AP Bio FRQ Fridays

2009 #3
Phylogeny & Evidence of Evolution

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Phylogeny is the evolutionary history of a species.

(a) The evolution of a species is dependent on changes in the genome of the species. **Identify** TWO mechanisms of genetic change, and **explain** how each affects genetic variation.

	Identification **(1 point each; 2 points maximum)**	**Explanation** **(1 point each; 2 points maximum)**
DNA (molecular)	Mutation, e.g., point, frameshift, insertions, deletions	Change in nucleotide sequence or amino acid sequence or protein structure or gene expression, or change in phenotype
	Duplication, e.g., gene, chromosome, genome, sympatric speciation	Gene "families," which then diverge by mutation; change in ploidy
	Rearrangement, e.g., gene order, inversions, chromosome fusion, transposons	Chromosome structure altered; change in crossover frequency
Cellular	Crossing over, independent assortment, segregation, nondisjunction (meiosis) Random fertilization (sexual reproduction)	Increase gamete diversity Many possible gamete combinations
Population	Genetic drift or bottleneck or founder effects Gene flow (migration) Geographic isolation or allopatric speciation Nonrandom mating (sexual selection) Sympatric speciation Natural selection	Population allelic/gene frequencies altered or gain or loss of alleles/genes Reproductive fitness/differential success

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ADDITIONAL PAGE FOR ANSWERING QUESTION 3

Changing genetics is a key factor in the theory of evolution. An unpredictable factor in this change is mutation. A random change in genetics as an addition, substitution, or deletion can alter an organisms structure or behavior. The ability for these changes to pass on requires that the mutation occur in the sex cells. If an autosomal mutation does not affect the sex cells then it will die with the individual. Mutations can be devestating or extremely helpful to a population depending on the circumstances and can sometimes create a new standard of sexual selection. Geographic isolation, often from changing migration paths or geologic activity can greatly alter the genetics of a population. When brought into a new environment, new challenges are brought to a population. Their adaptations will be different than those in their original habitats or than their counterparts remaining there. Selection of different traits often arises from predation, new food sources, leaving a genetically and phenotypically different population and can sometimes lead to speciation. The genetic similarities in organisms can

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(b) Based on the data in the table below, **draw** a phylogenetic tree that reflects the evolutionary relationships of the organisms based on the differences in their cytochrome *c* amino-acid sequences and **explain** the relationships of the organisms. Based on the data, **identify** which organism is most closely related to the chicken and **explain** your choice.

THE NUMBER OF AMINO ACID DIFFERENCES IN CYTOCHROME *c* AMONG VARIOUS ORGANISMS

	Horse	Donkey	Chicken	Penguin	Snake
Horse	0	1	11	13	21
Donkey		0	10	12	20
Chicken			0	3	18
Penguin				0	17
Snake					0

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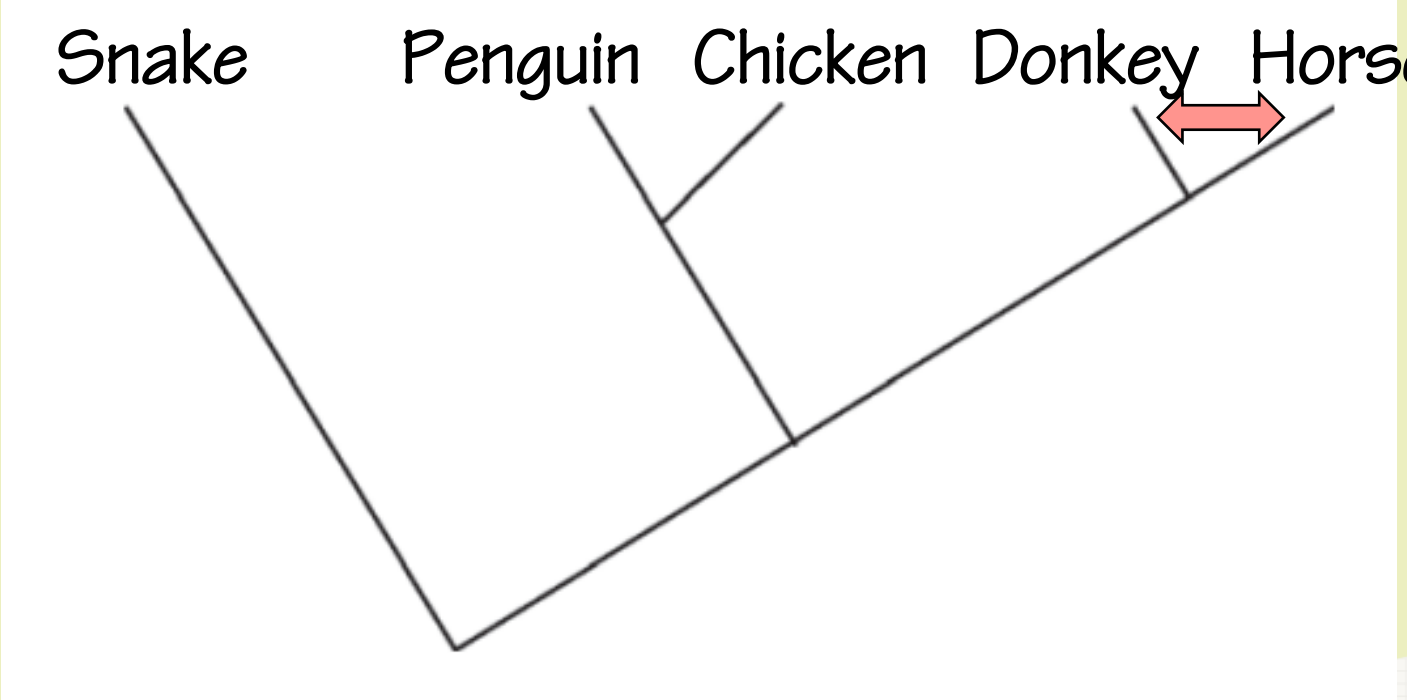

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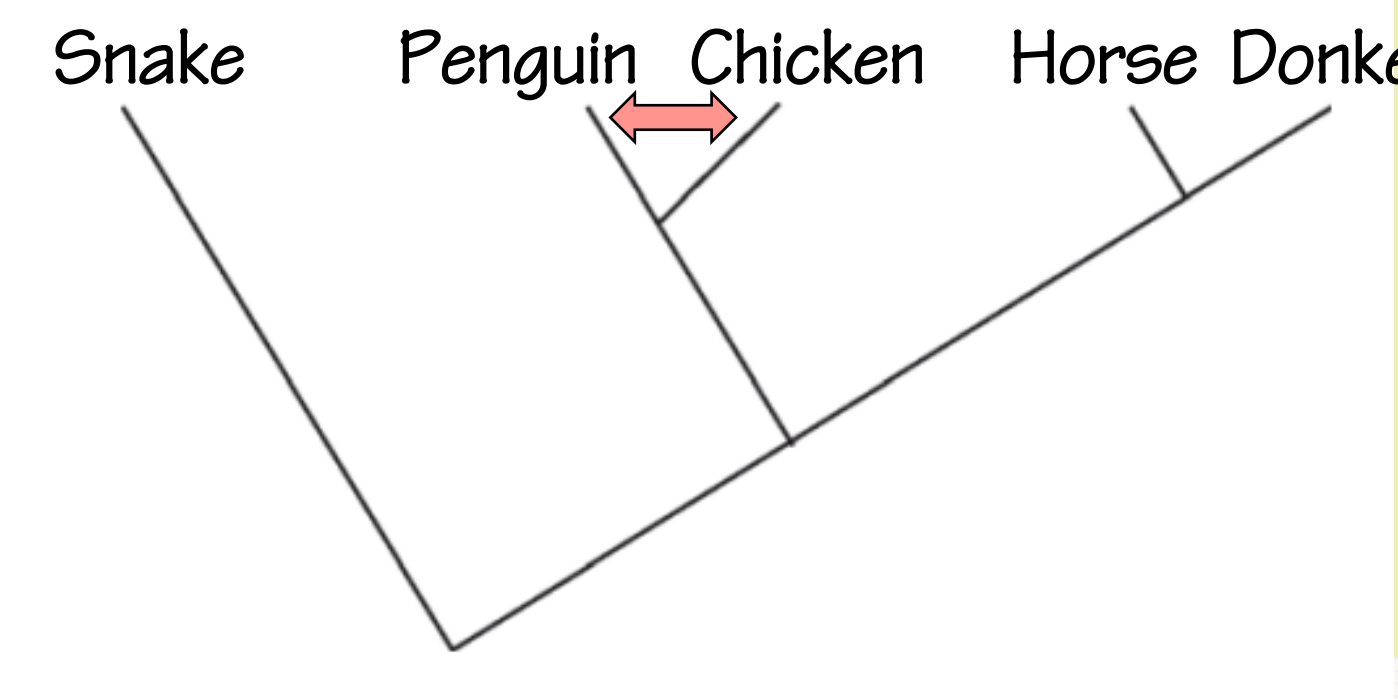

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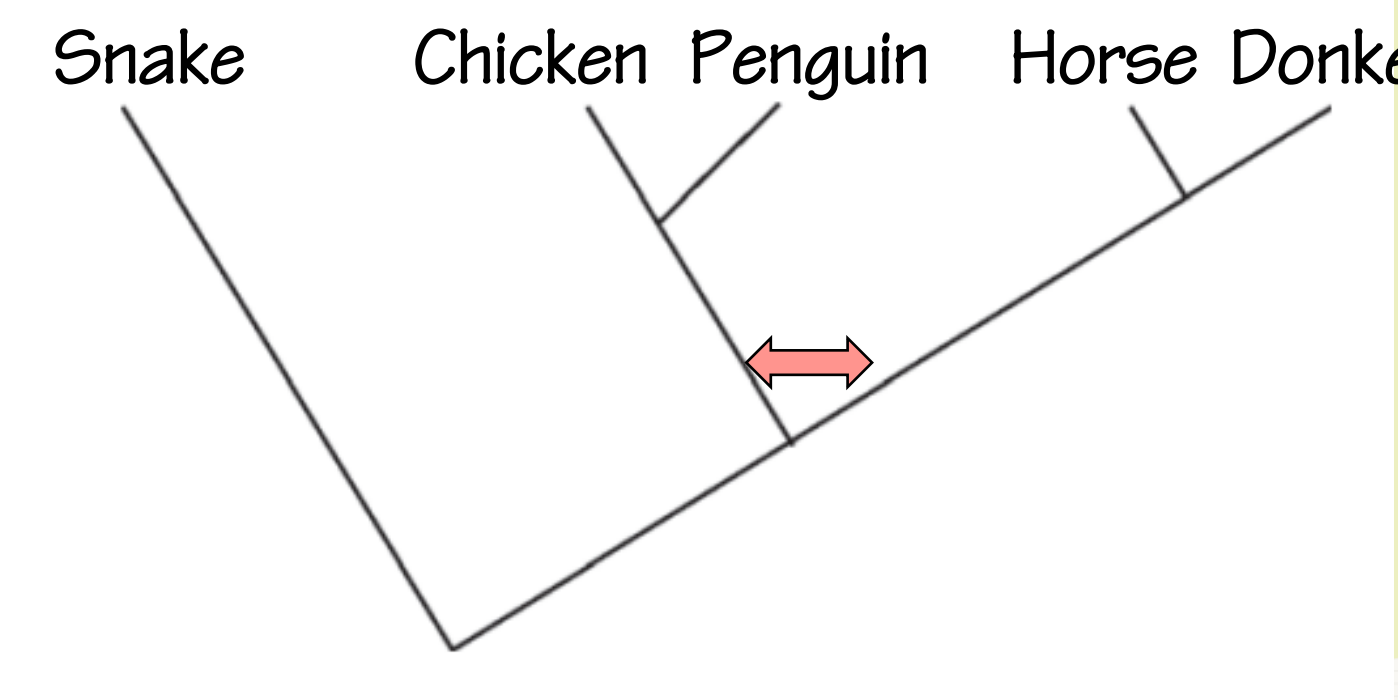

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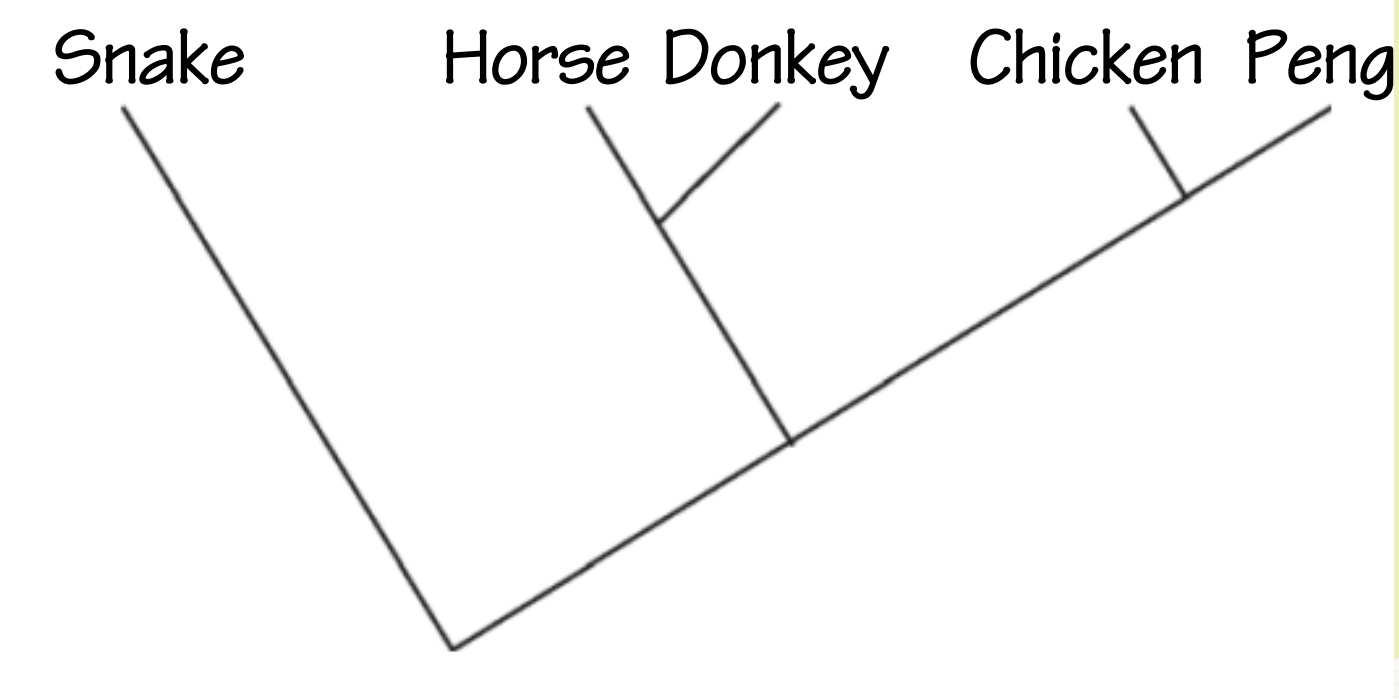

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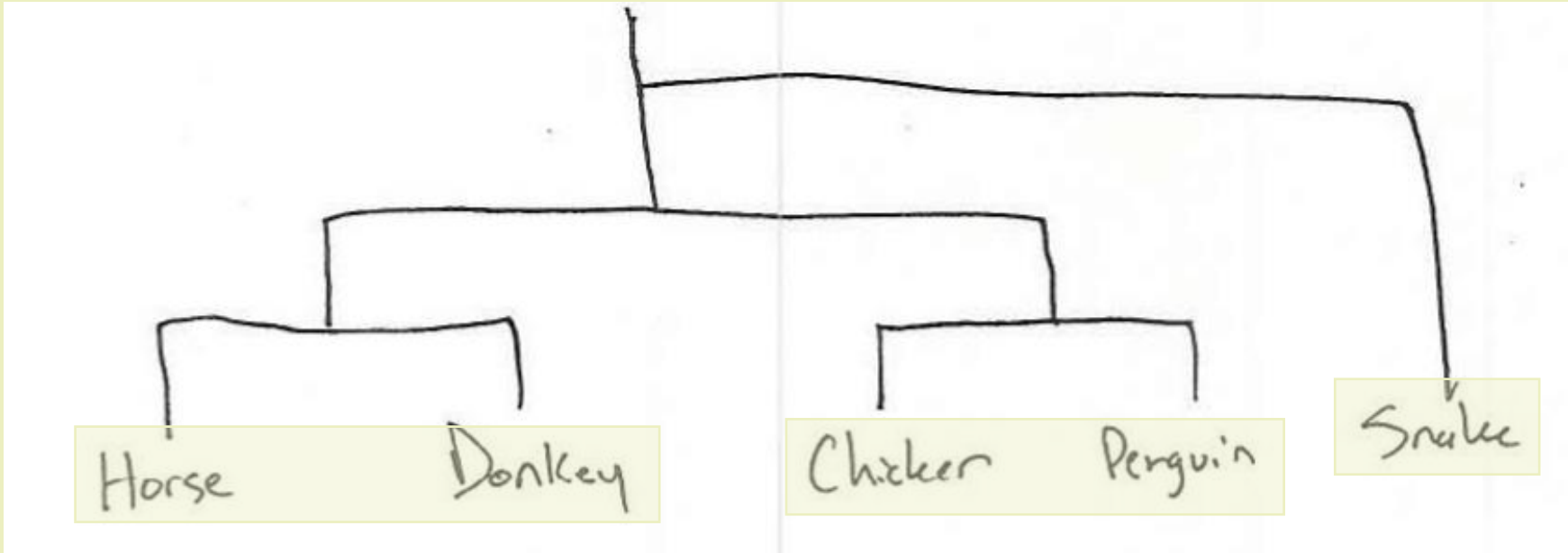

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- Cytochrome *c*: the more differences in amino acids of cytochrome *c*, the less closely related, OR fewer differences, more closely related. **(1 point)**
- Penguin is most closely related to chicken. **(1 point)**
- Three amino acids differing between penguin and chicken/penguin has fewest differences from chicken. **(1 point)**

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(on sometimes lead to speciation. The genetic similarities in organisms can point to their degree of relation and how recent a common ancestor might be. Based on the differences of the cytochrome-c in these organisms, it would seem that the donkey and horse are very closely related (already obvious from the hybrid viability in the two) as well as the chicken and the penguin. The snake is the furthest related from them all. This makes sense since the donkey and horse are both members of mamamalia and the chicken and penguin both members of Aves. It appears that the penguin is most related to the chicken since it had the fewest differences of cytochrome c (3). Embryology is another way to observe the relation of

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(c) **Describe** TWO types of evidence—other than the comparison of proteins—that can be used to determine the phylogeny of organisms. **Discuss** one strength of each type of evidence you described.

Description **(1 point per box; 2 points maximum)**	**Strength** **(1 point each; 2 points maximum)**
Fossil Observe past organisms	Shows direct evidence of common ancestor, follow evolution (changes over time) from common ancestor
Homology: morphology Organismal structure/form Vestigial structures	Similarities in form(s) show common ancestry/DNA
Homology: embryology/development Morphology of embryos; changes in gene expression during development	Similarities in development show common ancestry/DNA
Homology: reproduction Comparison of reproductive strategies or life cycles: cell division, gamete production, gamete type, etc.	Similarities in reproduction strategies show common ancestry/DNA
DNA sequence Comparison of DNA sequences in specific genes; molecular homologies	Similarities in sequences show common ancestry
Biogeography Analysis of organism distribution(s)	Uses both past and present information to show common ancestry/DNA
Direct observation/behavior Watch organism in natural setting	Similarities in behaviors indicate common ancestry/DNA

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(c) **Describe** TWO types of evidence—other than the comparison of proteins—that can be used to determine the phylogeny of organisms. **Discuss** one strength of each type of evidence you described.

c (3). Embryology is another way to observe the relation of organisms, especially in mammals. Similarities in embryonic structure and appearance support the notion of a more recent common ancestor and can be very uncanny to note in photographs just how similar we are as embryos. Homologous structures of organisms link them together in their adult forms. It's visible in the forearm and hand bones of chordates. The bones in a bat's wing bear striking resemblance and structure to those of the human hand. This also promotes the idea of a common ancestor and can highlight the deviations from it very graphically.

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