

Incorporating Molecular Data into your Phylogenetic Tree
 Activity adapted from Bishop Museum ECHO Project Taxonomy Module
 and ENSI/SENSI Making Cladograms Lesson

In addition to morphological data, molecular data, such as DNA sequences, can also tell us about the evolutionary relationships between organisms. For example, in the DNA sequence data below, we can see that the *E. coli* sequence is very different from the sequences of humans, yeast and corn (this sequence data comes from one slowly evolving gene, called the 16S rRNA gene). This makes sense considering that bacteria are in their own domain, and so their DNA sequences are very different than the other organisms.

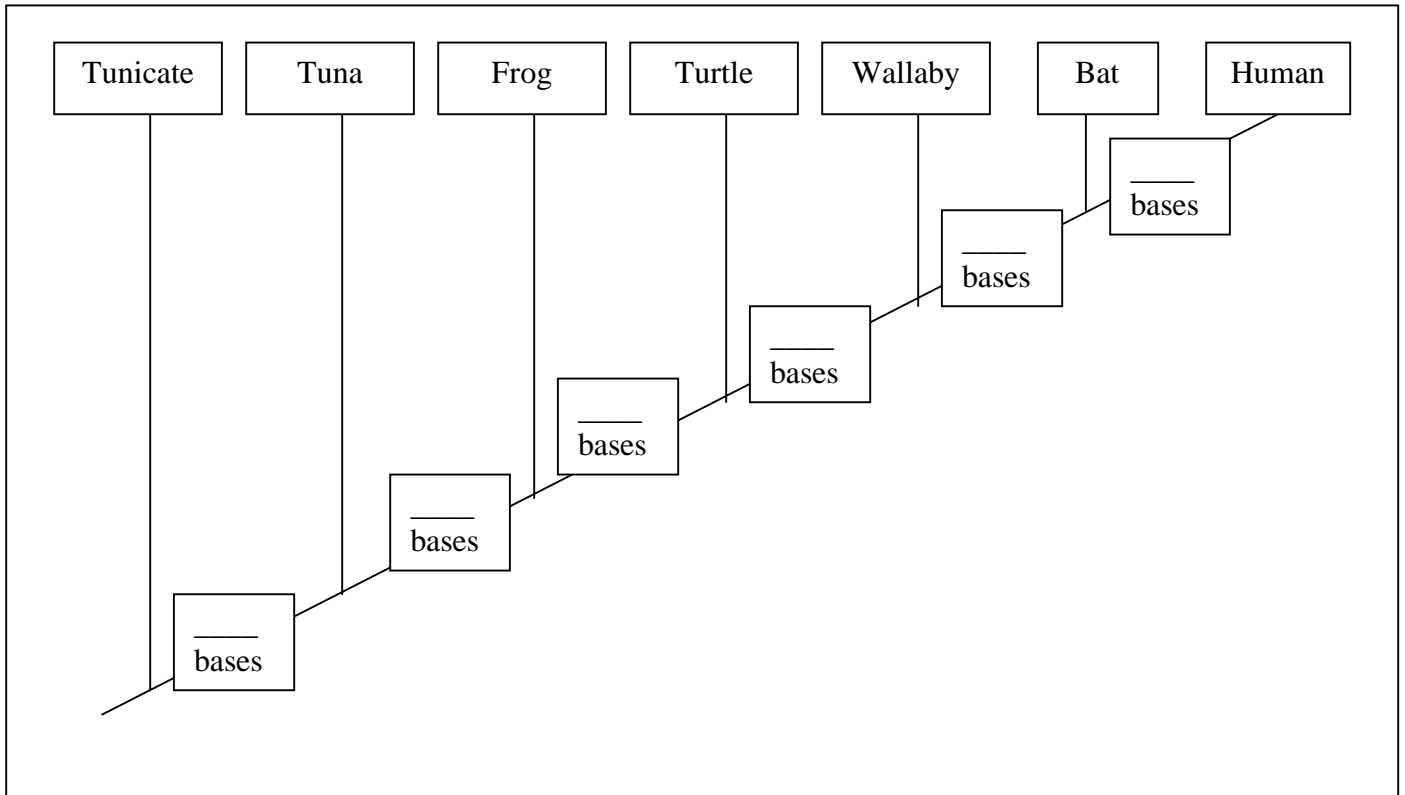
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human ... GTGCCAGCAGCCGCGGTAATTCAGCTCCAATAGCGTATATTAAAGTTGCTGTCAGTTAAAAAG...
yeast  ... GTGCCAGCAGCCGCGGTAATTCAGCTCCAATAGCGTATATTAAAGTTGTTGTCAGTTAAAAAG...
corn   ... GTGCCAGCAGCCGCGGTAATTCAGCTCCAATAGCGTATATTAAAGTTGTTGTCAGTTAAAAAG...
E. coli ... GTGCCAGCAGCCGCGGTAATACGGAGGGGTGCAAGCGTTAATCGGAATTACTGGGCGTAAAGCG...
  
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Your job is to incorporate the DNA sequence data in the following table into your morphological phylogeny from last class. You can consider the tunicate to be the most ancestral species. Examine the sequences, and determine how many DNA bases each organism has in common with the tunicate. It may help to highlight common sequences in different colors.

Organism	Genotype	# of Bases in Common
Tunicate (Ancestor)	GTAAGCCGTTTAGCGTTAACGTCCGTAGCTAAGGTCCGTAGC	42
Yellowfin tuna	GTAAAATTTTAGCGTTAATTCATGTAGCTAAGGTCCGTAGC	33
Coqui frog	GTAAAATTAAAAGCGTTAATTCATGTAGCTAAGGTCCGGCGC	28
Green sea turtle	GTATAATTAAAAGCGTTAATTCATGTAGCTTCCGTCCGGCGC	24
Wallaby	GTTTAATTAAAAGCGTTCCTTCATGTAGCTTCCACGCGGCGC	18
Hoary bat	GTTTAATTAAAAGATTTCCCTTCATGTAGCTTCCACGCGGCGC	16
Human	GTTTAATTAAAAGATTTCCCTTCATGTGGCTTCCACGCGGCGC	15

Enter the number of bases each organism has in common with the tunicate into the phylogeny below:



Does the molecular data agree with the morphological data?

What would you do if the molecular and morphological data do not agree?

Name _____

Comparing Molecular and Morphological Techniques

Scientists debate the positive and negative aspects of using molecular or morphological characters to analyze relationships. What do you think are the pros and cons of each method?

Method	Pro	Con
Morphological	<p><i>Morphological traits are easily observed, and rarely require specialized techniques or equipment.</i></p> <p><i>Morphological characteristics can be more easily observed in fossilized or otherwise preserved organisms, and more readily provide information about extinct species.</i></p>	<p><i>Phenotype reflects genotype, and relatedness can only be inferred from morphological traits, and is subject to more error.</i></p> <p><i>Morphological characteristics may be more subject to homoplasy, that is appearing.</i></p> <p><i>Resolution using morphological characteristics may be lower, since there are often fewer of them to support analysis.</i></p>
Molecular	<p><i>Rather than inferring genetic relatedness from phenotype, genotypes can be directly read from the sequence.</i></p> <p><i>Organisms that are very different morphologically can be more easily compared to one another.</i></p> <p><i>One gene can yield a significant amount of information, the equivalent of many characters, while a morphological trait yields only one characteristic.</i></p>	<p><i>Equipment and technology required to gather genetic information is expensive and requires training.</i></p> <p><i>All organisms must have the gene.</i></p> <p><i>Some organisms, like bacteria, undergo a process called lateral transfer, where they directly exchange genetic material. Genes that are transferred do not reflect evolutionary heritage and cannot be used in taxonomy.</i></p> <p><i>If the gene is too conserved there is too much similarity to examine where species diverge. If it is not conserved enough, there is so much variation that relatedness cannot be accurately estimated</i></p> <p><i>Small genes do not contain enough nucleotides to provide enough evolutionary historical information.</i></p>