Ancient: folk taxonomy → impulse to classify organisms
- Carl Linnaenus: binomial nomenclature (1735)
Darwin’s tree of life

- Darwin, *On the origin of species*

“The affinities of all the beings of the same class have sometimes been represented by a great tree... The green and budding twigs may represent existing species; and those produced during former years may represent the long succession of extinct species. At each period of growth all the growing twigs have tried to branch out on all sides, and to overtop and kill the surrounding twigs and branches....... The limbs divided into great branches, and these into lesser and lesser branches, were themselves once, when the tree was young, budding twigs; and this connection of the former and present buds by ramifying branches may well represent the classification of all extinct and living species in groups subordinate to groups. Of the many twigs which flourished when the tree was a mere bush, only two or three, now grown into great branches, yet survive and bear the other branches; so with the species which lived during long-past geological periods, very few have left living and modified descendants.....”

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Darwin’s tree of life

- Darwin

“As buds give rise by growth to fresh buds, and these, if vigorous, branch out and overtop on all sides many a feebler branch, so by generation I believe it has been with the great Tree of Life, which fills with its dead and broken branches the crust of the earth, and covers the surface with its ever-branching and beautiful ramifications...”
Darwin’s tree of life

Haeckel’s tree of life

- *The Evolution of Man* (1879), Haeckel
Today’s tree of life

- Darwin, 1857
  "the time ....when shall have very fairly true genealogical trees of each kingdom of nature"
- 1960, molecular sequencing & advancement of computational methods
- Advantage: define ancestor for group of organism with plesiomorphy phenotypes

No matter how had the methods evolved....

- Center: all the life forms on earth are related
- all organisms, from the smallest microbe to the largest plants and vertebrates, are connected by the passage of genes along the branch of the tree
Definition

- Tree of life:
  a universal phylogenetic tree which united all of the kingdoms into a single phylogenetic “empire”. (Carl R. Woese)
  a “natural” hierarchical classification of all living things (Doolittle, 1999)
- Supertree: combine information to reveal tree of life

Why tree of life?

- Origin of species, root
- How the entity give rise to organismal lineages
- biodiversity
- Appreciate importance of microbial world
- Open the door to the future
Root of tree of life

earliest stage of evolution before modern cell formation
interplay between vertical derived and horizontally acquired variation
First stage of cellular evolution that organismal lineages could exist by overcoming HGT

Root of tree of life (cont.)

- rRNA
  - Ubiquitous
  - Functional constant
  - Slow change in sequence
  - Experimental tractable
  - Refractory to horizontal gene transfer (HGT)

- Conflicting views
  - Because of HGT, root is unknown?
  - Representative of the organismal tree? aminoacyl-tRNA synthetase
Horizontally and vertically generated variation

- Vertical:
  - Variation in a lineage
  - Key to evolution of biological complexity and specificity
  - Preferable

- Horizontal
  - Erase the record of branching
  - Give rise to diversity of the biosphere
  - Non-preferable = bad?

Work together

Tips from Doolittle

- HGT was a problem in early evolution, but things are improved since
- Abandon the idea of forcing data into mold
- Appreciate the creative role of HGT instead of trying to dismiss HGT
The tree of life web project

- Open-access, database-driven system to present biodiversity and phylogenetic tree
- Goals:
  - document all species and their phylogeny on earth
  - Provide basic information of phylogeny of life
  - Encouraging understanding of biodiversity, evolution

Development of The tree of life web project

- 1988: a complete, digital phylogenetic tree of all life
- 1994: put online
- 1995: first branch contributed by another author
- 1996: formally announced
- 2000: database-driven, dynamically created website
Content

- Branch page: groups of species
- Leaf pages: terminal (species)
- Treehouse: resources, stories and images for education

Problems

- Imbalance: 3% complete, 96% animals, 60% temporary skeleton
- Punctuated growth of the project
- Lack of integrity
- Editing is open to everyone
iTOL (interactive tree of life)

- [http://itol.embl.de/index.shtml](http://itol.embl.de/index.shtml)
- online, free
- novel circular tree layout, several graphical formats
- upload and display your own trees and data
<table>
<thead>
<tr>
<th>Intelligent design</th>
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"I signed the Scientific Dissent From Darwinism statement, because I am absolutely convinced of the lack of true scientific evidence in favour of Darwinian dogma. Nobody in the biological sciences, medicine included, needs Darwinism at all. Darwinism is certainly needed, however, in order to pose as a philosopher, since it is primarily a worldview. And an awful one, as George Bernard Shaw used to say."

Dr. Raul Leguizamon, Pathologist, Autonomous University of Guadalajara, Mexico