

Your DNA Adventure

Your DNA Adventure

The story of your ancestry
as never told before



your story begins

Welcome to the story of your DNA. Prepare to explore your own, personal, genetic history.

Whilst your DNA adventure will show you countries and regions based on today's map of the world, it is important to remember that, genetically, these borders don't truly exist.

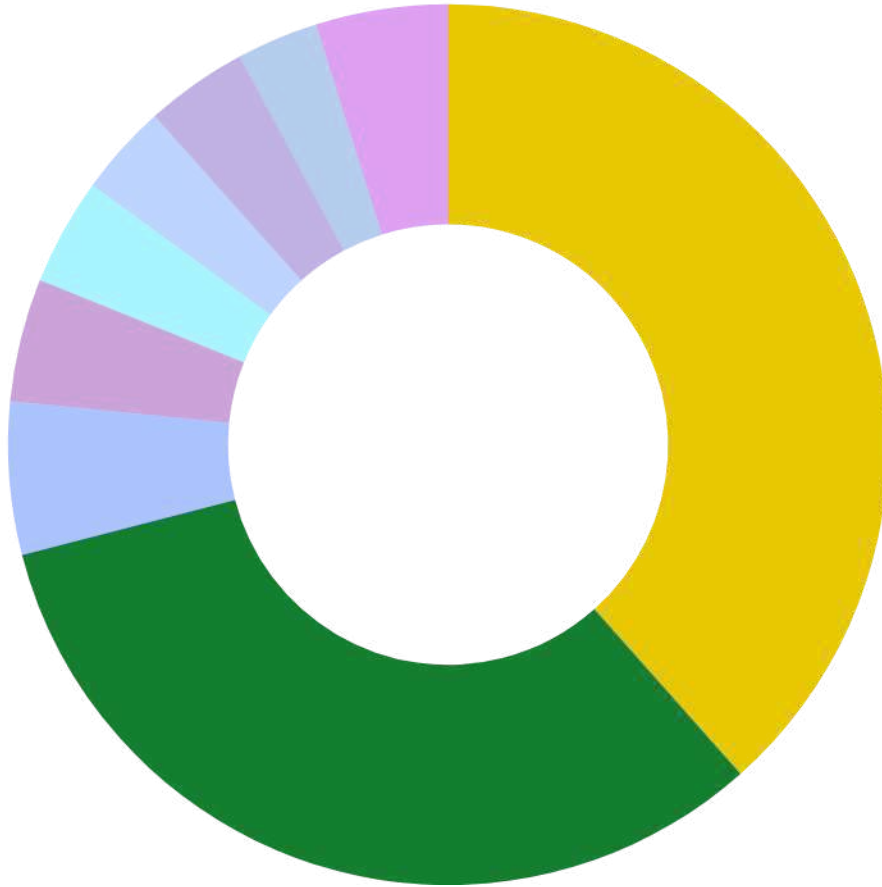
Genetic blueprints are very much shaped by Migrations, Intermarriage, Conquest and Warfare. This could mean that a person from modern day Germany may be more closely related to a person from Syria, than two people in Uganda in adjoining villages.

As you enjoy your DNA discovery, remember that your DNA is a unique combination of genetic markers that are found all over the world.

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A summary of your results



Your Family Ancestry

(Autosomal DNA)

- Indian subcontinent 38.4%
- Sindhi 32.5%
- Finland 5.6%

+ 6 others

Your Motherline (MTDNA)

Haplogroup

U1

Subclade U1a1c

Summary An ancient motherline, thought to be 32,000 years old.

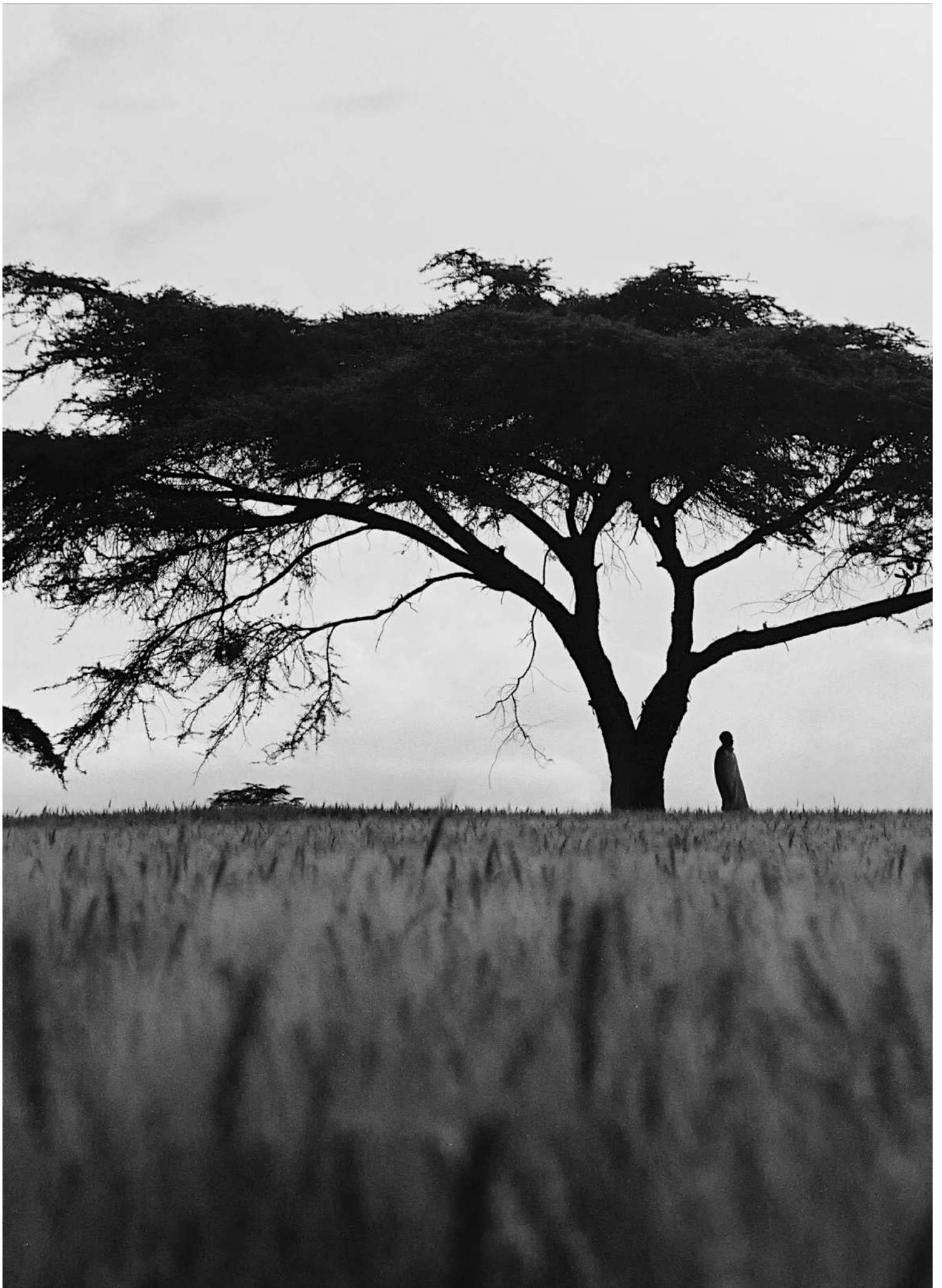
As you read through your results, you will gain a deeper understanding of where your genetic ancestry originated. The fascinating story shows just how diverse your ancestry is.

Revealed within your DNA are the great migrations your ancestors took, which are today part of your genetic code.

Within this book you will see this come to life, through personalised maps, historic information and simple, easy to understand visuals.

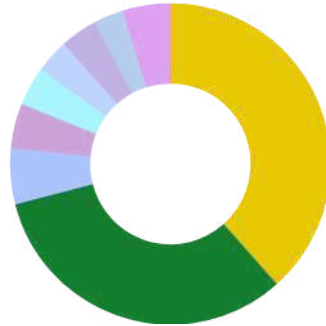
Your results will help you to discover the history of up to three different types of DNA:

- Family Ancestry (autosomal DNA). This DNA test shows where your ancestors come from, covering up to the past ten generations. This represents up to roughly two hundred and fifty years.
- Motherline Ancestry (mtDNA). Mitochondrial DNA is always inherited directly from your mother, almost unchanging, allowing us to trace its migration over thousands of years.
- Fatherline Ancestry (Y-DNA). Males pass on their Y chromosome, father to son, down the paternal line. We show which form of the Y chromosome males have, and its history.



Your Family Ancestry

AUTOSOMAL DNA REPORT



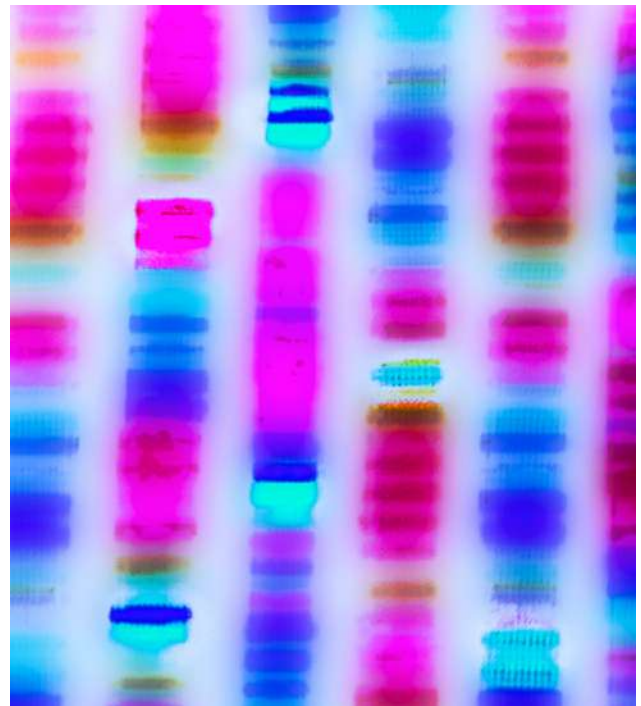
How your family ancestry works

Your Family Ancestry is how we refer to the breakdown of your Autosomal DNA. Everyone has twenty three pairs of chromosomes in almost every cell in the body. The first twenty two make up the Autosome, whilst the final pair are the sex chromosomes.

The chromosomes are inherited from both parents, and mix together in the body. This mixing, called recombination, means that, although you inherit half your DNA from each parent, you do not get exactly a quarter from each grandparent. If you had a grandparent that was 100% Eastern European, you may expect to see anywhere between 0% and 35% in your own results.

Our scientists examine more than 680,000 DNA markers in your genome, in order to provide your ancestry breakdown. Using our unique statistical model, we compare your

DNA to many thousands of reference data sets, to provide your percentage estimate.



Your family ancestry breakdown

Asia (South) **71%**

- INDIAN SUBCONTINENT 38.4%
- SINDHI 32.5%

Europe (North and West) **10%**

MORE INFORMATION ON PAGE 8

Great Britain and Ireland **7%**

MORE INFORMATION ON PAGE 8

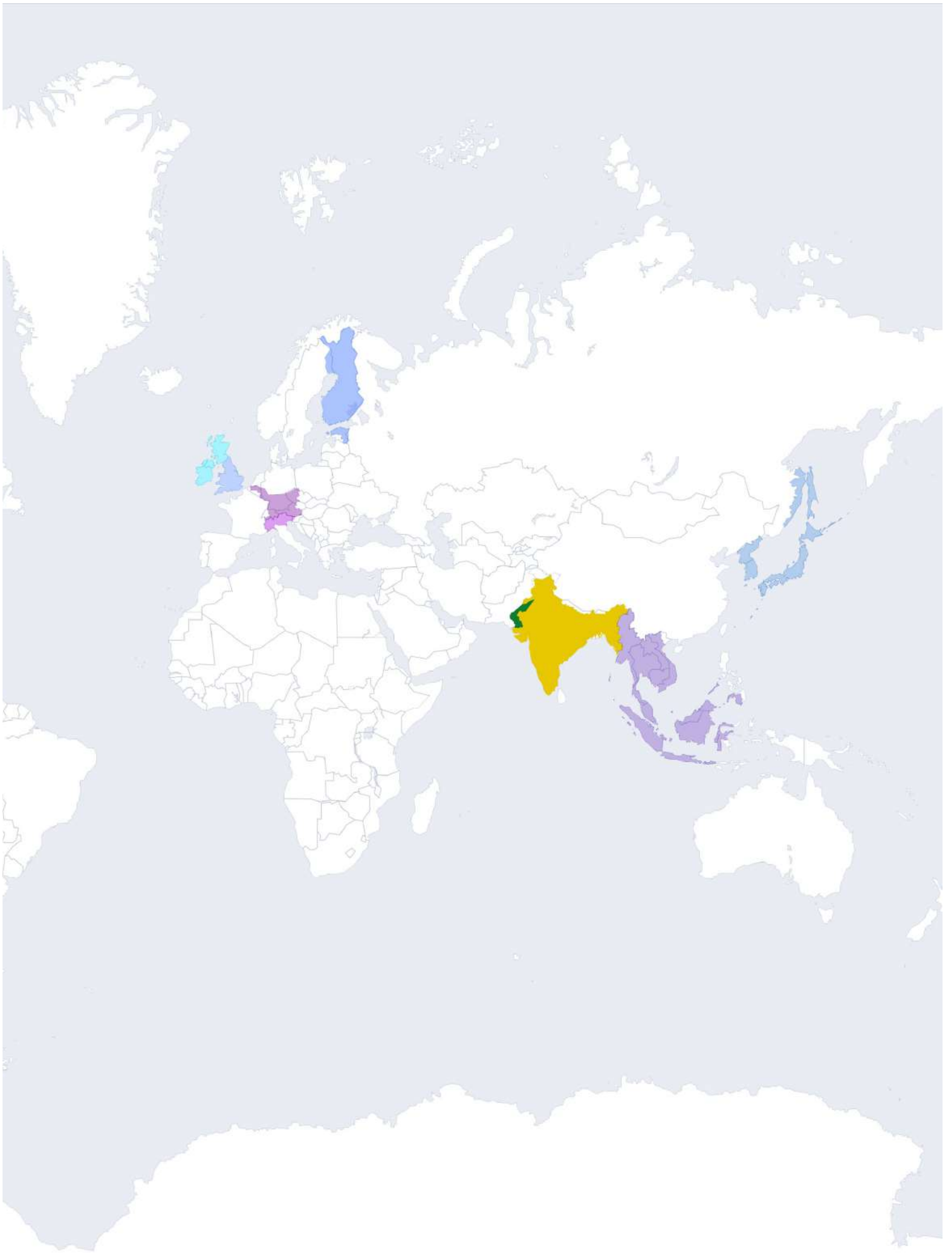
Asia (East) **7%**

- SOUTHEAST ASIA 3.8%
- JAPAN AND KOREA 3.0%

Europe (South) **5%**

MORE INFORMATION ON PAGE 8





© Mapbox © OpenStreetMap

Your family ancestry breakdown

Europe (North and West) **10%**

- FINLAND 5.6%
- SOUTH GERMANIC 4.5%

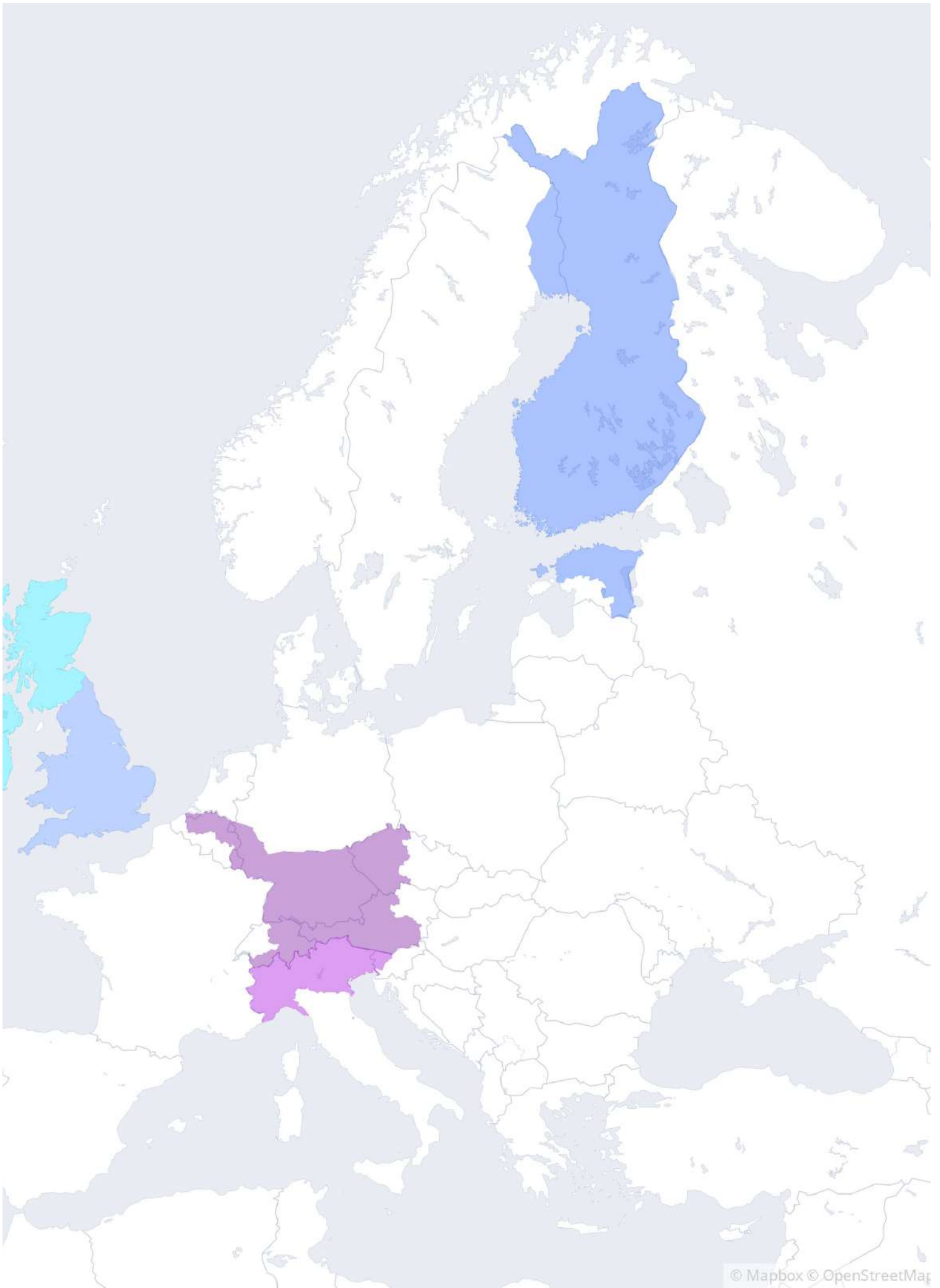
Great Britain and Ireland **7%**

- SCOTLAND AND IRELAND 4.0%
- ENGLAND AND WALES 3.4%

Europe (South) **5%**

- NORTH ITALY 4.9%





© Mapbox © OpenStreetMap

Understanding the population areas

Asia (South): Indian subcontinent

Although this may change with additional information, the South Asia genetic mixture appears to correspond approximately to the modern-day borders of India, Nepal, Bangladesh, and Bhutan, as well as parts of eastern Pakistan and western Myanmar. Jutting out into the Indian Ocean on two sides and bordered by the Himalaya and Central Asian steppe on the other, this area has always been a major melting pot of people, genetics, and culture. As a result, the region is steeped in history and infused with spirituality. The subcontinent has been home to one of the very first civilisations, and is also the birthplace to many religions still meaningful to billions of people today.

Recent genetic studies have noted two major populations who have contributed to South

Asian genetics. These are the older ancient South Indian population (who had occupied the area since shortly after the first true humans left Africa), and the more recent 'Ancient North Indian' population, who are more closely related to present-day European and Central Asian people. These groups integrated rapidly over roughly two millennia. It then appears that the caste system became increasingly strict 2,000 years ago so that these mixtures became essentially frozen in time. More recent migrations have added less to this mix, but notable genetic signatures can be detected in various populations from southeast Asian nomads, East African merchants, and Middle Eastern Islamic conquerors.





Asia (South): Sindhi

Unknown to many people, the southwestern Pakistani province of Sindh was once the heart of one of the world's first great civilisations. Today, all that remains of the Indus Valley Civilisation are windswept and long-abandoned cities, only visible through decades of archaeological work. With no enduring monuments left behind like the towering pyramids of Egypt to speak of, the original inhabitants of Sindh still hold many secrets. 3700 years have passed since their great civilisation disappeared, and since then many people from across Asia have shaped the genetic and cultural makeup of this ancient region.

The gateway between Iran and India, the genetic signature of Sindh today is most

similar to the nearby Pashtun and Punjabi people. Here, an expansive history of migration and invasion can be read through the DNA of the region's inhabitants. The original people of the Indus Valley Civilisation probably reached this area via a southern coastal route out of Africa, and after their collapse, a group dubbed the 'Ancestral North Indians' appear to have moved in from further west, intermingling with pre-existing populations. More recently, Greek, Indian, Persian, Mongol, and British armies have all claimed this region for themselves. Today, the Sindhi live in Pakistan alongside many other related ethnic groups that call the country their home, including Pashtuns, Balochis, and Kalash.

Europe (North and West): Finland

Humans first inhabited Finland after the Ice Age came to an end, reaching the northern regions of Europe by around 10,000 years ago during the Stone Age. These early settlers would have been hunter-gatherers, utilising the marine resources by fishing, whilst also hunting land mammals and foraging plants. The Sami, who are an indigenous population group to Norway, Finland, and Sweden, are thought to be descendants of these early people. Seen as the last hunter-gatherers of Europe, the Sami were largely isolated and continued to hunt reindeer and moose long after the agricultural revolution. They later domesticated reindeer and many Sami are reindeer herders to this day, but nontraditional occupations are becoming more common.

The genetic signature of Finland is seen as being quite unique when compared to the rest of Europe. This is largely due to isolation and a series of major genetic bottleneck events. A genetic bottleneck relates to the significant reduction in population size followed by recovery, resulting in less genetic variation. One major bottleneck event is thought to have occurred during the Neolithic. This event occurred around 4,000 years ago when farming communities migrated into Finland. This has been linked to migrations of the Corded Ware culture, an Indo-European group that spread out from the Eurasian Steppe.





Europe (North and West): South Germanic

You belong to the South Germanic genetic signature, which spreads out across South Germany and into parts of Belgium, Austria, and partially southeast Germany. These regions have experienced an intertwined past dating back to the first settlements of people after the Ice Age. During the Bronze Age, the regions were connected by the Hallstatt Culture. Farming was a significant component of the Hallstatt culture, as well as metalworking which was used in vast trade networks across the Mediterranean.

During the Neolithic Era (New Stone Age), populations associated with the Linear Pottery Culture swept across Germany, Austria, and parts of Belgium. The Linear Pottery culture is

traced largely by its pottery style, consisting of simple vessels with parallel lines design. This culture represents a huge milestone in the region's history: the development of agriculture. This would change the way of life indefinitely, supporting larger populations and eventually supporting Kingdoms and civilisations.

Belgium proved to be quite the strategic location for war, with many battles taking place from the Viking Battle of Leuven to the Napoleonic Battle of Waterloo. This region was not only strategic battlefield location but also resulted in Belgium becoming a catalyst for trade and migration with nearby Germany.

Great Britain and Ireland: Scotland and Ireland

The areas now known as Scotland and Ireland were once an unrecognisable and uninhabitable icy tundra. Around 10,000 years ago the ice sheets retreated bringing the Ice Age to a close - it is at this time that people from Europe began to populate the landscape. They followed the animals that migrated with the warming weather and ate a mixture of terrestrial prey, nuts, and plants. Although divided by a watery barrier, Scotland and Ireland have always shared migrations across the Irish sea, connecting the two areas from prehistory to present. A great change arose across Britain when further migrations from Europe led to the introduction of farming. This marked the beginning of the

New Stone Age and changed the lives of the island's inhabitants forever.

Scotland and Ireland have been previously seen as having a shared Celtic legacy. However, new research has shown that there was never one unified 'Celtic' group. Instead, there were many different Celtic tribes scattered across what came to be Scotland and Ireland, who had a loose connection to each other through language and culture. Various historical migrations have had an impact on the Scottish and Irish populations to this day. Uncommon to British genetics, the DNA in Scotland and Ireland have been influenced by a relatively recent 17th-century population movement, the 'Ulster Plantation'.





Great Britain and Ireland: England and Wales

After the Ice Age began to end, people began to travel into England and Wales from Central and Western Europe. The environment had become more hospitable, slowly changing from icy tundra to a warmer, wetter, and more inhabitable land. People followed the migrating animals, which made up a significant part of the diet of these hunter-gatherers along with plants and berries. This was the normal way of life until a further wave of migrations from Europe changed everything with the introduction of farming. This initiated the New Stone Age and it was during this time that the famous Stonehenge was built - although situated in Salisbury, the stone has been found to originate in Wales!

The Iron Age brought another migration of people from Europe who are known by their Beaker style of pottery. At this time, England and Wales were made up of multiple tribes that had a chieftom structure. The Romans invaded from 43 AD, and many of these tribes tried to resist the Roman occupation. However, by 80 AD, both England and Wales fell under Roman control. Subsequent conquests and invasions targeted England and Wales. The Anglo Saxons spread across England from the 5th century, and the Vikings later reached regions across England and Wales. The famous Battle of Hastings in 1066 marked the beginning of the Norman conquest, taking hold of England and Wales.

Asia (East): Southeast Asia

Although this may change with additional information, the Southeast Asia mixture appears to correspond approximately to the modern-day territories of Thailand, Laos, Cambodia, Vietnam, Malaysia, eastern Myanmar, as well as many of the western islands of the Indonesian archipelago including Borneo and Sumatra. Today, the area has a strong and varied regional heritage, and its geography is reflected in its culture where strong indigenous roots are tinged with influences from both China and the Indian subcontinent. This area is home to a vast array of ethnic groups and is notable for its cultural diversity derived through generations of migration and integration of neighbouring peoples.

The region is also a linguistic mosaic - people from different areas sometimes only miles apart speak languages from entirely different linguistic families. Austro-Asiatic, Tibeto-Burman, and Thai migrations across different parts of history have shaped the demographics of the area in a complex pattern where the genetic mixture of different groups seems only loosely connected to the languages spoken today. It seems that the first people arrived here along the southern coastal route from India, before multiple splinter groups left and reentered sometimes thousands of years later. There is still much to be learned about the genetic history of the region, and undoubtedly the picture will only grow more complex as we gain a greater understanding in years to come.





Asia (East): Japan and Korea

The shared genetic bond between Japan and Korea dates back to around 2,500 years ago when the Yayoi people appear to have migrated across the Korean straits to settle in Japan. Here, they encountered the indigenous and mysterious Jomon people, who gradually retreated across the island chain as the agricultural settlers established new towns and villages. Today, the Ainu people of Hokkaido are the most closely related living group to the Jomon, although all mainland Japanese people appear to have inherited at least a small amount of Jomon DNA, meaning that there must have been some level of mixing between populations.

The Korean people who did not make the crossing over to Japan share ancestry with

Japanese people from before this time, even if the histories of the two areas have since diverged throughout the centuries. Whilst the Japanese have been considerably isolated from the outside world for much of their time on the island, the Koreans have had more contact with various people across East Asia, The Goguryeo Empire, for example, included much of Manchuria under its sway, and it would not be inconceivable to suggest that these connections could have affected the Korean genetic signature. Today, the Korean and Japanese nations extend great influence across the Asian sphere - two peoples separated by geography and history, but united by ancestry.

Europe (South): North Italy

Italy has been a hub for genetic admixture over many millennia. The location connects the peninsula to the rest of Europe, allowing for migration and population expansion. Caves, such as the Fumane cave in the north towards the Alps, provided shelter and refuge for Neanderthals and early humans. The Alpine region near the Italian-Austrian border was where Europe's oldest mummified body was found - Otzi the "ice man", who lived around 5,000 years ago.

North-Central European DNA can be found in the genetics of the North Italian population today. This is thought to be due to the closer proximity of the north to Europe, as Southern

Italian populations typically showcase much less of this signature. Attempts have been made to pinpoint this genetic change, and studies suggest the influx of European DNA most likely occurred during the "migration period" from 476 AD after the Roman Era. Admixture could possibly have occurred earlier, when Celtic tribes pushed the boundaries across the Alps and into Northern Italy from 400 BC. The Roman Era is no doubt one of the most famous periods in Italy's history. The Gauls and Etruscans fought against the Roman conquests, but by 264 BC, the whole of the north had fallen at Rome's feet.



Your Motherline

MTDNA REPORT

Haplogroup

U1

Subclade U1a1c

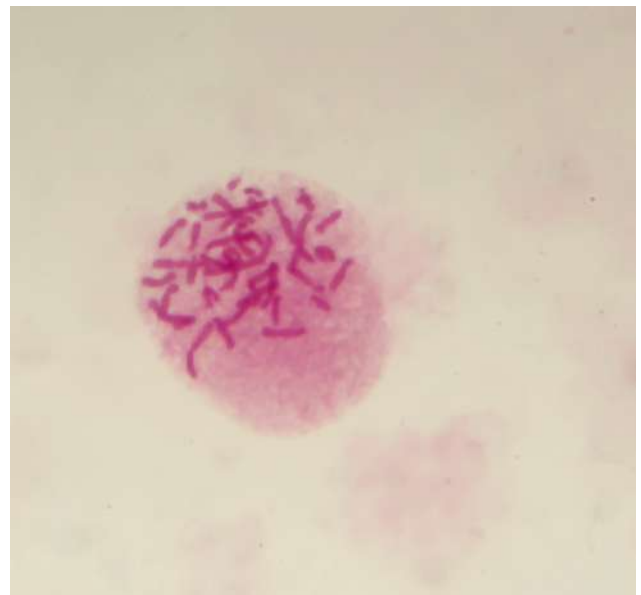
An ancient motherline, thought to be 32,000 years old.

How your Motherline works

In order to find your haplogroup, your sample is compared to a known tree of haplogroups. Each group has its own unique markers.

Mitochondria are found in almost every cell in the body. They provide the cells with energy, but also contain their own, unique set of DNA, separate to the chromosomes in the cell nucleus. Everyone inherits this mitochondrial DNA (mtDNA) directly from their mother, as there are few mitochondria in a sperm cell, compared to the thousands in the egg. Males receive their mtDNA from their mother, but do not pass it on to their children.

The DNA does not change much over time, so as small changes do occur, new branches of the mtDNA tree are formed. These new forms are passed on to descendants.

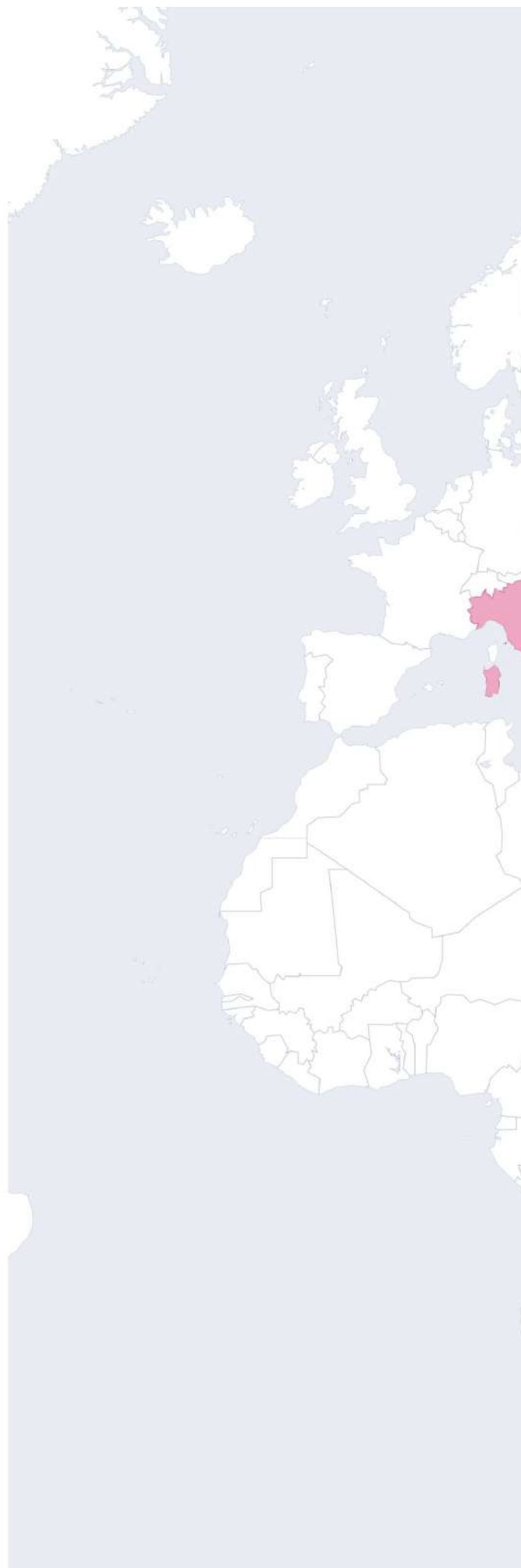


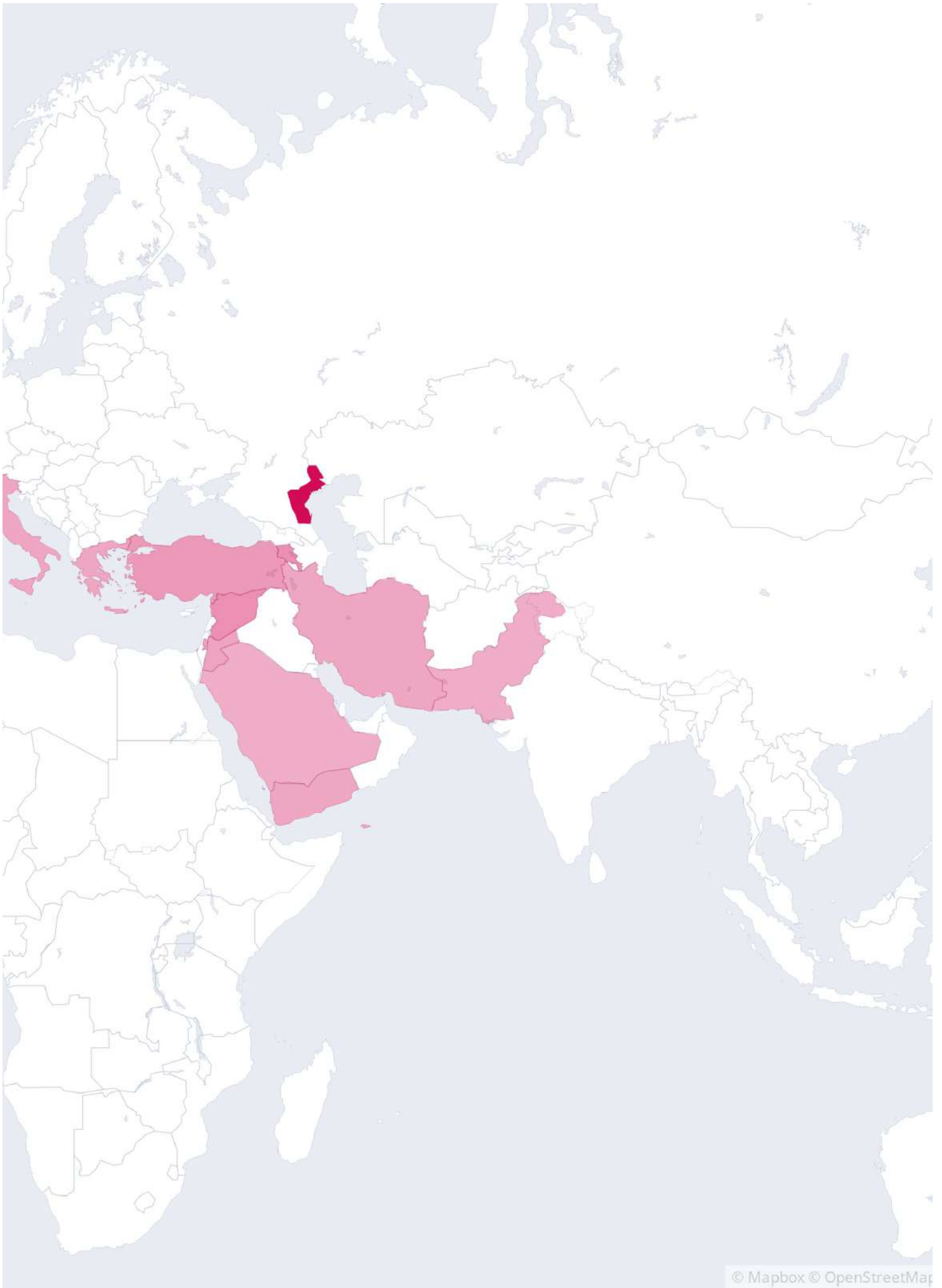
Where your Motherline haplogroup U1 is found

For the full distribution of your haplogroup, visit the [Living DNA portal](#).

Your Motherline is based on a separate piece of DNA to your Family Ancestry. Everyone, male and female, inherits this 'mitochondrial DNA' directly from their mother. As it does not change much over time, we can identify different forms of the DNA, called 'Haplogroups'. Your Motherline map shows where your group is found today. If you are in the same haplogroup as a person, it means that you have a common female ancestor, somewhere along your mothers side of your ancestry.

It is **important to note** that the map may show current geographical locations, as well as some tribal groupings. Mitochondrial DNA migrations may be many thousands of years ago, so additional historic regions may be represented.







The genetic migration of your motherline

Your motherline signature belongs to the U1 group. U1 is rare, and there is not a huge quantity of information on this group as a result. Haplogroup U1 is most commonly distributed across the Middle East, as well as Anatolia and in low frequencies in Eastern European people (Derenko et al., 2013). However, it is still found in low frequencies

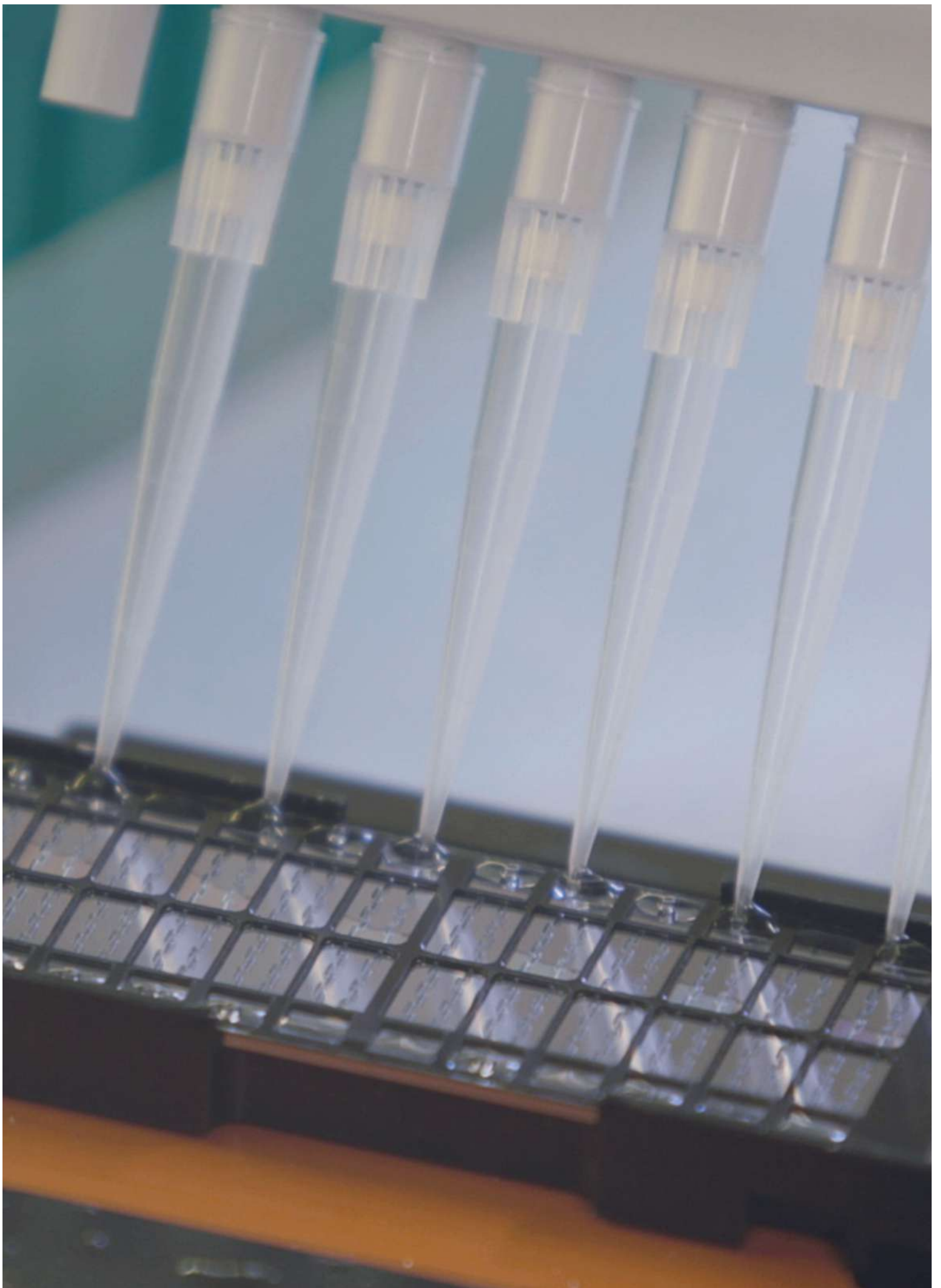
due to being such an ancient haplogroup. It has been estimated to have arisen around 32,000 years ago. The exact place of origin is not necessarily determinable at this point, but the frequencies in the Near East today may suggest that it arose around this area.

Who were your ancestors

There is not a huge amount of information on this ancient haplogroup, but we can try and infer the sort of populations that originally carried it. As it has currently been dated to 32,000 years old, we can attempt to understand the lifestyles of those it originated with by looking at the general way of life in the Middle East at this time. As it is most commonly found in Middle and Near Eastern areas, it may be the case that this is where U1 originated. At this time, farming had not yet been established, and people led a mostly

nomadic lifestyle of hunting and gathering food. This motherline, although very rare, has made appearances in the archaeological record. The U1 group has been detected in human remains of people in Sudan. The remains from the cemetery in Kulubnarti were dated around 550 A.D (Sirak et al., 2016). The cemetery in question had two types of burial, both Christian and Muslim. This shows that at this time, the Christian era was beginning to rise.

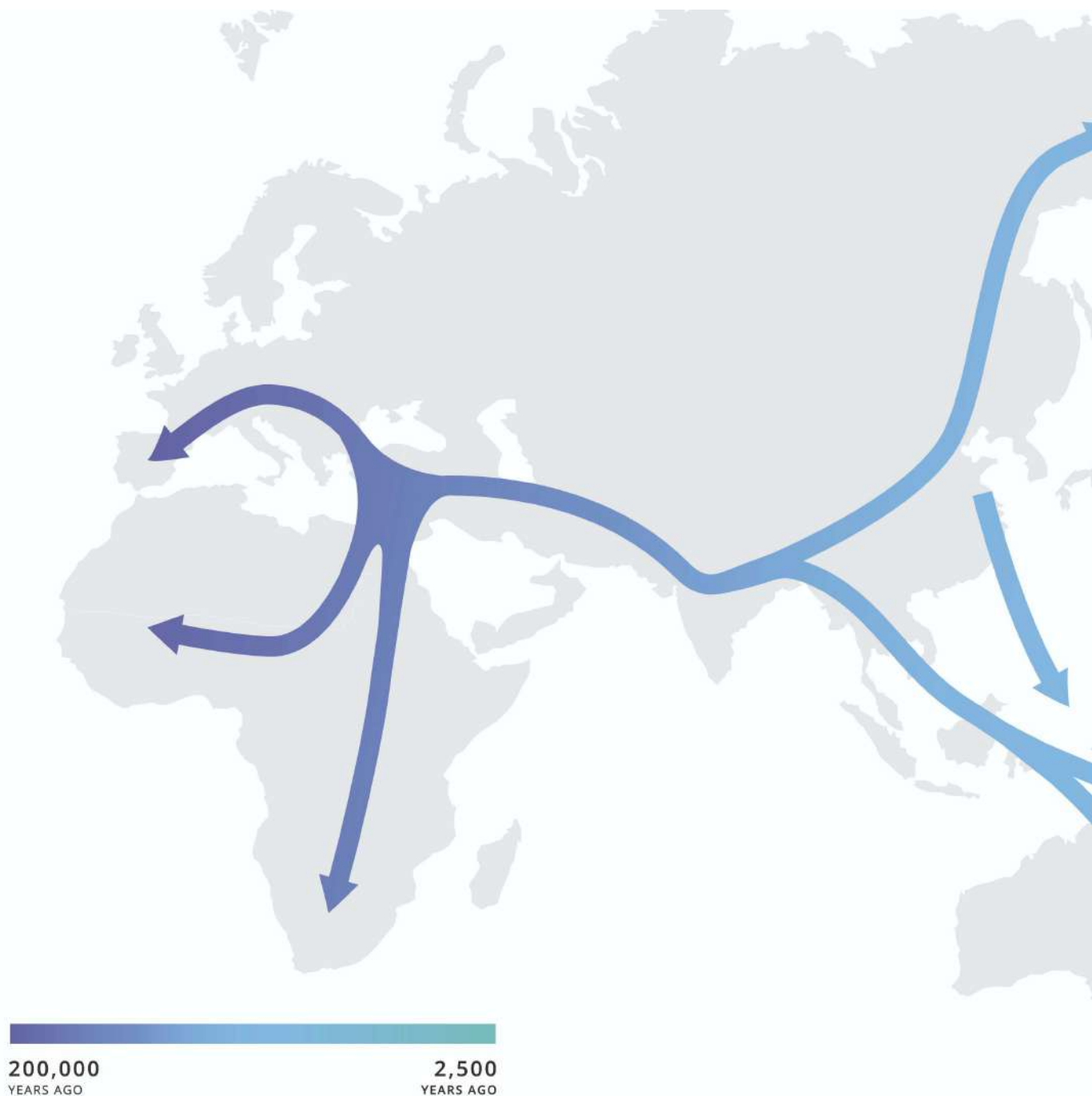




Science through the body

A HISTORY OF DNA



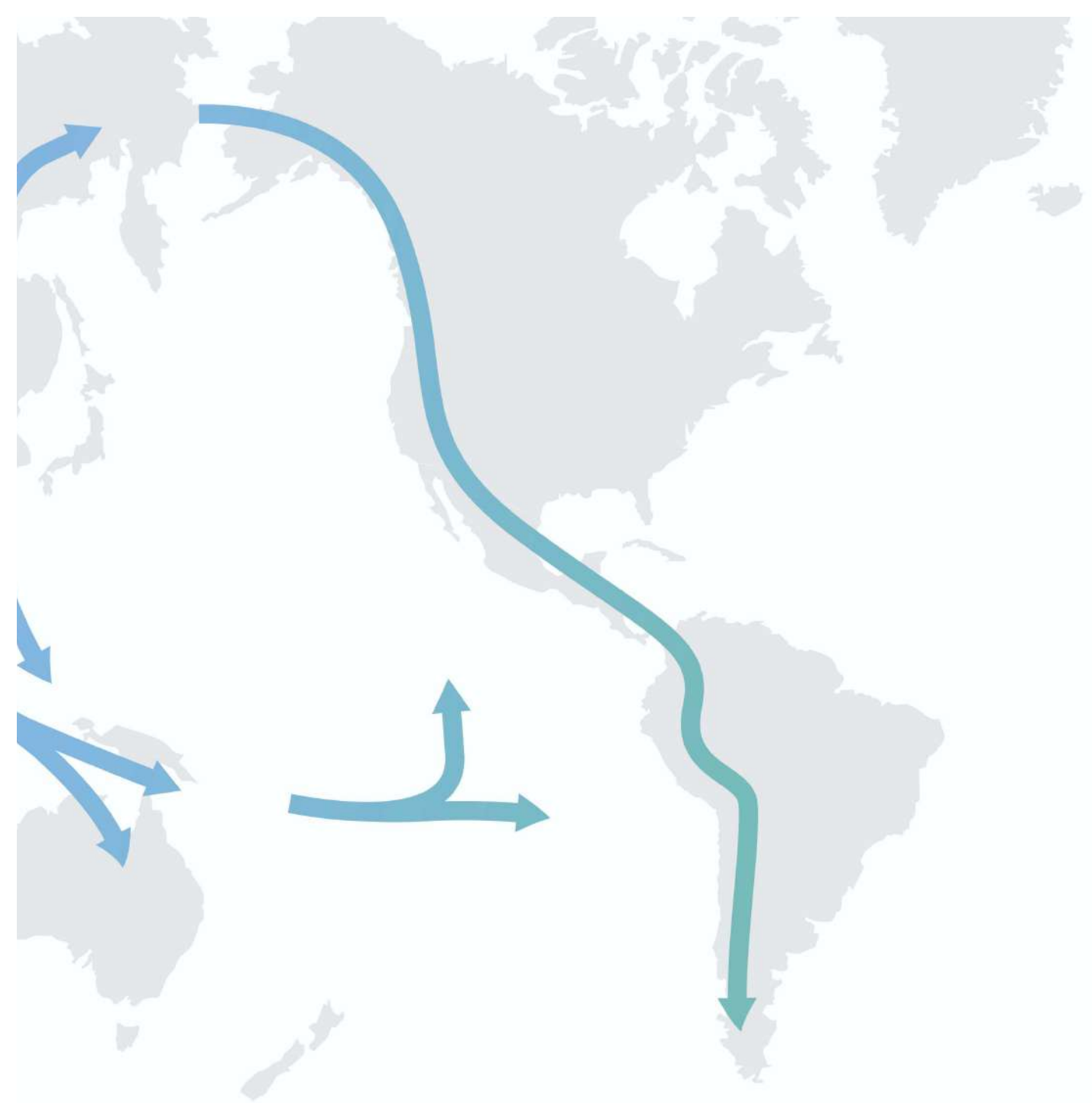


Human migration

Modern Humans (*Homo sapiens*) first appeared around 200,000 years ago on the continent now known as Africa (Pickernell, 2006).

For the majority of human history, our distant ancestors remained within Africa. As such, the first branches of both the Mitochondrial, and

Y chromosome trees are based in Africa. Current scientific understanding shows us that no modern human ventured outside Africa before c. 120,000 years ago. Several small scale migrations into the Middle East, Europe and Asia did not lead to lasting populations.



The first, large-scale, migration, leading to established settlement happened around 65,000 years ago. Humans reached India, Australia and New Guinea roughly 50,000 years ago. This was followed by a wave of

migration into the Middle East and then into Europe c. 45,000 years ago (Nature 2015). Finally migration into the Americas took place within the last 15,000 years.

Three types of DNA; three paths to explore

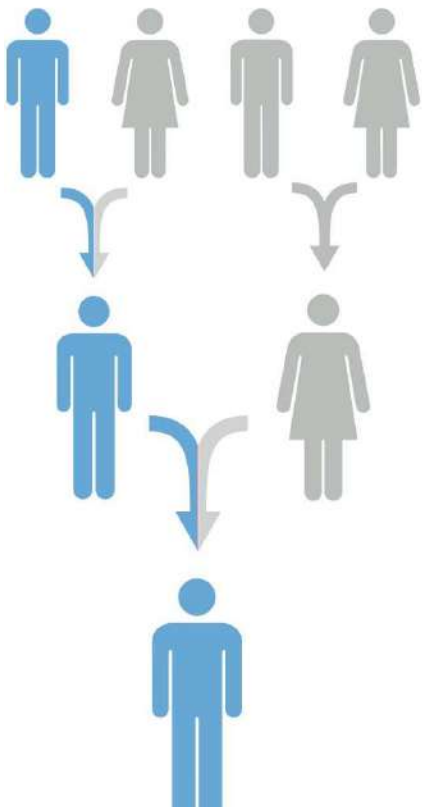
Within the body, there are several types of DNA (DeoxyriboNucleic Acid), stored in a number of ways. Twenty three pairs of chromosomes are contained in the nucleus of almost every cell, except red blood cells. One chromosome of each pair is inherited from each parent. As the chromosomes are able to mix their DNA within the body, a random mix of the four grandparents DNA is received from the parents. The first twenty two pairs make up the Autosome, from which the Family Ancestry can be discovered.

The last pair are the sex chromosomes, XX in Females, and XY in Males. The Y chromosome is such a different shape to the X, that the

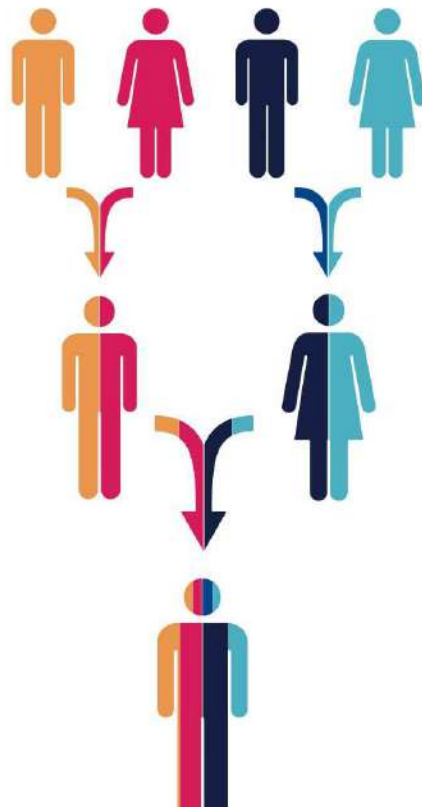
DNA does not mix very much. The Y chromosome (Y-DNA) is therefore passed directly from father to son over many generations.

Outside the chromosomes, the mitochondrial DNA (mtDNA) is stored very differently. Separate to the nucleus, the mitochondria provide cells with energy. They have their own, unique, piece of DNA, stored as a ring. The egg contains several thousand units of mitochondrial DNA, whilst the sperm has very few. As such, everyone inherits their mtDNA directly from their mother.

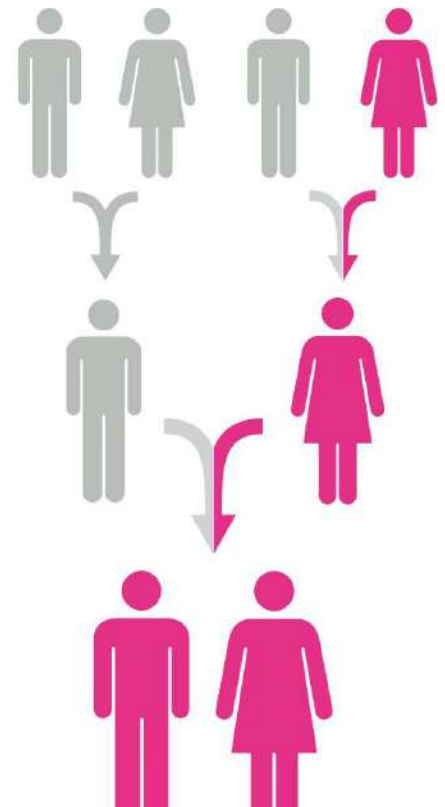
Y-chromosomal DNA is inherited from your male lineage



Autosomal DNA is inherited from all of your ancestors.



Mitochondrial DNA is inherited from your female lineage





Discovering how DNA can trace your ancestry

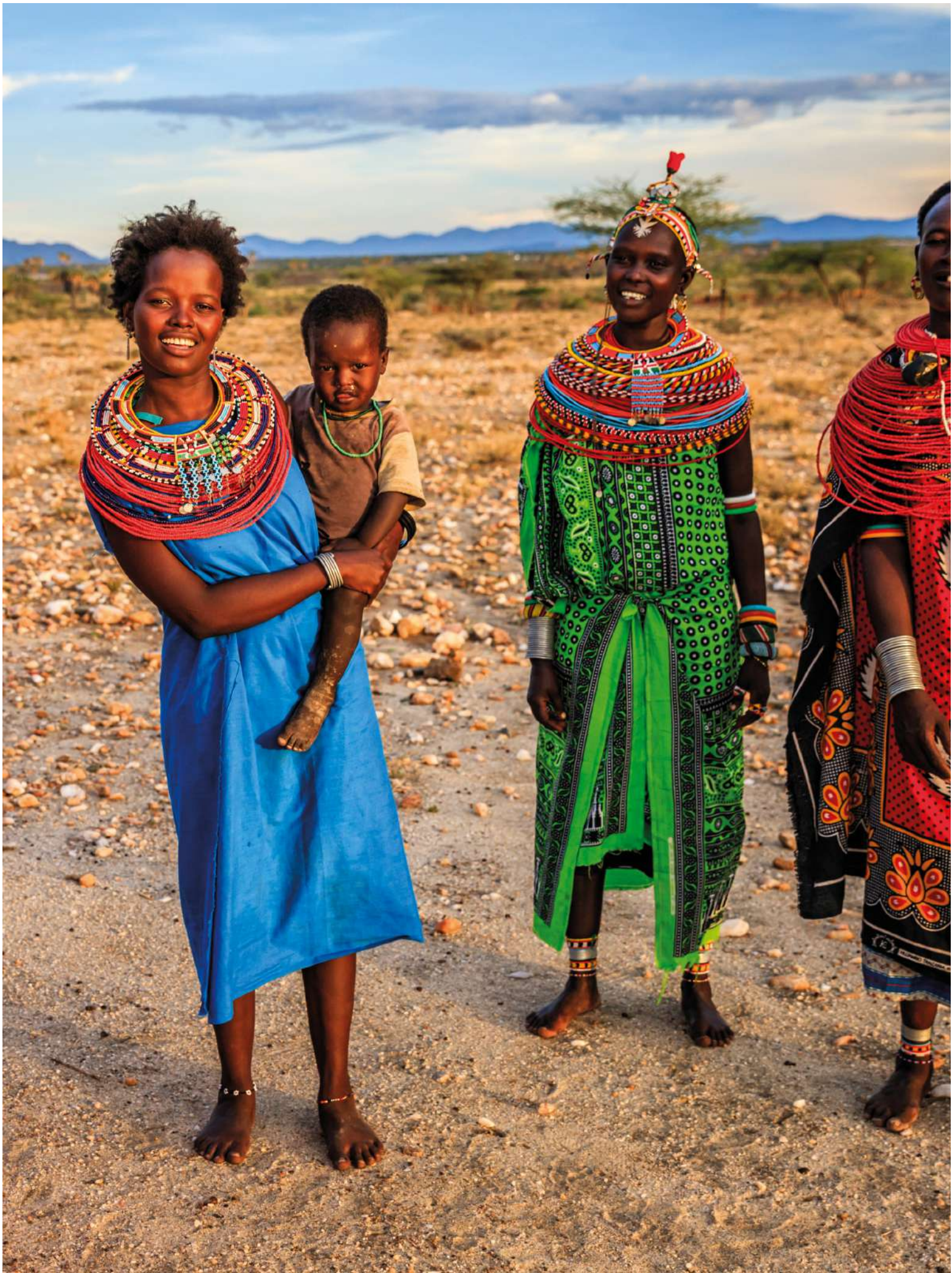
On January 1st 1987, three scientists (Rebecca Cann, Mark Stoneking and Allan C. Wilson) published an article in Nature called 'Mitochondrial DNA and Human Evolution'.

They theorised that all living human beings can trace their ancestry back to a single woman living in Africa around 200,000 years ago.

The concept, however, stirred debate and further research. Wilson put forth that there was not just one woman, but numerous women with the same mtDNA. Furthermore, studies showed that the Y chromosome used

to determine Fatherline ancestry was even older (anywhere up to 340,000 years ago).

Many newspapers and magazines were sold on the basis of finding the 'first' male and female through DNA research. However, this is not currently possible, given the thousands of years difference between the oldest male and oldest female lines. What scientists were able to determine is that there was a time around 200,000 years ago when a relatively small number of human beings were living and all those who survived came from this group (Barras, 2013).



The debate

There had been much debate around the emergence of human populations prior to the 1987 paper. Different theories suggested that pockets of evolution occurred in many areas of the world.

As the scientists considered various populations, Africans seemed to show more genetic variance than non Africans (Asians, Europeans, Native Americans, etc.). This confirmed that African lines are the oldest and lead many to continue to call Africa “the cradle of civilisation” (Highfield, 2008).

Establishing our genetic ancestors

Mitochondrial DNA was chosen as it is only passed down from mother to daughter and should remain intact with little change taking place. This makes it ideal for building family lineages. When mutations do occur, they are then carried forward to future generations. The theory went that, looking further back in time, fewer women had contributed to the modern mtDNA pool. Therefore, going back far enough, we would find the original woman or mtDNA line. By testing the DNA in placentas from populations around the world, scientists were able to confirm that African groups are the oldest, and all other populations can be traced from these groups.





Determining just how old our ancestry is

Having determined a single African group to be the oldest, the next step was to discover just how old the group was. In order to establish this, a technique called the 'molecular clock' was used. This is based on the number of mutations in the mtDNA. The assumption is that one mutation occurs every 1,000 years. Therefore, 10 mutations found between us and an ancient ancestor would

suggest they had lived around 10,000 years ago. After extensive work, research on various models, and comparisons to anthropology and archaeology, the estimate of 200,000 years was concluded. A similar approach is taken to determine the age of the oldest Y chromosome (Cann et al., 1987 as cited in Haskett, 2014).



The 'molecular clock' model is still seen as a legitimate theory and researchers still use it for their modelling. However, there is another theory which is known as "punctuated equilibrium", whereby when an environment is stable, there will be less genetic change in a

species. However when the environment is less stable, mutations and adaptations may give an advantage. With less stability the theory proposes drastic splits in populations rather than slow consistent genetic changes.

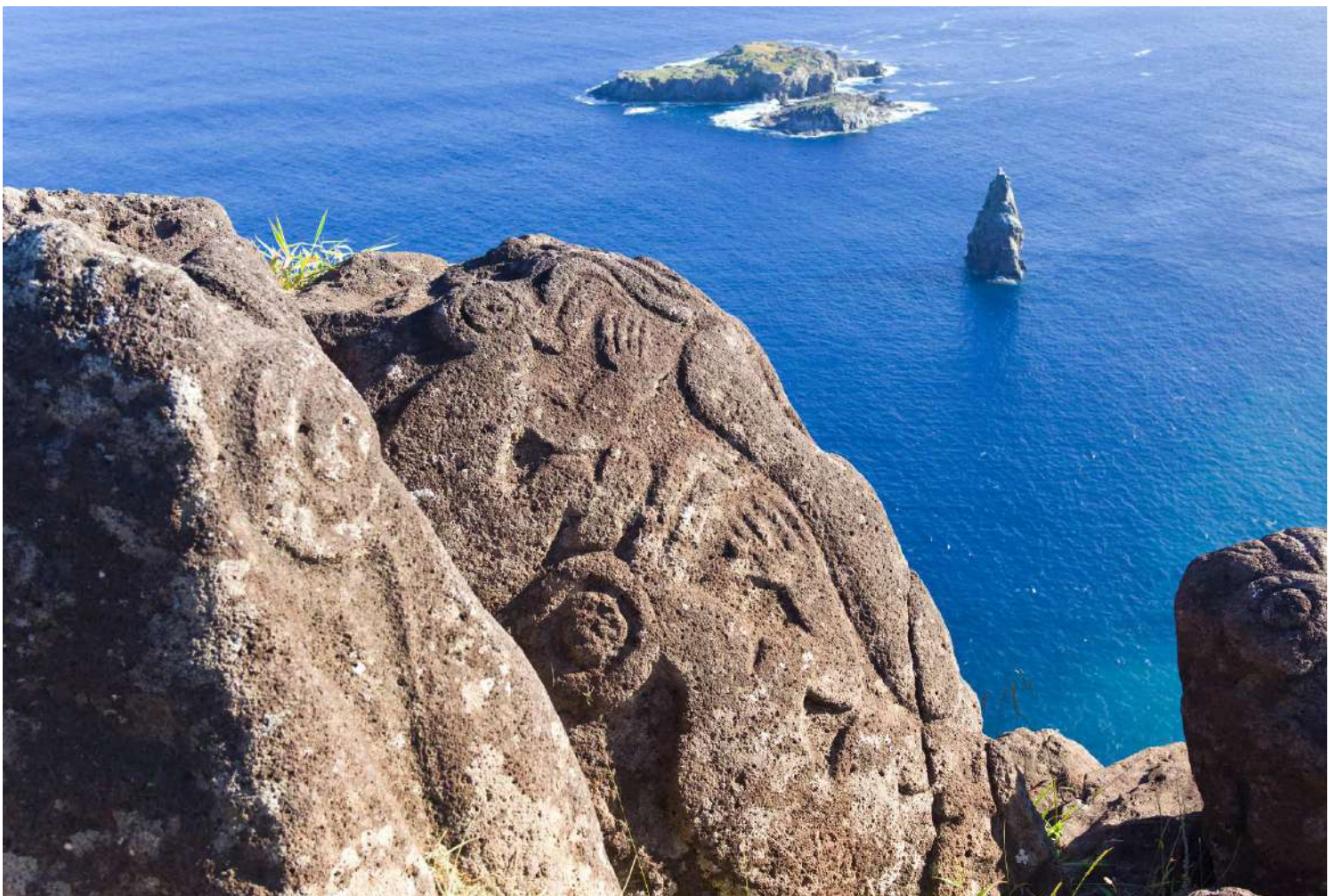
What about the other theories of migration?

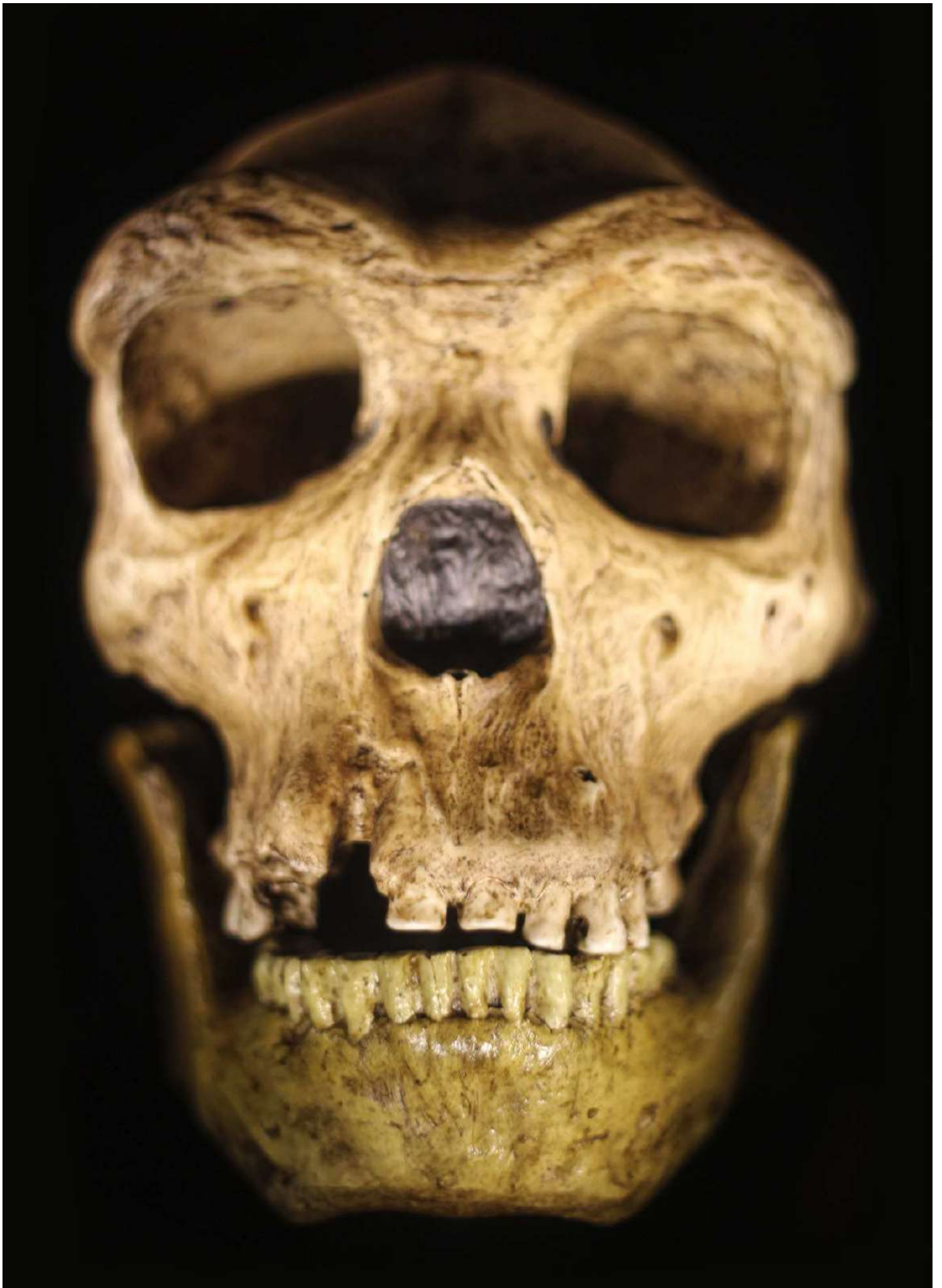
There are many theories regarding human migration. Some paleoanthropologists have shown a continuation of traits between Homo erectus (an older species of human that did not survive) and some varieties of modern humans.

While mtDNA supports the "Out of Africa" theory as the most accurate, fossils may indicate otherwise. Similarities exist with the fossils of other early humans, suggesting a parallel evolutionary process. For example, the claim is that modern Chinese would be

descendants of Chinese erectus and modern Africans of African erectus.

Anthropologist Professor Chris Stringer countered these arguments summing up that; "Your fossils are not ancestors of modern men" a valid point when you consider, as Rebecca Cann has done, that you can never tell if a specific fossil actually left any descendants. On the other hand, "Genes in modern populations have a history that can be examined and will track back in absolute time to real ancestors" (Brown, 2016).





What we can clearly identify is that there were many lines before modern human beings; however they all died out.

We do not currently know what caused these lines to disappear. As a result of this population loss, the direct maternal and paternal lines of all individuals living today can be traced to the same groups of people living around 200,000 years ago.

This is not the only example of a population bottleneck in the evolutionary history of modern humans. Another population loss occurred around 74,000 years ago. When the volcano that produced Lake Toba in Indonesia erupted it ejected 2,800 cubic kilometres of volcanic ash. Sunlight was not seen through the entire Southeast Asian, South Asian and Arabian Peninsula, with ash forming a thick layer on the floor. It is understood that only 10,000 people survived the eruption. Our distant ancestors were all from this small remaining group. (Encyclopedia Britannica 2016).





Evolution and "The Origin of Species"

Charles Darwin is famously known for his work entitled "On the Origin of Species". As a man taken by the magic of nature he spent much of his life cataloging animals and plants. An avid butterfly lover, he was fascinated by the structures and detail he found.

Darwin's book did not, however, address human evolution, saying only that "Light will be thrown on the origin of man and his history".

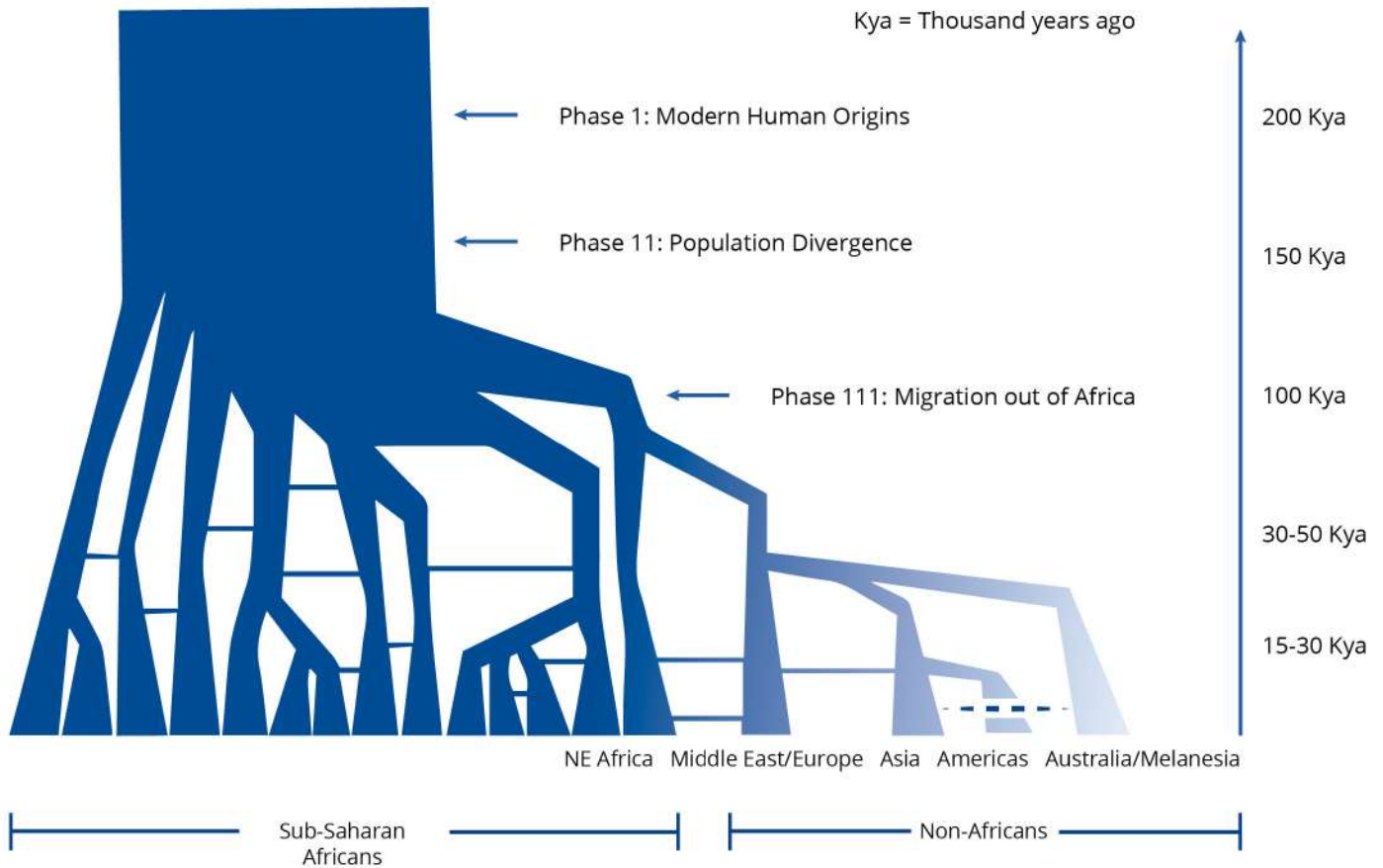
All that we know is that around 200,000 years ago the species known as modern human beings appeared. We are yet, as Darwin shared, to fully understand why or how.

Darwin's theory for the gradual change in species is reflected in the changes observed in mitochondrial DNA and the Y Chromosome. With small changes over large periods of time leading to increased diversity, and the spreading of the genetic trees, as well as the tree of life.

These changes continue today, with the ongoing development of human populations. Our DNA is by no means fixed, nor beyond new changes.

After all, Salamanders are genetically far more complex than we are. Even wheat has more DNA complexity than we do (Hedrick, 2012).





Genetic diversity out of Africa

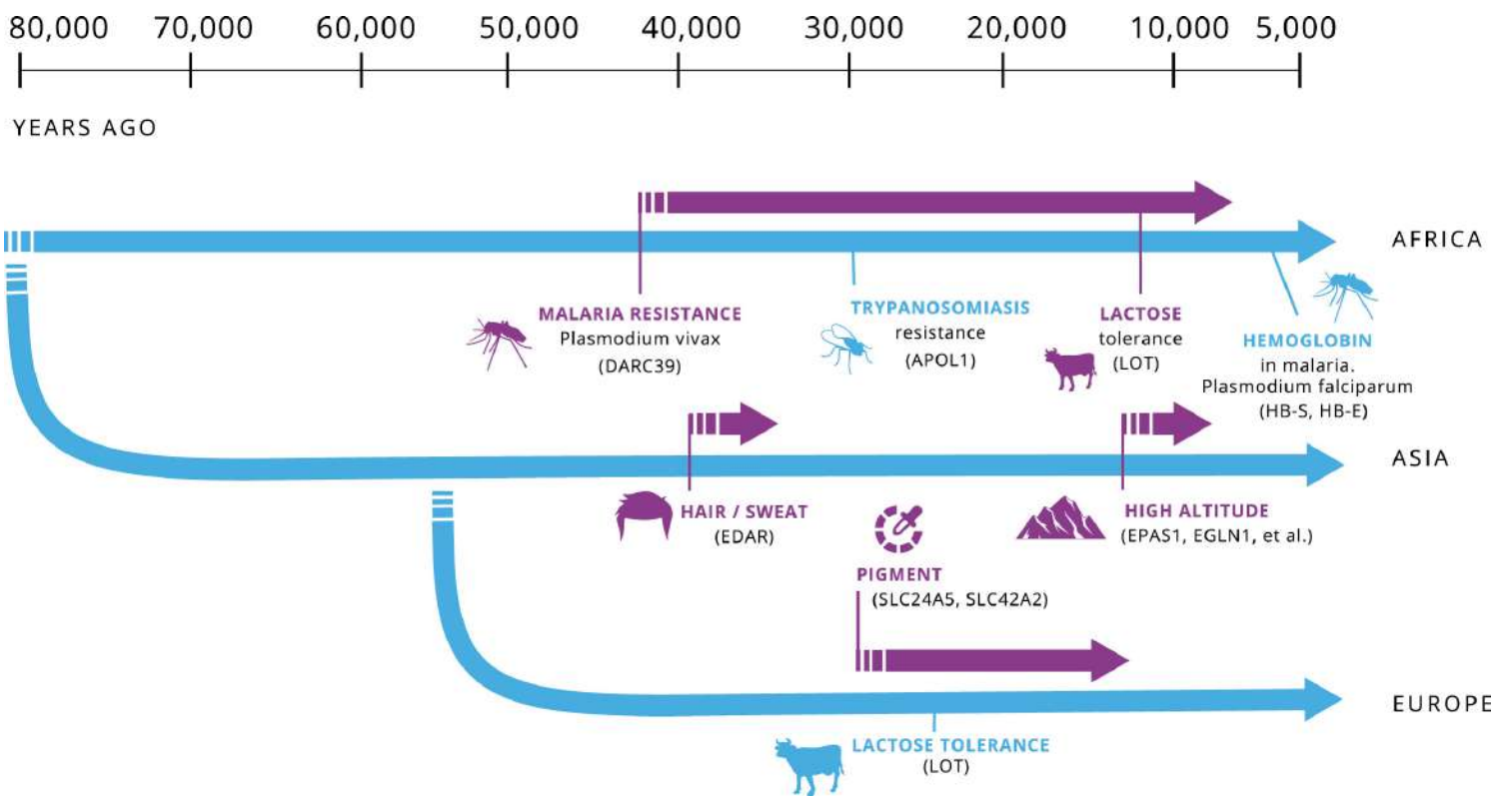
This is the Recent African Origin model of modern humans and population substructure in Africa, illustrated by Campbell and Tishkoff (2010). The intensity of colour represents greater genetic diversity within the population. Decreasing intensity shows a loss of genetic diversity, as populations migrated from Africa.

The solid horizontal lines indicate interbreeding between ancient populations, whilst the dashed horizontal line shows more

recent mixing between Asian and Australian/Melanesian populations.

When we explore modern genetic diversity using genetic markers, we can see that two individuals from neighbouring villages in Uganda can have a greater genetic difference than two individuals living in the areas now known as Europe, India or Asia.

This shows how genetic diversity is very limited in modern human beings outside of Africa.



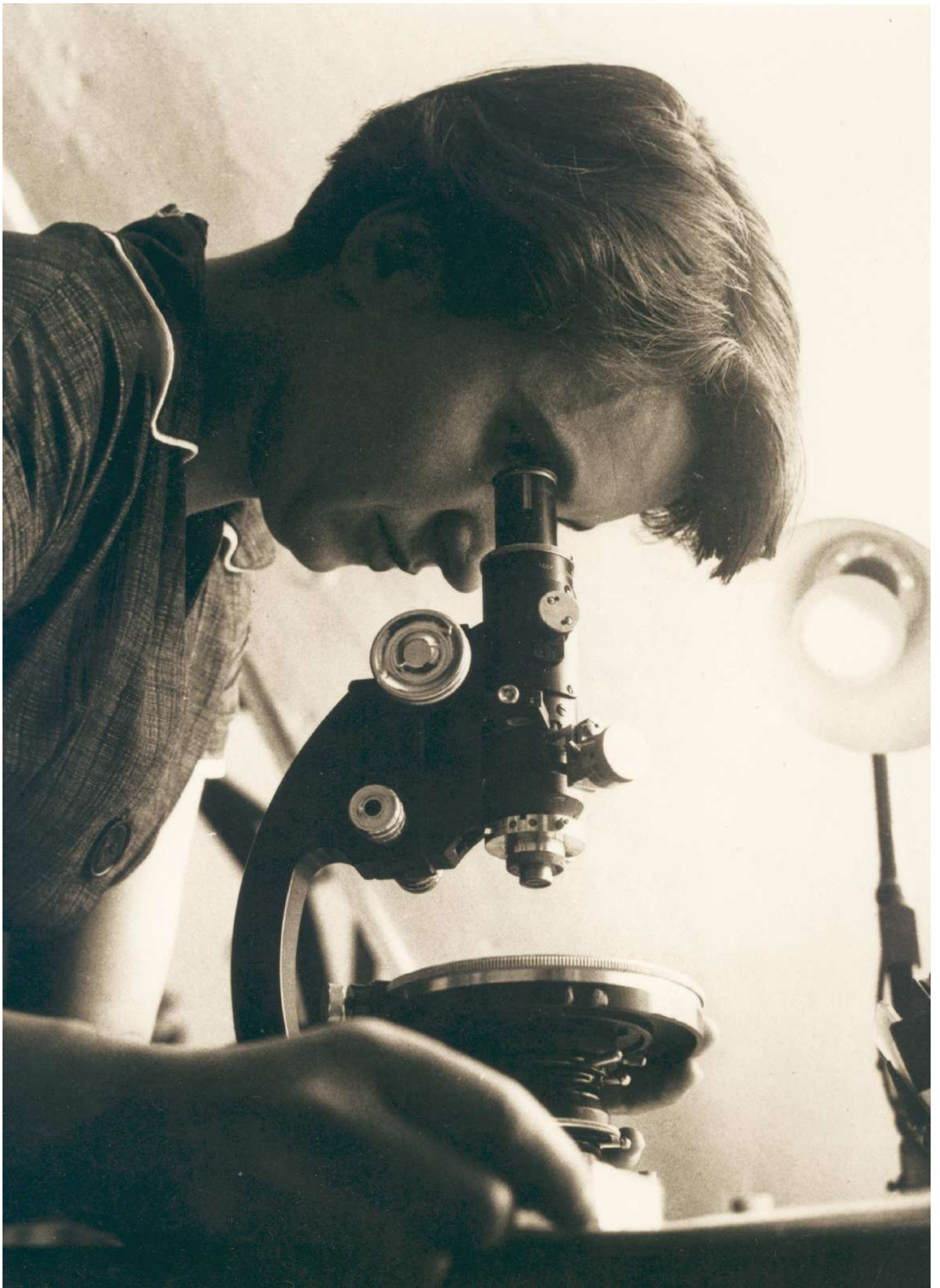
A change in your genes

Early humans faced different challenges in each of their migrations. The genetic code of different branches of human beings were suited to their environments, and the way that they lived.

Within a population group those individuals with a certain genetic mutation may have greater survival rates than those without. Those without the mutation would die at a

faster rate and therefore the mutated gene spreads.

One reason why many Africans are naturally resistant to malaria is because 33,000 years ago the genetic structure of the African population group changed (mutated). Because Europeans had already migrated out of Africa, they did not carry this mutation and therefore many are not resistant to malaria.



The discovery of DNA

Whilst the concept of DNA was studied in 1869 by Friedrich Miescher, it is James Watson and Francis Crick who are often referred to as the individuals who discovered the structure of DNA in April 1953. They later went on to win the Nobel Prize in Physiology or Medicine in 1962.

However, not everything is as it seems. Since early 1951, Rosalind Franklin had been working as a Research Associate for John Randle at King's College London. She took X-ray diffraction images of DNA, which showed the helical form of the molecule. In lecture notes written 16 months before Watson and Crick published their findings, Franklin wrote;

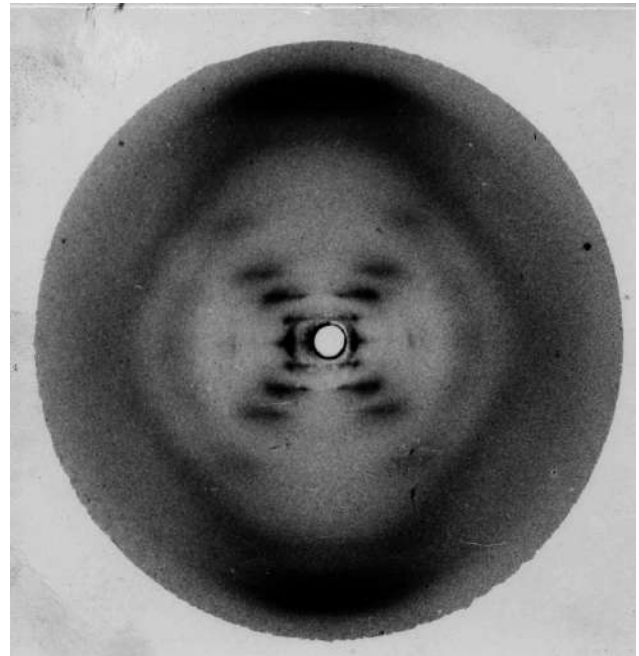
Conclusion: Big helix in several chains, phosphates on outside, phosphate-phosphate inter-helical bonds disrupted by water. Phosphate links available to proteins.

The photographs that Franklin took clearly showed that DNA was a double helix. This was a theory that contradicted the widely accepted belief that DNA structure had three chains (a view that Watson and Crick actually shared at the time).

Unknown to Franklin, John Randall had taken her unpublished research and presented it at a seminar. Maurice Wilkins, her colleague at King's College, reported her findings to

Watson and Crick. Two weeks later, Crick and Watson had built their famous model of DNA. Franklin was unaware that Watson and Crick had seen her X-rays and data. In 1961, Crick sent a letter to the editor of Nature advising that Franklin's work was "the data we actually used". Yet in 1962, when accepting the Nobel Prize, no mention of Franklin was made.

As Watson writes; "Rosy, of course, did not directly give us her data. For that matter, no one at King's realized they were in our hands". (Wade, 2003).



What if the structure of DNA was known long before 1951?

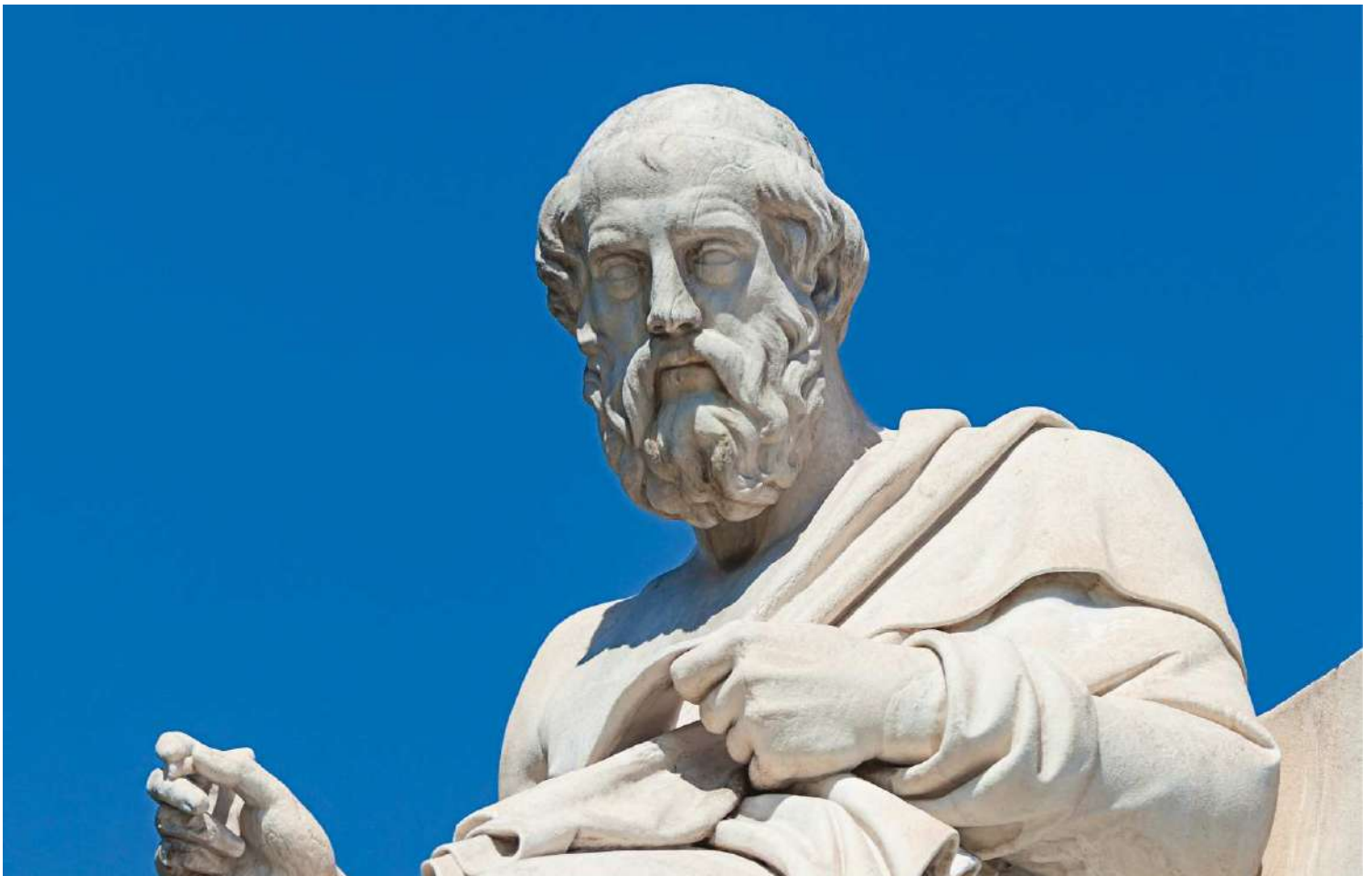
Plato (born c. 428 BC / died c. 348 BC) was a philosopher as well as a mathematician in Classical Greece. Deeply inspired by the work of Pythagoras, and often called the greatest philosopher of all time, Plato helped lay the foundation of western philosophy and science.

In c. 360 BC, Plato completed his dialogue 'Timaeus'. In which, when he starts to explain the creation of man, he describes DNA in perfect detail. This is several thousand years

before the structure of DNA could be observed.

Opposite is an extract from Plato's work, as well as the description of DNA in a book called "The Incredible Machine" by National Geographic in 1986. The words in bold compare Plato's terms with the modern equivalent.

It is exciting to consider how new developments in DNA science will continue to expand upon current understanding.



PLATO	MODERN SCIENCE
Vast River	Twisted
Pegs	Rungs
Welded	Interlocking
Elements	Bases
Influx and Efflux	"Breathes"
Hurried	Bends fast
Progressed	Genetic traits

"...in imitation of their creator they borrowed portions of fire and earth and water and air from the world, which were hereafter to be restored - these they took and **welded** them together, not with the indissoluble chains by which they were themselves bound, but with little **pegs** too small to be visible, making up out of all the four **elements** each separate body, and fastening the courses of the immortal soul in a body which was in a state of perpetual **influx and efflux**. Now these courses, detained as in a **vast river**, neither overcame nor were overcome, but were hurrying and **hurried** to and fro, so that the whole animal was moved and **progressed**, irregularly however and irrationally and anyway..."

Plato c. 360 BC

"Heredity is written on a chemical ribbon that twists like a spiral staircase, the steps build of four chemical **bases** attached to chains of sugars and phosphates - DNA. The DNA molecule is a miracle of organization, structured like a **twisted** ladder. The sides of the ladder - alternating sugars and phosphates - form the molecule's backbone. The "**rungs**" are **interlocking** pairs of four chemicals called **bases**. Elegant in structure DNA is also vibrant. Any still portrait of this molecule conveys only part of its nature, for motion characterizes the rest. DNA **bends and twists** a billion times a second while its ladder sides "**breathe**" in and out. Through segments called genes, DNA determines the makeup of every cell and the **hereditary traits** of each one of us. DNA dictates the protein mix that fulfills our genetic inheritance. One strand of DNA unfurls to become two. Each separate strand serves as a template, or positive mold, for a full, new strand. Some six billion steps of DNA in a single cell record one life's blueprint. This DNA plan for a single human life can be stretched six feet, yet is coiled in a repository just 1/2500 of an inch in diameter - the cell's nucleus."

Modern Science - National Geographic 1986

The story of Living DNA

Living DNA is a collaboration of over 100 academics and experts from around the world who are committed to revealing the information that DNA contains.

Founded by David Nicholson and Hannah Morden in 2016, Living DNA aims to make DNA and science accessible to all.

Your greatest adventure starts with your DNA.

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