

# The Statistical Analysis of Relatedness

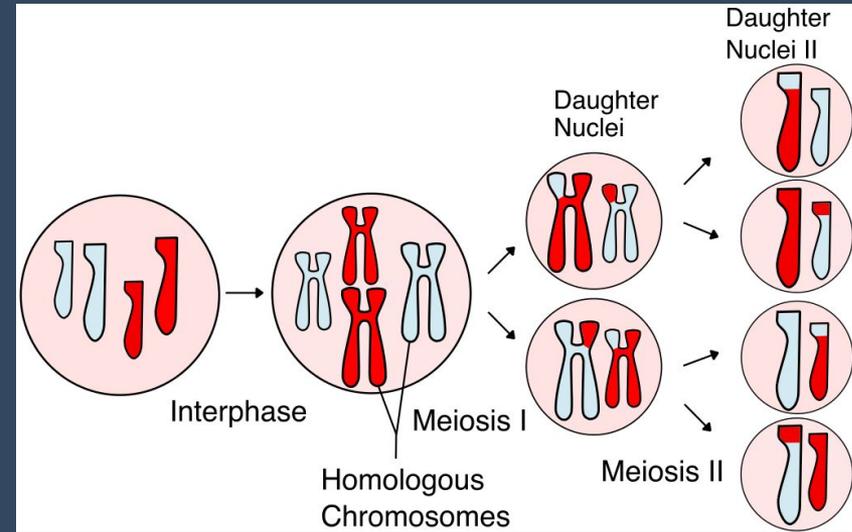
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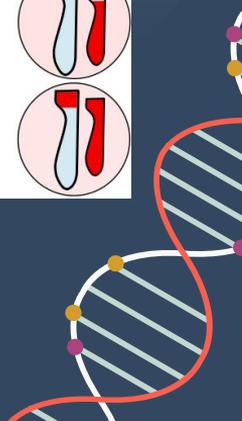
# Quick Biology Refresher

## ● Meiosis

- We have two pair of chromosomes, passing one down.
- Recombination, exchanges in genetics material.
- Chromosome in the gamete is a mosaic of the pair, “passed down in chunks”.

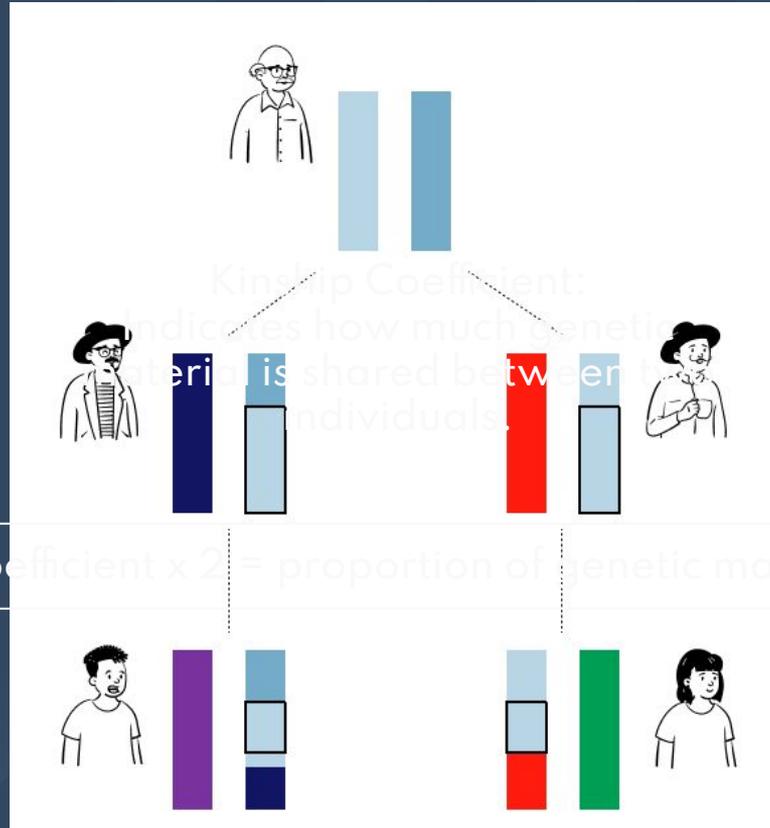


[1] Meiosis



# Larger Perspective

Identical-by-descent



\* Kinship Coefficient  $\times 2$  = proportion of genetic material shared

# Let's Suppose a Pedigree

## Calculating Kinship Coefficient w/ Path Counting

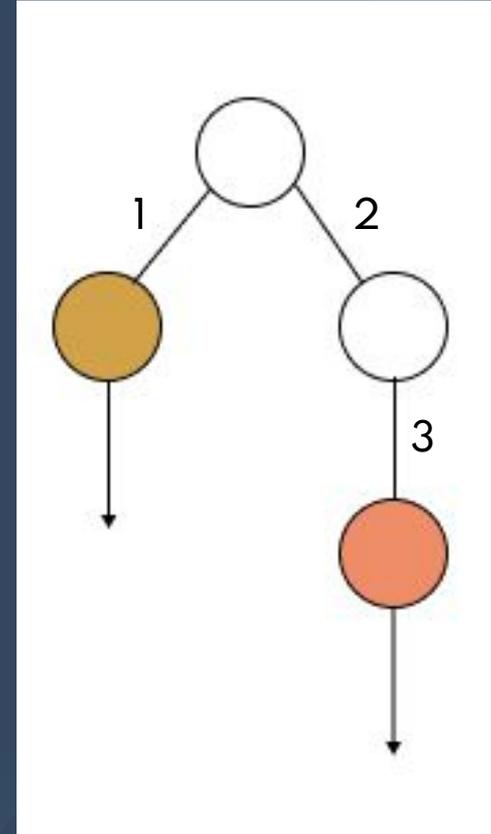
How many “segments” through the  
common ancestor?

Formula:  $(1/2)^{\text{(# of segments + 1)}}$

Formula:  $(1/2)^{\text{(3 + 1)}}$

$= (1/2)^4$

$= 1/16$



# Let's Suppose another Pedigree

## Calculating Kinship Coefficient w/ Path Counting

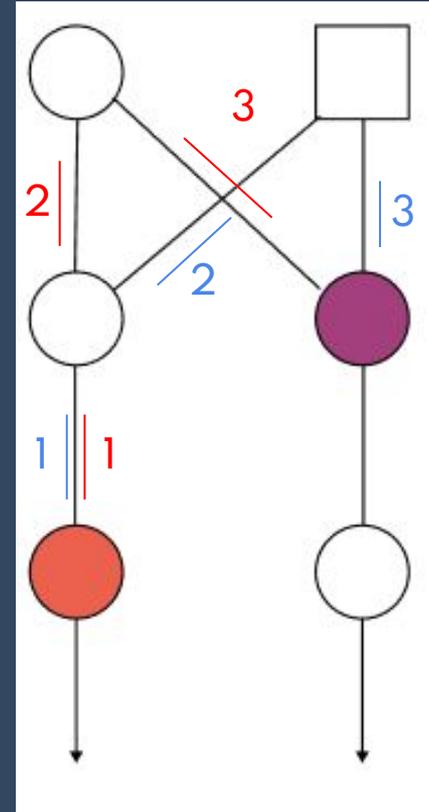
How many “segments” through the  
common ancestor?

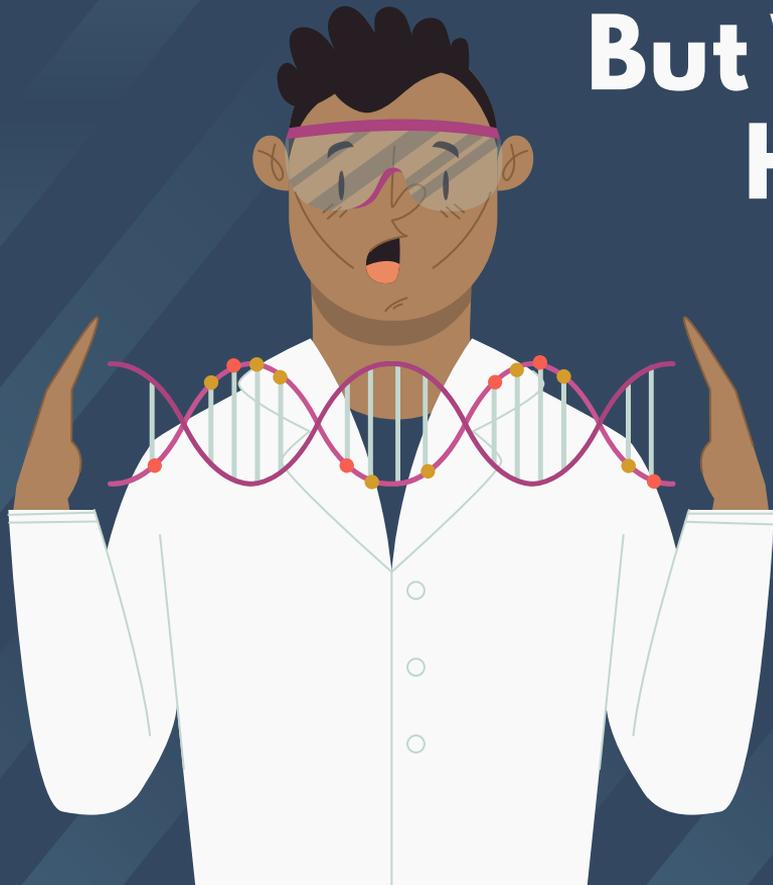
Formula:  $(\frac{1}{2})^{(\# \text{ of segments} + 1)}$

Formula:  $(\frac{1}{2})^{(3 + 1)} + (\frac{1}{2})^{(3 + 1)}$

$= (\frac{1}{2})^4 + (\frac{1}{2})^4 = 2(\frac{1}{2})^4$

$= 1/8$

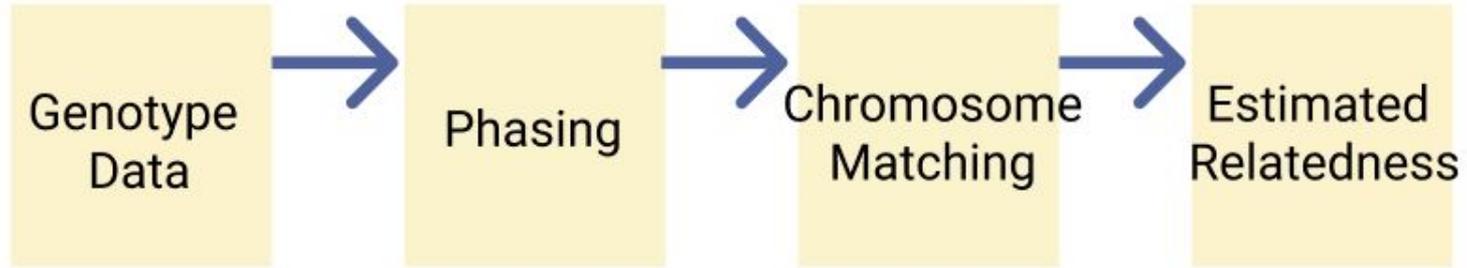




# But What if We Don't Have a Pedigree?

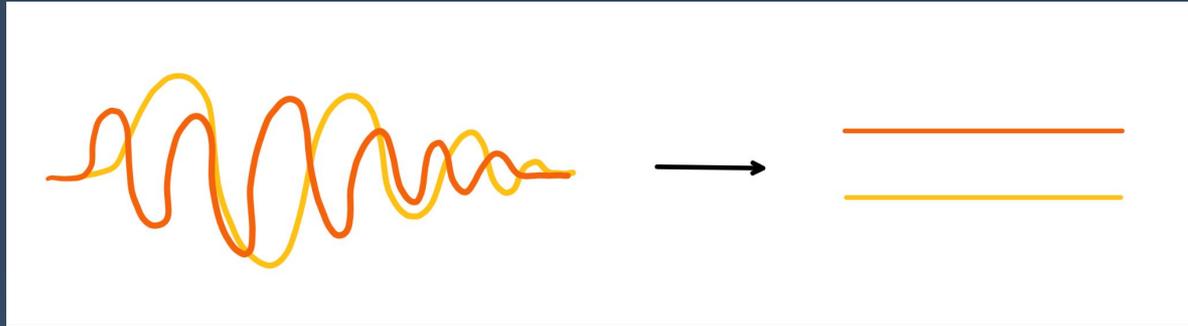
Instead, we have genetic data from a lot of people.

# Algorithmic Analysis



# Algorithmic Analysis- Phasing

- **Statistical phasing programs**
  - “Unjumble” the genetic data so that matches could be more easily found.
  - The Hidden Markov Model [2](Browning)



# Algorithmic Analysis- Matching

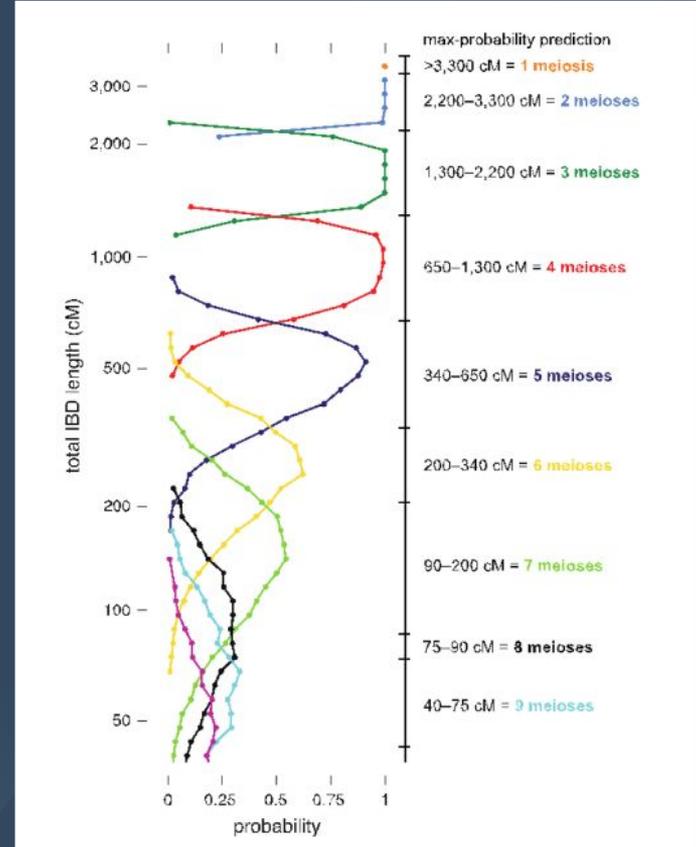
- **Systematically match**
  - Number of Matching/Total genome
  - Evaluate relationship based on the result.

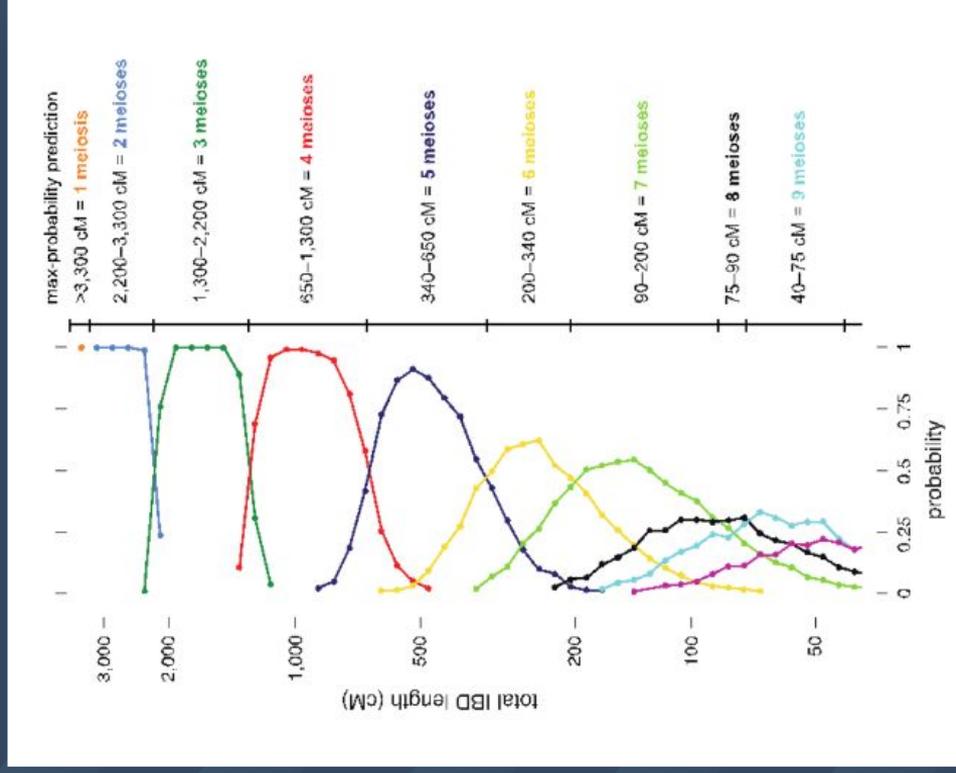
GCGCTCACC**GACTGTTCCCAA**...TCAAGGC

CCACC**CACC**GACTGTTCCCAA...TCAACAT

# AncestryDNA; 23andMe

- These companies are doing essentially the same thing.
- Own algorithms, information sorting systems.
- Two services:
  - % your DNA comes from certain geographic regions.
  - In our database: who are you related to.





# 23andMe



Pink = One matching chromosome

# Citations

[1] “Meiosis.” Wikipedia, Wikimedia Foundation, 23 Nov. 2021, <https://en.wikipedia.org/wiki/Meiosis>.

[2] Browning, Sharon, and Brian L. Browning. “On Reducing the Statespace of Hidden Markov Models for the Identity by Descent Process.” *Theoretical Population Biology*, Academic Press, 13 June 2002, <https://www.sciencedirect.com/science/article/pii/S0040580902915832>.

