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DNA for the Overwhelmed

DNA and the Cell

- DNA is a molecule made up of **C**ytosine, **G**uanine, **A**denine, and **T**hymine, arranged in base pairs, where C aligns with G, and A with T.
- Within a cell nucleus, DNA exists in the form of chromosomes.
- Most cells in the human body have a nucleus with 23 chromosome pairs, with one chromosome of each pair coming from the biological mother, the other coming from the biological father.
- A cell with chromosome pairs is called a diploid cell.

Meiosis and Fertilization

- Germ cells, i.e., the sperm and egg cells, are haploid cells, called so because they have only a single, unpaired copy of each chromosome.
- Germ cells are created by the process of meiosis, in which the chromosomes of a diploid cell first duplicate, then cross-over (recombine) and then separate into four haploid cells.
- Cross-over (recombination) involves an exchange of genetic material between the paternal and maternal copies of each paired chromosome.
- 22 of the 23 chromosome pairs undergo this cross-over process. These are called the autosomes, and their DNA is called autosomal DNA, abbreviated atDNA.
- At fertilization, the sperm injects its nucleus and its single copy of each chromosome into an egg which has its own single copy of each chromosome, and the resulting cell then becomes diploid, now having a pair of each chromosome.

The Sex-Determining Chromosomes

- Two special chromosomes are the X and Y. They determine the sex of the child.
- Women are XX; Men are XY.
- Every egg, therefore, has an X chromosome. A sperm has either an X or a Y.

- If the sperm has an X, then the fertilized egg with be XX (a girl). If the sperm has a Y, then we have XY, a boy.
- A Y chromosome is passed, without recombination, from father to son, father to son, over the generations. X DNA inheritance patterns are more complicated.

Mitochondrial DNA

- Outside of the nucleus, in the cytoplasm of the cell, are bodies called mitochondria. They have their own DNA, called mitochondrial DNA, abbreviated mtDNA.
- Sperm and egg cells also have mtDNA, but since the sperm injects only its nucleus into the egg, the fertilized egg contains only the mtDNA of the mother.
- mtDNA is passed, without recombination, from mother to daughter, mother to daughter, over the generations. mtDNA is also passed to sons but is not then passed on to their children.

Summary of Genetic Inheritance Patterns

Type of DNA	Recombines	Men get it from	Women get it from
Autosomal (atDNA)	Yes	Both parents	Both parents
X	Only in women	Mother only	Both parents
Y	No	Father only	Women don't have it
Mitochondrial (mtDNA)	No	Mother only	Mother only

Reasoning With DNA

Given a hypothesis, and one or more alternative possibilities:

1. Look at the patterns of inheritance (atDNA, X, Y, and mtDNA).
2. Identify ways in which the inheritance would be different if the hypothesis were true.
3. Determine the subjects to test and what tests to use.
4. Interpret results.

This heuristic is simple to state, but each case is unique and real-world complications are numerous.

Other hints:

- A child gets exactly 50% of the DNA from each parent, but not exactly 25% from each grandparent.
- There is no guarantee that you will share DNA with an actual distant cousin. Odds are around even that you would not have any DNA in common with any given 4th cousin. So, using atDNA further back is more challenging, and would require testing more people.
- Think outside the tree: We're typically using DNA to solve tough problems, where official records fail us. These are also the kinds of problems other things could be going on, infidelity, incest, etc. It is important not to limit your focus to the "recognized" family tree indicated in official records.

DNA for Cousin Bait

Getting your DNA tested, and results publicly viewable, can help attract the attention of 2nd and 3rd cousins. Getting in contact with them can be valuable because they might have photographs, letters, documents or other heirlooms that pertain to your common ancestors. This is the easiest way to use DNA to advance your family history.

Other Resources

- Blaine Bettinger's Shared cM project: https://thegeneticgenealogist.com/2020/03/27/version-4-0-march-2020-update-to-the-shared-cm-project/
- ISOGG's Cousin Statistics Chart: https://isogg.org/wiki/Cousin_statistics