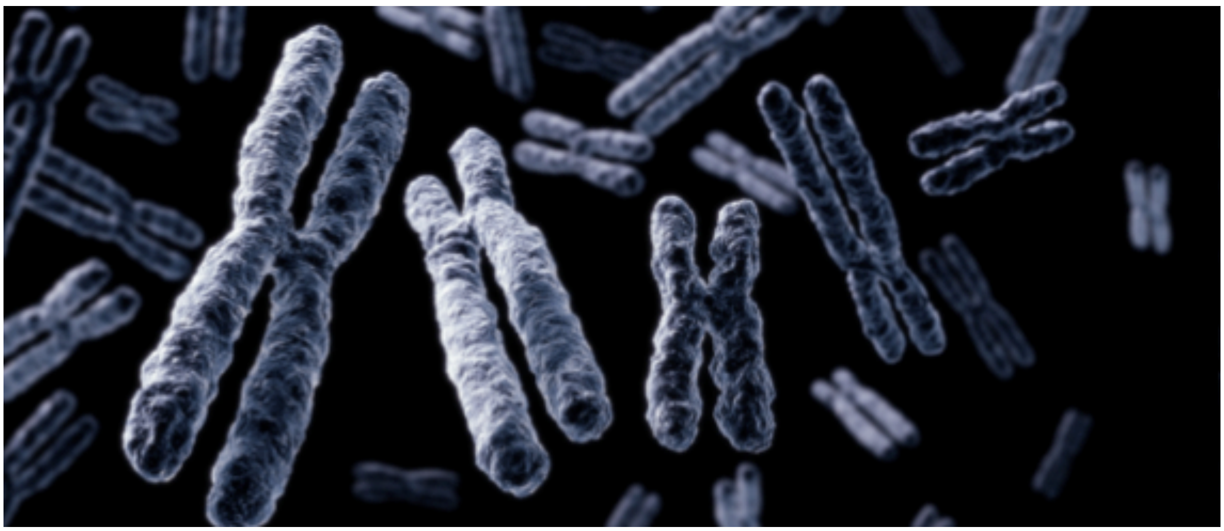
THE BIOLOGOS FOUNDATION

Who was Mitochondrial Eve? Who was Y-chromosome Adam? How do they relate to Genesis?



Mitochondrial Eve

Human cells contain two types of DNA: chromosomal and mitochondrial. Chromosomal DNA makes up the vast majority of DNA and is found on 23 pairs of chromosomes.[1] One chromosome in each pair comes from the father and the other from the mother. These chromosomes are found in the nucleus of almost all cells in the body. Human cells also have organelles called mitochondria, which act as power plants for the cell by converting sugars and other compounds into energy. Mitochondria actually have their own DNA, but this DNA is only transmitted through the maternal line.[2] Through a concept known as coalescence, it is possible to trace all mitochondrial DNA sequences back to the one maternal ancestor from whom all mitochondrial DNA descended.[3] However, it should be emphasized that this does not mean there was only one woman alive at that time.

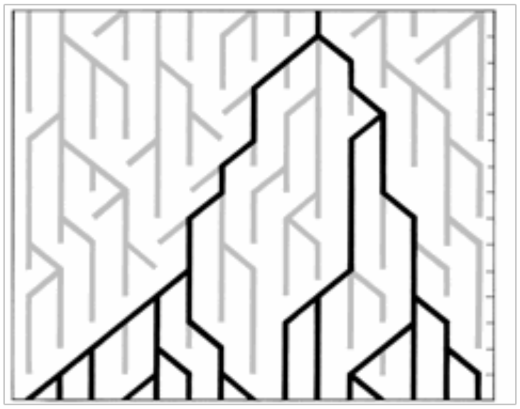


Figure 1. A graphical representation of coalescence. Each branch represents a new generation, with more ancient generations at the top and more recent generations at the bottom. The **bold** lines trace the mitochondrial DNA that is found in the most recent generation. The faded lines trace the passage of mitochondrial DNA that did not persist to the current generation. Note: For simplicity, only 15 generations are shown, and no increase in population is shown. However, *Homo sapiens* has greatly increased in population over the last 200,000 years, spanning many generations. However, the conclusion is the same. **Source*: Image is used by permission from Denis Alexander, *Creation or Evolution: Do We Have to Choose?* (Oxford: Monarch Books), 223, figure 16.

Every woman alive today received her mitochondria from her mother. And the number of mothers who provided the mitochondria is less than or equal to the number of women alive today. Some mothers had more than one daughter, anid other women had no children at all. (See figure 1.) If we trace the passage of the mitochondria back one generation to the mothers, we have fewer women than today. If we trace back another generation, we find an even smaller number, and with each previous generation this number decreases. Eventually this traces back to a single woman from whom all women alive today received their mitochondrial DNA. (see figure 1.) Using careful measurements of genetic diversity, scientists estimate that this woman, called the Mitochondrial Eve, lived between 150,000 and 200,000 years ago.[4] However, this does not mean that

Mitochondrial Eve was the only female alive at the time. Indeed, based upon study of diversity in the genome as a whole, geneticists estimate that thousands of others lived at the same time.[5]

Y-Chromosome Adam

A similar calculation can be done looking at the Y-chromosome. Each male receives his Y-chromosome from his father. As with mitochondrial DNA, we can trace back the Y-chromosome DNA to the one man from whom all Y-chromosomes came. This Y-Chromosome Adam is thought to have lived approximately 50,000 years ago.[6] It is possible to use our knowledge of Y-chromosome diversity to study human migration in ancient history. For example, all Y-chromosomes of individuals outside of Africa carry a particular Y-chromosome mutation called M168. Hence, all of these variant Y-chromosomes are descended from the single male in which this mutation occurred. Some men of African descent have the M168 mutation and some do not. This is evidence that a small group of humans left Africa and, through succeeding millennia, spread around the globe. Genetic diversity studies estimate that the migration from Africa occurred approximately 50,000 years ago, not too long after the existence of Y-chromosome Adam.[7]

Implications for Human Ancestry

Mitochondrial Eve and Y-chromosome Adam lived at different times, were probably separated by thousands of years and quite possibly were in different locations. Thus, a pictorial diagram tracking all men's Y-chromosome DNA would not trace back to the spouse of Mitochondrial Eve. Although coalescence does not indicate that all humans descended from a single couple, Mitochondrial Eve and Y-chromosome Adam are nonetheless the source of a portion of our DNA, namely the Y-chromosome DNA and the mitochondrial DNA. The rest of our DNA, located in the nucleus, comes from a large number of other ancestors. Looking at the total variation in the DNA of humans around the world, scientists have estimated that all our DNA came from an original population of several thousand individuals.[8] This relatively small population size suggests there was at least one bottleneck — a period of time where the population was reduced significantly — from which our current human population expanded.

Consulted Experts:

The BioLogos Foundation is grateful for the assistance of Darrel Falk and Francis Collins in drafting this response.[9]

Notes

1. More precisely, we all have 22 pairs of chromosomes, plus either an X and Y chromosome (for males), or two X chromosomes (for females).
2. It is thought that mitochondria are actually the remains of bacteria that lived within cells in a symbiotic relationship.
3. For a good popular explanation of coalescence, see Steve Olson, *Mapping Human History* (Boston, MA: Houghton Mifflin, 2002), 24-29.
4. Olson, *Mapping Human History*, 27. See also Simon Y.W. Ho and Greger Larson, "Molecular Clocks: When Times are A-Changin'," *Trends in Genetics* 22, no. 2 (2006): 79-83.
5. Nicholas Wade, *Before the Dawn* (New York: The Penguin Press, 2006), 54.
6. Wade, *Before the Dawn*, 57.
7. Ibid.
8. Wade, *Before the Dawn*, 57-63.
9. All of Dr. Francis Collins' work on this response was completed before being sworn in as Director of the National Institutes of Health.

Further Reading

Books

- Olson, Steve. *Mapping Human History*. Boston, MA: Houghton Mifflin, 2002.