https://www.nationalgeographic.com/news/2017/10/genetics-history-race-neanderthal-rutherford/

When scientists mapped the Neanderthal genome, they discovered signs of "gene flow events"—sex—with *Homo sapiens*. A Neanderthal woman might have looked like this artist's rendition.

BOOK TALK

Why Race Is Not a Thing, According to Genetics

Scientists are unlocking the secrets to how we're all related—to each other and to the species that came before us

BY SIMON WORRALL
PUBLISHED OCTOBER 14, 2017

Today, scientists routinely map the genomes of the long dead, from Neanderthals to medieval kings. What they're finding out, says British geneticist Adam Rutherford in *A Brief History of Everyone Who Ever Lived*, rewrites the story of human life on Earth—with some unexpected twists.

Speaking from the BBC studio in London where he hosts the weekly radio program *Inside Science*, Rutherford explains how the development of farming changed human biology; why the most important story our genes tell is that we are all family, despite race or tribe; and why it's not genes that turn people into mass shooters.

Paleogenetics is transforming our understanding of ancient human history. Explain how it works and share with us a few Wow! moments.

If you think of DNA simply as a data storage device, the data it stores is biological information. In us, it's three billion letters of individual code, or 20,000 genes. Paleogenetics is the study of our DNA from things that have been dead for a long time—*paleo* simply means old. It's new because we've only invented the technology to do it in the last 10 years and, in a serious way, in the last five years.

What's interesting is that DNA is far more stable than a digital disk or tape. Under the right conditions, DNA will last for thousands or even hundreds of thousands of years trapped inside the bones of a person or organism. With the advent of our ability to get it out, we can do genome studies on creatures that have been dead for thousands of centuries.

The first big landmark came in 2009, when DNA was extracted from the bone of a Neanderthal. From that we have the whole genome sequence of a human species different from us, which answered one of the big questions that had dogged paleontologists: How did we interact with Neanderthals? And, more specifically, did we have sex with them?

The answer is an unequivocal yes! Neanderthal DNA contains *Homo sapiens* DNA and *Homo sapiens* DNA contains Neanderthal DNA. Europeans on average have between one and two percent Neanderthal DNA. Using sophisticated statistics and computer models, we can also pinpoint when that DNA went from Neanderthal to humans and vice versa. We call them "gene flow events," a hilarious euphemism, because what we are talking about is sex! [Laughs]

It got even crazier a year later, when the tip of a little finger bone and the molar tooth of a teenage girl were found in a cave in Russia in a place called Denisova. That proved enough to get the full genome out of this creature, which turned out not to be *Homo sapiens*, not *Homo neanderthalensis*, and not anything we were aware of!

NEANDERTHALS 101
Who were the Neanderthals? Do humans really share some of their DNA? Learn how the species fits into our evolutionary story.
https://video.nationalgeographic.com/video/101-videos/0000015e-e909-da71-a3de-ebfd48a10000

We call these people the Denisovans. They're a human species but are not us, not Neanderthals, and not one that was previously known. We saw that we interbred with the Denisovans, and they interbred with us. The further east you go today, the more Denisovan DNA you see in living people and the less Neanderthal.

This story is so close to magic that I almost can't believe it. When you analyze the amount of DNA of the three species that we know interbred (Denisovans, Neanderthals, and *Homo sapiens*), they don't quite add up, which makes us confident that we also carry the DNA of another human species for which we have no bones and no DNA. The shadow of another human species—its trace—is inside us all right now. That's pretty special!

Another exciting discovery is how our genes change culture, and vice-versa. Explain how this works—and how we now know when ancient Europeans developed a taste for milk and honey.

[Laughs] We are a technological species. Even before we were *Homo sapiens*, we were using technology like fire to cook with or tools like stones. That developed in our species what we broadly refer to as culture, which includes art and music but also agriculture.

The emergence of farming as our dominant technology 10-12,000 years ago fundamentally changed human behavior and our own biology. The best-understood example of that is what is referred to as lactase persistence. Most Europeans drink mother's milk and, after weaning, continue to drink cow's milk.

Most people on Earth can't do that. They get gassy tummy and diarrhea as a result of drinking milk after they have weaned. It's to do with this enzyme called lactase, which works in newborns but after weaning ceases working and you stop being able to process milk in the same way.

The fact that Europeans can process milk, when most people on Earth can't, is an interesting question because it's genetically based. Looking at the genetics of ancient people, we know that we had, in fact, started dairy farming before lactase persistence evolved, rather than the other way around.

It wasn't that we became lactase persistent and then started dairy farming. We were already using goats and sheep for their dairy products before we had the ability to drink raw milk into adulthood.

Fast forward millennia to the recent riots in Charlottesville, which showed how volatile the issue of race still is in America. How can the study of DNA enlighten us?

In many ways, genetics makes a mockery of race. The characteristics of normal human variation we use to determine broad social categories of race—such as black, Asian, or white—are mostly things like skin color, morphological features, or hair texture, and those are all biologically encoded.

But when we look at the full genomes from people all over the world, those differences represent a tiny fraction of the differences between people. There is, for instance, more genetic diversity *within* Africa than in the rest of the world put together. If you take someone from Ethiopia and someone from the Sudan, they are more likely to be *more* genetically different from each other than either one of those people is to anyone else on the planet!

You had your own DNA analyzed. Did you find out anything new about yourself? And why are you so skeptical about commercial DNA companies?

By spurious interpretation, some of the companies turn real genetic data into what I refer to as "genetic astrology." When I got my results back from one of these companies, it put me in a high-risk category for developing Alzheimer's because I have a variant of the APOE gene.

That could be extremely worrying to someone if they didn't understand its implications. It doesn't bother me in the slightest because the risk doesn't refer to *me* specifically. The data refers to a proportion of people in a population who have that characteristic.

Genes can tell us a lot about populations and our history, as a species, but very little about individuals. That's partly why I wrote this book: to broaden the public understanding of genetics in order to move away from this culturally ingrained idea that genetics is destiny.

In 2012, geneticists were asked to analyze the DNA of mass-shooter Adam Lanza for clues to his violence. Why do you think this is dangerous?

It says something about us that we look for simple answers to complex questions. Inevitably, people have turned to the relatively new science of genetics to try to explain otherwise unfathomable human behaviors, such as spree killing or murder. But the notion that there would be a deterministic, genetic component to someone who went out and shot 20 kids in a school, as Adam Lanza did, is incredibly misguided.

There is a genetic basis to human behaviors. But there is also an environmental component. We used to say nature *versus* nurture. But we might say nature *via* nurture. Almost all spree killers display similar characteristics of profound psychological problems, and Adam Lanza was typical in that regard.

Some of those problems have a heritable component. But we don't understand the genetics of these types of behavior well enough to say that *this gene* is causing *this behavior*. It's perfectly possible for two people to have identical genomes and one of them to be schizophrenic and the other one not.

If we sequenced Adam Lanza's genome, we would simply find that he has a human genome and that all the variants in him would be found in other people that don't commit spree killings. Turning to genetics to try and find out why this guy killed all of those kids in this wicked act *completely* misses the point!

The single common factor in all spree killings is access to guns. That seems straightforward to me.

Are we still evolving? If so, how might we end up in 5,000 years?

There's a simple answer, which is that evolution is simply change over time. If we continue to have children, by the traditional means, then we *are* still evolving because our genomes are *all* unique, and our children's genomes will be different from ours. In that sense, we are changing.

The real question that underlies this is, Are we still evolving under the auspices of natural selection? That is a much more difficult question to answer, partly because evolution happens slowly. Adaptation to different environmental pressures happens generally very slowly, over many, many generations.

This is effectively a history book. Our new ability to get DNA out of the long dead has made geneticists like me *historians*, with this new source text that is complementary to all the traditional forms of knowing the past.

I've been professionally involved with science for 25 years and have never known a more continuous revolution as in genetics in the last five years. Every week a paper comes out that makes me catch my breath and also makes me sigh because it means I have to rewrite the book. And will probably be rewriting it for many years to come. [Laughs]

This interview was edited for length and clarity.

Simon Worrall curates Book Talk. Follow him on Twitter or at simonworrallauthor.com.