

BIOL 428: Introduction to Systematics
MIDTERM EXAM

Please, write your name on each page!

The exam is worth 150 points. Verify that you have all 8 pages. Read the questions *carefully*, and make sure that you write legibly.

Q#1 (6 points) 1. List at least 3 methods for polarizing a character for phylogenetic analysis. Biogeographic, outgroup, developmental, paleontological criteria and criteria of how common the character state is have all been used.

Briefly describe the distinction between each pair of concepts (30 points total).

Q#2a (6 points) Paraphyletic *vs* Monophyletic Paraphyletic refers to a group in which some of the descendants of an ancestor are missing; a monophyletic group always includes *all* descendants of an ancestor.

Q#2b (6 points) Classification *vs* Nomenclature Classification is the process of organizing and recognizing groups (taxa). Nomenclature is simply the process of applying names to the groups that have been recognized.

Q#2c (6 points) an “evolutionary systematics” classification *vs* a “phylogenetic systematics” classification An “evolutionary systematics” classification attempted to compromise between a wide variety of aspects of the evolutionary and practical considerations: recognizing cladogenesis, anagenesis, group size, group distinctiveness, and adaptive zone . . . as all factors that could influence the optimal classification. In phylogenetic systematics groups must be monophyletic.

Q#2c (6 points) essentialistic view of species *vs* nominalistic view of species In the essentialistic view, each species had a core set of properties that describe its unchanging essence; a species was the set of organisms that had the essential properties. The nominalistic view of species questioned whether species are “real” in any objective sense, and viewed species as a convenience constructed by systematists (rather than nature)

Q#2d (6 points) cladogenesis *vs* anagenesis Cladogenesis is the speciation process– the production of new branches on the tree of life. Anagenesis refers to evolutionary changes within a lineage (without the creation of new lineages)

Q#2e (6 points) maximum compatibility tree estimation *vs* parsimony tree estimation Maximum compatibility tries to find the tree which can explain the largest # of characters with no homoplasy. Parsimony tries to find the tree that requires the fewest number of events of homoplasy

Q#3 (21 points) Matching (3 points each)

- | | |
|------------------------------|-------------------------------|
| (A) additive distance matrix | (B) long branch attraction |
| (C) homoplasy | (D) <i>p</i> -distance matrix |
| (E) symplesiomorphy | (F) patristic distance matrix |
| (G) maximum likelihood | (H) Hamming distance matrix |
| (I) clustering by similarity | (J) transversion |
| (K) parsimony | (L) synapomorphy |
| (M) parallelism | (N) phenetics |
| (O) cladistics | (P) compatibility |
| (Q) the molecular clock | (R) autapomorphy |

For each of the statements below, write the letter in the blank to the left of the question part number.

Choose the letter that corresponds to the word or phrase (shown above) which best matches the statement or fills in the blank. You will not use all of the possible words and phrases!

F Q3 part 1: Informally speaking, Buneman's method seeks to find a tree for which the _____ matches the input distances.

B Q3 part 2: The phenomenon in which homoplasy is more likely on some branches with high character divergence can mislead parsimony. This phenomenon is called _____.

I Q3 part 3: If you were going to summarize the goal of UPGMA it would be to produce a tree using _____.

L Q3 part 4: Hennig thought that all of the phylogenetic information came from _____.

H Q3 part 5: If you summarize the number of characters which differ between two OTUs in a table, you will have created a _____.

N Q3 part 6: The school of systematic thought that focuses on summarizing similarity between species, rather than evolutionary relationships is referred to as _____.

C Q3 part 7: Hennig's method and Buneman's method are both guaranteed to succeed if your data has no cases of _____.

Q#4 (10 points) Describe Linnaeus' attitude about how species names should be constructed. What were the strengths and weaknesses of the way(s) that he named species? Linnaeus thought the true name of a species was the long polynomial that described the essential characteristics that differentiate it from its congeners. These names were descriptive, but difficult to remember and unstable. He used binary nomenclature as a short cut, but noticed that the binomials did not have to change from version to version of the *Systema Naturae*.

Q#5 (10 points) Briefly describe whether Darwin's contributions to systematics were mainly practical or theoretical and explain your answer. Discuss how Darwin reacted to the practice of classifying organisms in the early 1800's. Did he reject the systematics of his time, revolutionize the practice of classification, or agree with the dominant classification practices?

Darwin's contributions to systematics were almost entirely theoretical. Hierarchical classification already existed, and these classifications convinced him of common descent before he understood the mechanisms of evolution. His work provided clarity about why the diversity of organisms could be structured hierarchically, but he did not provide easy-to-use methods for estimating phylogenetic relationships.

Q#6 (10 points) Explain the ways that Sokal and Hennig disagreed about the goals of classification and how trees should be constructed.

Sokal thought classifications should reflect overall similarity. Hennig thought they should reflect phylogenetic relationships. Sokal thought trees should be built using all available data with equal weighting and as little subjectivity/judgement as possible. Hennig thought that you had to determine groups solely on synapomorphy, and revising the primary homology statements was OK.

Q#7 (10 points) A group of researchers is interested in whether sexual dimorphism is associated with polygamous mating systems in birds. They categorize 16 species of birds as dimorphic or monomorphic and polygamous or monogamous. 10 species are dimorphic and polygamous; 5 species are monomorphic and monogamous; and 1 species was found to be monomorphic and polygamous. They use a simple χ^2 test of association and conclude that there is statistically significant association between dimorphism and polygamy. What error have the researchers made, and (in general terms) how could they fix their error? The researchers have failed to take into account that some of the species share portions of their evolutionary history. These are not 16 independent data points. They need to estimate a tree and analyze the evolutionary events, not just treat the data for extant species as independent data.

For questions 9 - 13 consider the following matrix with *Mimulus* as the outgroup:

Taxon	Character #							Total
	1	2	3	4	5	6	7	
<i>Mimulus</i>	R	Y	R	R	Y	R	R	
<i>Antirrhinum</i>	R	Y	R	Y	R	Y	Y	
<i>Bacopa</i>	Y	Y	R	Y	R	R	Y	
<i>Plantago</i>	R	R	R	Y	R	R	R	
<i>Veronica</i>	R	R	R	Y	Y	R	R	
Tree #1	1	1	0	1	2	1	1	7
Tree #2	2	2	0	1	2	1	1	8

Q#9 (4 points) Which of the characters are parsimony informative? **2, 5, and 7**

Q#10 (10 points) For tree #1: Using the outgroup assumption, draw the tree with:

- *Antirrhinum+Bacopa* forming a clade, and
- *Plantago+Veronica* forming a clade.

Draw the tree and show its parsimony score. Fill in the scores for the characters in the table row “Tree #1”

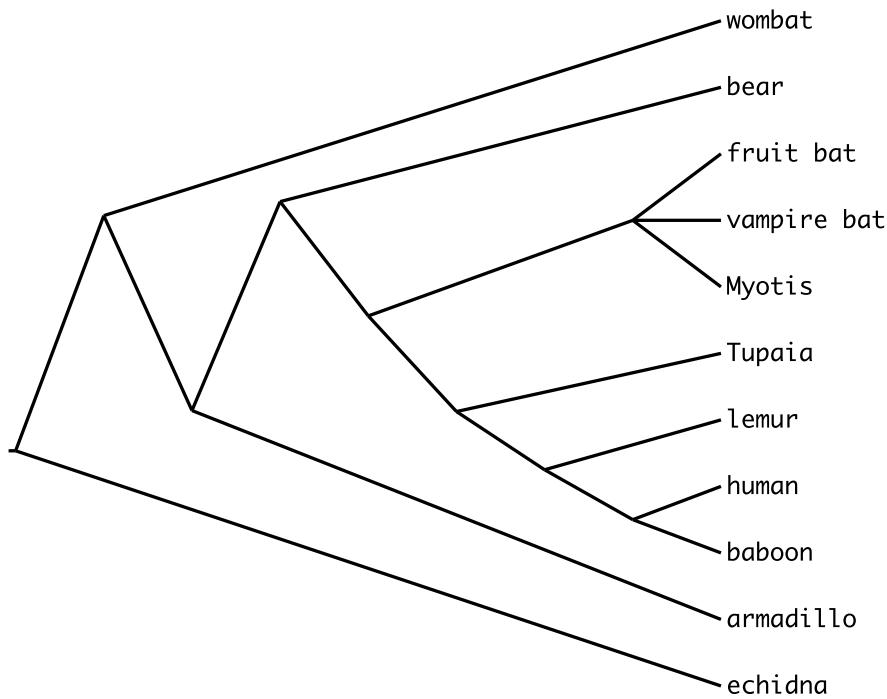
Q#11 (10 points) For tree #2: Using the outgroup assumption, draw the tree with:

- *Antirrhinum+Bacopa* forming a clade, and
- *Antirrhinum+Bacopa+Veronica* forming a clade.

Draw the tree and show its parsimony score. Fill in the scores for the characters in the table row “Tree #2”

Q#12 (2 points) According to parsimony, which of these trees is preferable (or are they equally plausible trees)? **Tree #1**

Q#13 (4 points) From a Hennigian perspective, is there evidence for conflict among the characters? If so, which characters are incompatible? **Yes. Characters 2 & 5 conflict. 2 “says” that *Plantago+Veronica* form a clade. 5 “says” that *Antirrhinum+Bacopa+Plantago* form a clade. Those statements are incompatible.**



Use the cladogram above to answer the following questions

Q#14a (3 points) Draw a solid line around the sister group to lemur.

Q#14b (3 points) Draw a dashed line around a paraphyletic group.

Q#14c (3 points) According to this tree, is the “fruit bat” more closely related to the human or to the bear? **human**

Q#14d (3 points) **TRUE**

OR FALSE baboon shares a more recent common ancestor with the armadillo than it does with wombat

Q#14e (3 points) **TRUE**

OR FALSE When interpreted as a cladogram, this tree tells us that the most recent common ancestor of “fruit bat” and Myotis was a species that lived after the most recent common of human and bear.

Q#14f (3 points) **TRUE** OR **FALSE**

When interpreted as a cladogram, this tree tells us that the most recent common ancestor of “fruit bat” and “vampire bat” was a species that lived after the most recent common of human and Tupaia.

There are 151 total points possible in the exam. The exam is worth 150 points. So there is one bonus point.