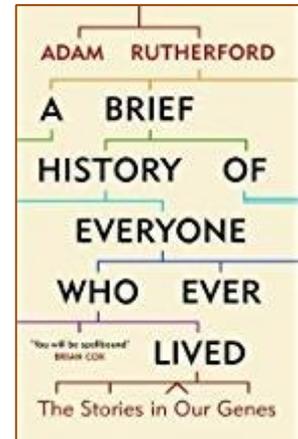


Adam Rutherford
A Brief History Of Everyone Who Ever Lived :
The Stories In Our Genes

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Notes by Revd Dr Alison Morgan Dec 2017



Introduction

Something in the order of 107 billion modern humans have existed; all are close cousins; we have a single African origin. Go back a few dozen centuries and we see that most of the 7 billion of us alive today are descended from a tiny handful of people, the population of a village.

Life on Earth has existed for c. 3.9 billion years; *homo sapiens* emerged a mere 300,000 years ago in pockets in east and north Africa. Writing began c 6000 years ago in Mesopotamia.

The sperm that made you started its life in your father's testicles within a few days before your conception. One single sperm out of a spurt of billions ground its head against your mother's egg, one of a just few hundred. Like a Russian doll, that egg had grown in her when she was growing inside her mother, but it matured within the last menstrual cycle and, taking its turn from alternating ovaries, eased its way out of the comfort of its birthplace. On contact, that winning sperm released a chemical that dissolved the egg's reluctant membrane, left its whiplash tail behind and burrowed in. Once inside, the egg sets an impenetrable fence that stops any others breaching her defences. The sperm was unique, as was the egg, and the combination of the two, well, that was unique too, and that became you. Even the point of entry was unique. Your mother's egg being roughly spherical, that sperm could've punched its way in anywhere, and at the behest of cosmic happenstance, penetrated its quarry at a singular point, a point which set waves of chemicals and effectively began the process of setting your body plan - head at one end, tail at the other. 5

Your parents' genetic material had been shuffled and halved, with only the Y chromosome passing down largely unchanged from father to son through time. It's a stunted piece of DNA, with only a few genes and a lot of debris. Inside the mitochondria of the egg there is also a mini genome which is transmitted through mothers. These are the bits used when tracking back through genealogies and ancient history.

You actually have far less in common with your ancestors than you may realise, and there are people from whom you have inherited no genes at all, even though you are descended from them.

PART ONE : HOW WE CAME TO BE

1. Horny and mobile

Life is transition: the only things that are truly static are already dead. Your parents had parents, and theirs had parents, and so on, two by two, back through the whole of history, and prehistory. If you keep going back and back, your ancestors will slowly and inevitably become unrecognizable to you, via apes and monkeys, two-legged then quadrupedal, and ratty mammals and brutish beasts on land, and before them in wading sea creatures and fishy swimmers, and worms and weedy sea plants, and around two billions years ago, you don't even need two parents, but just the binary fission of a single cell, one becomes two. Eventually, at the beginning of life on earth around two billion years ago, you're locked in a rock at the bottom of the oceans, inside the hot bubbling tumult of a hydro-thermal vent. This geologically slow, incremental change is like a colour chart, where pixel-by-pixel white becomes black, whether it's the gap from reptile to mammal, or from four-legged to upright. On occasion there will be a splash of colour thrown into the mix, but for the most part, the pathway to your ancestors creeps rather than jerks, and all of it grey in its depths. 15-16

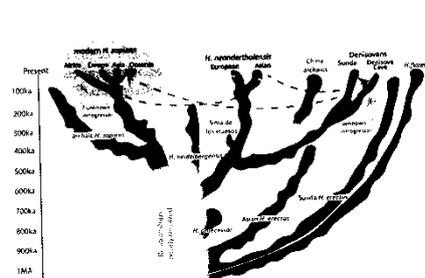
We now know that it's not so much an evolutionary tree as a bush, a set of dribbly blobs running into the pool that is us.

Bipedal apes walked the Earth at least 4m years ago. The most famous is Lucy, born in the Rift Valley c 3.2m years ago. She belonged to the sp *Australopithecus Afarensis*. We don't now if we are related. We belong to the genus *homo*. There are currently thought to be at least 7spp that fit into the genus *Homo*. Evolving from *Homo erectus* we get *Homo ergaster*, *H heidelbergensis*, and *H antecessor*. On Indonesia we get metre high mini humans *Homo floresiensis*.

Then there was *H Neanderthals*, who lived all over W Europe from Spain E to Asia N to Wales and S to Israel 30-300,000 years ago. The branch which led to the Neanderthals diverged from the branch which led to us 500,000 years ago. We

have sequenced the genome of a Neanderthal. They had larger brains than us, they could probably speak, they sewed and made clothes and jewellery. And they interbred with us – we have Neanderthal DNA. 81m of the 3b letters of our DNA are from Neanderthals – about 3%. We mated when H sapiens first reached Eurasia 60,000 years ago, and we coexisted in Europe for 5000 years – as long as the history of writing.

Then another human sp was found in a cave in Russia – the Denisovans. A million years ago the Neanderthals and Denisovans lived in Africa. The Neanderthals left Africa 500,000 years ago, and we did 100,000 years ago. The Denisovans went to Melanesia, where modern humans still have 5% of their DNA. They had dark eyes, hair and skin. Neanderthals and Denisovans had also interbred; and the Denisovans had also interbred with another, unknown sp of human. So we are the last remaining group of humans from a set of at least four that existed 50,000 years ago. The others aren't extinct; we just merged.



The murky evolutionary shrub of humankind. Old bones, combined with new analysis of old DNA, has meant that what was once a confident branching tree has been pollarded and pruned and replanted as an unrooted bush. The broad blobs represent individual human species, and the dotted lines are the flow of genes via sex between them. The more we learn, the messier the picture becomes.

2. The first European Union

We've been the sole human occupants of Europe for more than 30,000 years. The first Europeans were the hunter-gatherers who had moved up from Africa via central Eurasia 40,000 years ago and overlapped with the indigenous Neanderthals. There were c 2m hunter-gatherers in Europe 12,000 years ago. We started farming 10,000 years ago, spreading from the Middle East. Slowly the hunter-gatherers and the farmers mixed.

8000 years ago there were c 5m people on Earth, spread far and wide. 5000 years ago the Yamnaya arrived from the Russian Steppe, bringing fair skin.

Only people of pastoralist descent are able to digest milk as adults; the gene gets turned off in most of the human population after childhood. That means N and W Europeans, and a handful of African, SE Asian and M Eastern peoples. It's a genetic change.

People had dark skin until 8,000 years ago, including in Hungary, Spain, Luxembourg. 7,700 years ago Swedes had pale skin and blue eyes. It was a genetic adaptation to life in the North.

In 2015 a People of the British Isles Project analysed the DNA of people living in different regions of the UK (choosing only those who still lived where their grandparents had). We consist of regionally distinct populations reflecting our history. People in Orkney are 25% Viking from their arrival 1100 years ago. The Cornish are distinct from the people of Devon, and the N Welsh from the S Welsh. The Cumbrians are distinct. S and C England is the same, ie 'Angles' and 'Saxons' - people from NE mainland Europe. There is almost no Italian (Roman) DNA anywhere, and almost no Danish – clearly we didn't get along as well as with the Vikings... In Scotland are the Picts and the Celts, who are different from Welsh Celts. Cornish people are more similar to those of Brittany. 'Celtic' is not a genetic term but a cultural one.

Plague – decimated the Byzantine Empire in the 6th (Constantinople), resulting in the deaths of 25m people. DNA analysis from the teeth and bones of victims shows the bacteria came from China, and travelled with trade, probably along the Silk Road. Then again in the 14th, killing 5m people, and also originating in the East, travelling from port to port along trade routes. The DNA of Europeans and Roma people shows immune adaptation to plague.

3. When we were kings

Every generation you go back, the number of your ancestors doubles. But the further you go back, the fewer people were alive. This means that the further back you go, the more ancestors you share with other people. It becomes less like a tree and more like a mesh. And because of this backwards contraction you are in fact descended from the same individual many times over; the further back we go, the more the lines coalesce on fewer individuals. A Yale statistician named Joseph Chang set out to discover mathematically how recently the people of Europe would have a common ancestor; it was only 600 years. Some time at the end of the 13th century, around the time of Richard II, lived a man or a woman from whom all Europeans could trace ancestry, in the sense that that individual would appear, could you trace that far back, on your family tree. The maths gets odder: go back 1000 years and 20% of people then alive are the ancestors of no one living today – their lines petered out. The remaining 80% are the ancestor of everyone living today. All lines of ancestry coalesce on every individual living in the 10th century. [Put the other way round, you are descended from everyone then living.] Including Charlemagne.

In 2013 geneticists Peter Ralph and Graham Coop showed that DNA says the same thing as Chang's maths. Chang added in data to account for the fact that marriage is not random but occurs within particular socio-economic groups, and concluded that if you go outside Europe you find that the most recent common ancestor of everyone alive today lived c 3600 years ago. That is, 1600 BC. Chang summarises: *our findings suggest a remarkable proposition: no matter the languages we speak or the colour of our skin, we share ancestors who planted rice on the banks of the Yangtze, who first*

domesticated horses on the steppes of the Ukraine, who hunted giant sloths in the forests of North and South America, and who laboured to build the Great Pyramid of Khufu. 152. NB being descended from someone does not mean you carry any of their DNA – it is constantly shuffled.

What we can say is:

- 100,000 years ago we were all African; there were no homo sapiens anywhere else
- Most Europeans are on average 2.7% Neanderthal
- The tendrils of ancestry that sprout upwards from ours become unfathomably enmeshed the further back you go, until all reach all people a thousand years ago. The genealogy is inferred, and much of the DNA from all these ancestors is not present
- We are all a bit of everything, and we come from all over. Even if you live in the most remote parts of the Hebrides, or the edge of the Greek Aegean, we share an ancestor only a few hundred years ago. A thousand years ago, we Europeans share all of our ancestry.

Richard III. Male descendants turned out not to be descendants; they did not have the same DNA on the Y chromosome, which means there was some illegitimacy at some point. It was done through the mitochondrial DNA of the female line. Hapsburg dynasty. They married within the family for generations, and eventually petered out through genetic deformation due to inbreeding. Same thing happened with the Darwins; Charles and Emma were first cousins; three of her brothers had also married first cousins – of these, Josiah Wedgewood and Jessie were double first cousins.

PART TWO : WHO WE ARE NOW

4. The end of race

Regional adaptation occurs – to milk, for low sunlight, and against plague in Europe; high altitude in Ethiopia and Tibet. In Africa genetic variation protects from malaria; blood cells become sickle shaped; two copies cause sickle cell anaemia. Skin colour is recent and non essential; there is greater genetic diversity within Africa than elsewhere, and Europeans are closer to some African peoples than those peoples are to each other. The bulk of the characteristics we class as racial are modern.

5. The most wondrous map ever produced by humankind

A human has about 20,000 genes. Most of the genome turns out to be not genes at all. 'DNA is a coded alphabet to be translated by the mechanics of a living cell into a protein; all life is made of, or by, proteins.'

6. Fate

Genetics is beginning to be used in defence against prosecutions. There is no gene which causes people to commit murders. There may be genetic factors; but others with the same genetic patterns do not commit murders... 'It doesn't matter whether we are talking about criminality, or psychological characteristics, or psychiatric disorders, or perfectly normal human behaviours like political bent, or susceptibility to alcohol, or being gay or anywhere on the spectrum of sexual preferences, the biology that tis revealed by genetics are not causes, or triggers, or foundations. They are potential factors: probabilities.' 337 eg Identical twins are both gay about 50% of the time.

7. A short introduction to the future of humankind

Evolution – the fossil record is replete with transitional forms. We see eyes in myriad forms in fossils that show subtle, slight shifts towards our own versions; we see every stage in living creatures too, from the photoreceptive patch in the simple, single celled Euglena, all the way to us and the many creatures with sight far superior to our own. p373 We are transitional. Over a long enough period, all species become something else living, or become dead. This is the continuous fact of life on earth.

Dr Adam Rutherford is a science writer and broadcaster. He studied genetics at University College London, and was part of a team that identified the first genetic cause of a form of childhood blindness. He has written and presented many award-winning series and programmes for the BBC, as well as writing for the science pages of the GUARDIAN. His first book, CREATION, on the origin of life and synthetic biology, was published in 2013 to outstanding reviews and was shortlisted for the Wellcome Trust Prize.