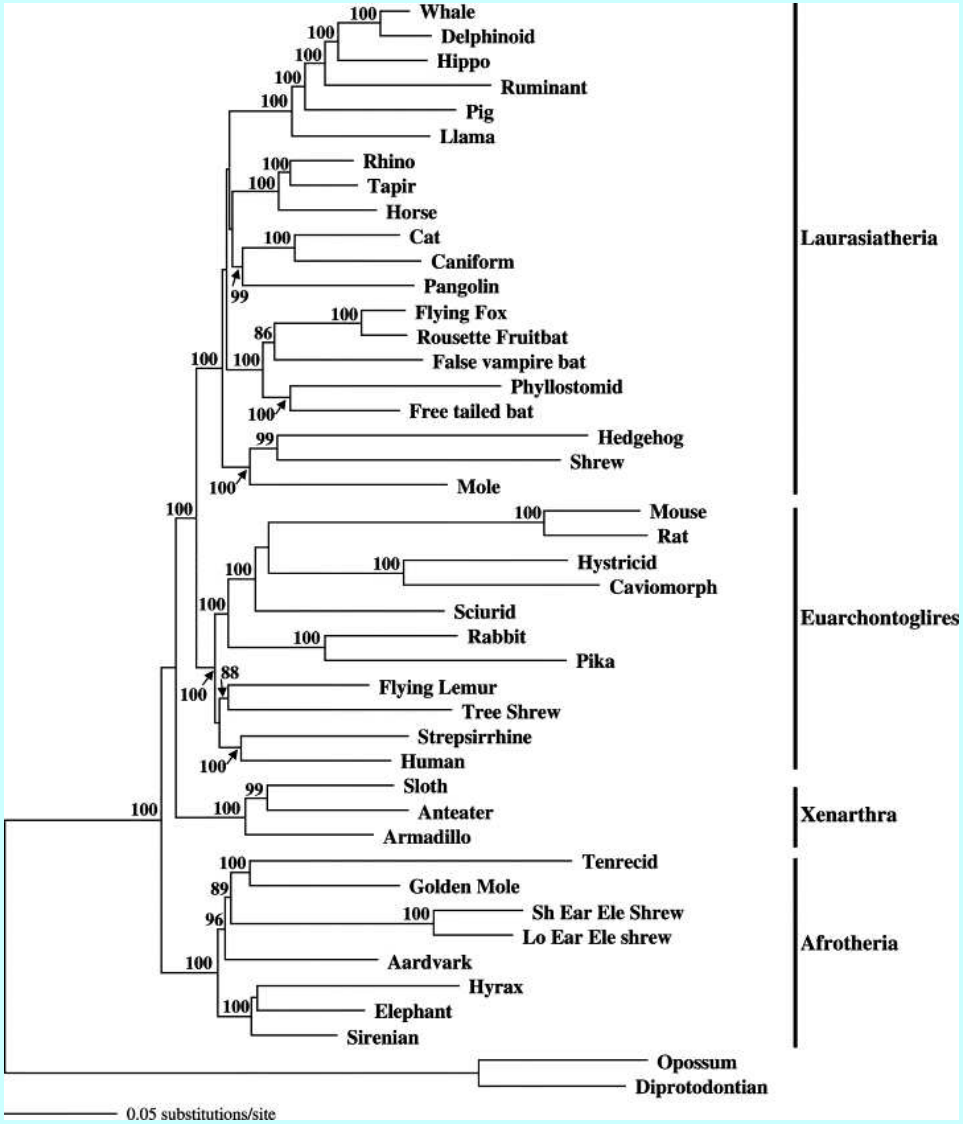
Mitochondrial Eve and Y-chromosome Adam: Who do your genes come from?

28 July 2010.

Joe Felsenstein

Evening At The Genome

Evolutionary trees from molecular sequences



from Amrine-Madsen, H. et al., 2003, *Molecular Phylogenetics and Evolution*

My ancestor?

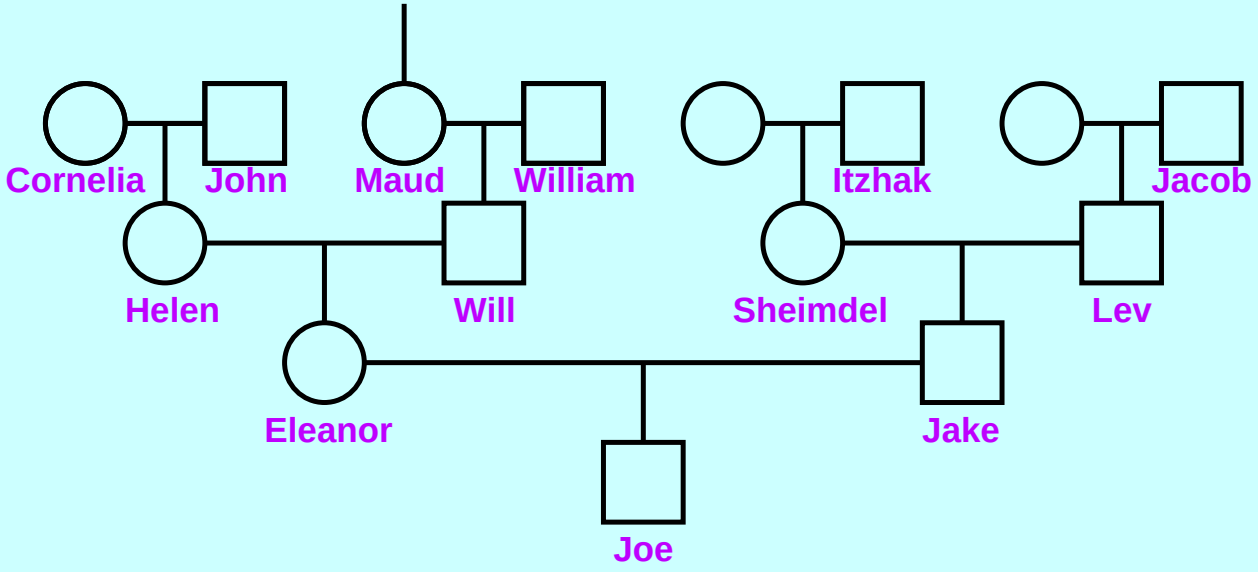
Charles the Great

(Charlemagne)

born

747

about 44 more generations



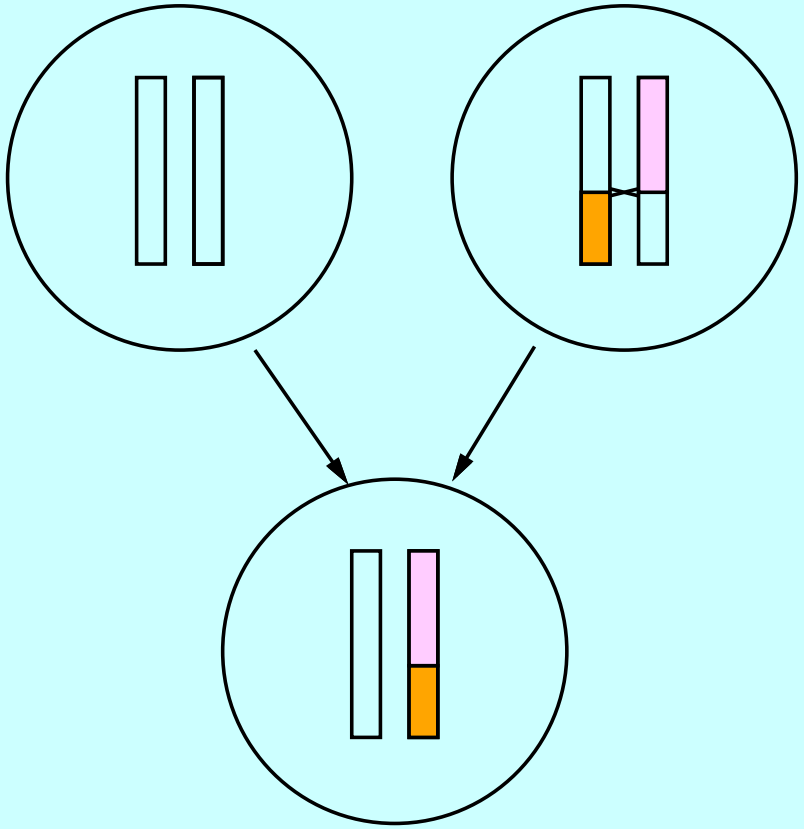
1850s

1880s

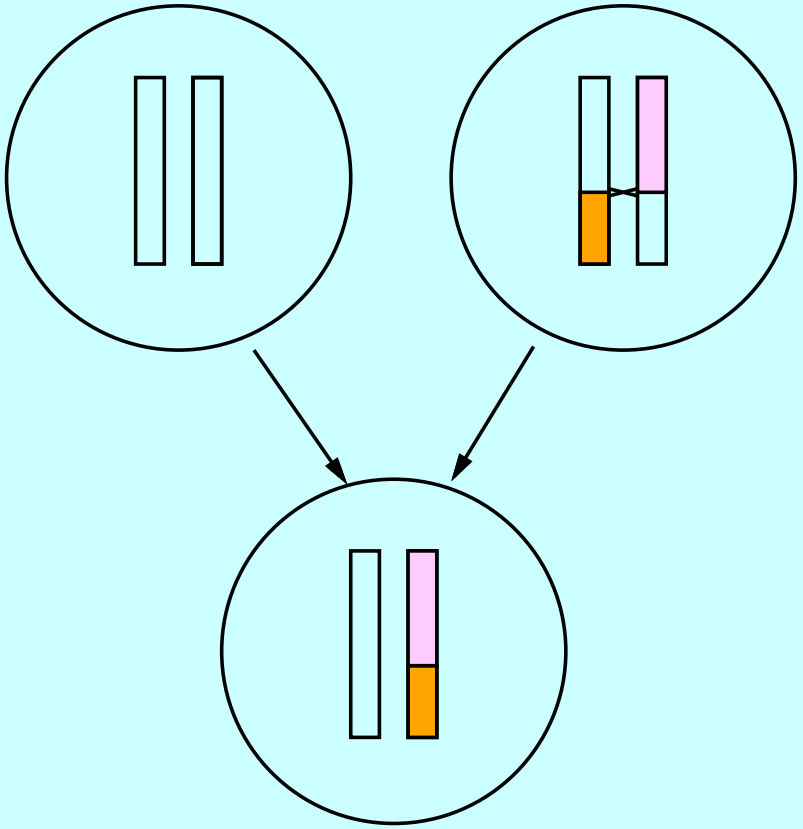
1910s

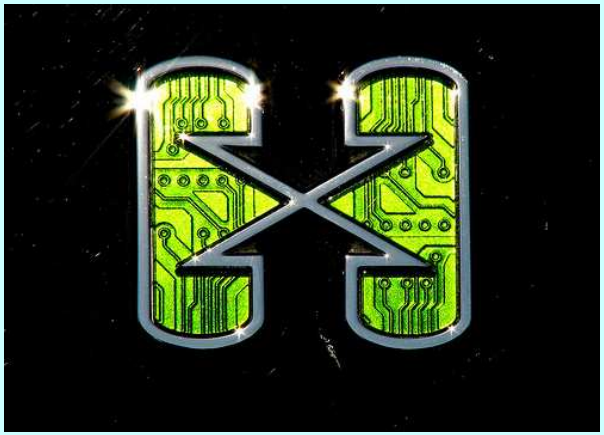
1942

Crossing over (recombination)



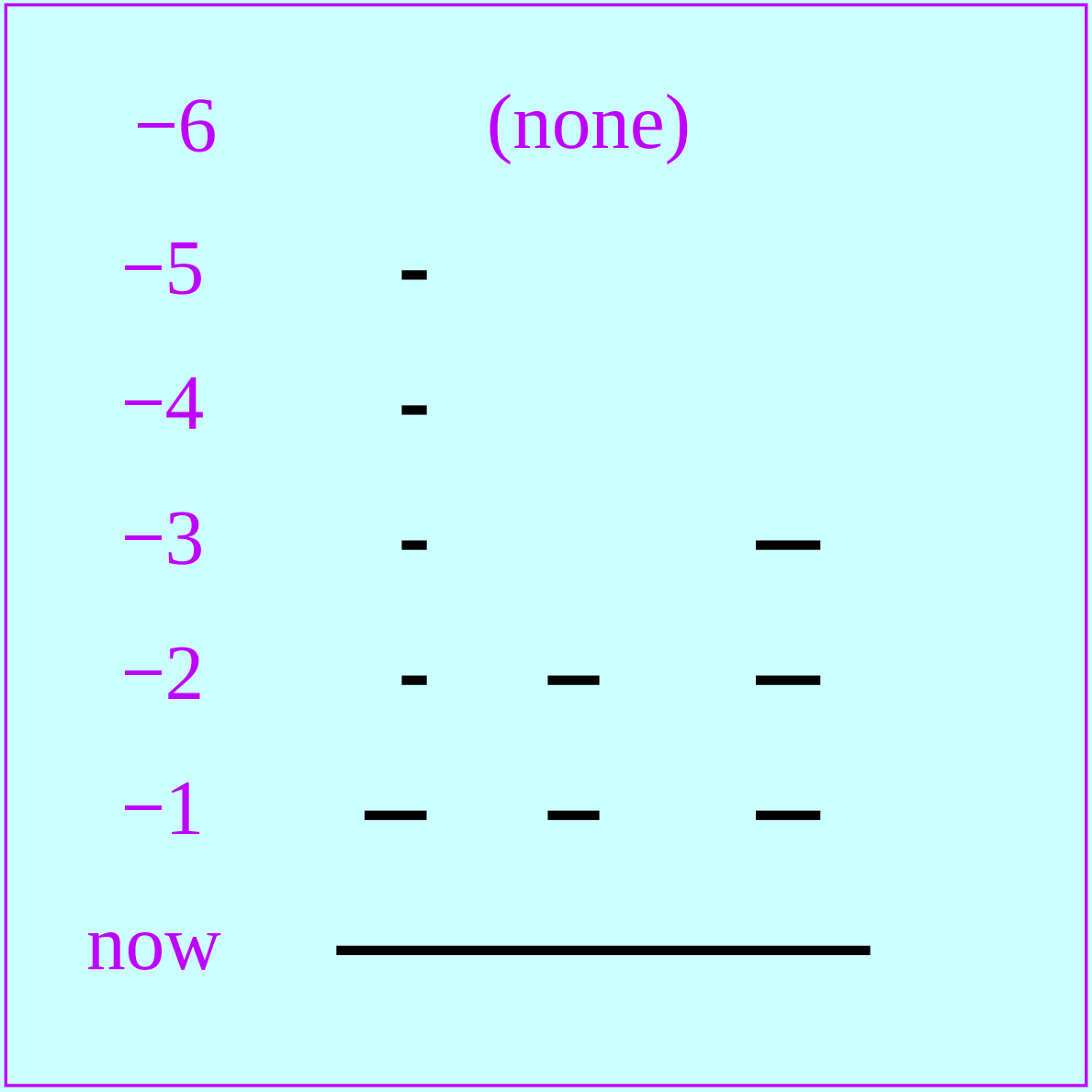
Did someone at General Motors take a biology course?





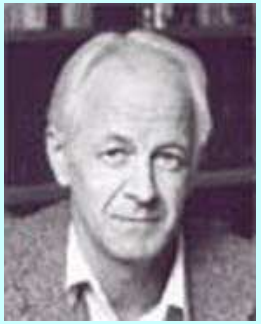
The GMC Hybrid logo.

Chromosome 1, back up one lineage



The “mitochondrial Eve” study in 1987





Rebecca Cann, Mark Stoneking, and the late Allan Wilson. In 1987 they made a molecular tree of mitochondria from humans.

One female ancestor? of what? When? Where?

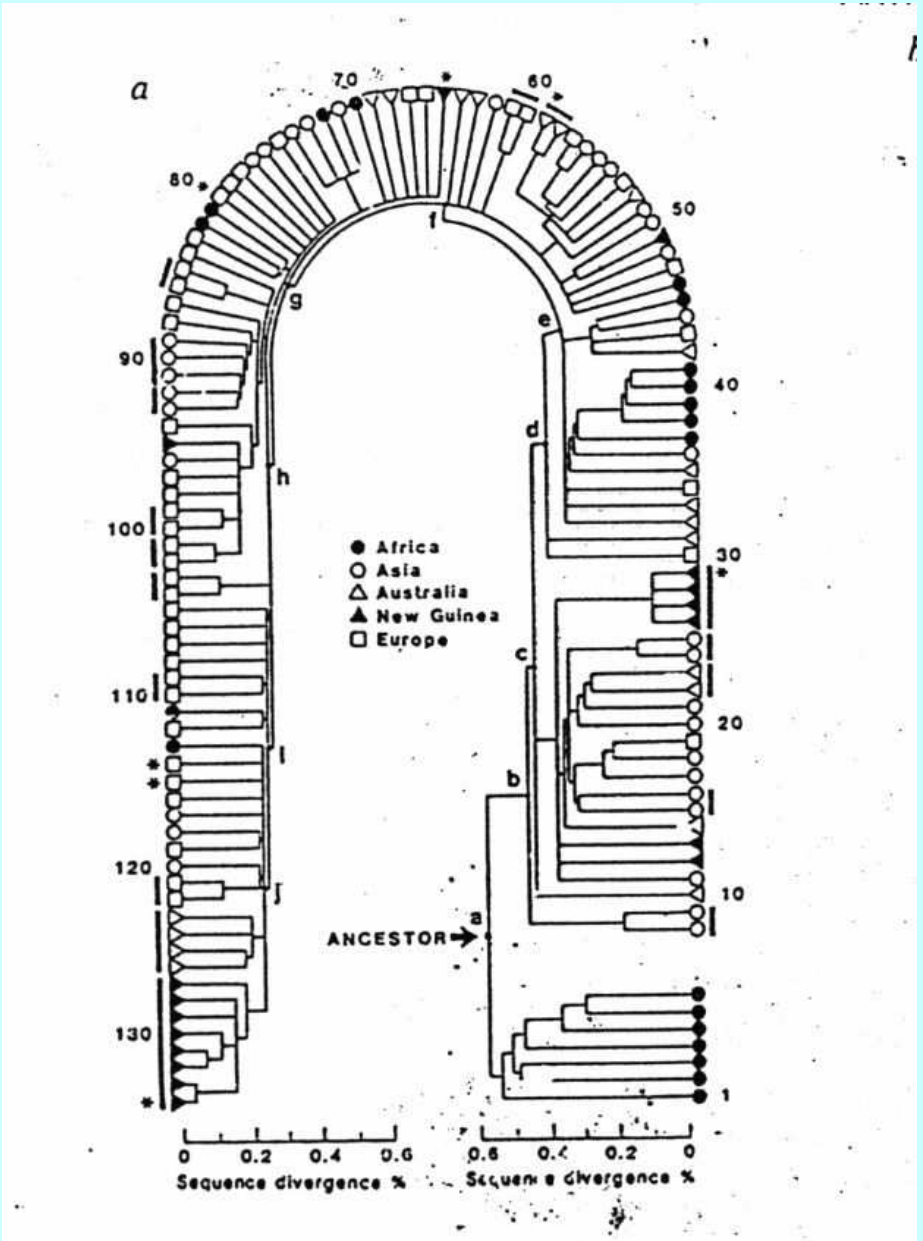
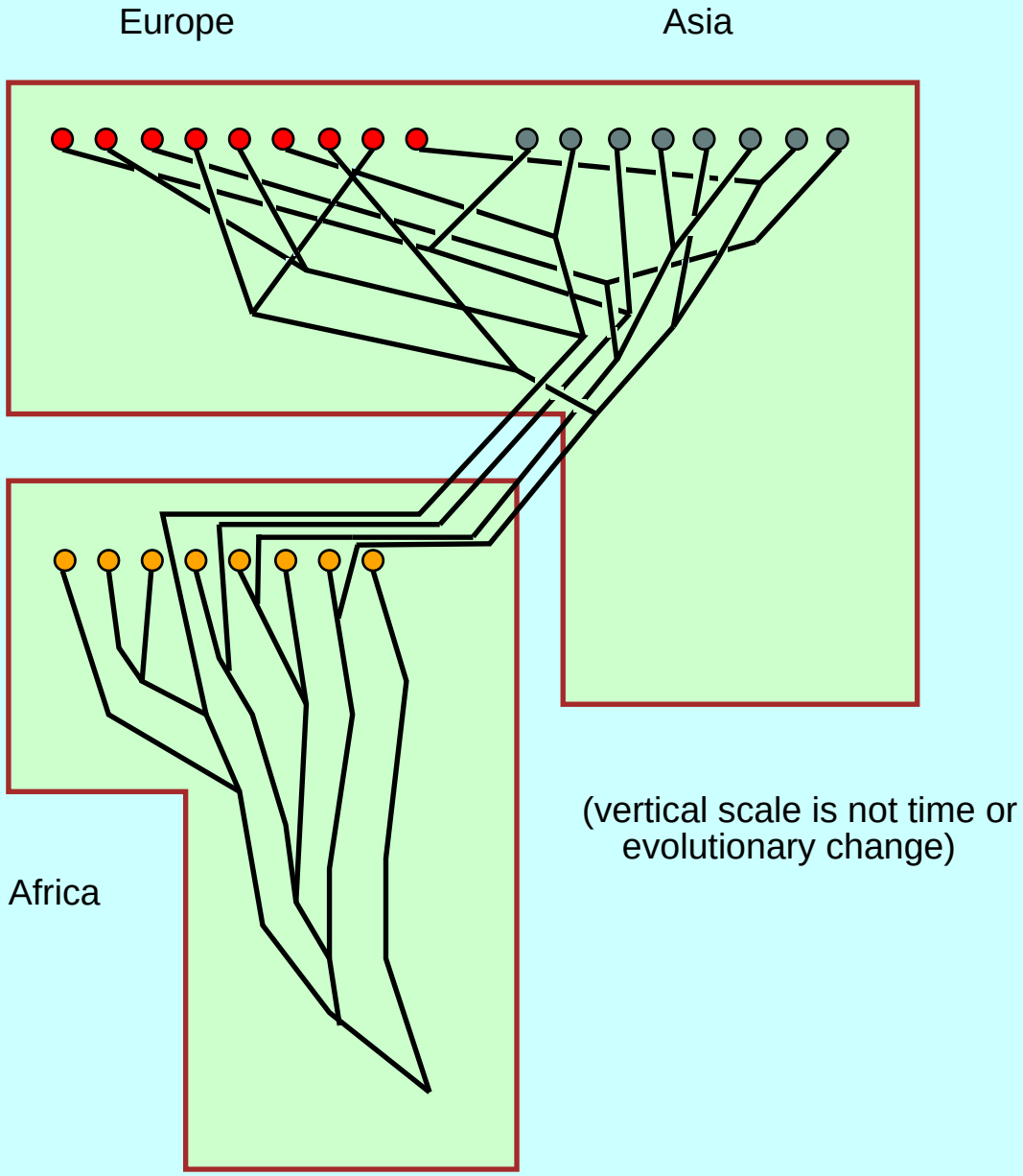
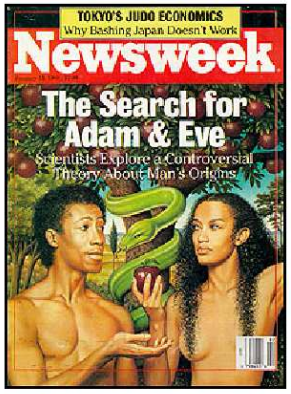


Fig. 3 *a*, Genealogical tree for 134 types of human mtDNA (133 restric

The “Out Of Africa” hypothesis



“Scientists find Eve”



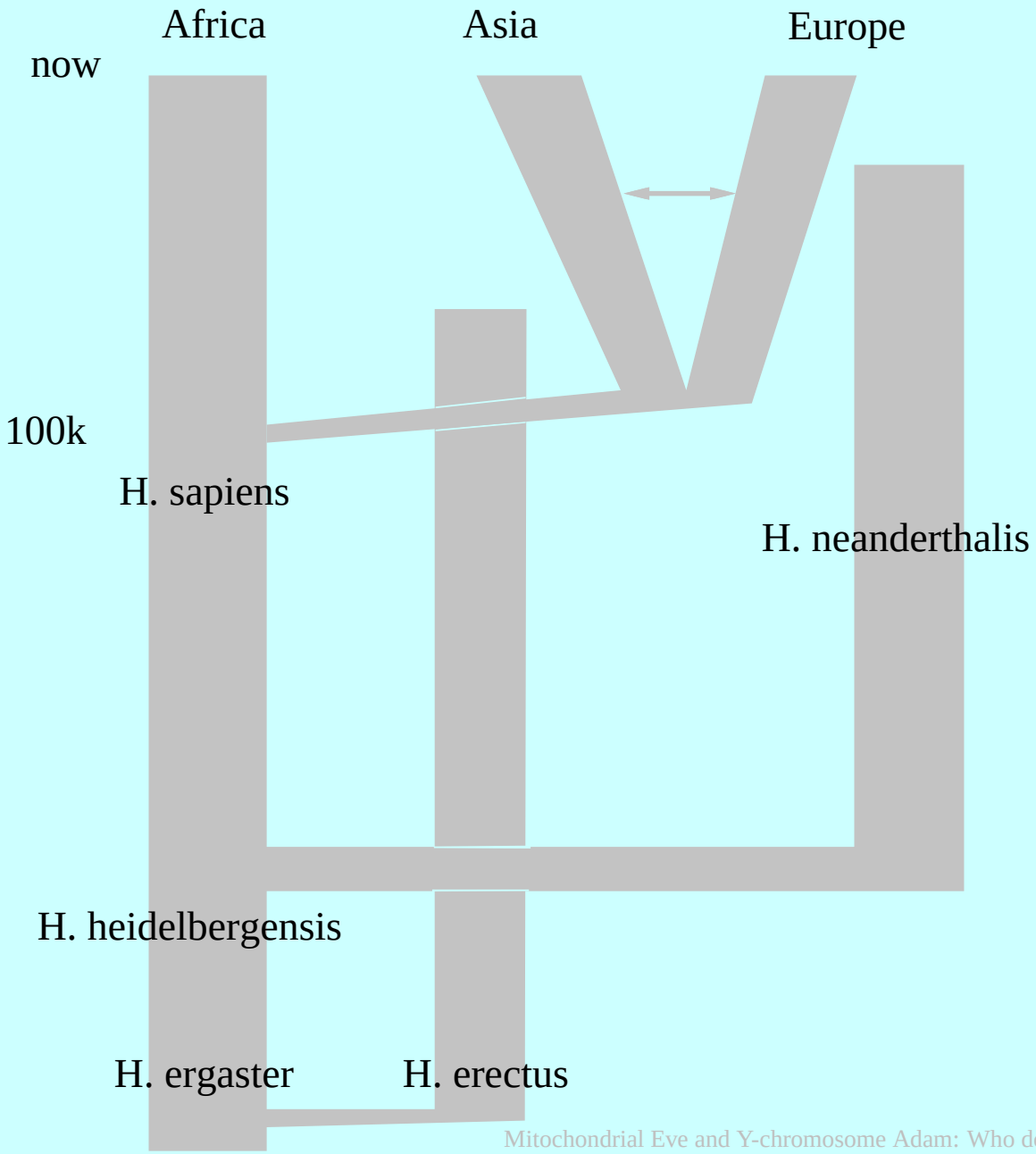
The Search for Adam and Eve

John Tierney
Newsweek

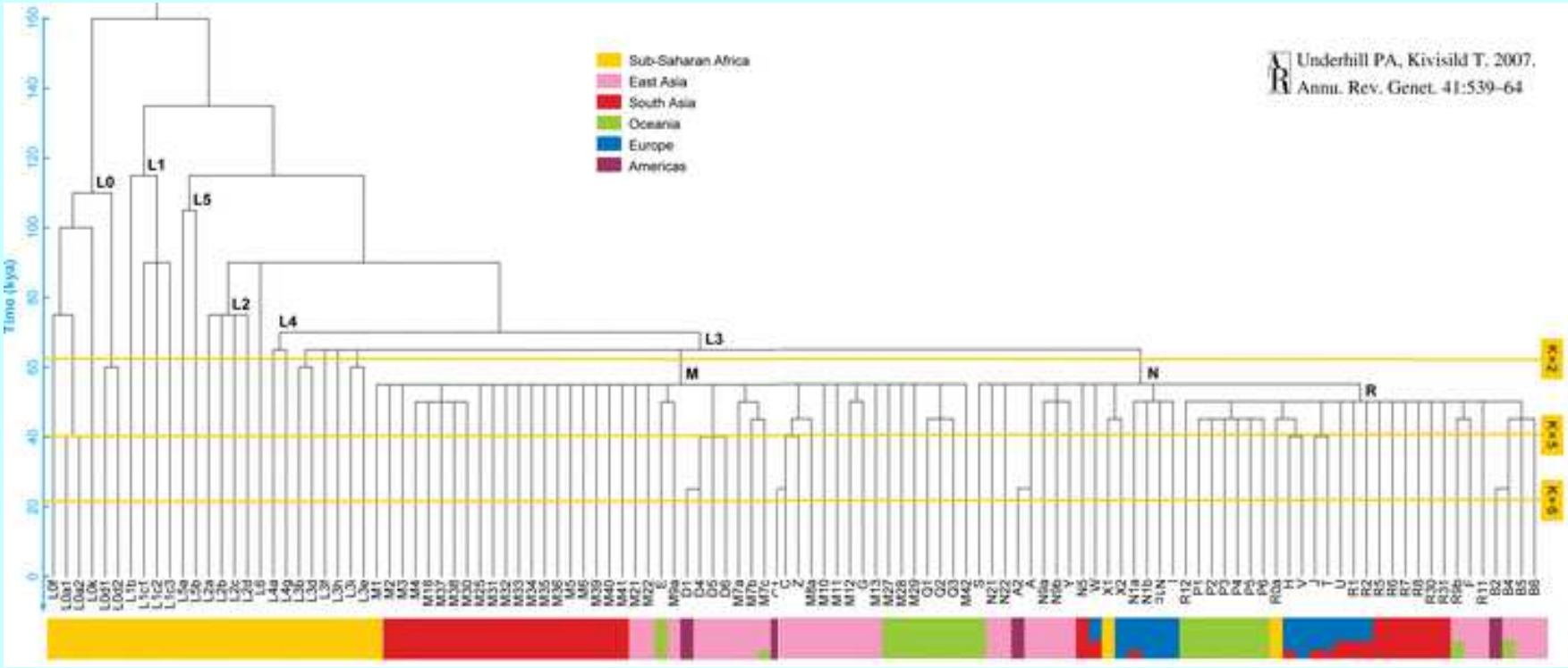
Source: *Newsweek* 111 (Jan. 11, 1988): 46-52.

Scientists are calling her Eve, but reluctantly. The name evokes too many wrong images -- the weak-willed figure in Genesis, the milk-skinned beauty in Renaissance art, the voluptuary gardener in "Paradise Lost" who was all "softness" and "meek surrender" and waist-length "gold tresses." The scientists' Eve -- subject of one of the most provocative anthropological theories in a decade -- was

Who was where when Out Of Africa happened?

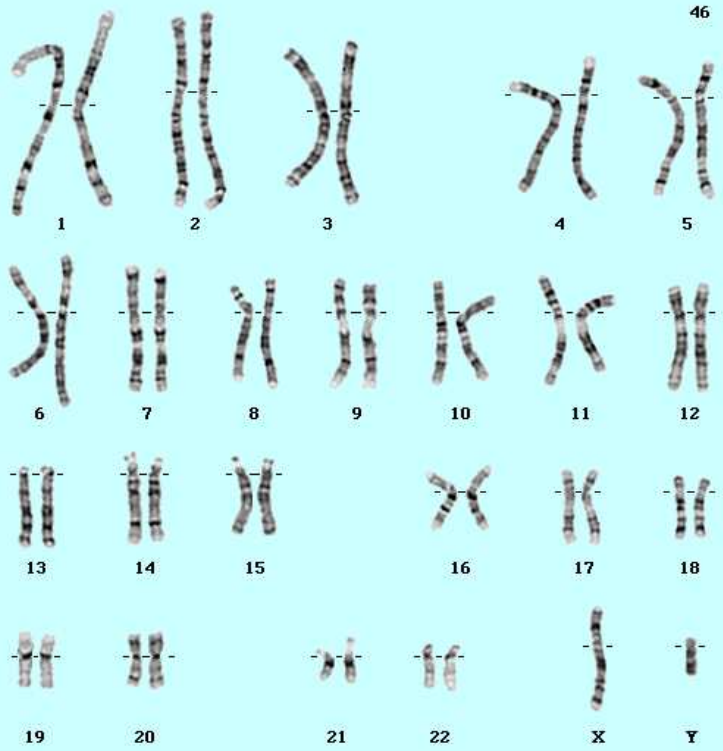


The Y chromosome



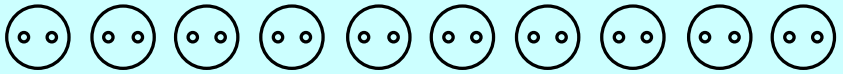
A genealogical tree of Y chromosome types, recent version, “growing” downwards. Geographical origin of the populations is color-coded along the bottom.

What about all the other parts of the genome?



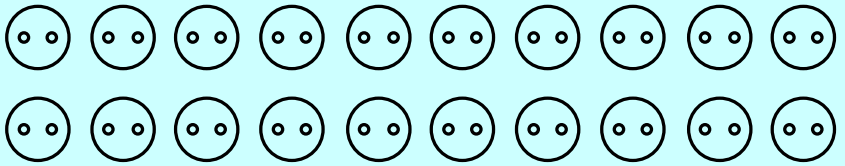
Part of the genome	bases	protein genes
Human mitochondrion	16,569	13
Human Y chromosome	60,000,000	45
All other human chromosomes	3,300,000,000	20,000 - 25,000

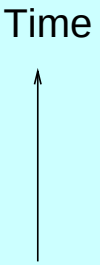
One generation of a (small) population



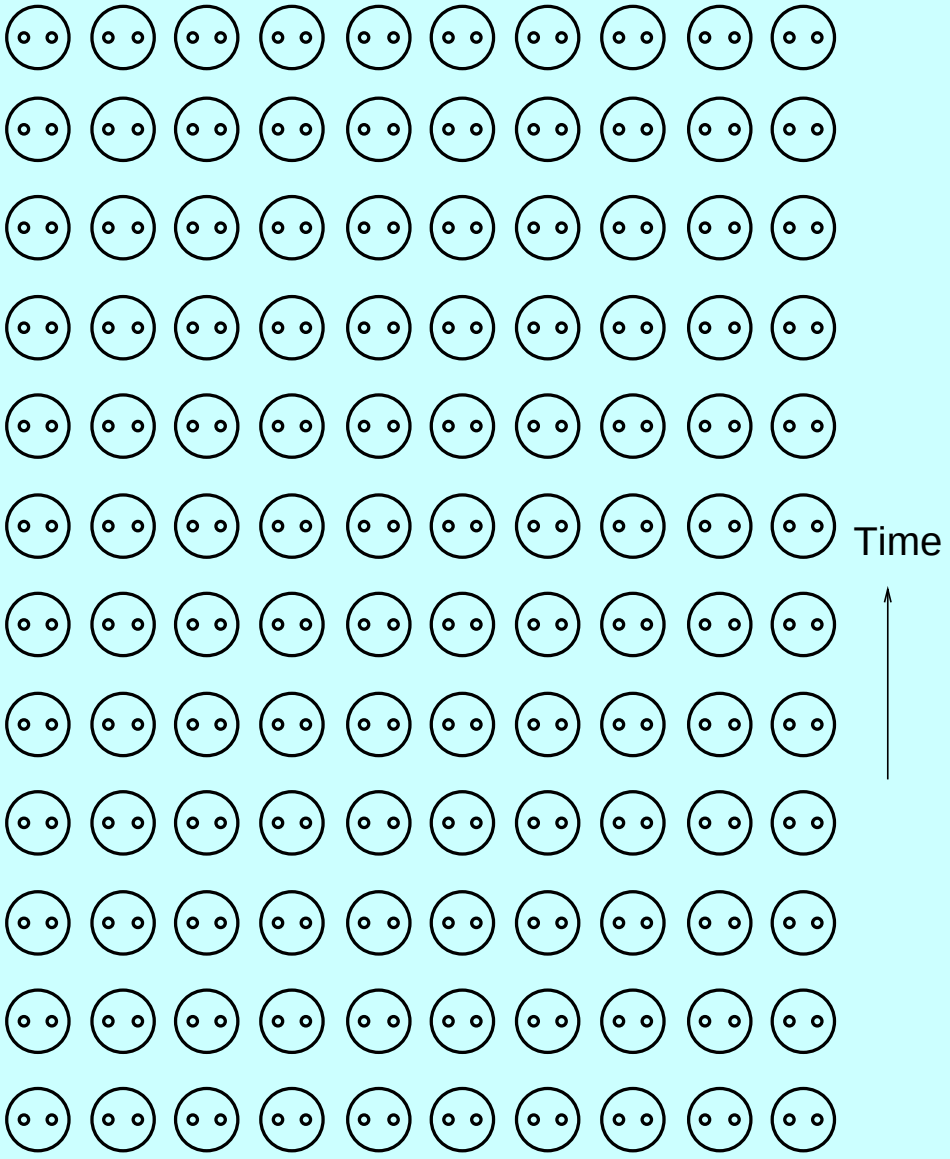
Time

... and its parent generation

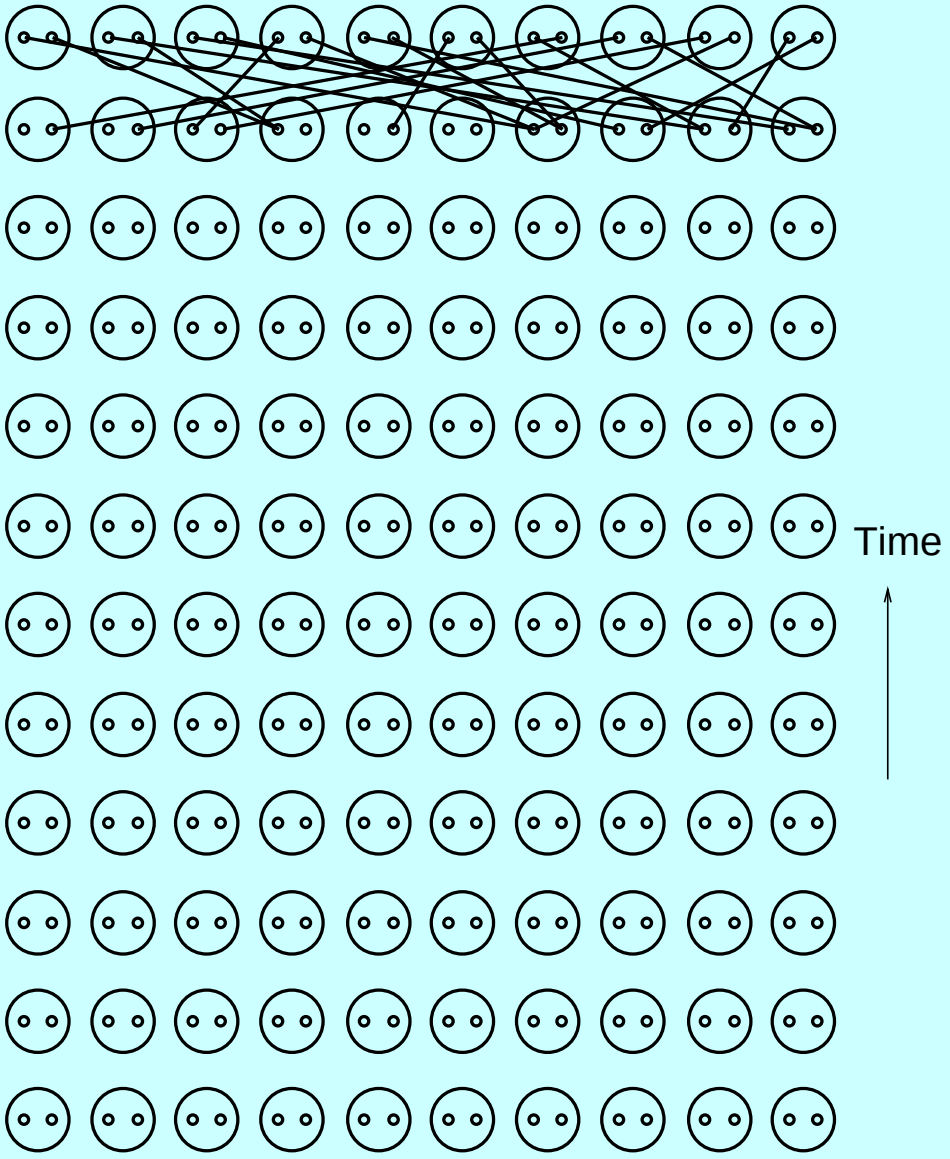




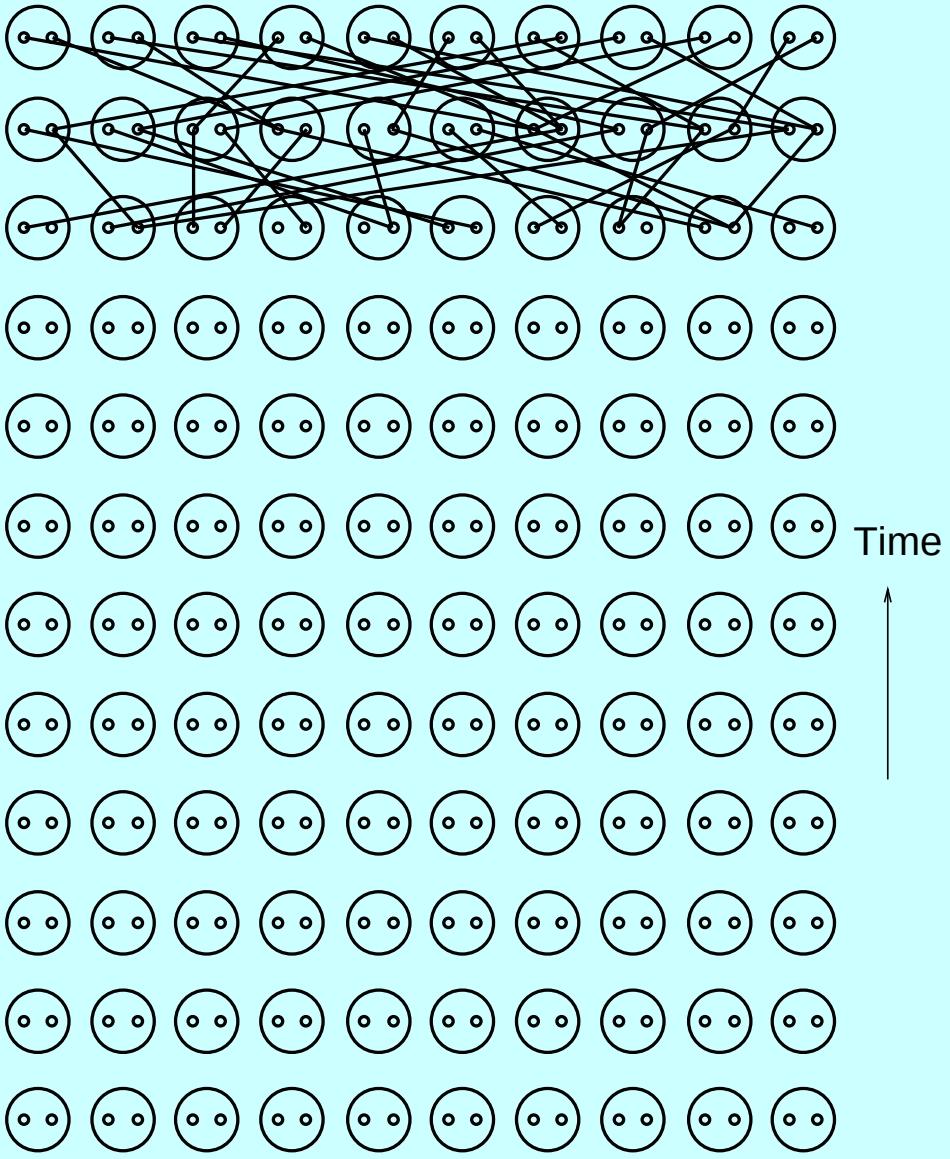
Where do the copies of the genes come from?



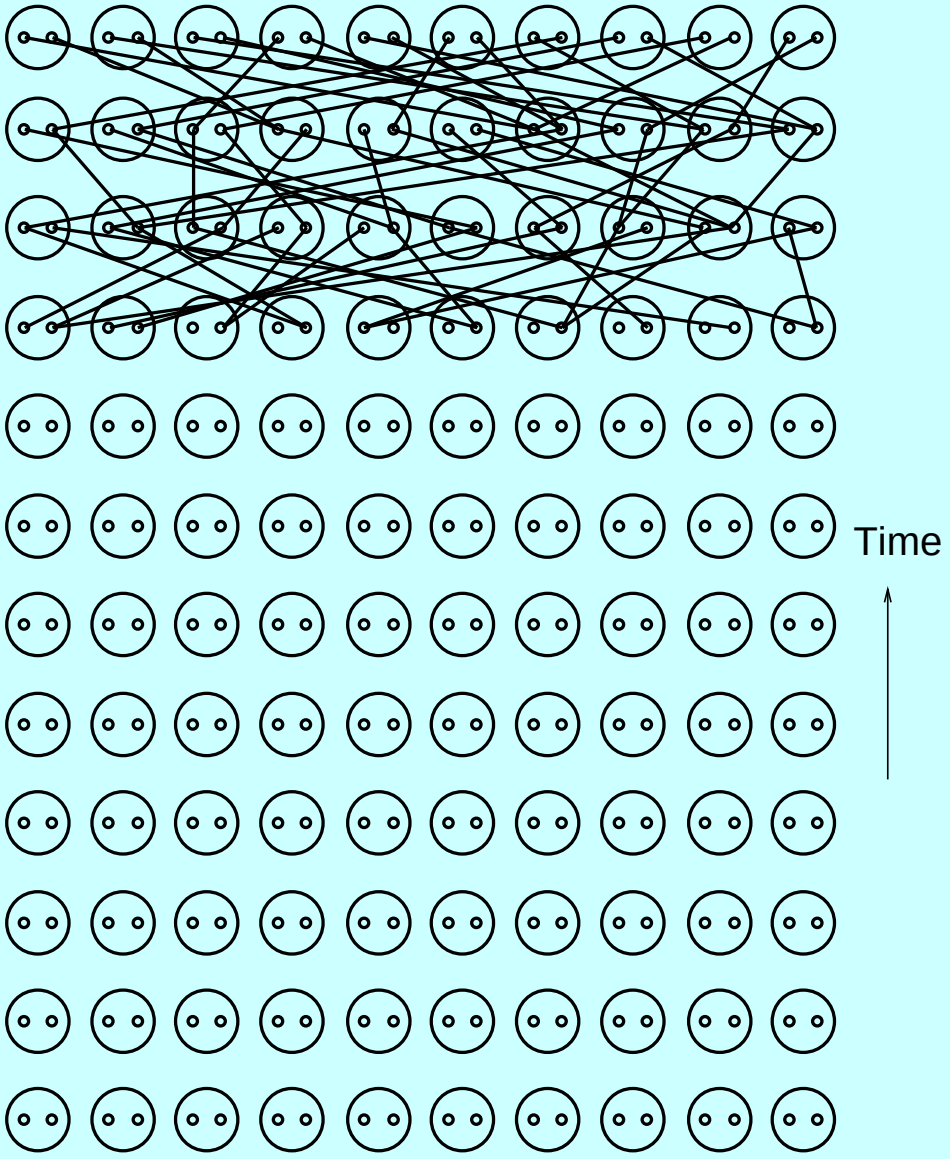
Coalescent genealogy for one gene



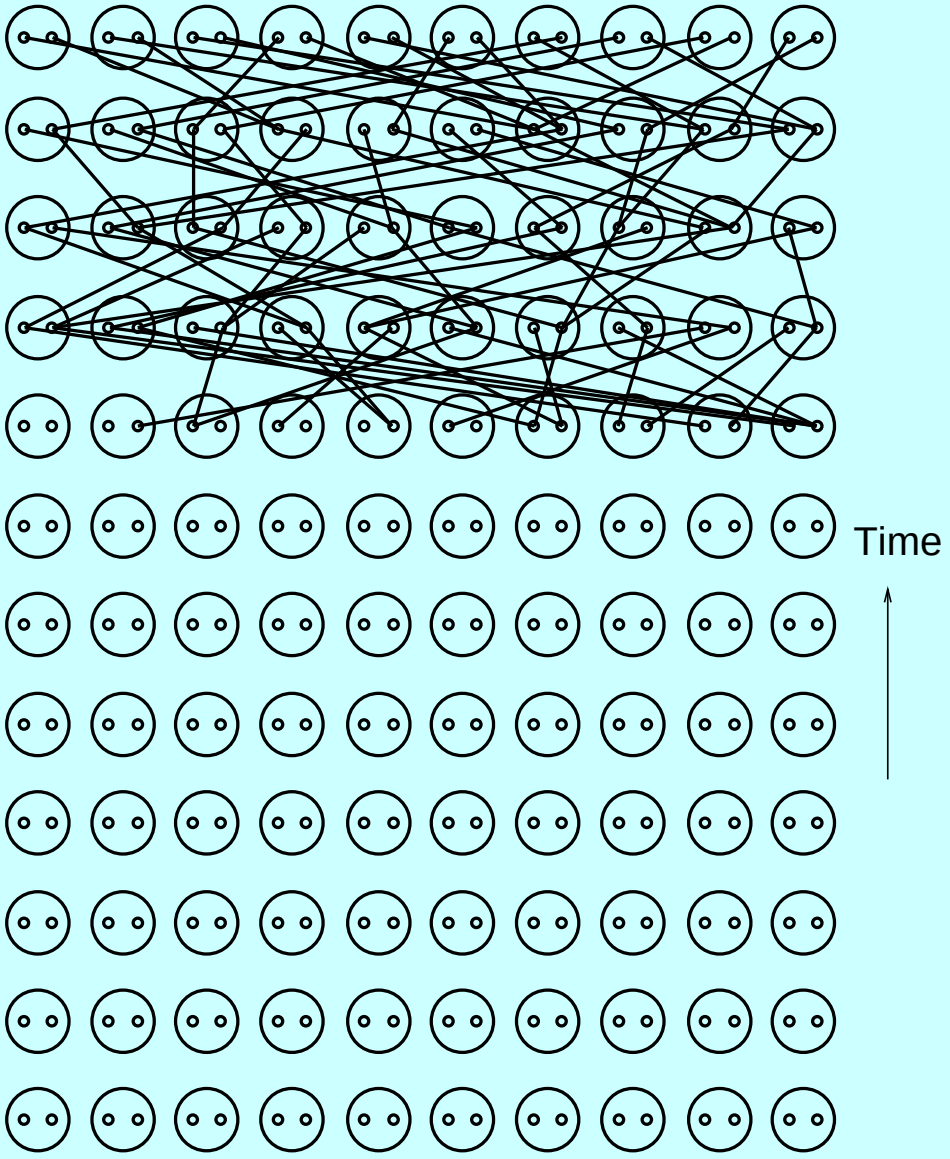
Coalescent genealogy for one gene



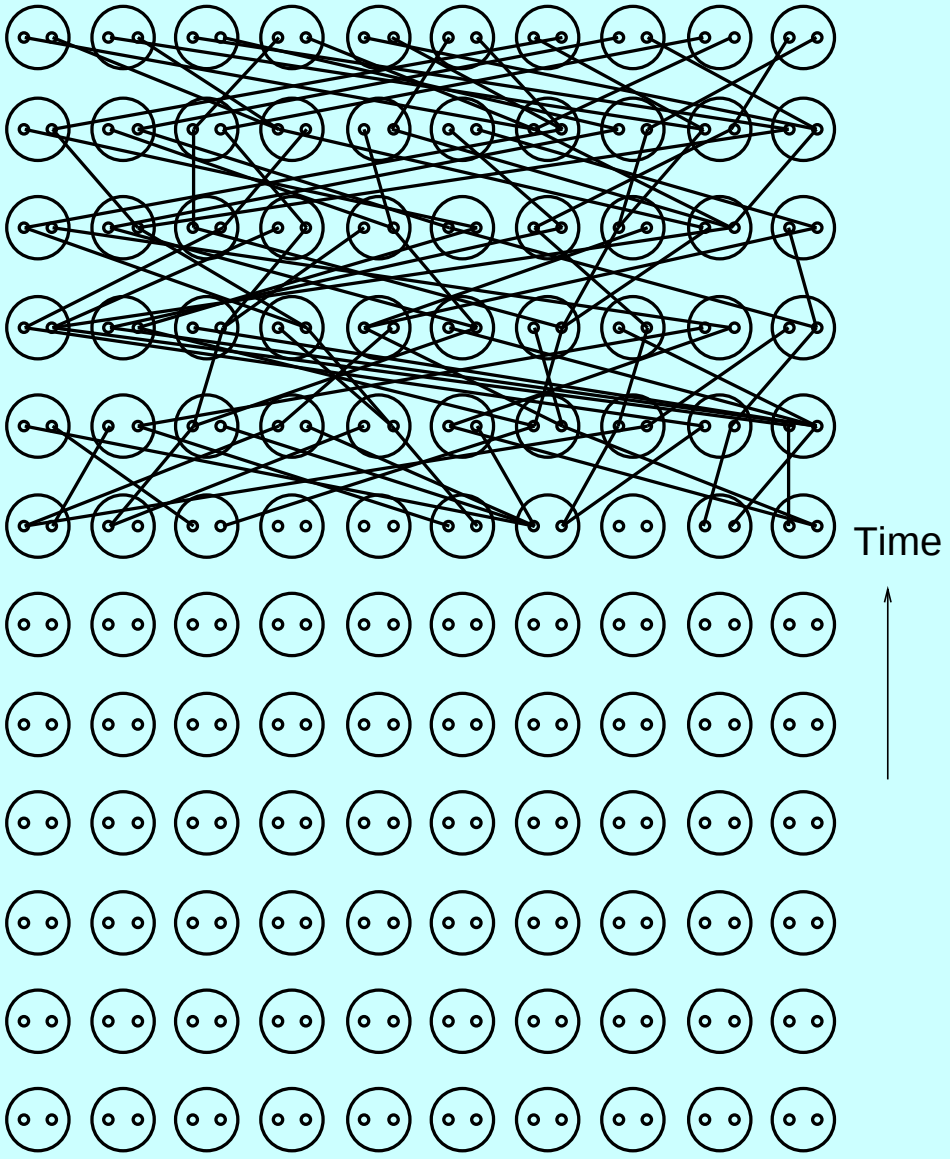
Coalescent genealogy for one gene



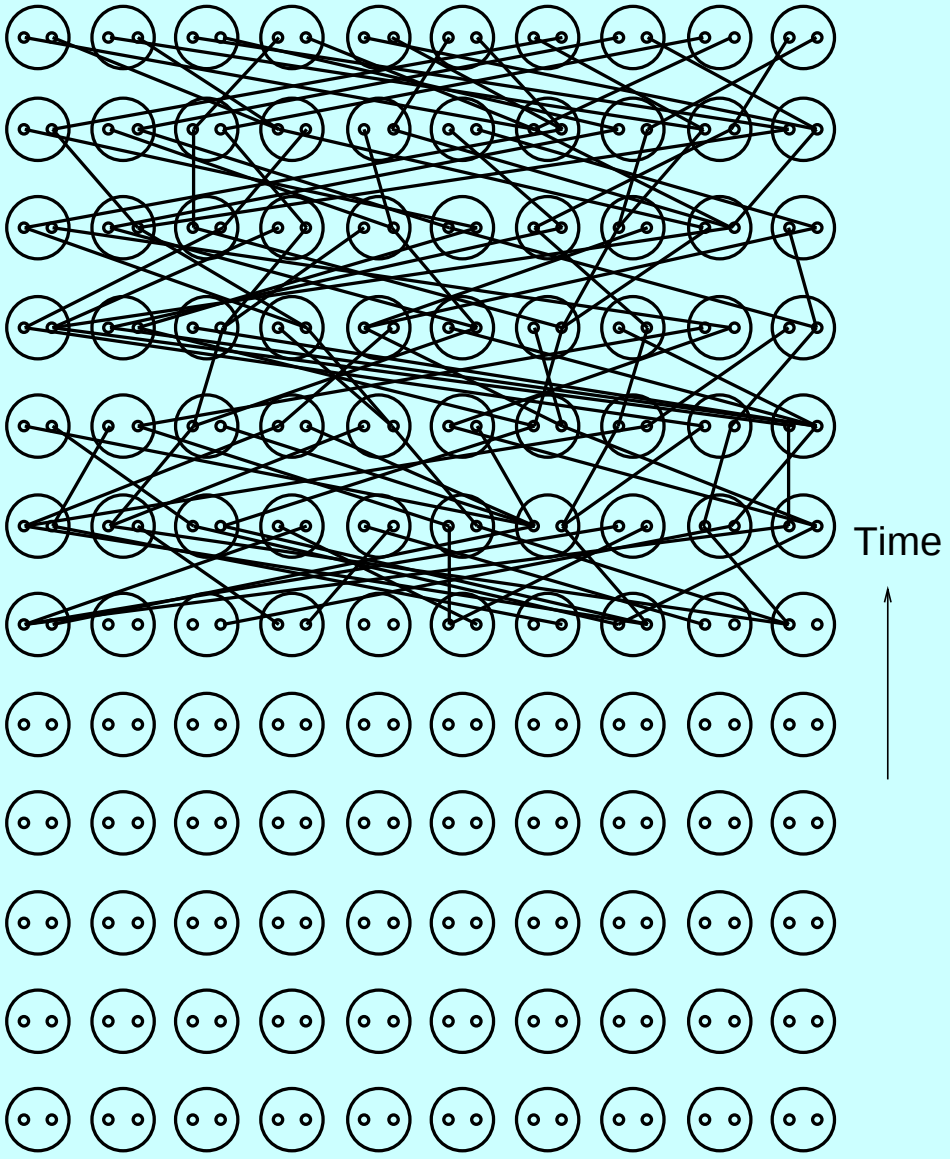
Coalescent genealogy for one gene



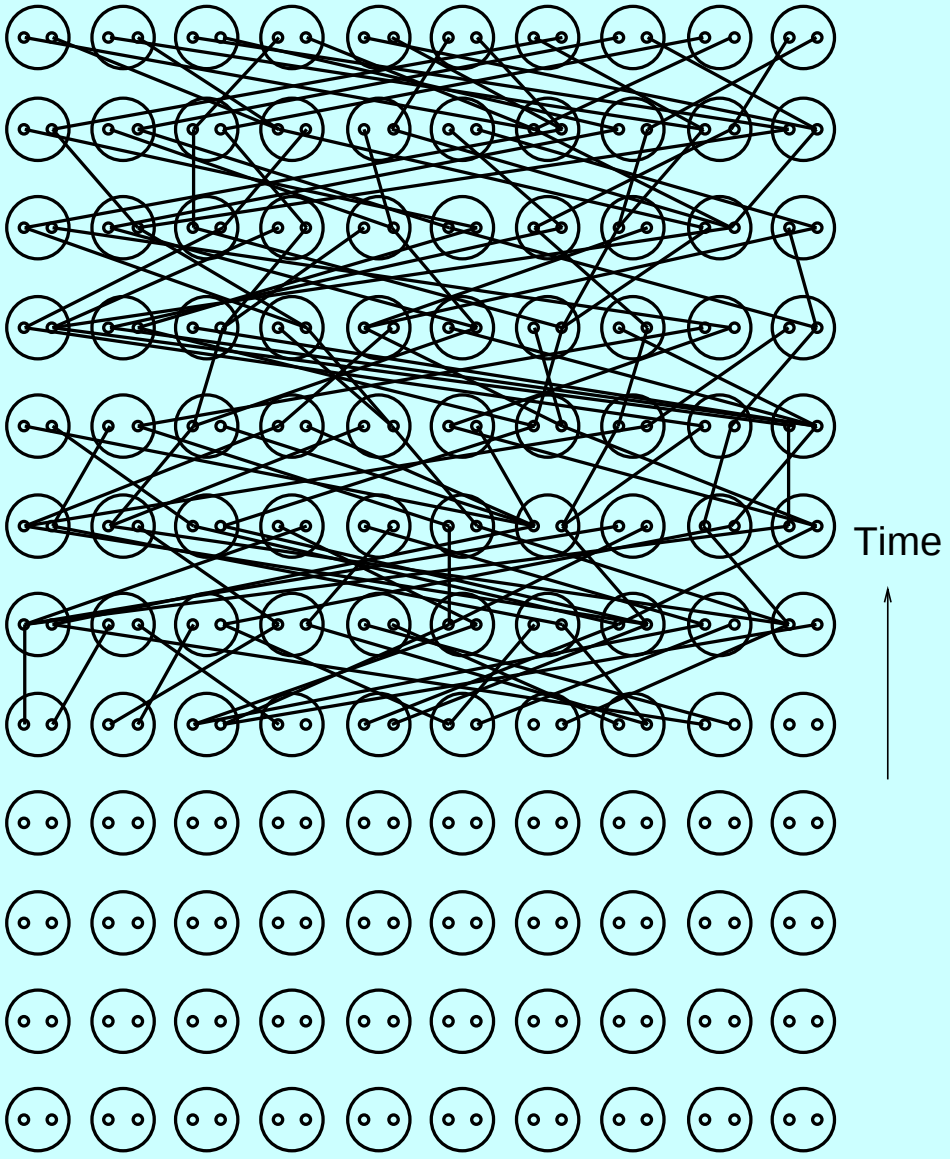
Coalescent genealogy for one gene



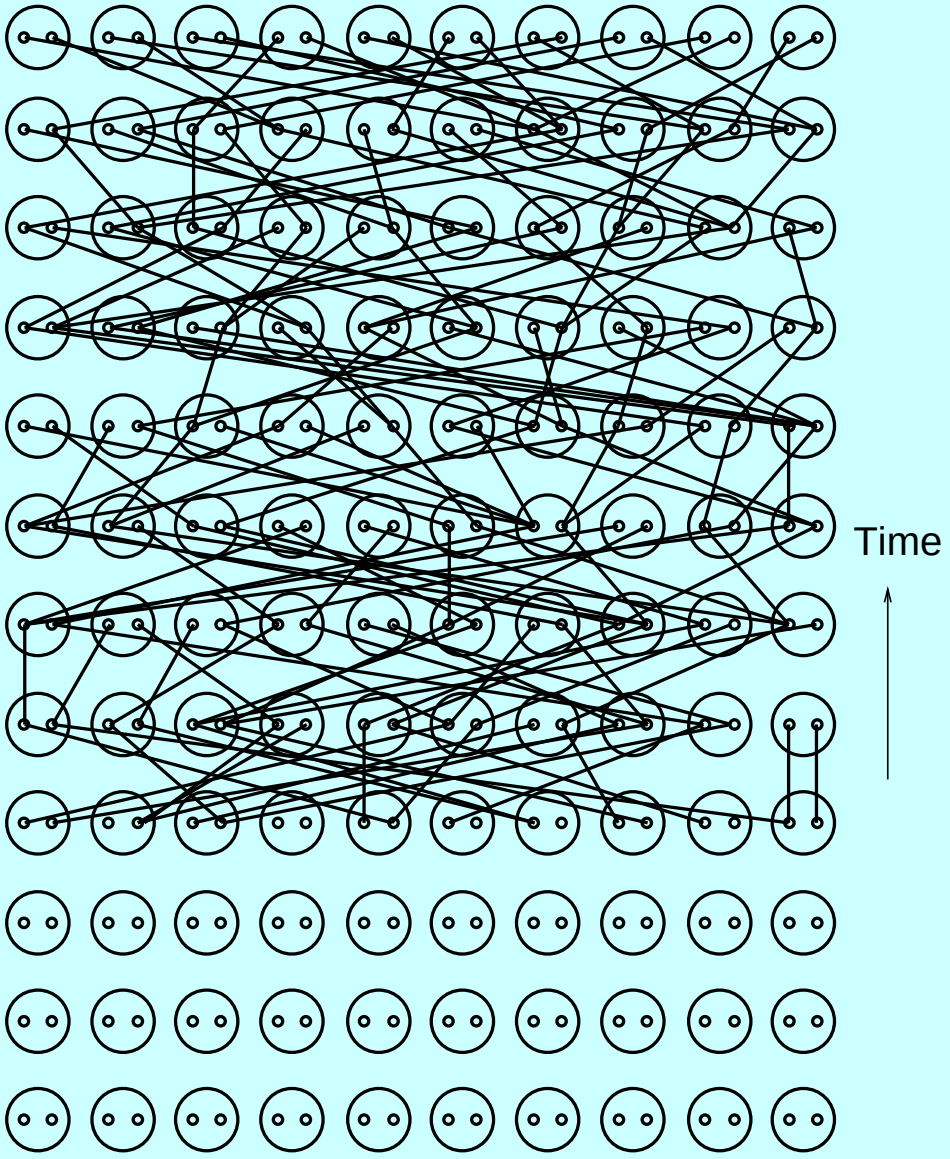
Coalescent genealogy for one gene



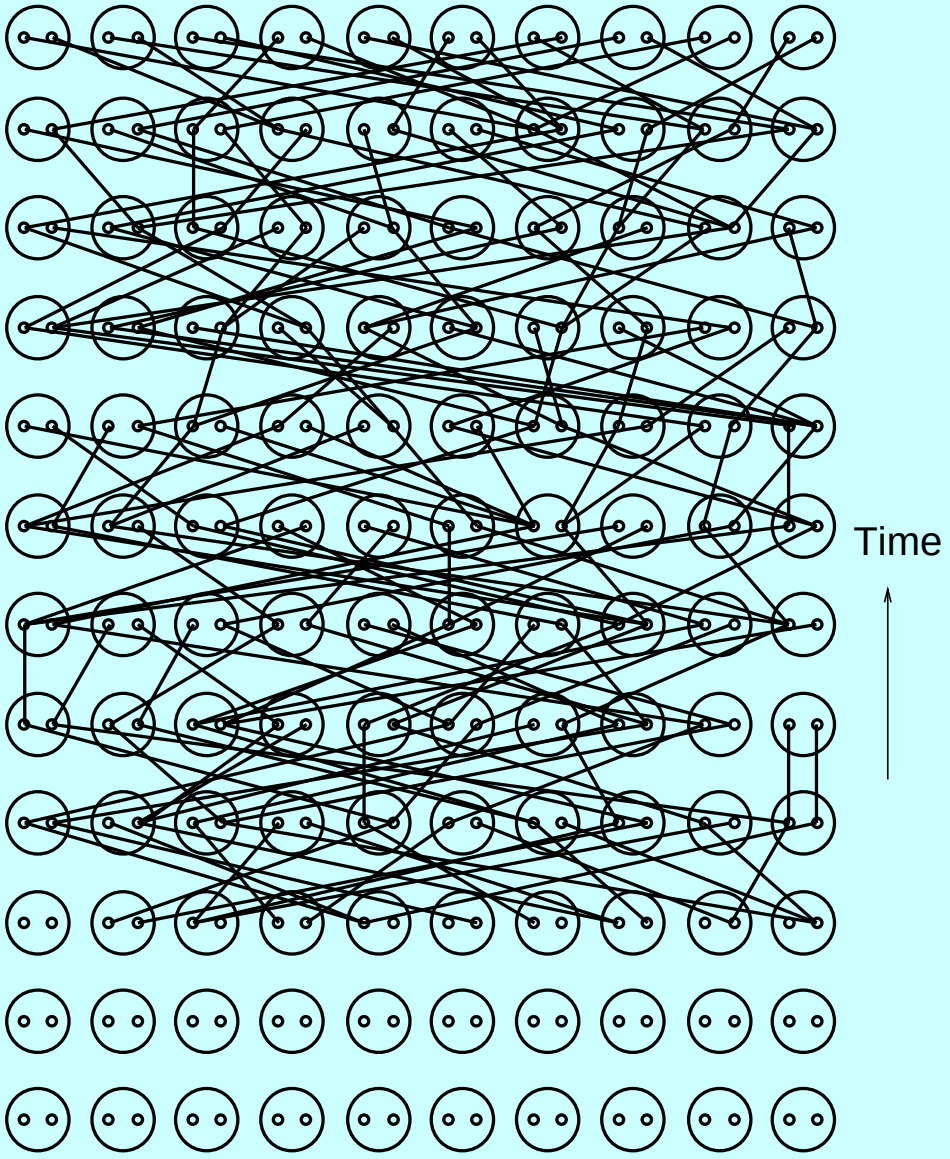
Coalescent genealogy for one gene



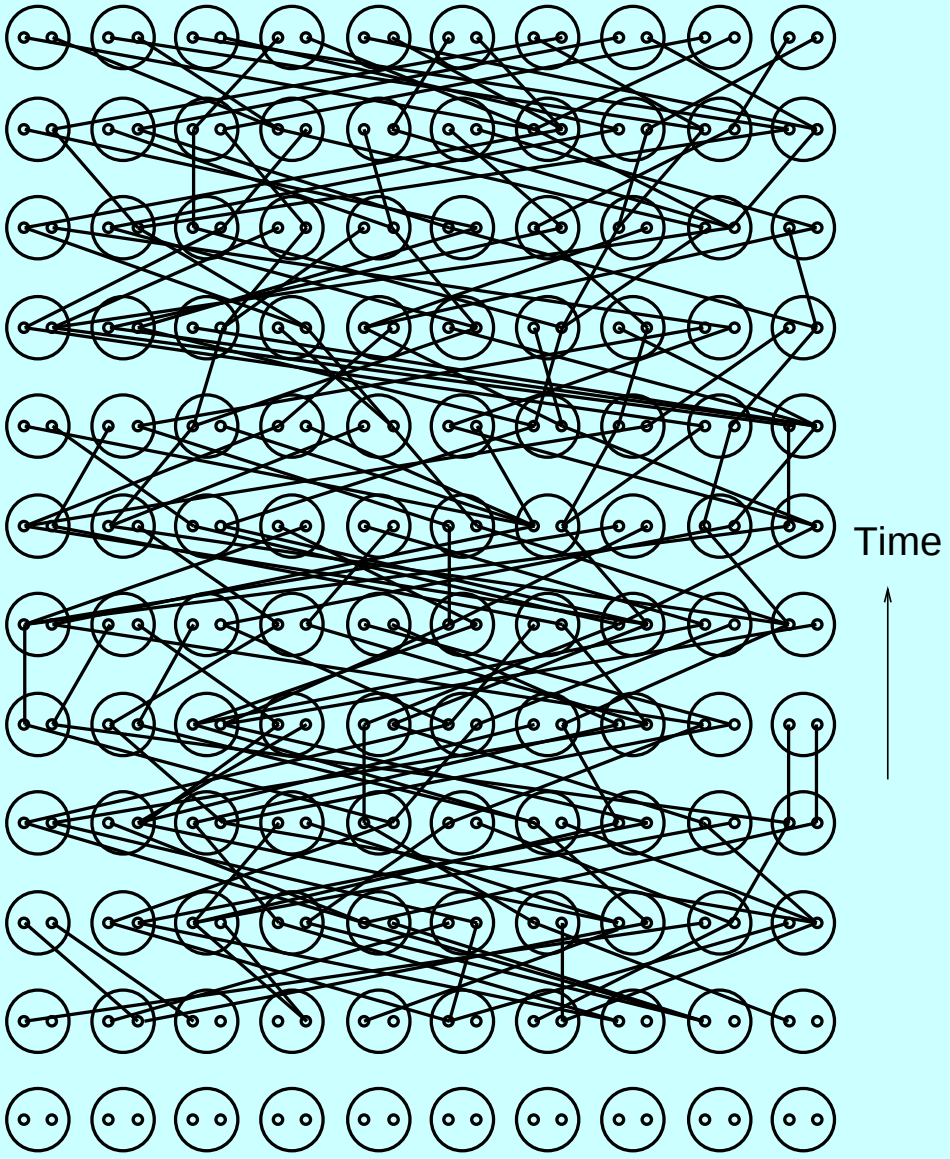
Coalescent genealogy for one gene



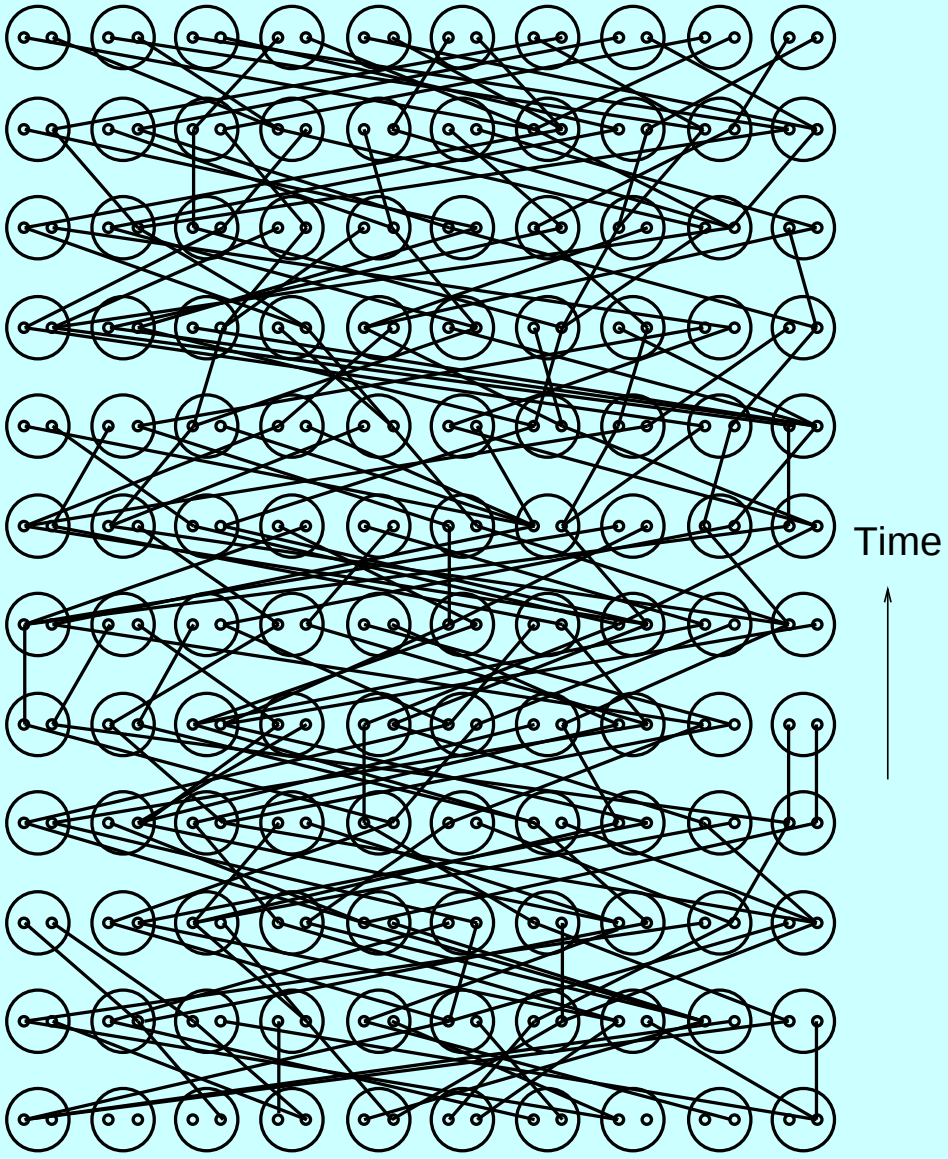
Coalescent genealogy for one gene



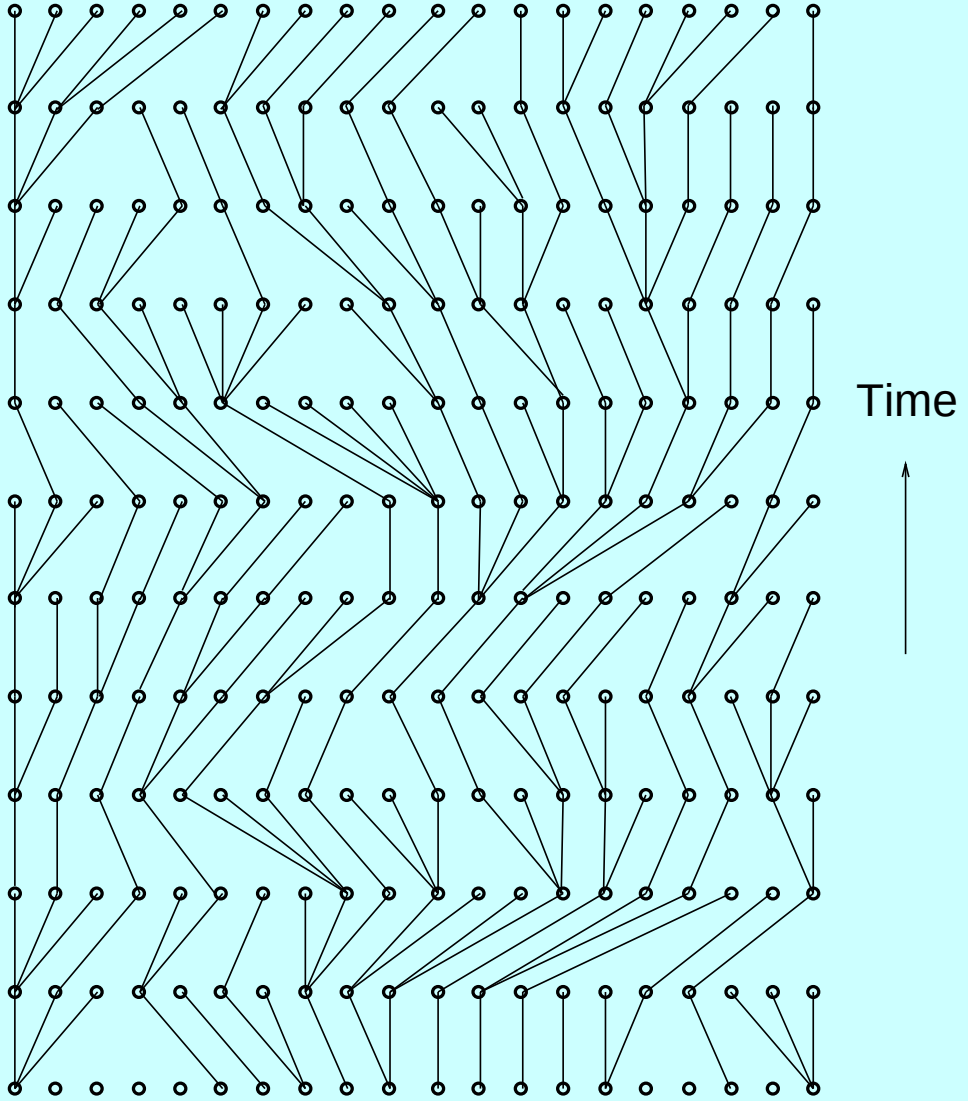
Coalescent genealogy for one gene



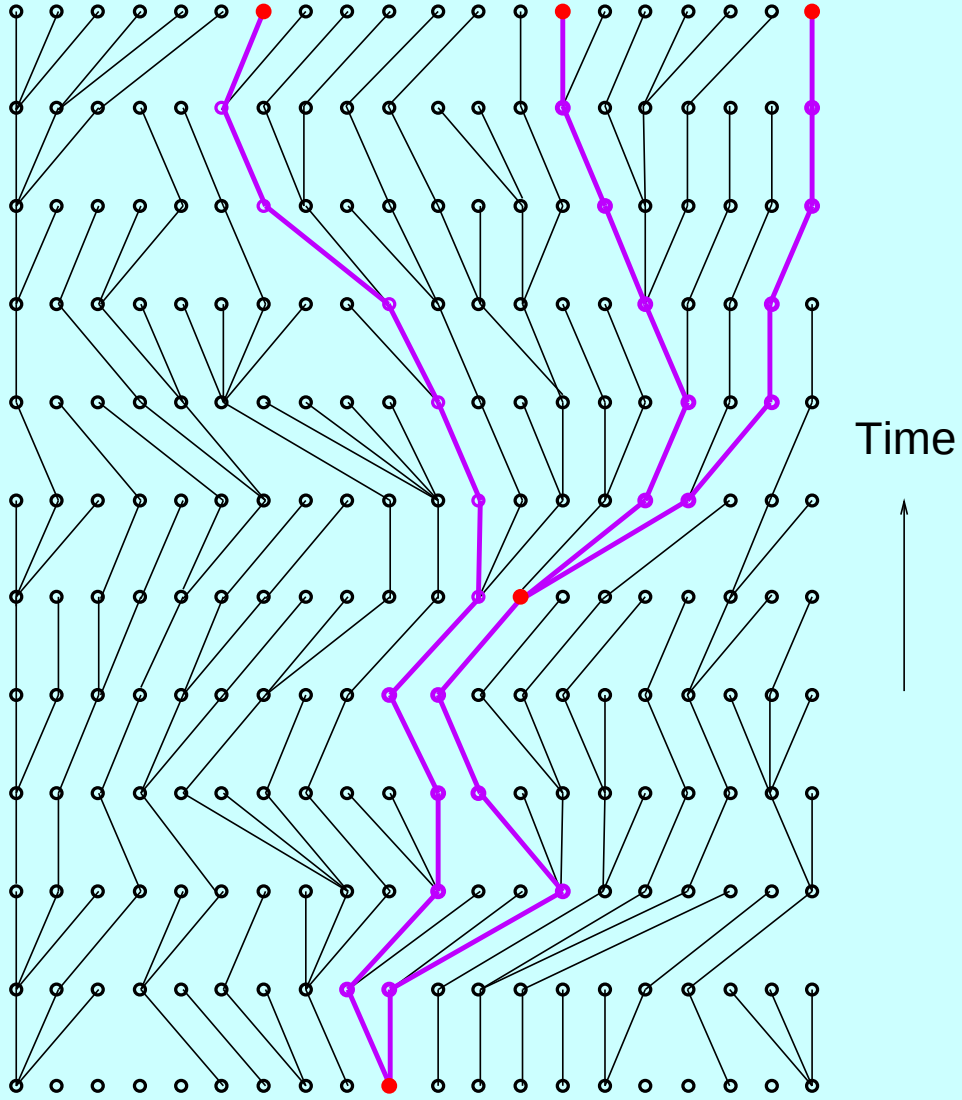
Coalescent genealogy for one gene



Untangling the crossed lines ...



Genealogy of a sample of 3 copies

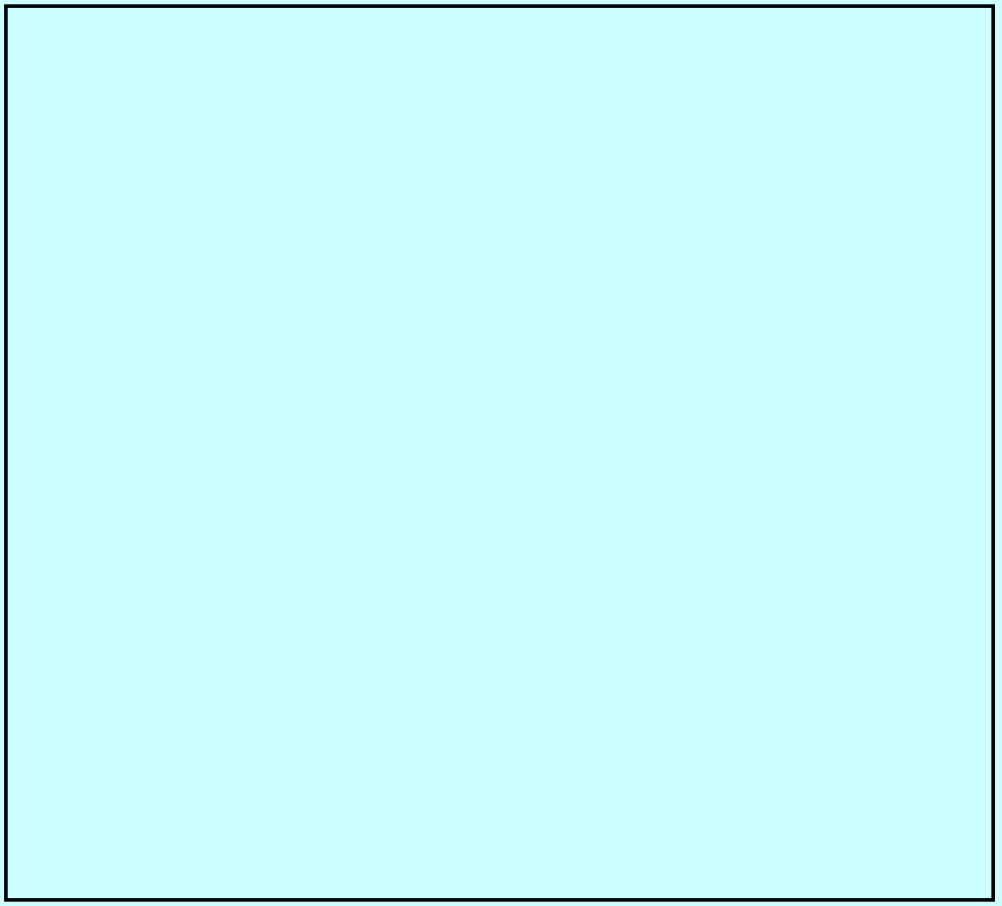


J. F. C. Kingman's (1982) "coalescent"

- Go back a random length of time, drawn from an exponential distribution with mean $4N/(k(k-1))$
- Join a random pair of lineages
- Reduce k by 1.
- If $k = 1$ then stop
- Otherwise go up to first step.

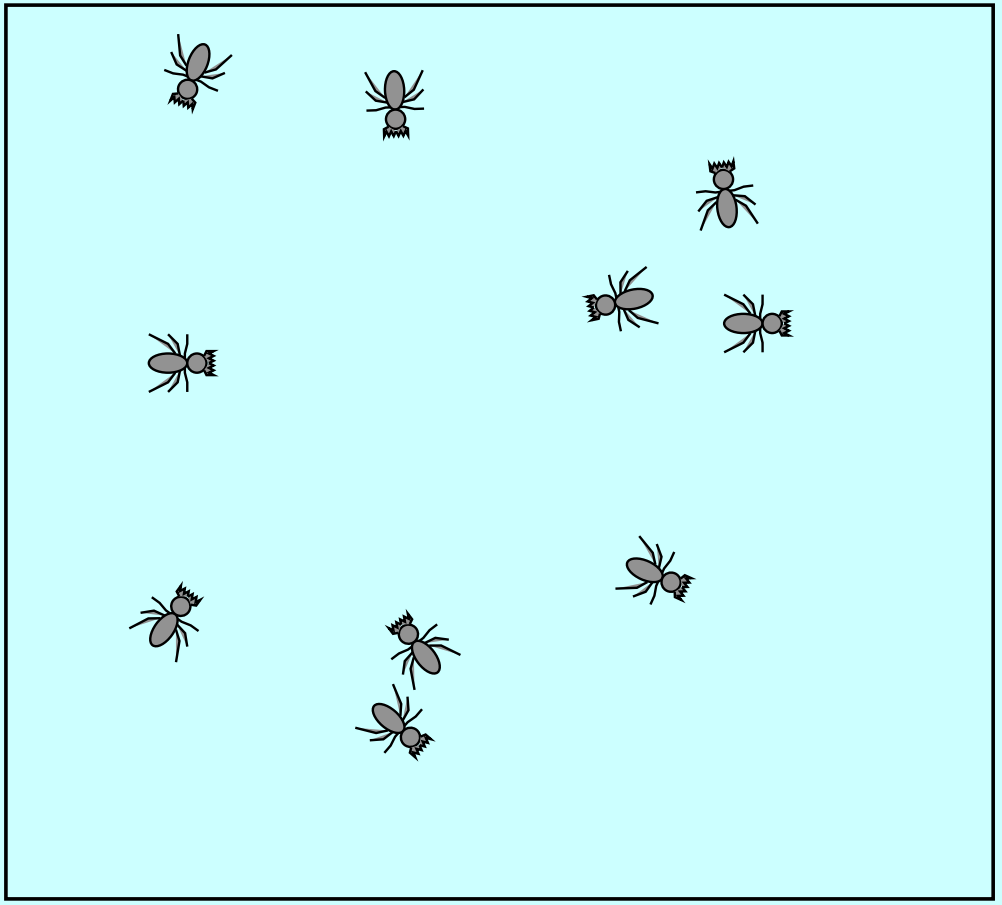
An accurate analogy: Bugs In A Box

There is a box ...



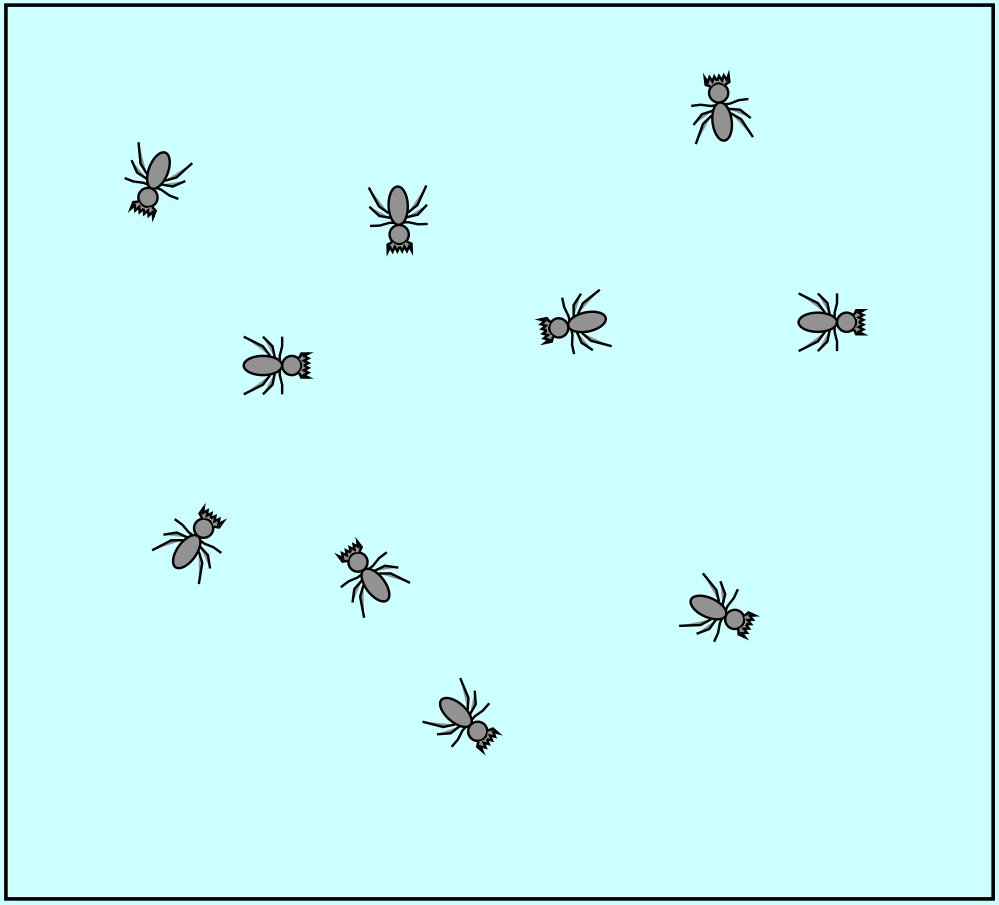
An accurate analogy: Bugs In A Box

with bugs that are ...



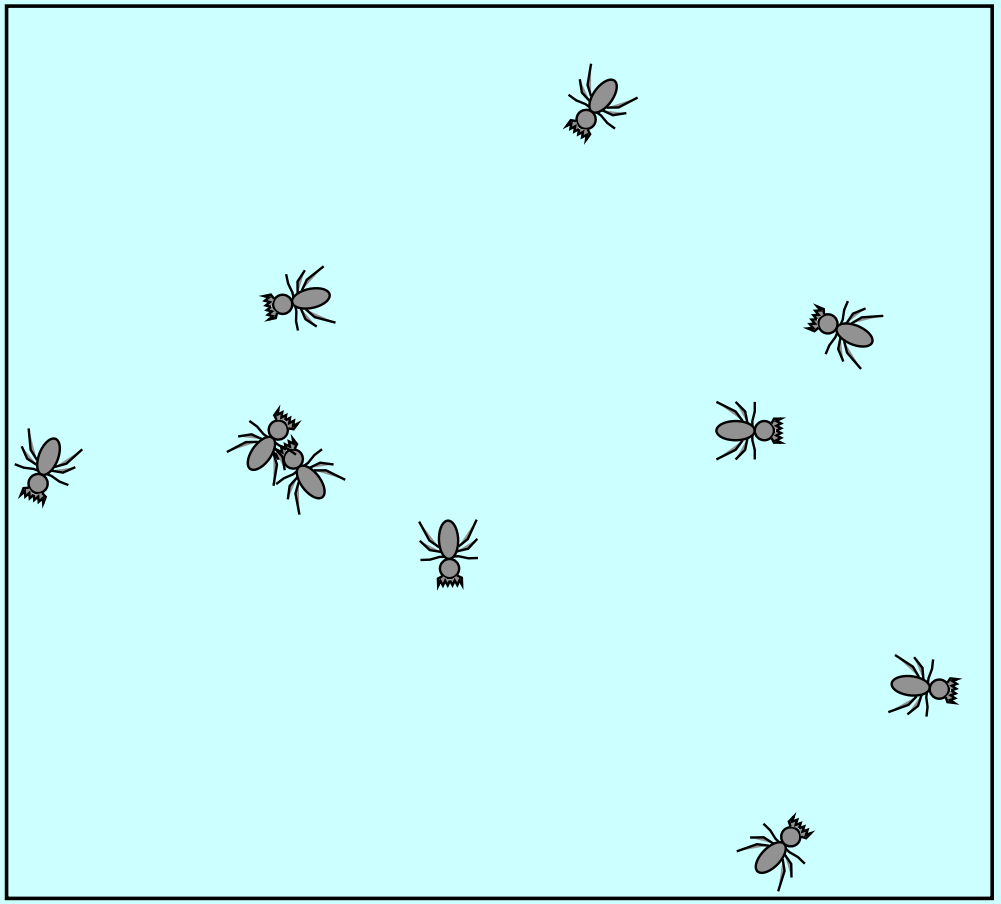
An accurate analogy: Bugs In A Box

... hyperactive ...



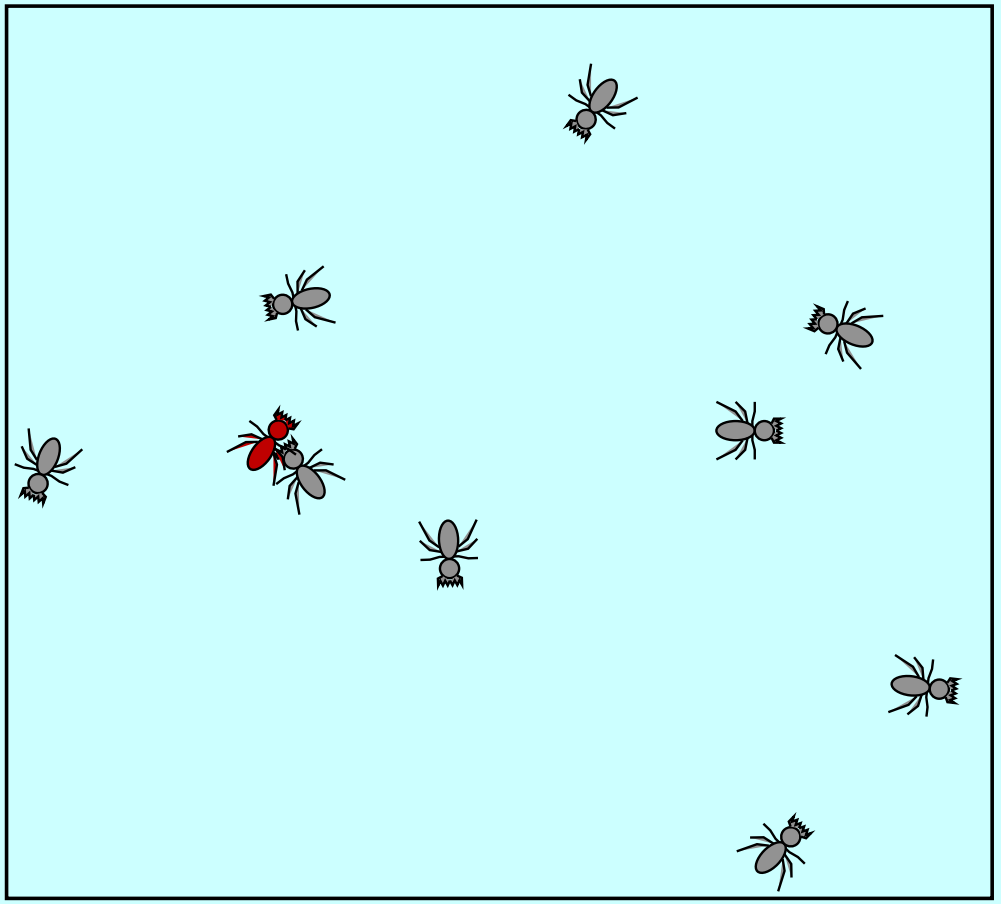
An accurate analogy: Bugs In A Box

... indiscriminate ...



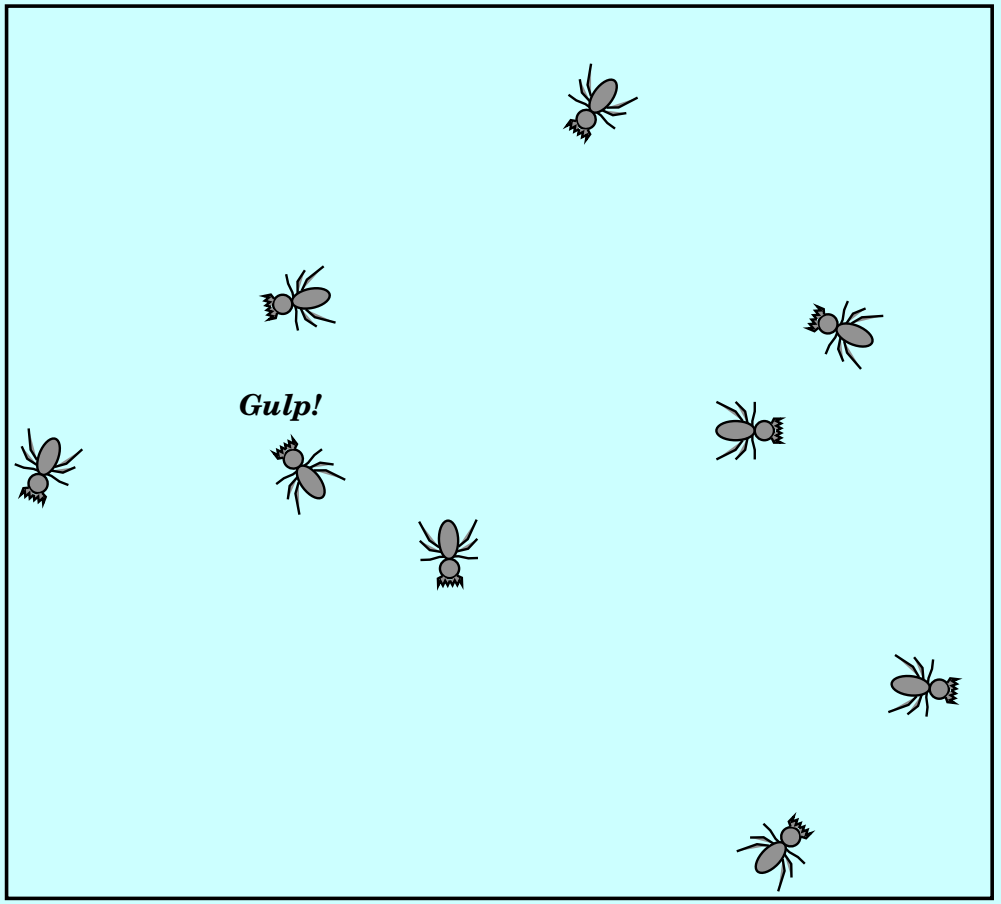
An accurate analogy: Bugs In A Box

... voracious ...



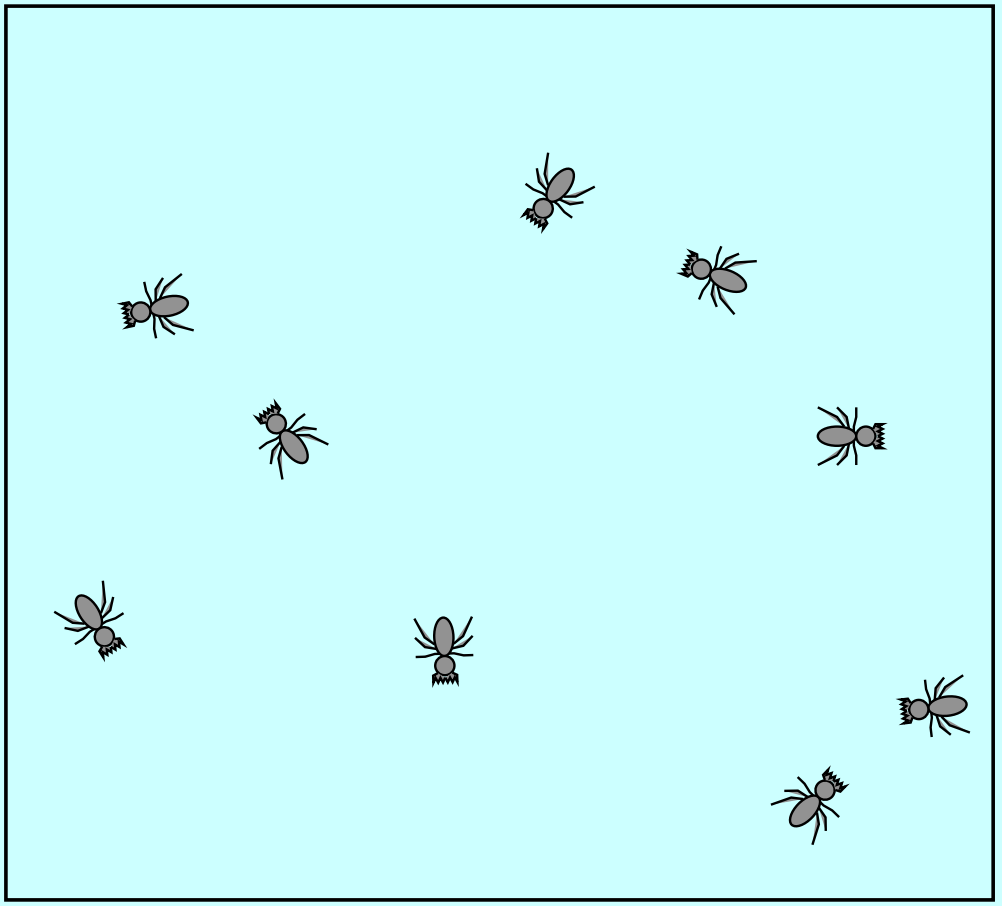
An accurate analogy: Bugs In A Box

... (eats other bug) ...

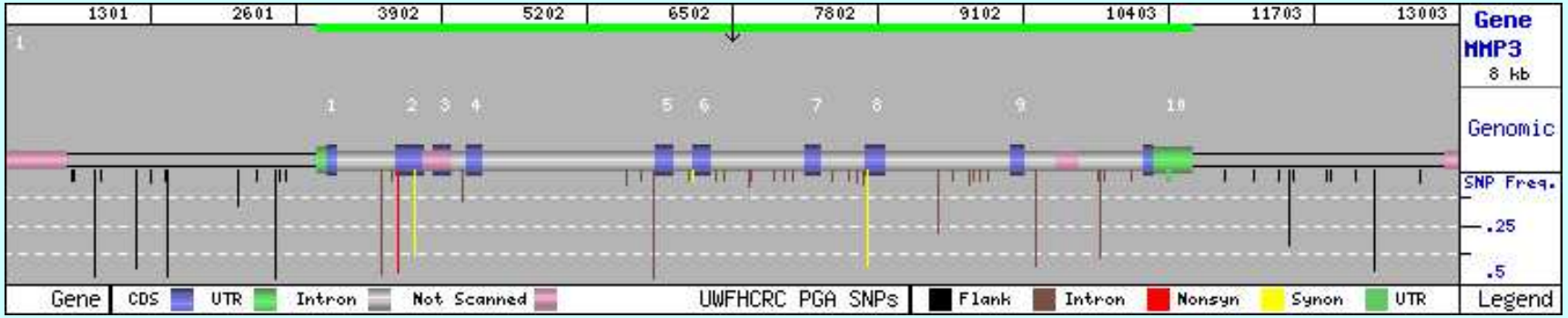


An accurate analogy: Bugs In A Box

... and insatiable.



A typical locus showing SNP variation



(From Debbie Nickerson's SeattleSNPs project). Single-nucleotide polymorphisms (SNPs) at the Matrix Metalloproteinase 3 locus.

Members of our lab

Current members

- Mary Kuhner
- Jon Yamato
- Elizabeth Walkup
- Bob Giansiracusa
- Jim McGill
- Brendan O'Fallon

Recent members, sadly departed

- Lucian Smith
- Chul Joo Kang
- Eric Rynes
- Ian Robertson