**Population Genetics**
**Problem Set 11**

1. [Note: This is the corrected format for the first part of **Chapter 10, Question 2**] Given that $Pr(A_1B_1) = 0.3$, $Pr(A_1B_2) = 0.1$, $Pr(A_2B_1) = 0.2$, $Pr(A_2B_2) = 0.4$

a. Calculate linkage disequilibrium, *D*

D = (product of coupling gametes) – (product of repulsion gametes)

$= (x_{11}x_{22}) – (x_{12}x_{21}) = (0.3 \text{ X } 0.4) – (0.1 \text{ X } 0.2) = 0.12 – 0.02 =$ **0.10**

b. What is the frequency of the $B_2$ allele? What is the frequency of the $A_1$ allele?

$Pr(B_2) = 0.1 + 0.4 = 0.5$

$Pr(A_1) = 0.3 + 0.1 = 0.4$

2. Give the best definition for the following terms:

a. Quantitative trait: a phenotype determined by many genes (polygenic). Quantitative traits are often distributed on a continuous scale, e.g., body size in livestock; percentage of oil in maize

b. Quantitative trait loci, QTLs: genes or loci that affect quantitative traits

c. Heritability: the proportion of phenotypic variance that is genetically determined

d. LOD score: (logarithm of odds), an estimate of the linkage between a marker and a QTL. Uses a log-ten scale, so a LOD score of **3** means the likelihood of observing result if **not** linked is less than 1 in $10^3$

e. Tag SNPs: single nucleotide polymorphisms that are especially useful for differentiating among different haplotypes in populations

f. Haplotype blocks: regions of the genome with little evidence of recombination, often separated by regions of low linkage disequilibrium (recombination hot spots).

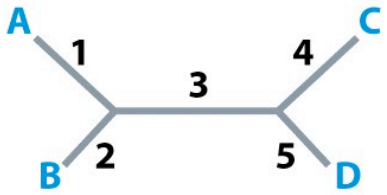
g. Association mapping: Use of genetic markers to identify QTLs or genes. The markers are in linkage disequilibrium with their surrounding haplotypes.

h. Dispersal: active or passive movement of organisms from an ancestral origin to a new geographic area

i. Vicariance: the separation of a previously continuous organismal range by past geological or environmental events

j. Evolutionarily significant units (ESUs): populations that are genetically unique enough to receive special protection.

3. Consider the unrooted tree on the right: How many of the following elements are present on the tree?




How many OTUs? 4

How many internal branches? 1

How many external branches? 4

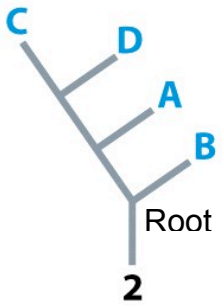
How many branches total? 5

How many terminal nodes? 4

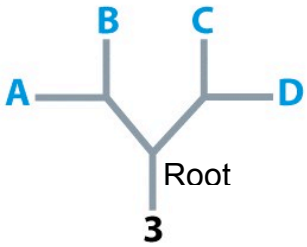
How many internal nodes? 2

How many nodes total? 6

If the root were at position **2**, what would be the tree's topology (indicate the root)?



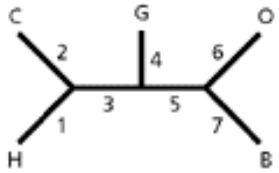

If the root were at position **3**, what would be the tree's topology (indicate the root)?




In terms of their most recent common ancestors, what are the relationship among A, B and C in the tree rooted at position 2; in the tree rooted at position 3, and in the unrooted tree?

In the tree rooted at position 2, A and C have a more recent common ancestor than either has with B. In the tree rooted at position 3, A and B form a clade with a more recent common ancestor than either has with C. The unrooted tree does not have evolutionary directionality, so the common ancestry is uncertain.

4. Consider the unrooted cladogram on the right: How many of the following elements are present on the tree?




How many OTUs? 5

How many internal branches? 2

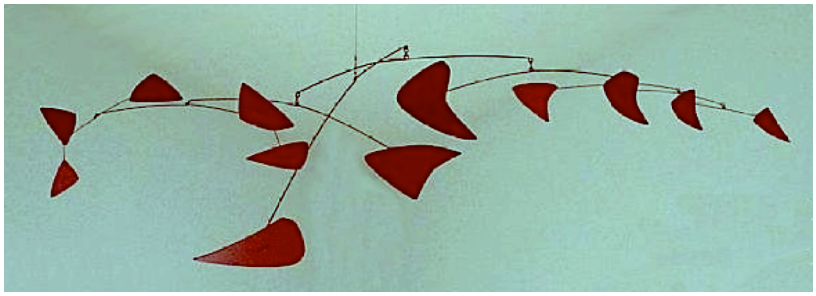
How many external branches? 5

How many branches total? 7

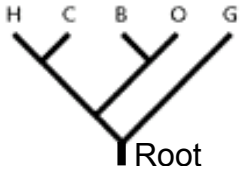
How many terminal nodes? 5

How many internal nodes? 3

How many nodes total? 8

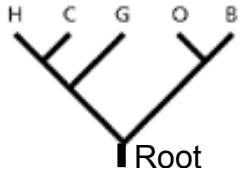


If the root were at position **4**, what would be the tree's topology (indicate the root)?

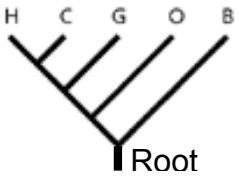



Note: since this is a **cladogram**, the relative branch lengths are not important

If the root were at position **5**, what would be the tree's topology (indicate the root)?




If in the tree at the top of the page, the letters B, C, G, H and O signify baboon, chimpanzee, gorilla, human and orang-utan, respectively, then what would a rooted tree look like that showed the true relationships among these species?




Note: for all the trees, there are other ways to draw the branching pattern, just as long as the relationships among the taxa are maintained. For example, in all 3 of the rooted trees on this page, H and C could be switched in position without affecting the topology. Think of a tree as a mobile sculpture (above) that is "hanging" from the root.