YOUR MOTHERLINE IS

L5

AFRICAN HUNTER GATHERER

Thank you for having your ancestral DNA tested. Not only are you about to discover things you could never know about your past, about where you and your ancestors come from, you have also made an important contribution to the sum of knowledge about our collective DNA. I hope you find your results fascinating, unexpected.

Congratulations on discovering a story about yourself that only DNA could have told, until now a hidden story about your long past and about where you come from.

Best wishes,

Alistair Moffat, Managing Director.

The Science

We have extracted DNA from your saliva and read your genetic code. As you may know, we all inherit about six billion letters of DNA from our parents and geneticists read them in sequences of the letters A, C, G and T, the chemicals that make up the DNA molecule, the double helix. We have looked at a large number of variable letters in your sequence, which are known as markers, in order to discover your personal genetic signature.

Mitochondrial DNA, or mtDNA, is a small piece of DNA which is passed on from mother to daughter to granddaughter. Men also inherit their mtDNA from their mothers, but do not pass it on. It is inherited as one block and contains many markers which allow us to identify almost two hundred different groups of related lineages and thousands of subtypes within these groups.

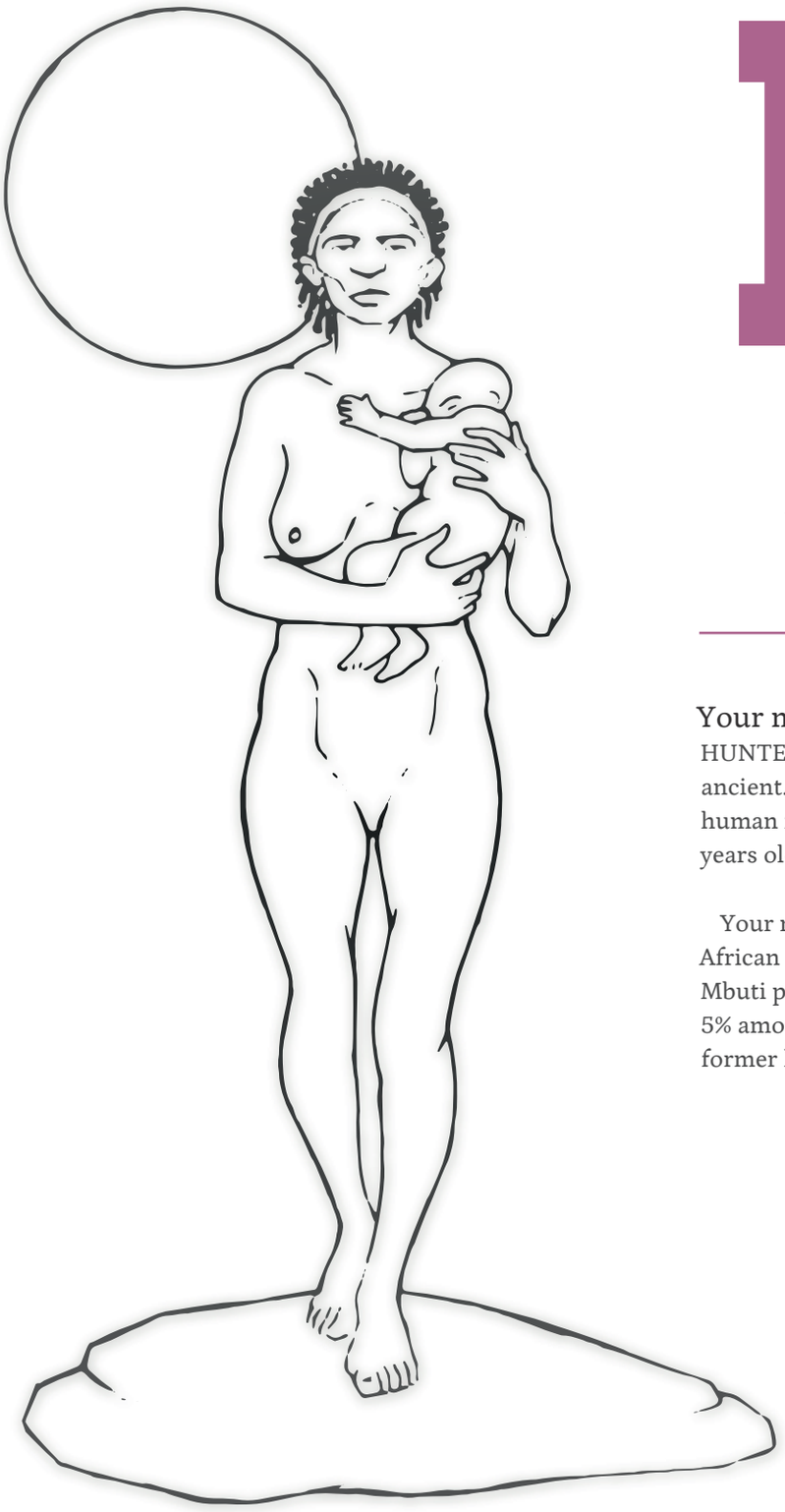
Mitochondrial DNA markers are named by their position in the sequence of mtDNA letters (from position 1 to 16569). When you look at the markers that define your personal DNA signature, the letter after the number indicates which variant (also known as an allele) you carry at that position. For example 3197C would mean you carry the C variant or letter at mtDNA position 3197 (rather than the T).

Some of the variants you carry are key markers which define a larger group of related ancestral lineages to which you belong, your haplogroup.

These ancient lineages are known by different names, such as H1 or U5 or J1b1. The 3197C variant is, for instance, part of the definition of haplogroup U5. Some haplogroups are specific to particular parts of the world and others are more widespread, but most are common in some places and rare elsewhere. By comparison with published and unpublished databases, geneticists are able to infer roughly where and when in prehistory each haplogroup originated, as well as tracing the probable route taken by the deeper ancestors of the haplogroup. For example U5 is about 36,000 years old and arose in the Near East.

We have tested about 3,000 mtDNA markers and report those where you differ from the Cambridge Reference Sequence or CRS, the first mtDNA ever to be sequenced, which is used as the reference standard for comparisons. Your blood relatives in the female line will share your mtDNA results.

Some markers have not yet been tested in large samples of known heritage, particularly those that have been discovered recently, and so they, not surprisingly, are poorly understood - as yet. We make it clear in your results if this is the case. There are inevitable biases in the databases of samples available, in the markers discovered or used, and in the statistical methods and study designs utilised in the published literature and elsewhere. And that therefore means that geneticists occasionally have different levels of confidence in the interpretation of some markers.



L5

The story of African Hunter Gatherer

Your mitochondrial DNA is that of the AFRICAN HUNTER GATHERERS and it is very rare and very ancient. Your lineage belongs to the third branch of the human family tree and it is estimated to be 120,000 years old, one of the oldest lineages yet discovered.

Your mtDNA haplogroup is L5 and is an East African group, most common amongst the Mbuti pygmies at a frequency of 15% and at 5% amongst the Sandawe people of Tanzania, former hunter-gatherers, it is significant.

Your haplogroup-defining markers

2758G	3523C	12432T	16166G
Branch L2'3'4'5'6	Branch L5	Branch L5	Branch L5

Rosalind Franklin made critical contributions to the understanding of the fine molecular structures of DNA.

The story of the discovery of the structure of DNA is in itself dramatic. In February 1953 two excited young men burst into the Eagle pub in Cambridge and announced to the lunchtime clientele that they had discovered the secret of life.

If an eyebrow was raised perhaps it was because this was the sort of declaration young men made after spending a few hours in a pub. But in this case it was no less than the truth. Francis Crick and James D Watson were researchers at the Cavendish Laboratory at the University of Cambridge and that morning they had completed a model of the molecular structure of DNA, a model they knew was correct, convincing in every detail.

Deoxyribonucleic acid is indeed the secret of life because it is the basis of heredity, a biochemical blueprint for reproduction. When Crick and Watson created a wholly coherent model of the molecule and comprehended how it copied itself, new scientific horizons opened. Their discovery enabled the creation of entirely new academic disciplines such as the science of molecular biology. How hereditary diseases and disabilities are passed on was at last understood.

And by understanding the DNA of diseases, effective means of combatting them could be found.

When the two researchers pushed open the doors of the Eagle, they also wanted to celebrate a victory. They had won a race. Three universities had been competing to be the first to make what they all knew would be a momentous, world-changing discovery. At the California Institute of Technology the chemist, Linus Pauling, had adopted two approaches by developing techniques called x-ray crystallography and by building three-dimensional models. In 1951 he published his model of the protein, alpha helix. With all the resources at his disposal, it was surely only a matter of time before Pauling's techniques led him to a similarly credible model for the structure of DNA, and following the research at CalTech, it was likely to be a helix, a spiral curve.

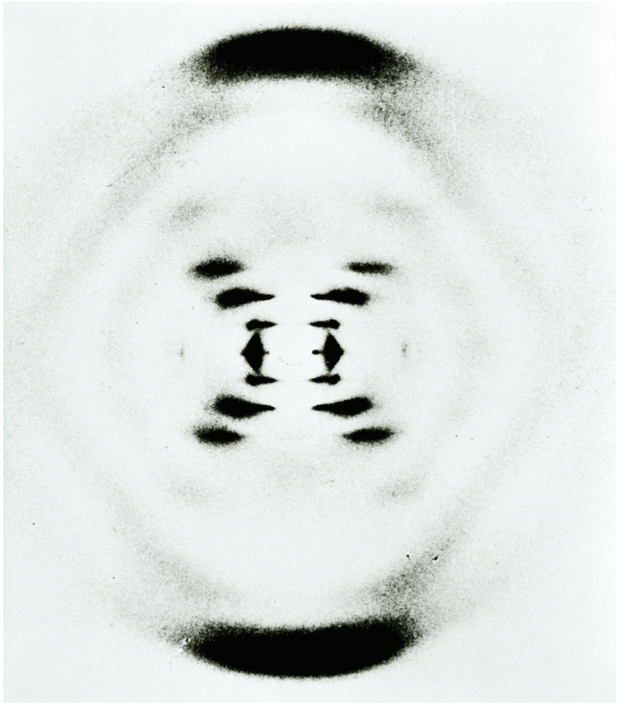
At King's College, University of London, two brilliant scientists were collaborating, but not happily. Maurice Wilkins was a New Zealander who took a physics degree at Cambridge before the Second World War. Seen as a brilliant young scientist, he found himself working on the improvement of cathode ray tubes for use in radar during the Battle of Britain.

At King's Wilkins was joined by a remarkable woman. Rosalind Franklin had also contributed to the scientific effort behind the allied victory in the more mundane field of investigating the properties of graphite, work that would eventually lead to the manufacture of carbon fibre.

The collaboration was not a success. Franklin and Wilkins disliked each other so much that the pace of their research slowed and academic plotting and bickering sometimes seemed more important. Rosalind Franklin's response was to do her research alone, and from her notes it appears that she was closest to understanding the structure of DNA. Using diffraction techniques where a beam of X-rays is shone at a DNA crystal and the resulting reflections are captured as a series of dark or grey bands to produce an image, she successfully photographed the DNA molecule early in 1951. Analysis of the image clearly showed that it was a double helix, two spirals and not three as Francis Crick, James Watson and others believed it to be at that time. In her notes, Franklin wrote;

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

When James Watson went to London to meet Maurice Wilkins at King's College, he found himself arguing heatedly with Rosalind Franklin. Immediately after this altercation, Wilkins took Watson into another room where, without her knowledge, he showed him Franklin's latest and best images of DNA taken by x-ray crystallography. And around the same time more of her findings came into the possession of Crick and Watson. As a matter of routine, researchers at King's College wrote short abstracts on the progress of their work and Franklin's found its way quickly to Cambridge. It was not a private document and there was no suggestion of anything underhand but Franklin was apparently unaware that Crick and Watson had her research findings. "Rosy, of course, did not directly give us her data. For that matter, no-one at King's realised that it was in our hands", wrote Watson some years later. In 1961 Francis Crick admitted that "the data we actually used" was the work of Rosalind Franklin.



X-ray diffraction photograph of DNA.

Soon after Wilkins showed Watson the latest images at King's, he and Crick built their famous model. But it included conclusions not visualised by Franklin. Francis Crick understood that the two helices, the spirals of DNA, twisted not in parallel but in opposite directions while Watson saw how the linked pairs of base compounds were dynamic. This brilliant apercu was the key to understanding how the molecule could copy itself, something even more critical than the structure itself. And when papers were published in the spring of 1953 in the leading academic journal Nature, it concluded with one of the greatest understatements in the history of science; 'It has not escaped our notice that the specific pairing we have postulated immediately suggests a copying mechanism for the genetic material'.

Berkeley Professors Vincent Sarich and Allan Wilson (right) discussing evolution.

Wilson's theory ran aggressively counter to the conventional multi-regional view that *Homo sapiens* had evolved in different places from slightly different origins.

DNA haplogroups are the basis of how deep ancestry is traced and a knowledge of how old they are and where they originated is relatively recent.

In the 1980s a New Zealander of Scots extraction, Allan Wilson, was working on what he called the molecular clock. This was postulated as a means of dating the evolution of *Homo sapiens*, modern human beings, by looking at how DNA changed over time. Wilson and his team noticed that mitochondrial DNA, a small piece of DNA that women pass on to their children, mutated more readily than the rest of our DNA. This made it easier to plot changes in mtDNA over relatively short periods of time, and not the millions of years of evolution conventionally envisaged.

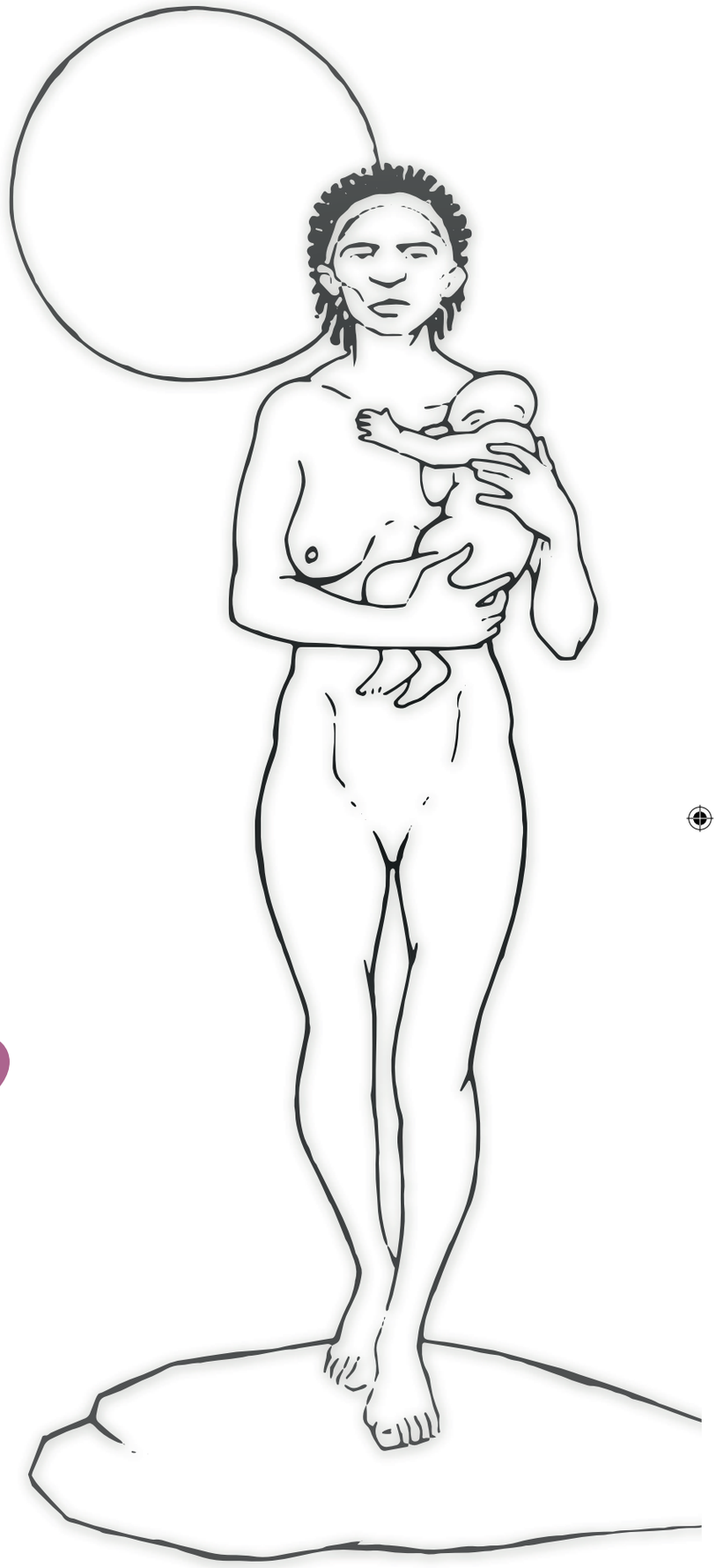
This research led to a bombshell. Allan Wilson announced the existence of the woman he called Mitochondrial Eve, the mother ancestor of all of us. Using the molecular clock, he believed that it was possible to estimate the time and place where modern humans first evolved. About 150,000 years ago, Wilson asserted, all of us, from Apaches to Aboriginal Australians, from Scots to Zulus, descended from one woman who lived in East-Central Africa. The announcement of the findings caused a sensation and a very attractive, black Mitochondrial Eve found herself on the cover of Newsweek Magazine, along with a rather mystified looking Adam.

In Europe it was thought that humans descended from Neanderthals, in China from Peking Man and in Indonesia from Java Man. But the new research insisted that we all have African ancestors, and a great deal of more recent work has supported Wilson's revolutionary view, although it is now been recognised that a small proportion of the DNA of non-Africans descends from these archaic humans.

Mitochondrial Eve is now thought to have lived approximately 190,000 years ago in East Africa, the area centred on modern Tanzania (although it must be added that evidence exists for a South African location for this prehistoric Garden of Eden since the lineages of the Kalahari Bushmen and others are very ancient and very diverse). Fossil evidence confirmed the earliest appearance of modern humans, people who looked like us, at this time and as its techniques have developed, readings of DNA samples began to convert a theory into a fact. Researchers now believe that a man who might be called Y Chromosome Adam also lived in Africa but not at the same time as Eve in a real version of the Garden. The ancestor of all men, traceable back through a Y chromosome line, is thought to have lived some time around 200,000BC. Theirs are the only lineages that survive in the male and female lines, while others have died out. But it is, sadly, clear that Adam and Eve never knew each other.

"Allan Wilson announced the existence of the woman he called Mitochondrial Eve."

It seems certain now that the whole of the rest of the world was populated by men and women who walked out of Africa around 60,000 years ago. The probable reason for this ancient exodus is dramatic, emphatic. A super-colossal eruption of the Indonesian volcano known as Mount Toba caused widespread nuclear devastation around 70,000BC and our species almost became extinct. As tsunamis smashed into coastlines, as dark ash-clouds hid the sun for a generation, plants withered and the animals and people who depended on them starved and died. Only in Africa did tiny remnant bands of people survive, perhaps as few as 5,000 outlived the sunless summers. When the weather at last warmed and new growth greened the land, a remarkable exodus took place...



Around 60,000BC, the first steps in the epic journey of our ancestors were taken. They headed north to the Horn of Africa and the mouth of the Red Sea. DNA evidence for a crossing of the southern Red Sea is very persuasive. From the L3 haplogroup, which originated in Africa between 60,000 and 70,000 years ago, the two mtDNA super-clusters of M and N are descended. Recent genetic research looked at people who carry old lineages that branch directly from the first non-African super-cluster of N. The results were emphatic and showed that there was indeed a very early ancestry in the Arabian Peninsula that originated soon after 60,000BC and that pioneers had certainly crossed the Red Sea, probably at the southern end near the Bab el Mandeb, the Gate of Tears, where it joins the Indian Ocean.

“Why did they cross the Red Sea? And how? What is now Yemen must have looked like a promising destination.”

Why did they cross? And how? Sea levels may have been much lower at that time and it may have been possible to get over in short hops, perhaps by poling or paddling rafts. The volcanic Hanish Archipelago lies north of the Gate of Tears and there the Red Sea widens considerably, but it may have been an easier crossing-point. Even in today's deeper waters there are a series of islets between the African shore and the main island. And its volcanic cone could have been kept in view at all points. Hanish itself is a large island able to support a substantial transient population.

The farther shore, what is now Yemen, must have looked like a promising destination. Otherwise why risk a crossing? Perhaps these pioneers sent scouting parties. It is difficult to imagine a migration on any scale and a potentially dangerous if brief voyage without knowing something of what lay on the other side.

NASA's Earth Observatory has offered some idea. Its photographs from space show clear traces of a landscape that was very different from the modern desert. The courses of many ancient rivers pattern the Arabian sub-continent, draining into the Persian Gulf, the Indian Ocean and the Red Sea. The beds of prehistoric lakes can be made out. Palaeoclimatologists believe that Arabia experienced a short-lived phase of wet climate around 55,000BC. Perhaps those who climbed the barren slopes of the volcano on Hanish Island will have seen a lush and green horizon to the east.

Once across, our ancestors caught what historians, geneticists and anthropologists have all called the Coastal Express. It seems that within 10,000 years of coming ashore in Arabia, and perhaps sooner, bands of *Homo sapiens* were settling in Australasia. They advanced an average of one kilometre a year.

Your maternal line ancestors were not with them They stayed behind and it is clear that they thrived and multiplied. At the moment of the exodus and for many millennia after it, there existed a far larger population of human beings in Africa than in the rest of the world. Different lineages arose and while only two mtDNA motherlines account for all non-Africans, there are at least 23 female African lineages of the same antiquity. For a long time, many millennia, our home continent, where our species clung on through the darkness of Mount Toba and thrived in what might be thought of as the Garden of Eden, supported a far higher population that became much more genetically diverse.

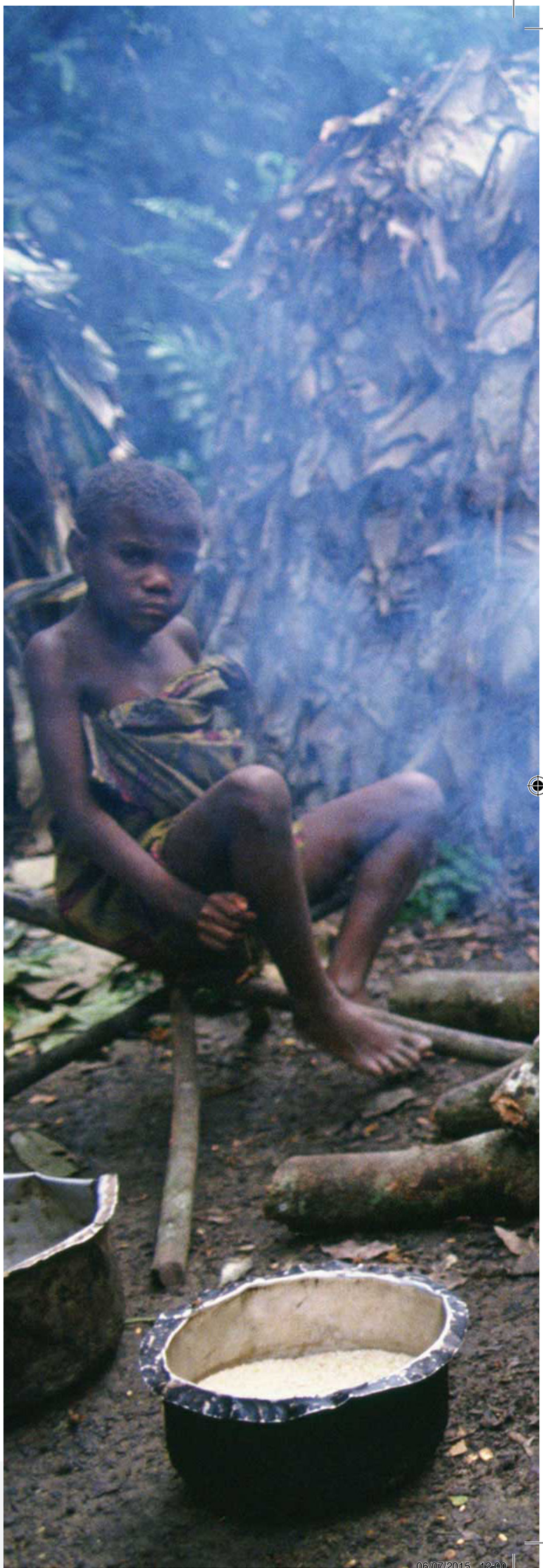
“While only two mtDNA motherlines account for all non-Africans, there are at least 23 female African lineages.”

Your genetic cousins are amongst the kindreds of the Mbuti pygmies of the Ituri tropical rainforest in the north and north-east of the Democratic Republic of the Congo in Central Africa. They are an ancient society of hunter-gatherers who live in small bands of between 16 and 60 people, all usually part of a kindred group. The total population is between 30,000 and 40,000. Their way of life is fragile, much influenced by fluctuations in the moist, warm climate. Through the 10 months of the wet season, they live in small villages but when the rains cease and the weather becomes dry, they enter the forest and range over wide areas to gather food and hunt. They use nets, traps, and bows and arrow to kill game such as wild pigs, antelope and monkeys. And they gather wild yams, berries, fruits, roots, succulent leaves and cola nuts.

These ancient kindreds have recently been assailed by a lethal mixture of politics and exploitation. Deforestation and gold mining are eating into the Ituri Forest and threatening the food supplies of the Mbuti. And in 2003 Sinafesi Makelo revealed to the United Nations Forum on Indigenous Issues the shocking effects of the Congolese Civil War where the pygmies were hunted and killed as though they were wild animals.

“The Mbuti pygmies are an ancient society of hunter-gatherers who live in small bands of between 16 and 60 people.”

Your haplogroup has not yet been seen in African Americans and unless steps are taken soon, those indigenous African populations where it is most common might disappear. But at least in you their DNA will carry on its journey into the future.



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The Geography

Now that you have read about the ancient history of your haplogroup, we will guide you through its geography.

Genetic genealogy and ancestry testing is an expanding area. More individuals, new populations, further markers and novel analytical techniques all mean more data. And that means we can learn more about both the history and geography of our ancestral DNA. Thanks to the participants in our project, we have been able to put together the first map of Britain and Ireland showing the frequencies of your haplogroup across the different regions. Is your haplogroup more common in the east or the west? Or is it more northerly? Or perhaps it has a more complicated pattern? It is interesting to consider how these patterns arose, why some haplogroups show such widespread distributions, while others are more local.

Because our participants detail where their grandparents and in some cases deeper ancestors lived, we can use that to plot frequencies of these types over 100 years ago. This avoids the mixing that has occurred in the 20th century, in the age of mass transport, which inevitably begins to erase these patterns. We can thus peer back in time to see the ancestral distribution.

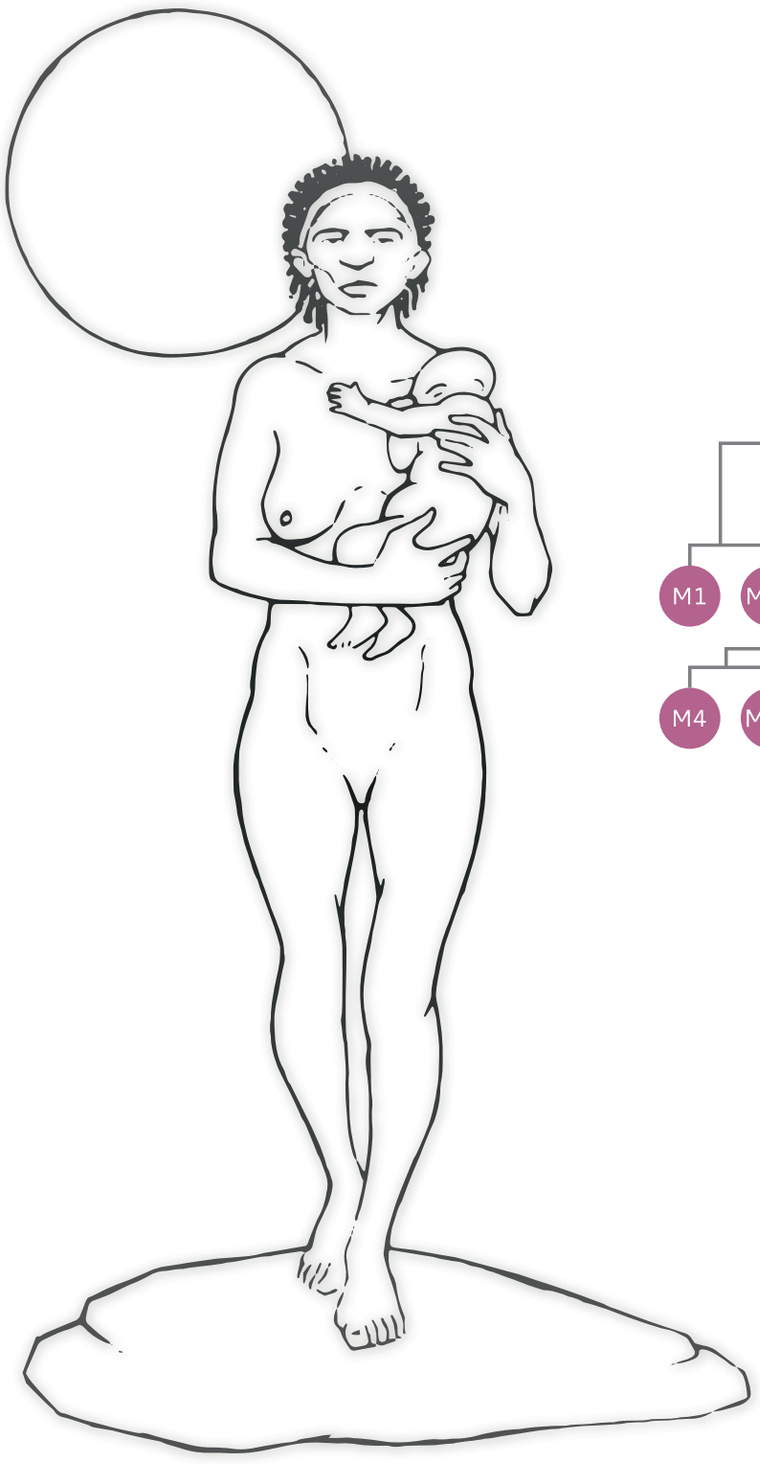
What about beyond Britain and Ireland? We show which populations in the world have the highest proportion of your haplogroup using data from many sources. In some cases the pattern in Britain and Ireland fits into a greater European distribution, at other times it is idiosyncratic.

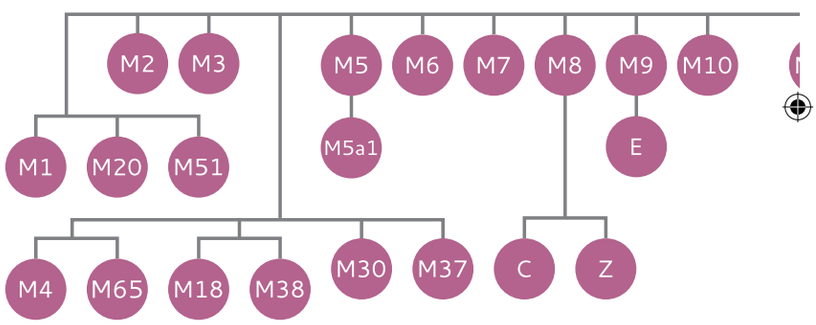
Finally we show you how your haplogroup fits in with all the others in the mtDNA tree. This tree links everyone in the world, a family tree of humankind, all descended from Mitochondrial Eve. We do not have room to show the full tree here but instead provide an outline to help you see which groups are more closely related to you, which are more distant, and how you descend from Eve, our motherline ancestress.

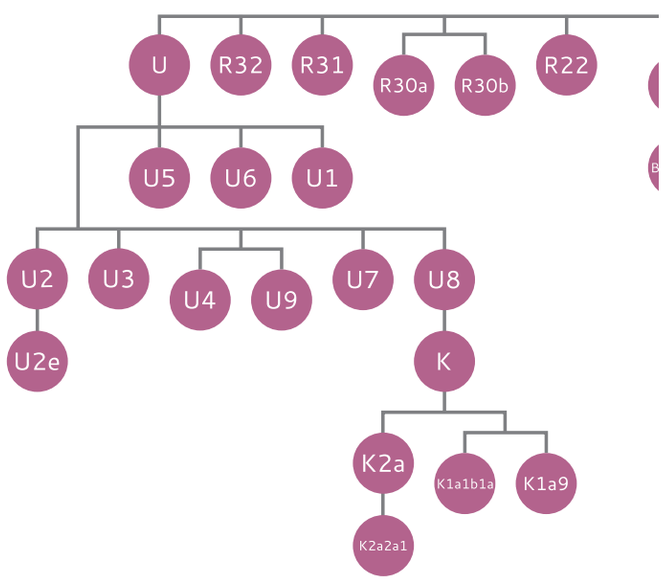
The mtDNA Tree

The mitochondrial DNA tree shows how your mtDNA haplogroup descends from Mitochondrial Eve and how it is related to all other haplogroups. The phylogenetic tree is very large with almost two hundred major haplogroups and thousands of individual lineages. Indeed this tree would connect every person in the world if everyone had their mtDNA tested! We have therefore provided a condensed tree which has been personalised to show where your haplogroup falls on the tree and which others it is related to.

A more complete version of the mtDNA tree can be viewed in the online results package, where you are able to pan and zoom across all the branches. Use the myDNA sign in at the top of the home page to access your results. If you do not have an online account, our customer services team will be happy to set one up for you.







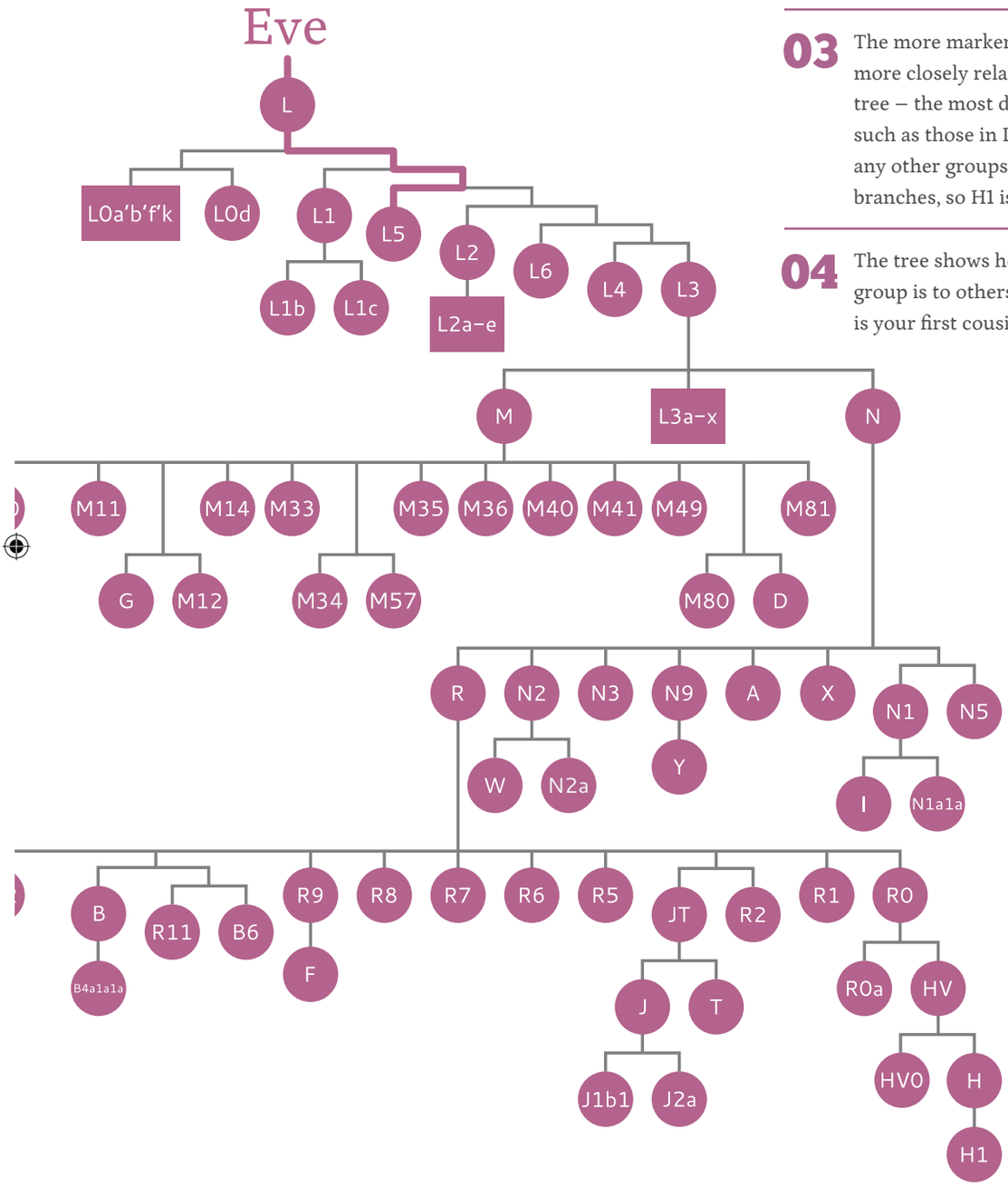
A Tree-Reading Tutorial.

01 Deep in the past all our motherlines descend from one woman, dubbed Mitochondrial Eve. She is our most recent common female line ancestor.

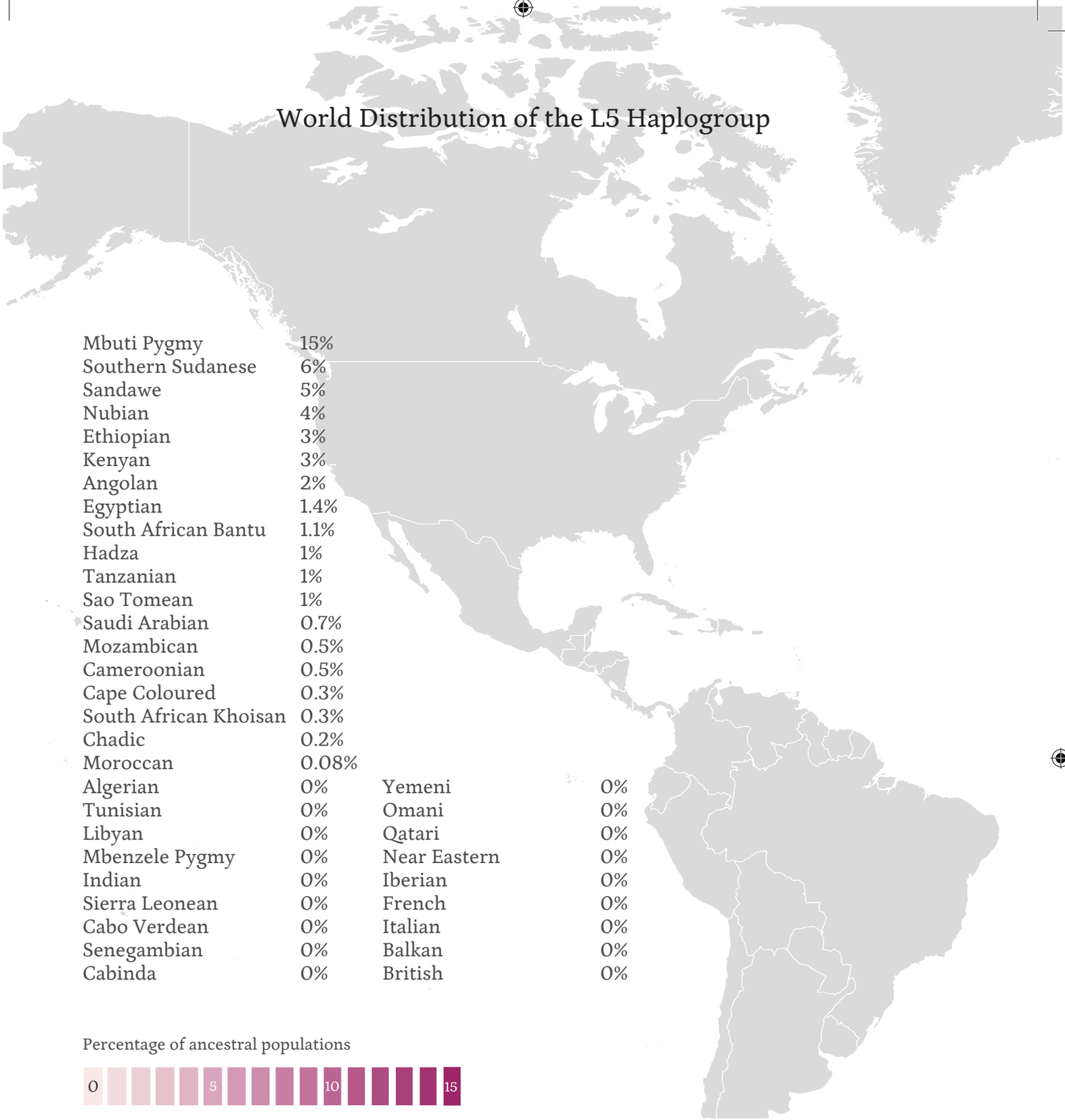
02 As Eve's mtDNA has been passed down the generations, changes have occurred, creating markers. These markers are used to define different branches of the tree, called haplogroups.

03 The more markers you share with someone, the more closely related you are. This is true deep in the tree – the most distantly branching haplogroups such as those in L0 share the least markers with any other groups. It is also true for more recent branches, so H1 is closely related to H2, H3 etc.

04 The tree shows how closely or distantly related your group is to others, just like a family tree shows who is your first cousin and who is your fourth cousin.



World Distribution of the L5 Haplogroup



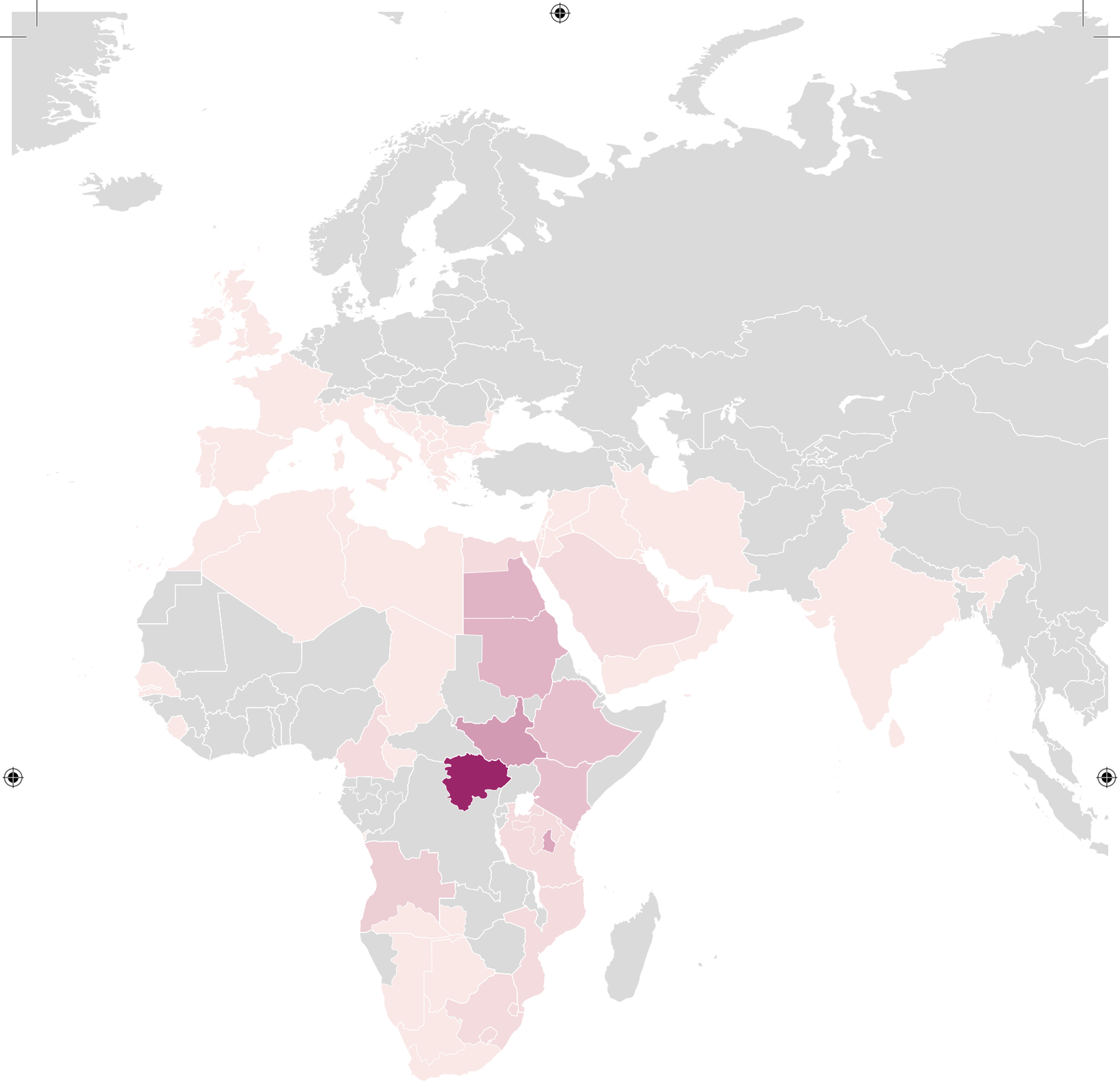
Mbuti Pygmy	15%		
Southern Sudanese	6%		
Sandawe	5%		
Nubian	4%		
Ethiopian	3%		
Kenyan	3%		
Angolan	2%		
Egyptian	1.4%		
South African Bantu	1.1%		
Hadza	1%		
Tanzanian	1%		
Sao Tomean	1%		
Saudi Arabian	0.7%		
Mozambican	0.5%		
Cameroonian	0.5%		
Cape Coloured	0.3%		
South African Khoisan	0.3%		
Chadic	0.2%		
Moroccan	0.08%		
Algerian	0%	Yemeni	0%
Tunisian	0%	Omani	0%
Libyan	0%	Qatari	0%
Mbenzele Pygmy	0%	Near Eastern	0%
Indian	0%	Iberian	0%
Sierra Leonean	0%	French	0%
Cabo Verdean	0%	Italian	0%
Senegambian	0%	Balkan	0%
Cabinda	0%	British	0%

Percentage of ancestral populations

Since the markers which define your haplogroup first arose, they have been spread far and wide by the migrations of people over many millennia. The frequency estimated for each population relates to the whereabouts of your haplogroup about 1500, in the era before inter-continental travel.

When a country is greyed out it means that we do not at present have data to plot, it does not mean that your haplogroup is not found there. A graduated colour scale is provided to highlight where your group is common and rare.

When a country is coloured the lightest colour, it means that reasonable numbers have been tested but that your haplogroup has not been found there.



A list of the populations tested is provided with their frequencies shown descending from highest to lowest. In some cases the figures relate to a particular people within that country.

The results for the world distribution have been brought to you from a combination of the published literature, our own data and databases available from other research projects.

L5 Haplogroup Distribution in Britain and Ireland

We are proud to be the first company to present a breakdown of your haplogroup distribution at a regional level across Britain and Ireland. As with the World Distribution map, it represents the locations of lineages 100 years ago or more, in the era before mass transport. Some maps show a steady decline from west to east whereas others show a more complicated pattern.

What does this map mean to you? Perhaps your haplogroup is common in an area you had not considered in your genealogical research or maybe your ancestral lineage has not moved far over a long line of generations.

Glossary of Terms

DNA

Deoxyribonucleic acid is the complex chemical in which the instructions to build and run our bodies are written – this genetic code is the 'blueprint' for life. It is also the means of transmitting this information to the next generation. The code is written in four letters, A, C, G or T, which are in reality different chemicals making up the larger molecule. We each carry an enormous number of DNA letters (six billion) – all of which we have inherited from our ancestors – it is thus an archive of our ancestry.

Genetic Signature

Your genetic signature is the list of all the tested markers which you carry. This includes the older markers which define your haplogroup, the markers which define your subtype and the most recent markers which are possibly specific to your recent lineage, such as your surname.

Haplogroup

A haplogroup is a large group of related lineages which share a common ancestor. A haplogroup is defined by a number of markers which it shares to the exclusion of other lineages. A haplogroup is made up of many different subtypes, some of which may have been accorded haplogroup status in their own right. Haplogroups are known by a series of letters, sometimes including a marker name.

Marker

A marker is a change or a mistake in the copying of the genetic code - the six billion letters of your DNA. These changes define different haplogroups and subtypes and help map your ancestors' journey across the globe. There are a number of different kinds of marker but the most abundant are known as single nucleotide polymorphisms or SNPs, where one DNA letter is changed to another.

mtDNA

Mitochondrial DNA is passed from a mother to all of her children, but only daughters then pass it on. Mitochondrial DNA is inherited as one block and contains many markers that allow us to identify over one hundred different groups of related lineages and many subtypes within each group.

Subgroup

Used in the text to refer to when a haplogroup is a subdivision of another haplogroup. For example, in YDNA, R1b-M222 and R1b-S530 are subgroups of R1b-S145 and in mtDNA, H1 is a subgroup of H.

Subtype

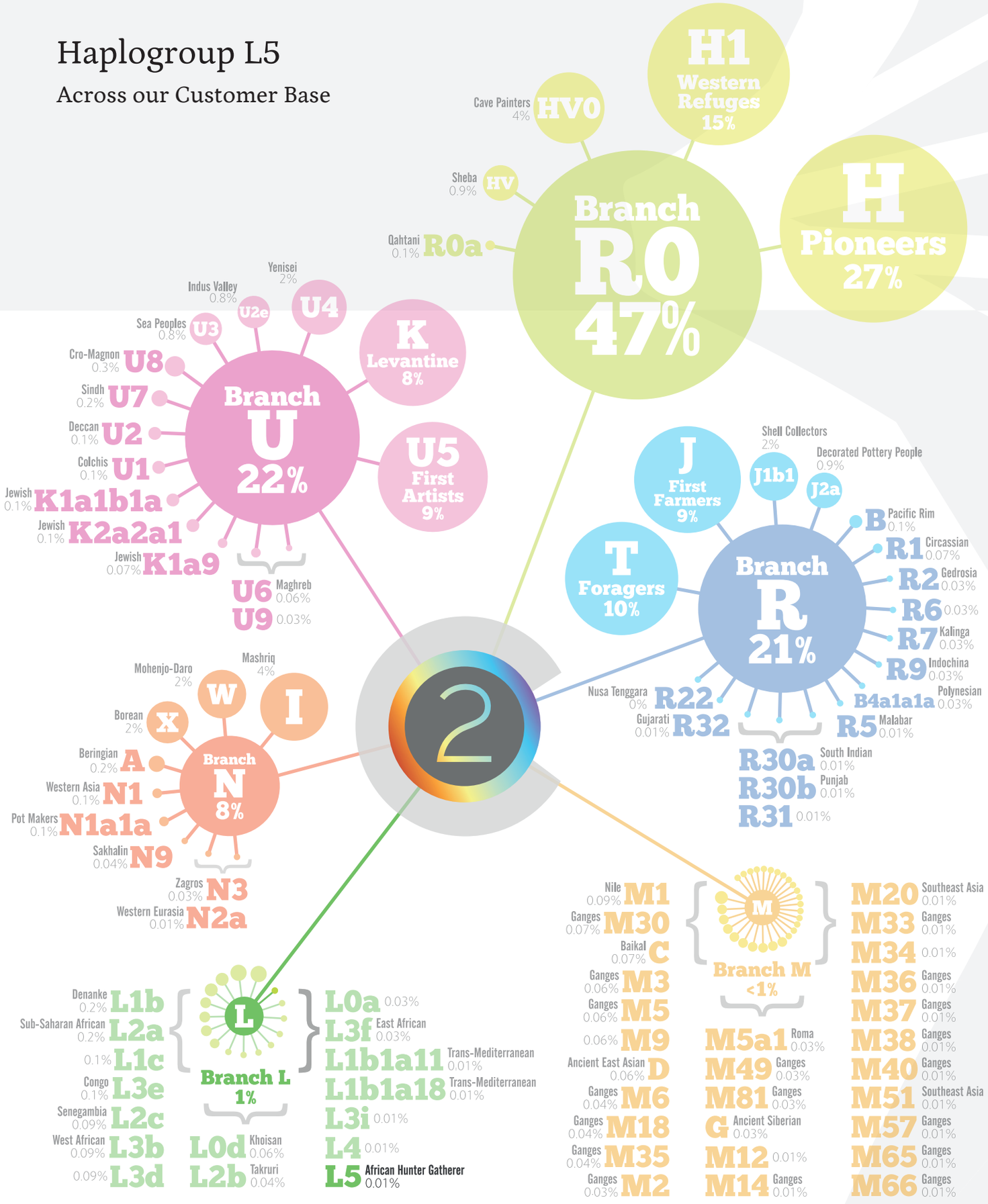
A subtype is a sub-branch of your haplogroup. This is sometimes known as haplotype and is younger than the haplogroup. Subtypes share more markers than lineages across a haplogroup: they are more closely related. A subtype ending in an asterisk indicates that this lineage is not part of any of the defined subtypes.

Super-cluster

A point deep in the tree from which many branches and haplogroups descend, e.g. in YDNA the M526 marker defines a super-cluster, from which arise all the R1a and R1b haplogroups, as well as Q, N, O, M and S. In mtDNA, the M, N and R branches are super-clusters, each of which divide into more than 20 haplogroups.

Haplogroup L5

Across our Customer Base



The main six circles coming from the centre represent the super-clusters of the mtDNA tree and the smaller circles stemming from these show the different haplogroups. The larger the circle, the greater percentage of customers who belong to the haplogroup. Your haplogroup and major branch have been highlighted. Note that the connections between haplogroups and super-clusters do not portray their genealogical connections - these are shown in the mtDNA tree.