Family tree of Darwin's Finches on the Galopagos Islands

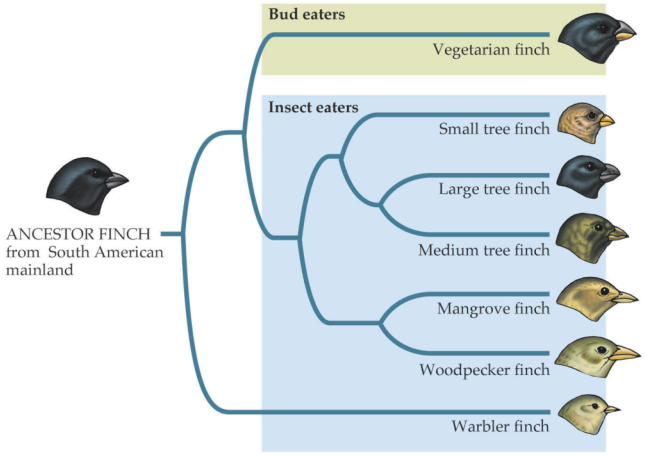
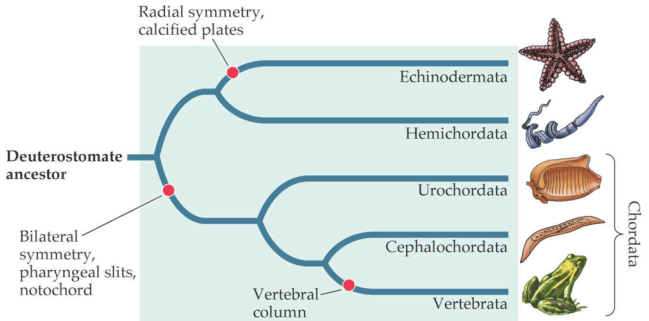
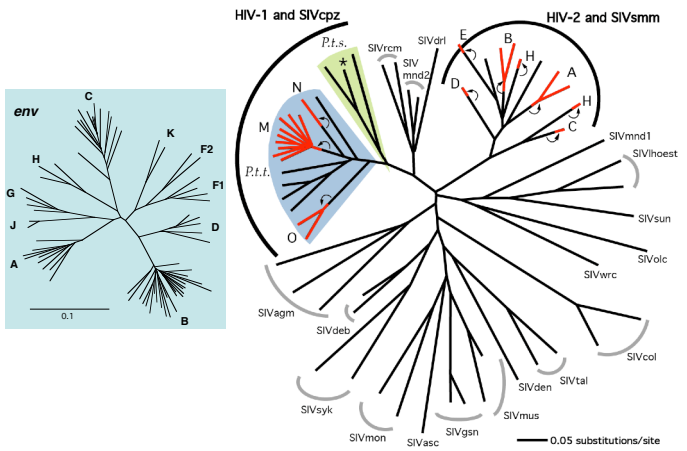


Figure 34.2 *A Current Phylogeny of the Deuterostomes*





What are the sufficient conditions?

- Like begets like (heritability)
- Descent with modification (offspring can be different from parents)
- Because of their differences, some individuals are more successful than others at reproducing, and thus passing their traits to the next generation

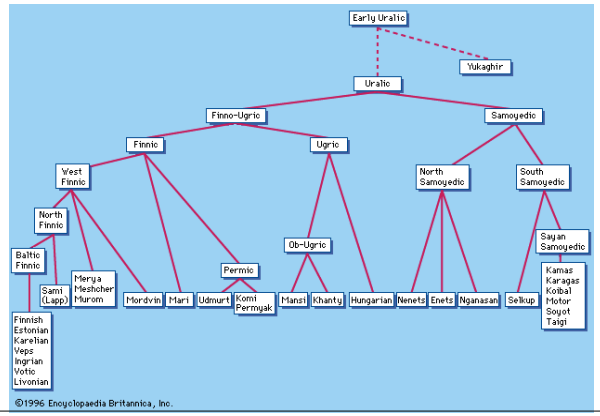
What can evolve?

- Not just organisms…
- Not just life…
- Not just physical entities?
- What about?...

Evolution of…

- Pieces of computer code
  (Genetic Algorithms, Evolutionary Programming)
- Ideas & behavior patterns
  - Darwinian learning & cognition
  - Darwinian economics
    - Evolution in markets (Doyne Farmer)
  - Cultural evolution & memetics
    - Business practices (John Padgett)
    - Words (linguistic evolution)

A language phylogeny



Coming attractions…

- Dr. Lee Altenberg on:
  - Evolutionary Computation
  - Evolved art!

Another perspective: complexity and functionality

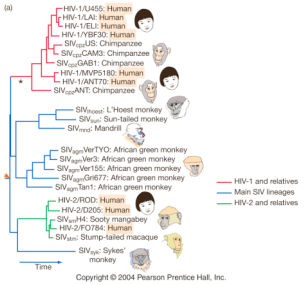
- Classic examples of complex *adaptive* systems include:
  - An immune system
  - A human brain
  - An economy

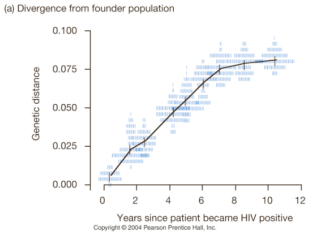
What are the important properties of CAS?

- What is important to understand, to predict, and to influence?
- They work!
- Functionality – where does it come from?
  - In natural, and maybe some artificial systems: Darwinian selection

Evolutionary Medicine:

The study of molecular evolution and phylogenetics can yield meaningful insights into disease evolution





Time for more?

Malign Evolution: Somatic selection and cancer

- Is 'improvement' always a good thing?

Selection can operate…

- Among organisms within a population
- Among cells within an organism?
  - Are necessary conditions met?

What are the sufficient conditions?

•Like begets like (heritability)

•Descent with modification (offspring can be different from parents)

•Because of their differences, some individuals are more successful than others at reproducing, and thus passing their traits to the next generation

What if…

- Certain cells within the body get <u>much</u> better at surviving and reproducing.
- They cast off normal limits on cell proliferation
- Uncontrolled cell proliferation = cancer

Cancers also evolve drug resistance

- When we apply chemotherapy to a population of tumor cells, there is quite likely to be a resistant mutant somewhere in that population of billions of cells. After sensitive cells are killed, resources are freed up for rapid growth by resistant cells.
- This is the central problem in oncology.
- The reason we haven't been able to cure cancer is that we're selecting for resistant tumor cells.
- When we spray a field with pesticide, we select for resistant pests. It's the same process.

Current work

- Cancer is an inevitable outcome of unrestrained somatic selection among cells.
- How is cancer ever avoided, given ongoing cell turnover & somatic mutation?
- Through cell differentiation, animal cells are compartmentalized in a way that suppresses cellular selection & adaptation. If this breaks down, cancer follows quickly

Pepper & Maley: SFI working paper
– posted on CSSS wiki