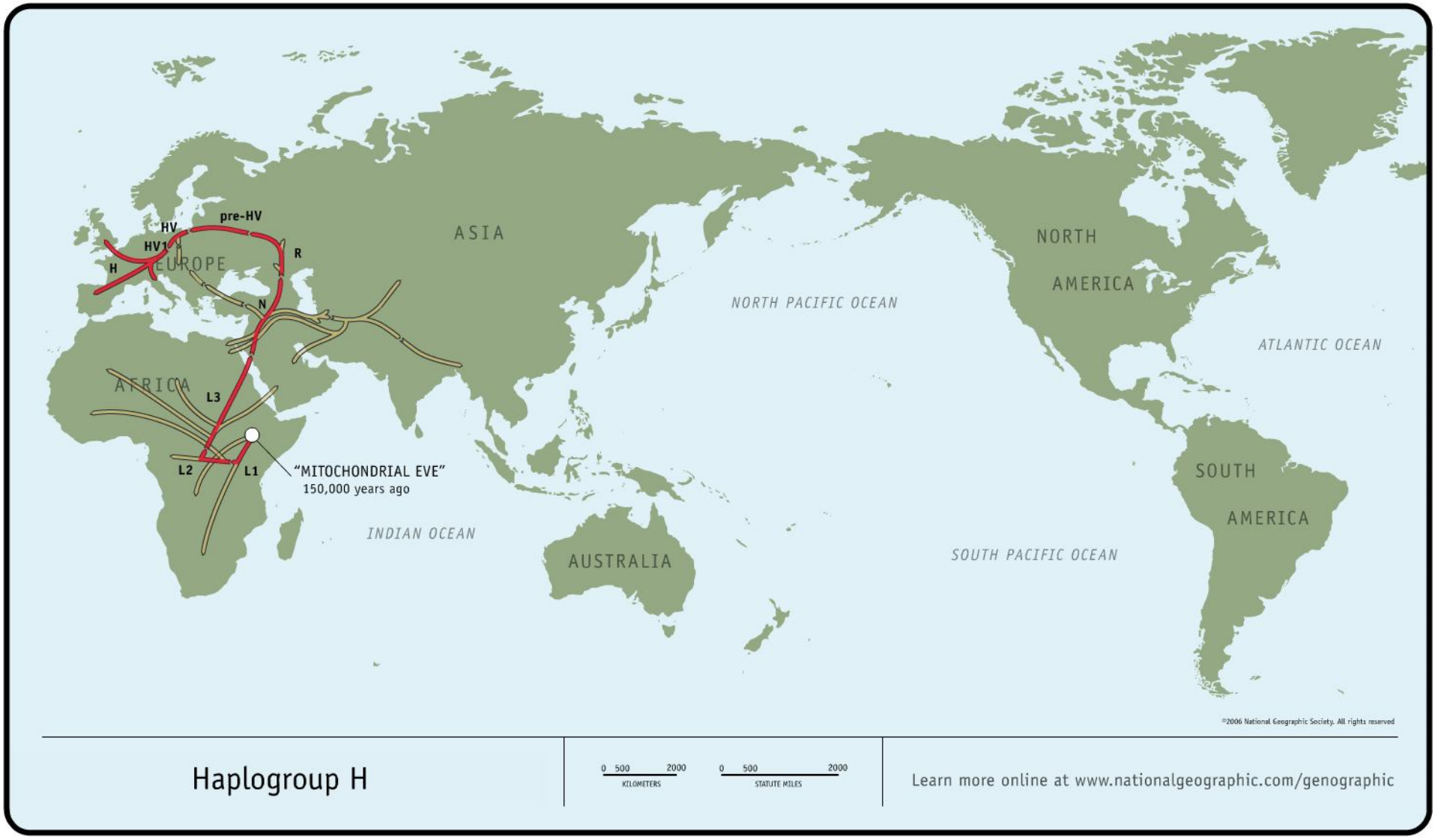
THE GENOGRAPHIC PROJECT

MIGRATION ROUTES: WILLIAM KINSEY KOERBER



Haplogroup H

0 500 2000 KILOMETERS

0 500 2000 STATUTE MILES

Learn more online at www.nationalgeographic.com/genographic

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Certificate of mtDNA testing

In recognition of your participation in the Genographic Project, we hereby certify that

William Kinsey Koerber

belongs to:

Haplogroup H

The letters designating the bases adenine, cytosine, guanine, or thymine of your mtDNA differ from Cambridge Reference Sequence (CRS) at each of the following positions:

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July 26, 2008

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HAPLOGROUP H

Your Branch on the Human Family Tree

Your DNA results identify you as belonging to a specific branch of the human family tree called **haplogroup** *H*. Haplogroup H contains the following subgroups: H, H*, H1, H1*, H10, H11, H11a, H12, H13, H14, H15, H1a, H1b, H1f, H2, H2*, H2a, H2a1, H2b, H3, H4, H4a, H5, H5*, H5a, H5a1, H6a, H6a1, H6c, H7, H8, H9.

The map above shows the direction that your maternal ancestors took as they set out from their original homeland in East Africa. While humans did travel many different paths during a journey that took tens of thousands of years, the lines above represent the dominant trends in this migration.

Over time, the descendants of your ancestors spread across Eurasia and today make up the most frequent western European haplogroup. But before we can take you back in time and tell their stories, we must first understand how modern science makes this analysis possible.

How DNA Can Help
(To follow along, click **See Your DNA Analysis** *above to view the data produced from your cheek scraping.)*

The string of 569 letters shown above is your mitochondrial sequence, with the letters *A, C, T,* and *G* representing the four nucleotides the chemical building blocks of life that make up your DNA. The numbers at the top of the page refer to the positions in your sequence where informative mutations have occurred in your ancestors, and tell us a great deal about the history of your genetic lineage.

Here's how it works. Every once in a while a mutation a random, natural (and usually harmless) change occurs in the sequence of your mitochondrial DNA. Think of it as a spelling mistake: one of the "letters" in your sequence may change from a *C* to a *T,* or from an *A* to a *G*.
(Explore the **Genetics Overview** *to learn more about population genetics.)*

After one of these mutations occurs in a particular woman, she then passes it on to her daughters, and her daughters' daughters, and so on. (Mothers also pass on their mitochondrial DNA to their sons, but the sons in turn do not pass it on.)

Geneticists use these markers from people all over the world to construct one giant mitochondrial family tree. As you can imagine, the tree is very complex, but scientists can now determine both the age and geographic spread of each branch to reconstruct the prehistoric movements of our ancestors.

By looking at the mutations that *you* carry, we can trace your lineage, ancestor by ancestor, to reveal the path they traveled as they moved out of Africa. Our story begins with your earliest ancestor. Who was she, where did she live, and what is her story?

(Click **Explore Your Route Map** *on the right side of the page to return to the map showing your haplogroup´s ancestral journey.)*

Your Ancestral Journey: What We Know Now

We will now take you back through the stories of your distant ancestors and show how the movements of their descendants gave rise to your mitochondrial lineage.

Each segment on the map above represents the migratory path of successive groups that eventually coalesced to form your branch of the tree. We start with your oldest ancestor, "Eve," and walk forward to more recent times, showing at each step the line of your ancestors who lived up to that point.

Mitochondrial Eve: The Mother of Us All

Ancestral Line: "Mitochondrial Eve"

Our story begins in Africa sometime between 150,000 and 170,000 years ago, with a woman whom anthropologists have nicknamed "Mitochondrial Eve."

She was awarded this mythic epithet in 1987 when population geneticists discovered that all people alive on the planet today can trace their maternal lineage back to her.

But Mitochondrial Eve was not the first female human. *Homo sapiens* evolved in Africa around 200,000 years ago, and the first hominids characterized by their unique bipedal stature appeared nearly two million years before that. Though *Homo sapiens* have been around for about 200,000 years, about 150,000 to 170,000 years ago, a woman was born from whom we are all descended. This happened 30,000 years after *Homo sapiens* evolved in Africa.

Eventually, for any number of reasons, all of the other lineages of people went extinct, and "Mitochondrial Eve" as we call her, was the only female who had descendants that are now living in the present day. We can all be traced back to that one woman, who lived about 170,000 years ago.

Which begs the question, "So why Eve?"

Simply put, Eve was a survivor. A maternal line can become extinct for a number of reasons. A woman may not have children, or she may bear only sons (who do not pass her mtDNA to the next generation). She may fall victim to a catastrophic event such as a volcanic eruption, flood, or famine, all of which have plagued humans since the dawn of our species.

None of these extinction events happened to Eve's line. It may have been simple luck, or it may have been something much more. It was around this same time that modern humans' intellectual capacity underwent what author Jared Diamond coined the Great Leap Forward. Many anthropologists believe that the emergence of language gave us a huge advantage over other early human species. Improved tools and weapons, the ability to plan ahead and cooperate with one another, and an increased capacity to exploit resources in ways we hadn't been able to earlier, all allowed modern humans to rapidly migrate to new territories, exploit new resources, and outcompete and replace other hominids, such as the Neandertals.

It is difficult to pinpoint the chain of events that led to Eve's unique success, but we can say with certainty that all of us trace our maternal lineage back to this one woman.

The *L* Haplogroups: The Deepest Branches

Ancestral line: "Eve" > *L1/L0*

Mitochondrial Eve represents the root of the human family tree. Her descendents, moving around within Africa, eventually split into two distinct groups, characterized by a different set of mutations their members carry.

These groups are referred to as *L0* and *L1,* and these individuals have the most divergent genetic sequences of anybody alive today, meaning they represent the deepest branches of the mitochondrial tree. Importantly, current genetic data indicates that indigenous people belonging to these groups are found exclusively in Africa. This means that, because all humans have a common female ancestor, "Eve," and because the genetic data shows that Africans are the oldest groups on the planet, we know our species originated there.

Haplogroups *L1* and *L0* likely originated in East Africa and then spread throughout the rest of the continent. Today, these lineages are found at highest frequencies in Africa's indigenous populations, the hunter-gatherer groups who have maintained their ancestors' culture, language, and customs for thousands of years.

At some point, after these two groups had coexisted in Africa for a few thousand years, something important happened. The mitochondrial sequence of a woman in one of these groups, *L1,* mutated. A letter in her DNA changed, and because many of her descendants have survived to the present, this change has become a window into the past. The descendants of this woman, characterized by this signpost mutation, went on to form their own group, called *L2*. Because the ancestor of *L2* was herself a member of *L1,* we can say something about the emergence of these important groups: Eve begat *L1,* and *L1* begat *L2*. Now we're starting to move down your ancestral line.

Haplogroup *L2:* **West Africa**

Ancestral line: "Eve" > *L1/L0* > *L2*

L2 individuals are found in sub-Saharan Africa, and like their *L1* predecessors, they also live in Central Africa and as far south as South Africa. But whereas *L1/L0* individuals remained predominantly in eastern and southern Africa, your ancestors broke off into a different direction, which you can follow on the map above.

L2 individuals are most predominant in West Africa, where they constitute the majority of female lineages. And because *L2* individuals are found at high frequencies and widely distributed along western Africa, they represent one of the predominant lineages in African-Americans. Unfortunately, it is difficult to pinpoint where a specific *L2* lineage might have arisen. For an African-American who is *L2* the likely result of West Africans being brought to America during the slave trade it is difficult to say with certainty exactly where in Africa that lineage arose.

Fortunately, collaborative sampling with indigenous groups is currently underway to help learn more about these types of questions and to possibly bridge the gap that was created during those transatlantic voyages hundreds of years ago.

Haplogroup *L3:* **Out of Africa**

Ancestral line: "Eve" > *L1/L0* > *L2* > *L3*

Your next signpost ancestor is the woman whose birth around 80,000 years ago began haplogroup *L3*. It is a similar story: an individual in *L2* underwent a mutation to her mitochondrial DNA, which was passed onto her children. The children were

successful, and their descendants ultimately broke away from the *L2* clan, eventually separating into a new group called *L3*. You can see above that this has revealed another step in your ancestral line.

While *L3* individuals are found all over Africa, including the southern reaches of sub-Sahara, *L3* is important for its movements north. You can follow this movement of the map above, seeing first the expansions of *L1/L0,* then *L2,* and followed by the northward migration of *L3*.

Your *L3* ancestors were significant because they are the first modern humans to have left Africa, representing the deepest branches of the tree found outside of that continent.

Why would humans have first ventured out of the familiar African hunting grounds and into unexplored lands? It is likely that a fluctuation in climate may have provided the impetus for your ancestors' exodus out of Africa.

The African Ice Age was characterized by drought rather than by cold. Around 50,000 years ago the ice sheets of northern Europe began to melt, introducing a period of warmer temperatures and moister climate in Africa. Parts of the inhospitable Sahara briefly became habitable. As the drought-ridden desert changed to savanna, the animals your ancestors hunted expanded their range and began moving through the newly emerging green corridor of grasslands. Your nomadic ancestors followed the good weather and plentiful game northward across this Saharan Gateway, although the exact route they followed remains to be determined.

Today, *L3* individuals are found at high frequencies in populations across North Africa. From there, members of this group went in a few different directions. Some lineages within *L3* testify to a distinct expansion event in the mid-Holocene that headed south, and are predominant in many Bantu groups found all over Africa. One group of individuals headed west and is primarily restricted to Atlantic western Africa, including the islands of Cabo Verde.

Other *L3* individuals, your ancestors, kept moving northward, eventually leaving the African continent completely. These people currently make up around ten percent of the Middle Eastern population, and gave rise to two important haplogroups that went on to populate the rest of the world.

Haplogroup *N:* The Incubation Period

Ancestral line: "Eve" > *L1/L0* > *L2* > *L3* > *N*

Your next signpost ancestor is the woman whose descendants formed haplogroup *N*. Haplogroup *N* comprises one of two groups that were created by the descendants of *L3*.

The first of these groups, *M,* was the result of the first great wave of migration of modern humans to leave Africa. These people likely left the continent across the Horn of Africa near Ethiopia, and their descendants followed a coastal route eastward, eventually making it all the way to Australia and Polynesia.

The second great wave, also of *L3* individuals, moved north rather than east and left the African continent across the Sinai Peninsula, in present-day Egypt. Also faced with the harsh desert conditions of the Sahara, these people likely followed the Nile basin, which would have proved a reliable water and food supply in spite of the surrounding desert and its frequent sandstorms.

Descendants of these migrants eventually formed haplogroup *N*. Early members of this group lived in the eastern Mediterranean region and western Asia, where they likely coexisted for a time with other hominids such as Neandertals. Excavations in Israel's Kebara Cave (Mount Carmel) have unearthed Neandertal skeletons as recent as 60,000 years old, indicating that there was both geographic and temporal overlap of these two hominids.

The ancient members of haplogroup *N* spawned many sublineages, which went on to populate much of the rest of the globe. They are found throughout Asia, Europe, India, and the Americas.

Haplogroup *R:* Spreading Out

Ancestral line: "Eve" > *L1/L0* > *L2* > *L3* > *N* > *R*

After several thousand years in the Near East, individuals belonging to a new group called haplogroup *R* began to move out and explore the surrounding areas. Some moved south, migrating back into northern Africa. Others went west across Anatolia (present-day Turkey) and north across the Caucasus Mountains of Georgia and southern Russia. Still others headed east into the Middle East, and on to Central Asia. All of these individuals had one thing in common: they shared a female ancestor from the *N* clan, a recent descendant of the migration out of Africa.

The story of haplogroup *R* is complicated, however, because these individuals can be found almost everywhere, and because their origin is quite ancient. In fact, the ancestor of haplogroup *R* lived relatively soon after humans moved out of Africa during the second wave, and her descendants undertook many of the same migrations as her own group, *N*.

Because the two groups lived side by side for thousands of years, it is likely that the migrations radiating out from the Near East comprised individuals from both of these groups. They simply moved together, bringing their *N* and *R* lineages to the same places around the same times. The tapestry of genetic lines became quickly entangled, and geneticists are currently working to unravel the different stories of haplogroups *N* and *R,* since they are found in many of the same far-reaching places.

Haplogroup *pre-HV:* In the Near East

Ancestral line: "Eve" > *L1/L0* > *L2* > *L3* > *N* > *R* > *pre-HV*

Descending from haplogroup *R* were a group of individuals who formed a western Eurasian lineage. The descendants of *pre-HV* live in high frequencies in the Anatolian-Caucasus region and Iran. While members of this group can also be found in the Indus Valley near the Pakistan-India border, their presence is considered the result of a subsequent migration eastward of individuals out of the Near East.

Individuals in haplogroup *pre-HV* can be found all around the Red Sea and widely throughout the Near East. While this genetic lineage is common in Ethiopia and Somalia, individuals from this group are found at highest frequency in Arabia. Because of their close genetic and geographic proximity to other western Eurasian clusters, members of this group living in eastern Africa are the likely result of more recent migrations back into the continent.

As we have seen from haplogroups *N* and *R,* descendants from these western Eurasian lineages used the Near East as a home base of sorts, radiating from that region to populate much of the rest of the world. Their descendants comprise all of the western Eurasian genetic lineages, and about half of the eastern Eurasian mtDNA gene pool. Some individuals moved across the Middle East into Central Asia and the Hindus Valley near western India. Some moved south, heading back into the African

homeland from where their ancestors had recently departed.

Haplogroup *pre-HV* is of particular importance because over the course of several thousand years, its descendants split off and formed their own group, called *HV*. This group thanks in large part to a brutal cold spell that was about to set in gave rise to the two most prevalent female lineages found in Western Europe.

Haplogroup *HV*:The Near East and Beyond

Ancestral line: "Eve" > *L1/L0* > *L2* > *L3* > *N* > *R* > *pre-HV* > *HV*

While some descendants of these ancestral lineages moved out across Central Asia, the Indus Valley, and even back into Africa, your ancestors remained in the Near East. Descending from haplogroup *pre-HV*, they formed a new group, characterized by a unique set of mutations, called haplogroup *HV*.

Haplogroup *HV* is a west Eurasian haplogroup found throughout the Near East, including Anatolia (present-day Turkey) and the Caucasus Mountains of southern Russia and the republic of Georgia. It is also found in parts of East Africa, particularly in Ethiopia, where its presence there indicates recent Near Eastern gene flow, likely the result of the Arab slave trade over the last two millennia.

Much earlier, around 30,000 years ago, some members of *HV* moved north across the Caucasus Mountains and west across Anatolia, their lineages being carried into Europe for the first time by the Cro-Magnon. Their arrival in Europe heralded the end of the era of the Neandertals, a hominid species that inhabited Europe and parts of western Asia from about 230,000 to 29,000 years ago. Better communication skills, weapons, and resourcefulness probably enabled them to outcompete Neandertals for scarce resources. Importantly, some descendants of *HV* had already broken off and formed their own group, haplogroup *H,* and continued the push into Western Europe.

Haplogroup *H:* Your Branch on the Tree

Ancestral line: "Eve" > *L1/L0* > *L2* > *L3* > *N* > *R* > *pre-HV* > *HV* > *H*

This wave of migration into western Europe marked the appearance and spread of what archaeologists call the Aurignacian culture. The culture is distinguished by significant innovations in methods of manufacturing tools, standardization of tools, and use of a broader set of tool types, such as end-scrapers for preparing animal skins and tools for woodworking.

Around 15,000 to 20,000 years ago, colder temperatures and a drier global climate locked much of the world's fresh water at the polar ice caps, making living conditions near impossible for much of the northern hemisphere. Early Europeans retreated to the warmer climates of the Iberian Peninsula, Italy, and the Balkans, where they waited out the cold spell. Their population sizes were drastically reduced, and much of the genetic diversity that had previously existed in Europe was lost.

Beginning about 15,000 years ago after the ice sheets had begun their retreat humans moved north again and recolonized western Europe. By far the most frequent mitochondrial lineage carried by these expanding groups was haplogroup *H*. Because of the population growth that quickly followed this expansion, your haplogroup now dominates the European female landscape.

Today haplogroup *H* comprises 40 to 60 percent of the gene pool of most European populations. In Rome and Athens, for

example, the frequency of *H* is around 40 percent of the entire population, and it exhibits similar frequencies throughout western Europe. Moving eastward the frequencies of *H* gradually decreases, clearly illustrating the migratory path these settlers followed as they left the Iberian Peninsula after the ice sheets had receded. Haplogroup *H* is found at around 25 percent in Turkey and around 20 percent in the Caucasus Mountains.

While haplogroup *H* is considered the Western European lineage due to its high frequency there, it is also found much further east. Today it comprises around 20 percent of southwest Asian lineages, about 15 percent of people living in Central Asia, and around five percent in northern Asia.

Importantly, the age of haplogroup *H* lineages differs quite substantially between those seen in the West compared with those found in the East. In Europe its age is estimated at 10,000 to 15,000 years old, and while *H* made it into Europe substantially earlier (30,000 years ago), reduced population sizes resulting from the glacial maximum significantly reduced its diversity there, and thus its estimated age. In Central and East Asia, however, its age is estimated at around 30,000 years old, meaning your lineage made it into those areas during some of the earlier migrations out of the Near East.

Haplogroup *H* is a great example of the effect that population dynamics such as bottleneck events, founder effect, genetic drift, and rapid population growth, have on the genetic diversity of resulting populations.

Anthropology vs. Genealogy

DNA markers require a long time to become informative. While mutations occur in every generation, it requires at least hundreds normally thousands of years for these markers to become windows back into the past, signposts on the human tree.

Still, our own genetic sequences often reveal that we fall within a particular sub-branch, a smaller, more recent branch on the tree.

While it may be difficult to say anything about the history of these sub-groups, they do reveal other people who are more closely related to us. It is a useful way to help bridge the anthropology of population genetics with the genealogy to which we are all accustomed.

One of the ways you can bridge this gap is to compare your own genetic lineage to those of people living all over the world. Mitosearch.org is a database that allows you to compare both your genetic sequence as well as your surname to those of thousands of people who have already joined the database. This type of search is a valuable way of inferring population events that have occurred in more recent times (i.e., the past few hundred years).

Looking Forward (Into the Past): Where Do We Go From Here?

Although the arrow of your haplogroup currently ends throughout Western Europe, this isn't the end of the journey for haplogroup *H*. This is where the genetic clues get murky and your DNA trail goes cold. Your initial results shown here are based upon the best information available today but this is just the beginning.

A fundamental goal of the Genographic Project is to extend these arrows further toward the present day. To do this, Genographic has brought together ten renowned scientists and their teams from all over the world to study questions vital to our understanding of human history. By working together with indigenous peoples around the globe, we are learning more about these ancient migrations.

Help Us Find More Clues!

But there is another way that we will learn more about the past. By contributing your own results to the project, you will be allowed to participate anonymously in this ongoing research effort. This is important because it may contribute a great deal to our understanding of more recent human migrations. Click the yellow button below in the "Help Us Tell the Story" section of your results profile to learn more about this. It's quick, easy, and anonymous, but will help us further refine our analyses.

Don't Be a Stranger

Finally, keep checking these pages to follow along with the project and our latest findings; your results profile will be automatically updated to reflect any new information that may come to light based on the research.

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