Biology from Hawaii Name

2014

**Molecular Phylogenetics**

*10 points*

**Introduction**

Scientists use comparisons between species in order to determine evolutionary history and draw cladograms. The most modern comparisons use similarities and differences in DNA sequence to determine relatedness.

1. Below are pairs of DNA sequences. Highlight and **count the number of differences** between each pair. Note: there is no nucleotide at the location of the dashes. The dashes are inserted only to shift the remaining nucleotides one space to the right in order to maintain alignment with the other strands.

Human GTGGACCACCCCGATGCGAAGTGGACCCC-CTACTGTAGGATGACTCGGGGACG

Rat ATGGGGCATCTCCACGCGAAGTGGGCTCCGCTACTGTAAGACGACTCGGGGACG

# of differences

Human GTGGACCACCCCGATGCGAAGTGGACCCC-CTACTGTAGGATGACTCGGGGACG

Fruit Bat ATGG-GCATCTCCACGCGAAGTGGGCTCCGCTACTGTAAGACGACTCGGGGACA

# of differences

Human GTGGACCACCCCGATGCGAAGTGGACCCC-CTACTGTAGGATGACTCGGGGACG

Horse ATAGGGCATCTTCAAGCGAAGTGGGCTCCGCTACTGTAAGACGACTCGGGTACG

# of differences

Human GTGGACCACCCCGATGCGAAGTGGACCCC-CTACTGTAGGATGACTCGGGGACG

Orangutan ATGGGCCACCCCCACGCGAAGTGGGTCTC-CTACTGCAGGATGACTCGGGGACG

# of differences

Human GTGGACCACCCCGATGCGAAGTGGACCCC-CTACTGTAGGATGACTCGGGGACG

Chimpanzee ATGGACCACCCCGATGCGAAGTGGACCTC-CTACTGTAGGATGACTCGGGGACG

# of differences

Human GTGGACCACCCCGATGCGAAGTGGACCCC-CTACTGTAGGATGACTCGGGGACG

Neanderthal GTGGACCACCCCGATGCGAAGTGGACCCC-CTACTGTAGGATGACTCGGGGACG

# of differences

2. a. Compared to humans, which species is our closest relative?

b. Compared to humans, which species is our most distant relative?

3. **Draw a cladogram** of these species: human, rat, fruit bat, horse, orangutan, chimpanzee, neanderthal

4. Now compare each species to rats. Again, count the number of differences.

Rat ATGGGGCATCTCCACGCGAAGTGGGCTCCGCTACTGTAAGACGACTCGGGGACG

Fruit Bat ATGG-GCATCTCCACGCGAAGTGGGCTCCGCTACTGTAAGACGACTCGGGGACA

# of differences

Rat ATGGGGCATCTCCACGCGAAGTGGGCTCCGCTACTGTAAGACGACTCGGGGACG

Horse ATAGGGCATCTTCAAGCGAAGTGGGCTCCGCTACTGTAAGACGACTCGGGTACG

# of differences

Rat ATGGGGCATCTCCACGCGAAGTGGGCTCCGCTACTGTAAGACGACTCGGGGACG

Orangutan ATGGGCCACCCCCACGCGAAGTGGGTCTC-CTACTGCAGGATGACTCGGGGACG

# of differences

Rat ATGGGGCATCTCCACGCGAAGTGGGCTCCGCTACTGTAAGACGACTCGGGGACG

Chimpanzee ATGGACCACCCCGATGCGAAGTGGACCTC-CTACTGTAGGATGACTCGGGGACG

# of differences

Rat ATGGGGCATCTCCACGCGAAGTGGGCTCCGCTACTGTAAGACGACTCGGGGACG

Human GTGGACCACCCCGATGCGAAGTGGACCCC-CTACTGTAGGATGACTCGGGGACG

# of differences

Rat ATGGGGCATCTCCACGCGAAGTGGGCTCCGCTACTGTAAGACGACTCGGGGACG

Neanderthal GTGGACCACCCCGATGCGAAGTGGACCCC-CTACTGTAGGATGACTCGGGGACG

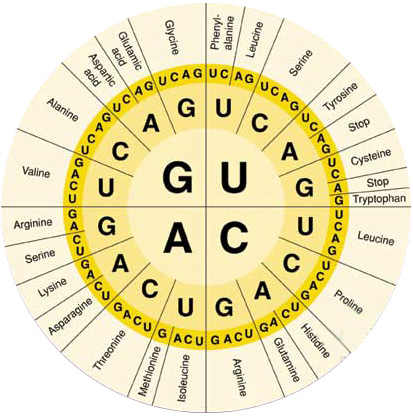
# of differences

5. a. Which species is most closely related to rats?

b. Which species is most distantly related to rats?

6. **Amend your cladogram** to account for this new information about rats. Note: it is often impossible to create a cladogram that perfectly accounts for all information. It should, however, be possible to *improve* your cladogram.

7. In your opinion, **which is easier**: drawing a cladogram after observing physical characteristics or drawing a cladogram after comparing DNA? Explain.



8. The DNA sequence we've been analyzing is from the middle of the GLUO gene, responsible for making vitamin C. Amazingly, rats can make their own vitamin C! Transcribe and translate the rat DNA to find the **correct** **amino acid sequence**.

Rat DNA ATGGGGCATCTCCACGCGAAGTGGGCTCCGCTACTGTAAGACGACTCGGGGACG

mRNA

------------------------------------------------------

amino acids

9. Humans cannot make our own vitamin C; our GLUO gene would make a useless protein.

a. Transcribe and translate the human DNA to find our useless amino acid sequence.

Human DNA GTGGACCACCCCGATGCGAAGTGGACCCC-CTACTGTAGGATGACTCGGGGACG

mRNA

----------------------------- ------------------------

amino acids

b. **Highlight** or **circle** the amino acids that differ from the rat amino acid sequence.

10. a. The human GLUO gene is a mutated version of the original GLUO gene. Explain why the **deletion mutation** in human DNA had the biggest effect on changing the amino acid sequence.

b. **Highlight** or **circle** all the species with the **same deletion mutation** as humans

Rat ATGGGGCATCTCCACGCGAAGTGGGCTCCGCTACTGTAAGACGACTCGGGGACG

Fruit Bat ATGG-GCATCTCCACGCGAAGTGGGCTCCGCTACTGTAAGACGACTCGGGGACA

Horse ATAGGGCATCTTCAAGCGAAGTGGGCTCCGCTACTGTAAGACGACTCGGGTACG

Orangutan ATGGGCCACCCCCACGCGAAGTGGGTCTC-CTACTGCAGGATGACTCGGGGACG

Chimpanzee ATGGACCACCCCGATGCGAAGTGGACCTC-CTACTGTAGGATGACTCGGGGACG

Neanderthal GTGGACCACCCCGATGCGAAGTGGACCCC-CTACTGTAGGATGACTCGGGGACG

Human GTGGACCACCCCGATGCGAAGTGGACCCC-CTACTGTAGGATGACTCGGGGACG

c. Refer to your cladogram in question #6. Mark the spot you think the **deletion** **mutation** first appeared.

d. Name any other species that likely carries this same **deletion mutation**

e. Humans get vitamin C from our food, primarily fruit. In light of all you just learned, discuss the diet of ancient hominids.