BIOLOGY – The Big Picture

“The natural world need not be logical in any obvious way. Science does not consist of imposing our reason on the world but rather reducing our preconceptions to the point that the world imposes its logic on us. This is very difficult indeed, involving a minimalization of our ego while maintaining our full powers of observation and receptivity. The capacity to perform this feat is what the teacher of science attempts to foster in the student. No one succeeds completely.”

--L. Slobodkin (from *Simplicity and Complexity in Games of the Intellect*)

THE TAKE-HOME LESSONS FROM BioSci 101.

I. Earth is the only planet in the universe actually known to support life.

(Get ready for a BIG surprise, but in the meantime, don't be short-sighted and stupid about how you interact with this planet. Technology is improving rapidly; we may find intelligence elsewhere after all.)

http://visibleearth.nasa.gov

I'm going to make a mummy out of that cat.

I'm going to charge up my iPod, download some music, then e-mail digital photos of this stuff to my friend in Mexico.

Technological change

http://visibleearth.nasa.gov

1937 Hiroshima Sputnik Apollo 11 E-mail MS-DOS WWW 090308

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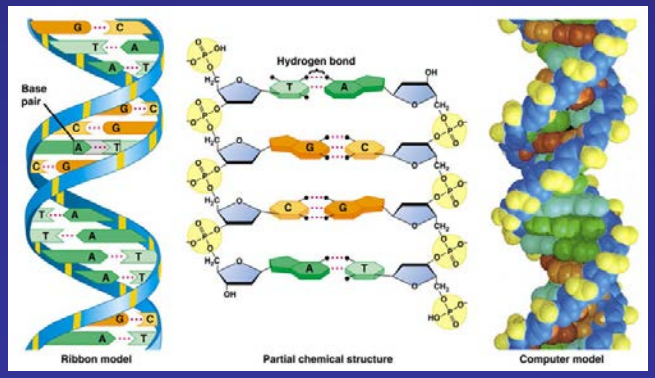
http://www.webopedia.com/DidYouKnow/Internet/2002/BirthoftheInternet.asp

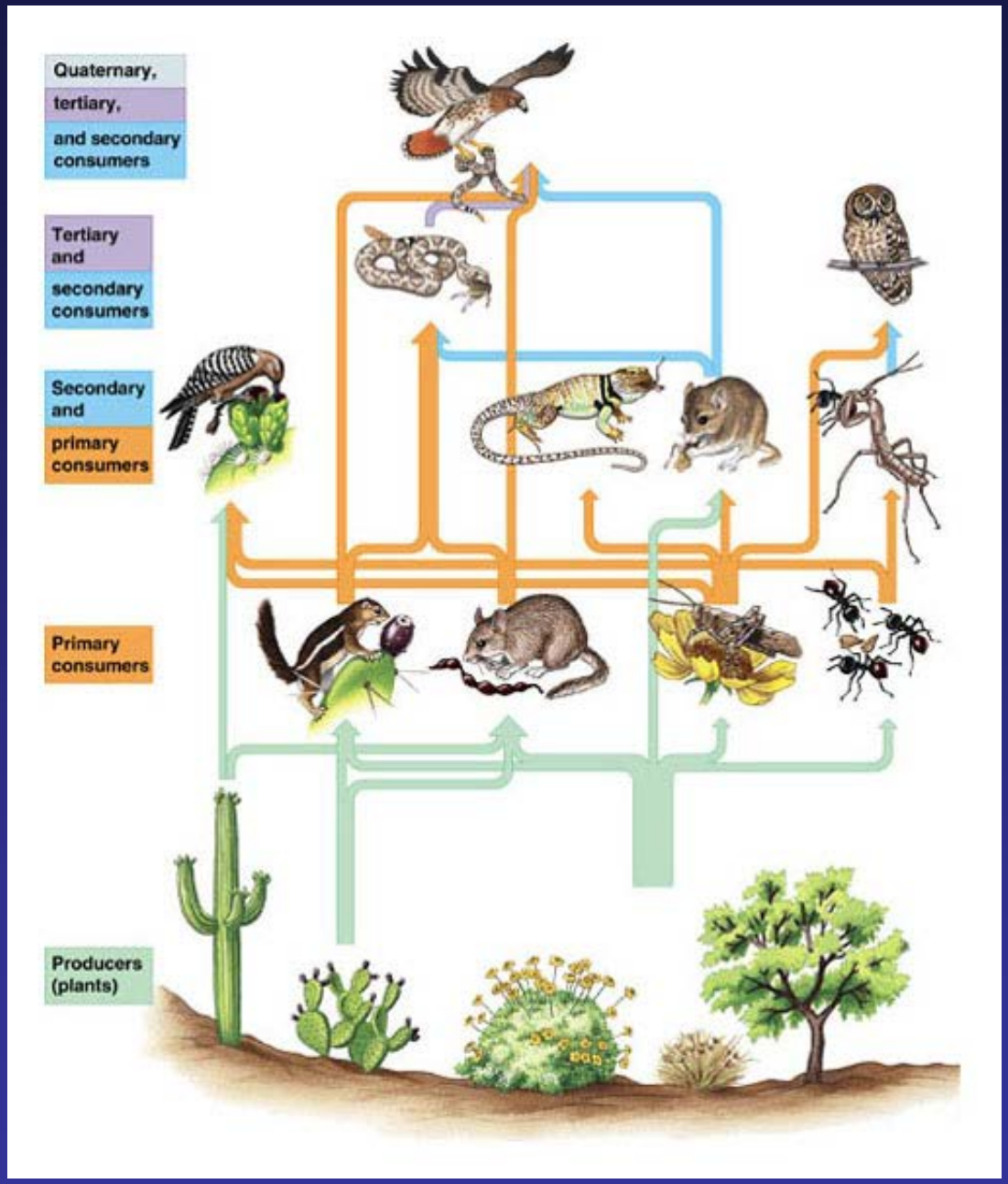
II. Life on Earth is characterized by enormous diversity superimposed on great uniformity.

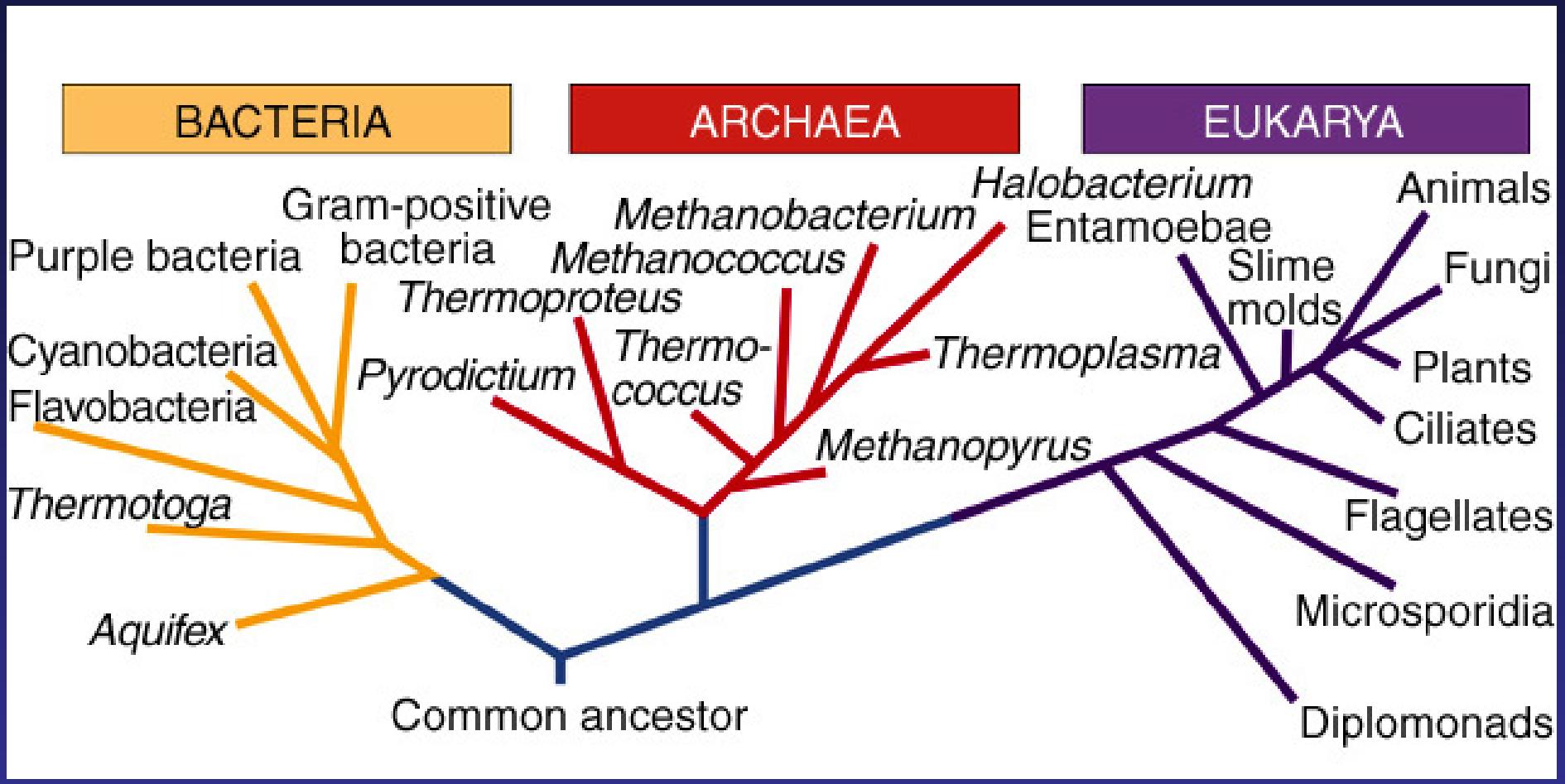
(Uniformity is in DNA structure, metabolic processes, etc.; diversity is in the massive number of species that occupy the planet.)

The diversity

The uniformity



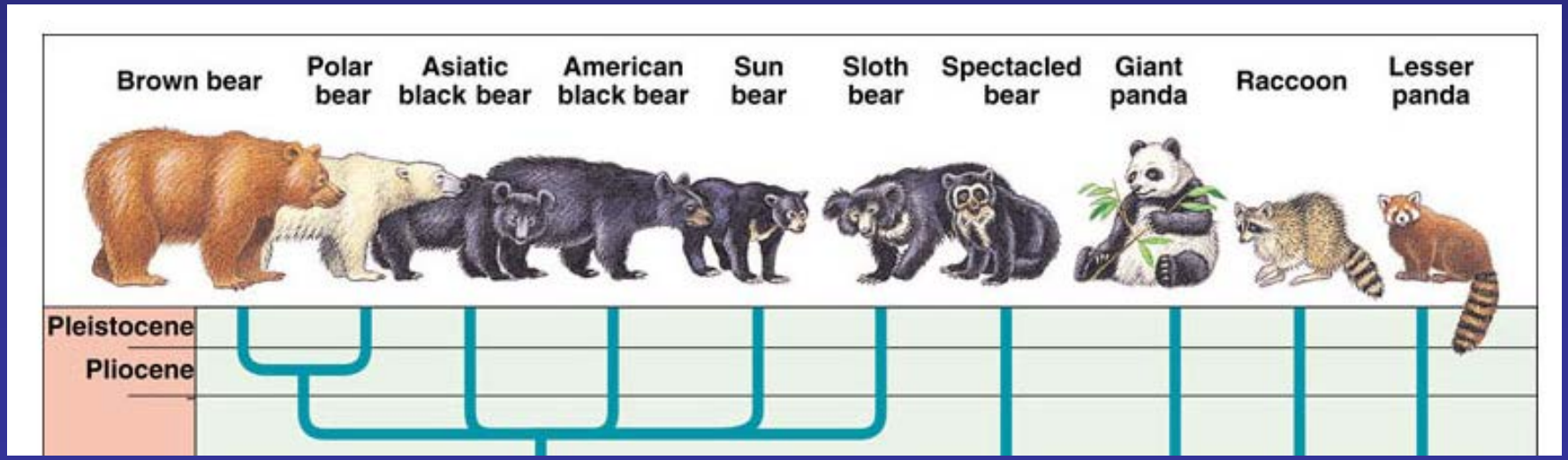




A molecular (rRNA) view of life's diversity superimposed on uniformity.

III. Evolution is the best general explanation *science* has for life's enormous diversity superimposed on great uniformity.

(That's why it's the central unifying theme of the discipline.)



Cnidaria (Jellyfish, hydra)

Nematoda (Roundworms)

Mollusca (Clams, snails)

Arthropoda (Crustaceans, insects)

Chordata (Vertebrates)

Porifera (Sponges)

Platyhelminthes (Flatworms)

Rotifera (Rotifers)

Annelida (Segmented worms)

Echinodermata (Sea stars)

⑦ Jointed appendages and exoskeleton

⑨ Notochord

⑧ Deuterostome development and endoskeleton

No segmentation ⑥ Segmentation

Pseudocuel ⑤ Coelom

No body cavity ④ Body cavity

Radial symmetry ③ Bilateral symmetry

No true tissues ② Symmetry and tissues

① Multicellularity

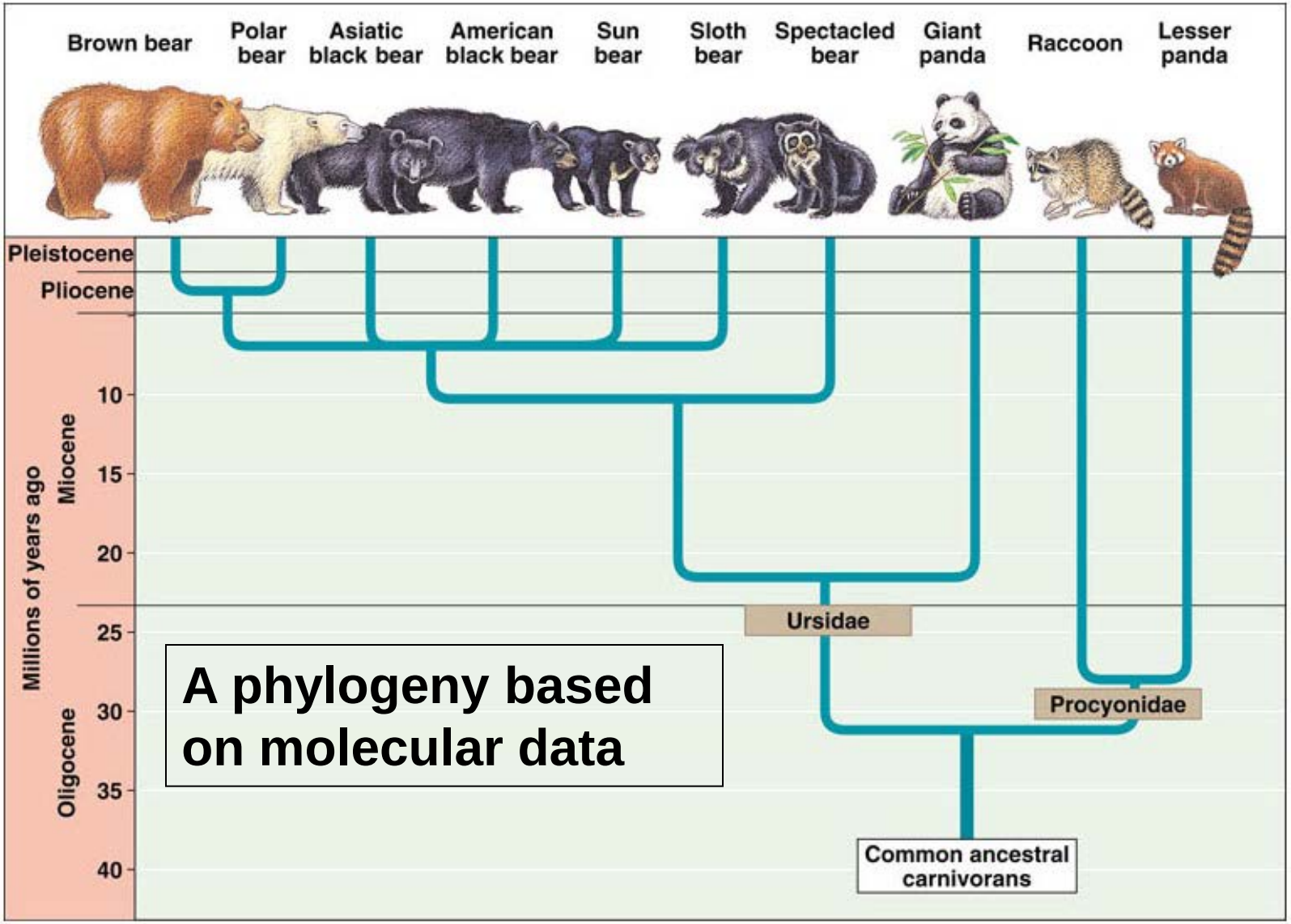
Ancestral protist

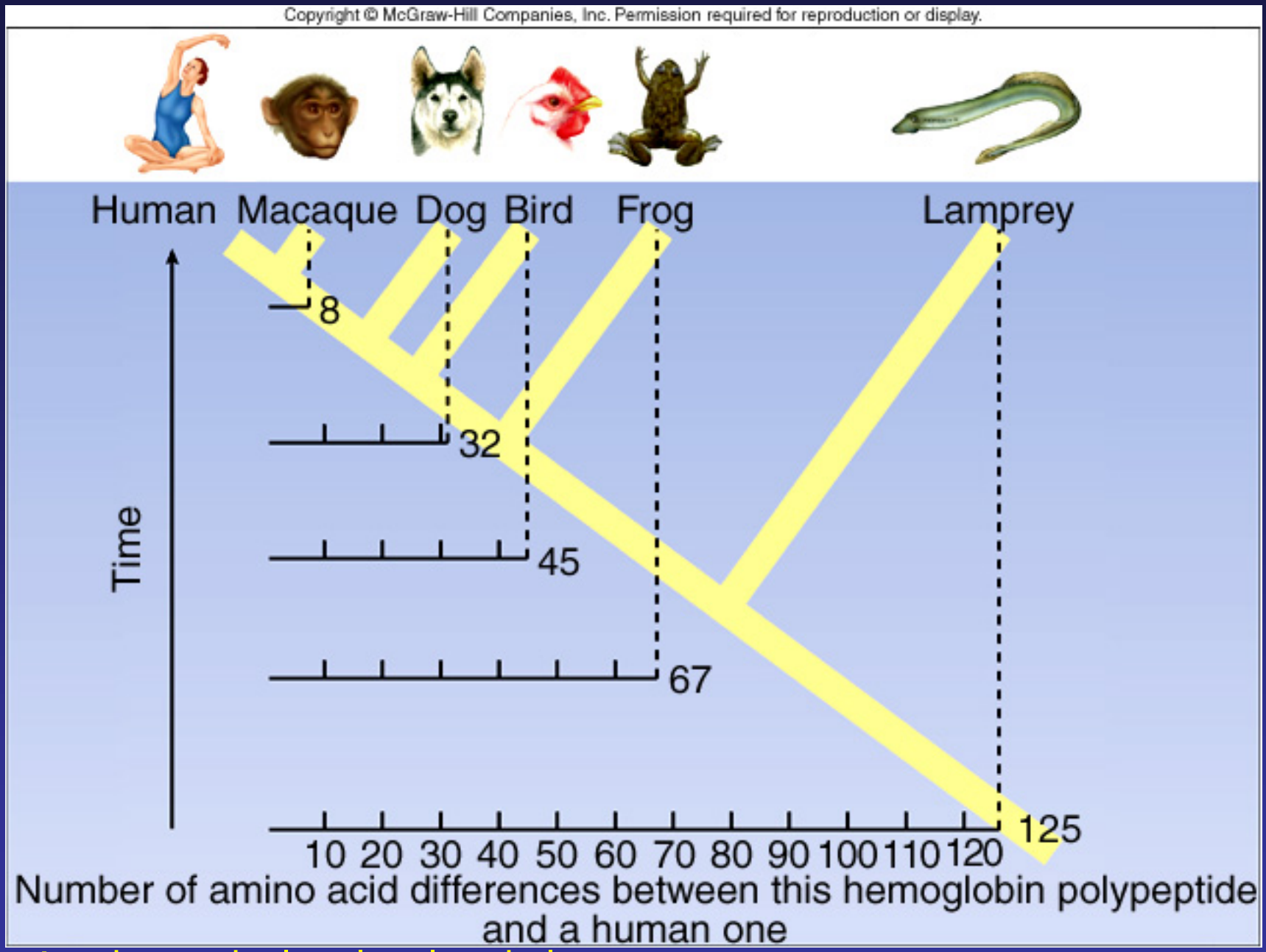
A typical cladogram – "tree thinking"

~~Key Evolutionary Innovations in the Animal Body~~

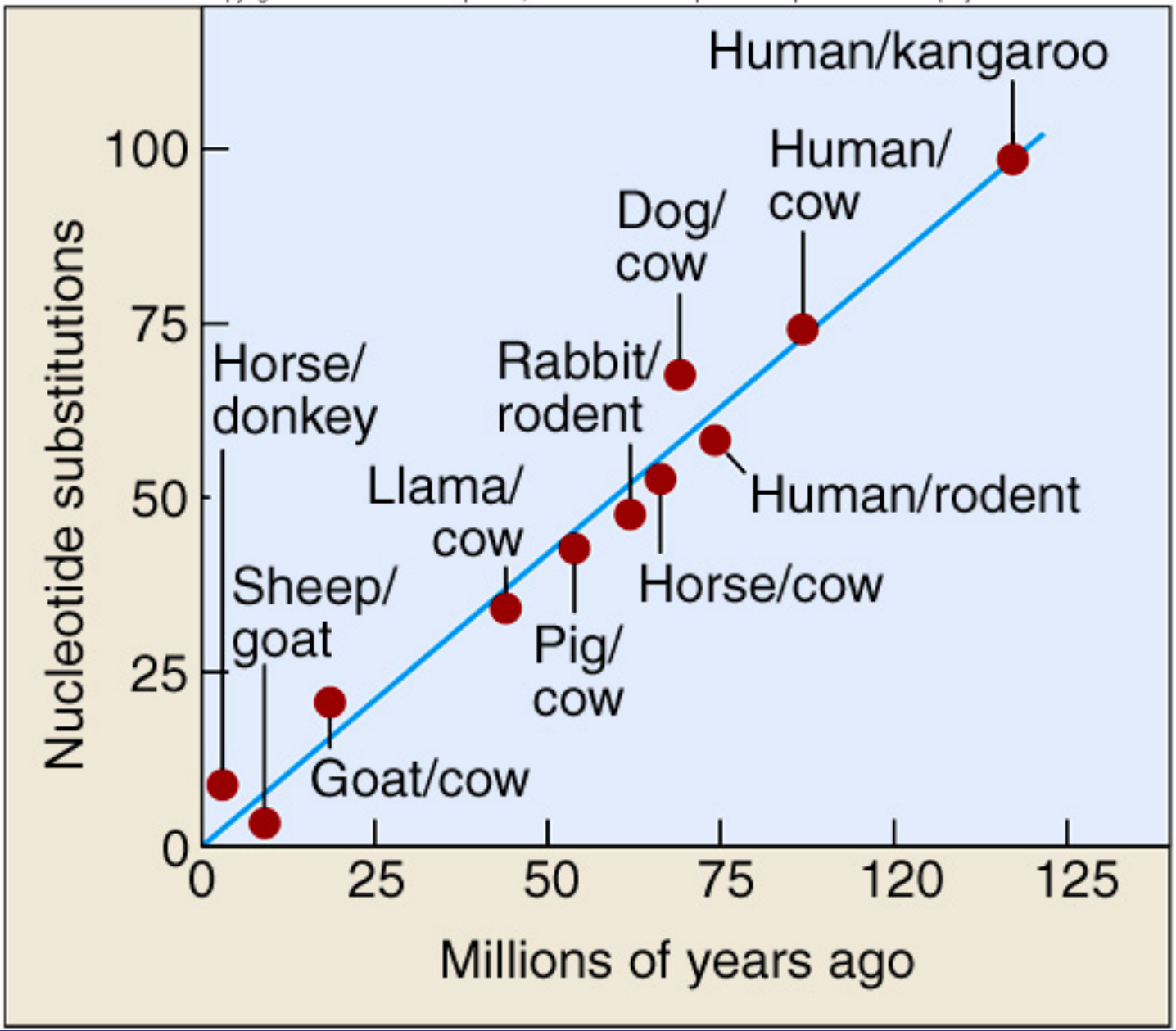
~~Stage Milestone~~

1 Multicellularity
2 Symmetry and tissues
3 Bilateral symmetry
4 Body cavity
5 Coelom
6 Segmentation
7 Jointed appendages and exoskeleton
8 Deuterostome development and endoskeleton
9 Notochord


Brown bear
Polar bear
Asiatic black bear
American black bear
Sun bear
Sloth bear
Spectacled bear
Giant panda
Raccoon
Lesser panda
Pleistocene
Pliocene
Miocene
Oligocene
Millions of years ago
10
15
20
25
30
35
40
Ursidae
Procyonidae
Common ancestral carnivorans
A phylogeny based on molecular data



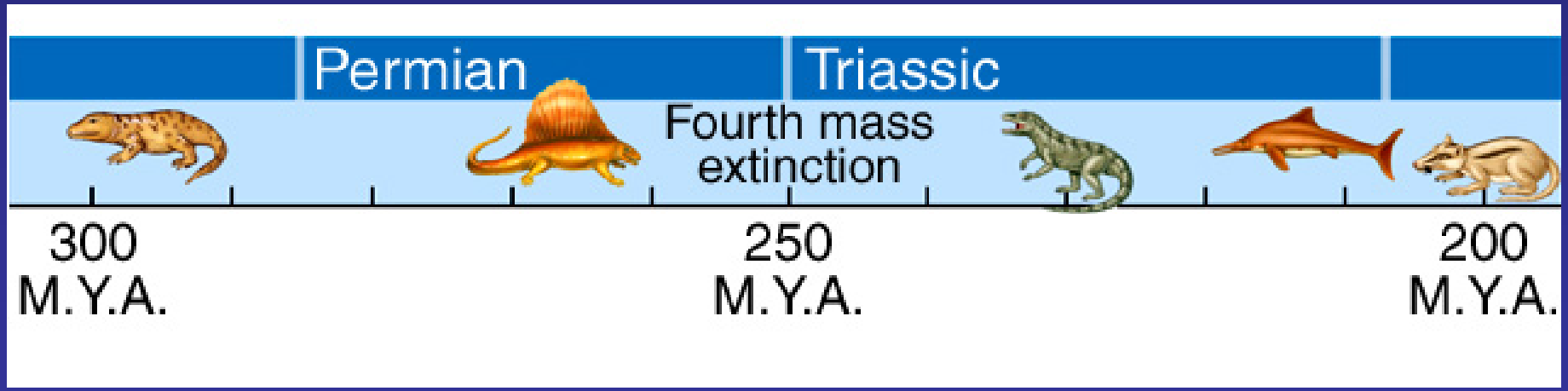
Another typical molecular phylogeny



A typical molecular clock calibrated with the fossil record

IV. The vast majority of species that have ever lived are now extinct.

(It's real easy to be naïve and arrogant about our own, mainly because we're so smart, but the evidence for IV. is *very* convincing.)



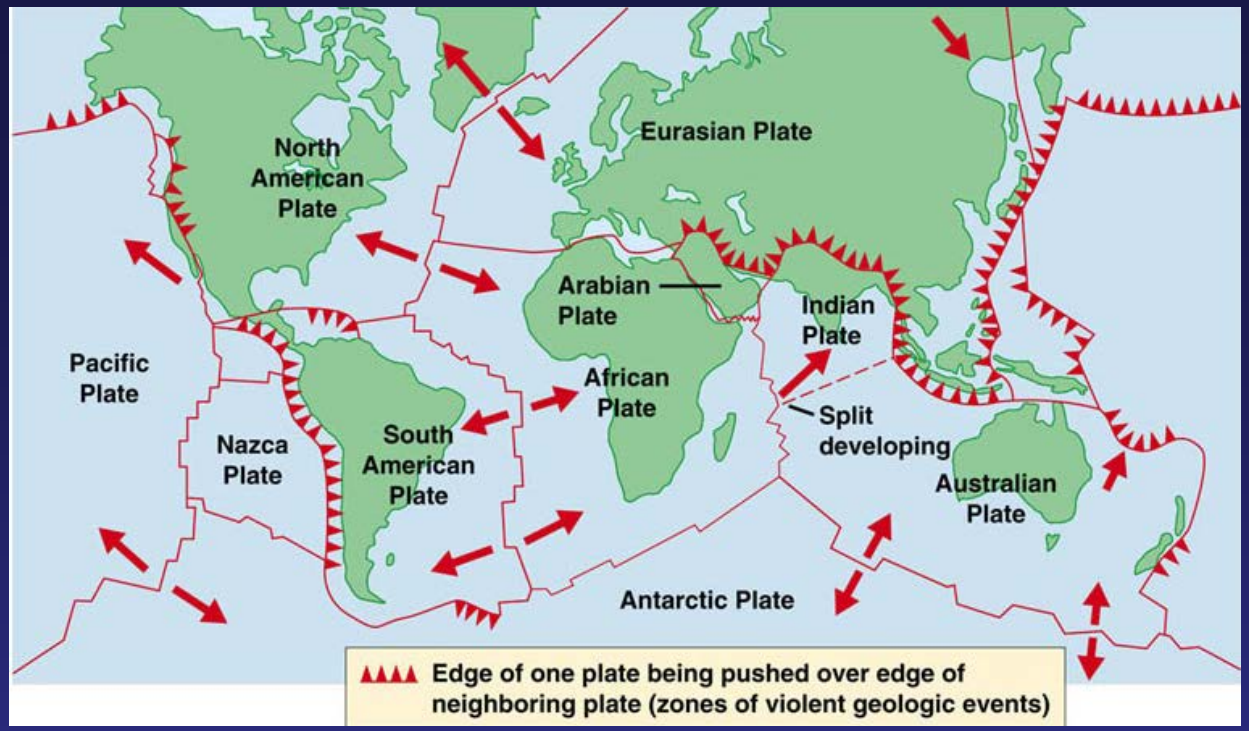
V. There is a staggering amount of scientific evidence that virtually all things in the universe have a beginning and an end, and our solar system is probably no exception.

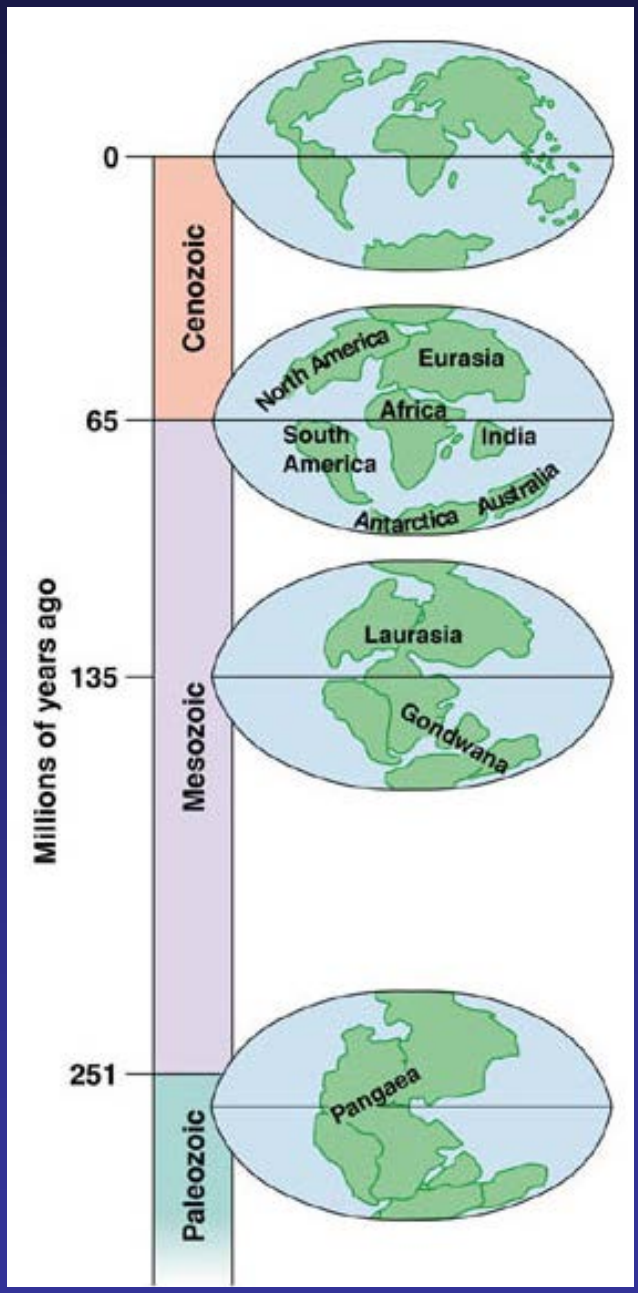
This image, taken by the Hubble Space Telescope, shows gaseous pillars in a star-formation region of the Eagle Nebula (also known as M16, or Messier 16). Within the pillars are denser regions dubbed "Evaporating Gaseous Globules" (EGGs) containing embryonic stars.

http://rsd.gsfc.nasa.gov/rsd/images/EGGs.html

VI. The present distribution of life and other natural resources is a result of several billion years of planetary change (evolution, both geological and biological).

That distribution has significant social and political consequences, and so to some extent, your daily headlines are a result of planetary forces at work, forces over which you have no control and did not make happen.





An example:

Plate tectonics and the breakup of Pangaea during the Mesozoic.

VII. *Science* is different from *Technology.*

(Both require fundamental knowledge, but technology seeks to *control* nature, whereas science seeks to *understand* nature. Control is not necessarily "good;" understanding is not necessarily "bad." It's what humans do with their control and understanding that make humans "good" or "bad."

VIII. Many of our most difficult social and political problems have a major biological component:

Racism, sexism, unwanted pregnancy, global energy distribution, intellectual and cultural richness, the definition of “human being,” narcotics, global water distribution, genetic “engineering” and its consequences, infectious disease evolution and transmission, our relationships with insects, etc.*

*This list could go on for several more pages.

IX. You are surrounded by biological information, but you need to take the time and effort to look for, then use, it.

(Your life, and the lives of those around you, will be greatly enriched by such awareness; after all, life is *the* characteristic that sets Earth apart from other planets and [insofar as we know] solar systems.)


Campus vegetation
(with labels!)

X. The scientific and technological explosion is not going away any time soon; it's better to be educated than ignorant about all scientific and technological issues.

(For one obvious example: evolutionary biologists never started any shooting war, but the information technology you use minute by minute is taking away your privacy about as fast as it can be done.)