
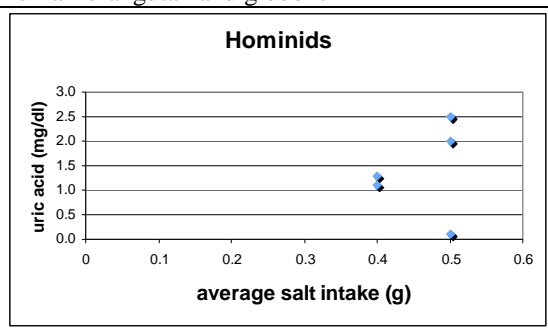


Branch lengths are scaled to Ma.

Which of the two hypotheses is supported by this analysis? **The Vitamin C hypothesis**. Why? (2 pts).

species	average salt intake (g)	average vitamin C intake (g)	average uric acid (mg/dl)
humans	0.5	1.0	2.5
lowland gorillas	0.4	5.0	1.3
mountain gorillas	0.5	2.0	2.0
orangutans	0.4	5.0	1.1
gibbons	0.5	9.0	0.1

Phylogenetic independent contrast	shift in salt intake (g)	shift in vitamin C intake (g)	shift in uric acid (mg/dl)
mountain and lowland gorilla	0.058	-1.732	0.404
gorilla and human	0.013	-0.668	0.227
gorilla-human and orangutan	0.014	-0.497	0.178
gorilla-human-orangutan and gibbons	-0.010	-1.128	0.319



7 pts