Regarding Molecular Phylogeny

The Root of the Problem: Unlike zoology and botany, microbiology developed without the knowledge of phylogenetic relationships among the organisms studied (e.g., absence of an evolutionary framework).

- Microbes function at the core of the global ecology.
  - -Base of the food chain
  - -Recycle organic matter
  - -Agents of mineral deposition
  - -Source of our oxygen atmosphere

- Milestone #1: Emile Zuckerkandl and Linus Pauling; 1965 - “Semantides” or DNA, RNA, and proteins as documents of evolutionary history (i.e., descriptors of genealogy).

- Milestone #2: Norman Pace; 1986 - Applied phylogeny concept to microbial ecology's need to take a census.

- Milestone #3: Carl Woese; 1987 - Applied phylogeny concept to redefine microbial systematics or the need to understand microbial genealogy.

Some Lessons from the BIG TREE:
Map of the Biological Record

1. Single origin for all life on Earth...

- Central Dogma intact.
- ATP and PMF are universal themes.
- Uniformity among chiral carbon compounds, i.e., amino acids and sugars.

2. General topology

- Three "primary lines of evolutionary descent."
- The Eucarya *"nuclear"* lineage almost as old as the prokaryote lines.
- Prokaryotes split between *Bacteria* and *Archaea*.
- Shown for only a limited number of representative org's.
- Mitochondria and chloroplasts proven to be of bacterial origin.

3. Evolutionary clock is NOT constant between different lineages

- Terminal nodes NOT all the same length, so not constant for all organisms either!
- Endosymbionts sped up very fast (semi-autonomous organelles).
- Eucarya – fast clocks
- Archaea – slow clocks
- Bacteria – Intermediate clocks

4. Rooting the three domain “BIG TREE” is not straight forward.

- Lacks an outgroup....
- Can use gene duplications to show root near Bacteria.
- This means that Eucarya and Archaea shared a common history after the divergence from Bacteria!

5. Origin of Life Implications

- Common ancestor was thermophilic – Might have lived at hydrothermal vents.
- Common ancestor was chemosynthetic & anaerobic – Probably oxidized H_2, remember the redox tower.
- When did photosynthesis hit the scene....after chemosynthesis! It only appears in peripheral branches
- Where’s the Eucarya? High-temp ether-lipid rep?

6. What does whole genomic’s add?

- The central information processing machinery encompasses core genome.
- Metabolic functions, relationships get murky.
- Endosymbiosis involved more than organelles, i.e., two-way transfer.