

OUR TOP PICKS: DNA TESTING REVIEWS

Direct-to-consumer (DTC) DNA testing is a fast-growing industry with over 26 million users worldwide. That number is expected to grow to [100 million](#) by 2021. DNA — the genetic building blocks of life — is what determines how all organisms will develop. Through genomic research, scientists seek to identify how organisms, including humans, work. DTC DNA companies make use of both ongoing genomic research and their own proprietary algorithms to offer [genetic tests](#) that can *“reveal some information about your ancestry and the health of you and your family.”*

DNA testing companies typically examine customers’ [“autosomal,” “Y,” and/or “mitochondrial” DNA](#). Autosomal DNA refers to the genes found in chromosomes 1-22, which is a mixture of both parents’ DNA and is often used to estimate ethnicity and health risks. Y DNA refers to DNA from the Y chromosome, which is only passed from father to son and can be used to trace patrilineal ancestry thousands of years. And mitochondrial DNA (mtDNA) refers to genes in the mitochondria, which is passed from mother to child and can be used to trace matrilineal ancestry.

Direct-to-consumer DNA testing, therefore, can offer a starting point for customers interested in researching their family history or gaining some insight into their genetic makeup. At the same time, during our research, it quickly became evident that many companies employ marketing tools and hyperbolic language that could lead to confusion or misunderstanding of what genomic research can and cannot tell us.

We will attempt to illuminate some of these areas of confusion, while also providing objective reviews of our top picks ahead.

ANCESTRY REVIEW



Best For Family Trees & Ancestry Research

With over 15 million completed DNA samples, [AncestryDNA](#) boasts the world's largest commercial genetic genealogy database. As their name suggests, AncestryDNA — a subsidiary of the larger company, Ancestry — primarily offers ancestry information in the form of “ethnicity estimates” as well as a family DNA matching service.

Paid subscribers to Ancestry.com can also connect their DNA results to their Family Trees and documented research to get a fuller picture of their family history.

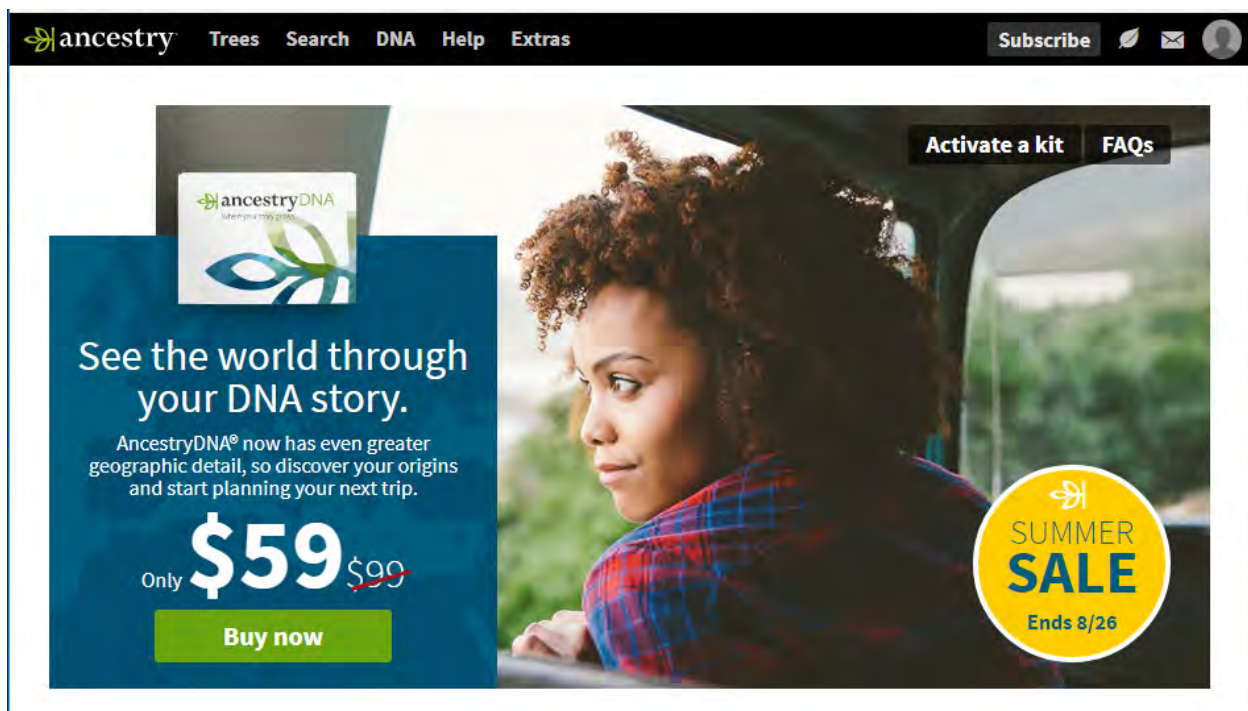
After purchasing and receiving a kit, customers need to “activate” it. This is done before sending in their saliva sample for analysis. Customers don't need to have an Ancestry.com subscription to do their DNA kits, but as explained ahead, some features and services will be unavailable without it.

Services Offered

Currently, AncestryDNA primarily offers ancestry-related services, as opposed to health-related services like some of its competitors. Nonetheless, its large database, supplemented by its regular subscription-based service, make it the best option for genealogy research and building family trees.

Unlike some direct-to-consumer DNA testing companies that only offer a one-time report, AncestryDNA regularly updates their estimates and family matches based on new research they have conducted.

AncestryDNA is currently only available in [34 countries](#) for an average price of \$99 USD (this varies depending on the currency). Depending on the time of the year, however, customers are able to buy the kits at a discounted price.



The image is a screenshot of the Ancestry.com website's summer sale banner. At the top, the navigation bar includes the Ancestry logo, links for 'Trees', 'Search', 'DNA', 'Help', and 'Extras', a 'Subscribe' button, and icons for a leaf, an envelope, and a user profile. The main banner features a woman with curly hair looking out a window. On the left, a dark blue box contains the text 'See the world through your DNA story.' followed by 'AncestryDNA® now has even greater geographic detail, so discover your origins and start planning your next trip.' Below this, the price is shown as 'Only \$59' with a crossed-out '\$99' next to it, and a green 'Buy now' button. On the right, a yellow circular badge says 'SUMMER SALE' and 'Ends 8/26'. In the top right of the banner area, there are buttons for 'Activate a kit' and 'FAQs'.

Screenshot of Ancestry.com's summer sale. August 20, 2019.

Ethnicity Estimates

[AncestryDNA](#) uses “microarray-based autosomal DNA testing” and looks at over 700,000 locations of a person’s genome, comparing customers’ DNA against the 16,000 samples in its reference panel.

It should be noted that some populations have contributed more samples than others. For instance, while the reference panel contains over 2,000 samples from the Germanic Europe region, it contains a mere 65 samples for Western and Central India, 41 samples for the entire Northern Africa region, and a mere 34 samples for the Africa South-Central Hunter-Gatherers region. This is why customers from non-European backgrounds [tend to receive](#) less precise results.

AncestryDNA focuses solely on customers’ autosomal DNA, as opposed to Y-DNA or mtDNA like other companies do, so while they can provide information about matching family members as well as percentage estimates about which population groups customers’ DNA might have originated from, they cannot trace genes to a specific [haplogroup](#). That can only be determined through patrilineal or matrilineal DNA. Instead, AncestryDNA targets more recent history (between a few hundred to a thousand years ago).

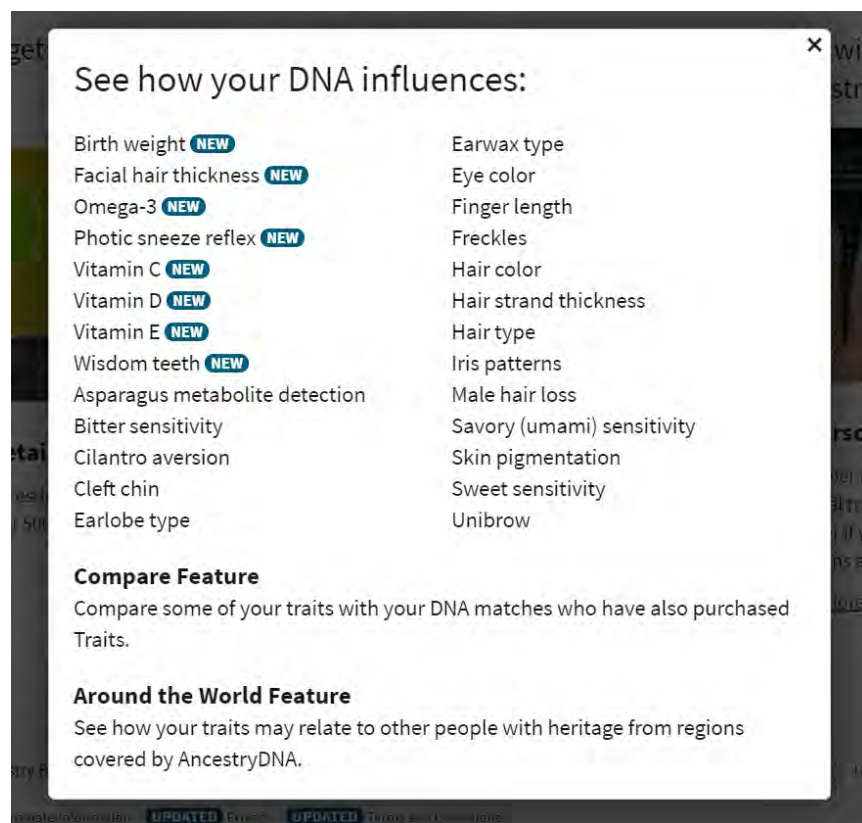
DNA Matches

In addition to ethnicity estimates, AncestryDNA’s best feature is its “Matches,” where each customer’s DNA is compared and associated with that of other customers. In order for customers’ DNA to be matched with potential relatives, they need to be on the database themselves. The service then offers both customers “hints” about their family tree, although it should be noted that this option to build trees is only available to Ancestry subscribers.

Traits

For \$20 dollars more, customers can unlock a bonus feature: a breakdown of 26 traits associated with their particular genes. These range from confirmation of features customers would already be aware of such as having a cleft chin, joined earlobes, and eye color, to ones that could inform their lifestyle choices or future like male hair loss, or the metabolization of various vitamins.

However, because many traits are influenced by multiple genes, some which have been identified and some that haven't, as well as by environmental factors, it should be noted that DNA Traits might not be 100% accurate. As with all other services, AncestryDNA is offering percentage estimates.



Screenshot of Ancestry.com's trait report features. August 20, 2019.

Currently, Ancestry doesn't offer any kind of health risk assessment or carrier status report.

Reports

All AncestryDNA results are accessed through an online account. Once the results are ready — after customers have activated their kit, created their account, and mailed in their DNA sample — Ancestry emails them notifying when the results are ready to be viewed through the online account.

AncestryDNA explicitly states that they will not send results through the mail.

Raw Data Download

The human genome is very big — [3 billion base pairs](#) big, comprising approximately between 20,000-30,000 genes. In order to analyze it, AncestryDNA and other similar companies digitize it. This allows them to quickly and effectively run their various proprietary algorithms on customers' genetic codes.

AncestryDNA, in particular, focuses on about 700,000 “pieces of data,” also called “locations” or “markers,” which have been associated with certain genes. This is how AncestryDNA generates ethnicity estimates and runs family matches. Their [2018 White Paper](#), a report that details their methodology, explores in detail how they interpret this data in order to produce their estimates.

However, the raw digitized data could be interpreted differently by other companies and services, depending on their own proprietary algorithms. AncestryDNA gives customers the opportunity to download this raw data file from their account. No other person other than the account holder (or someone who has been granted access to the account) can view a customer's raw DNA data.

Customers who download their raw data file are responsible for keeping that data secure, even when uploading their raw data file to other services.

Privacy & Security

The very first “Top questions about AncestryDnA” on the main page directly addresses the security and privacy concerns, promising they use “industry standard practices” to store DNA samples, results, and data. Ancestry.com’s [Privacy Statement](#) also establishes that customers always “maintain ownership” of their DNA data.

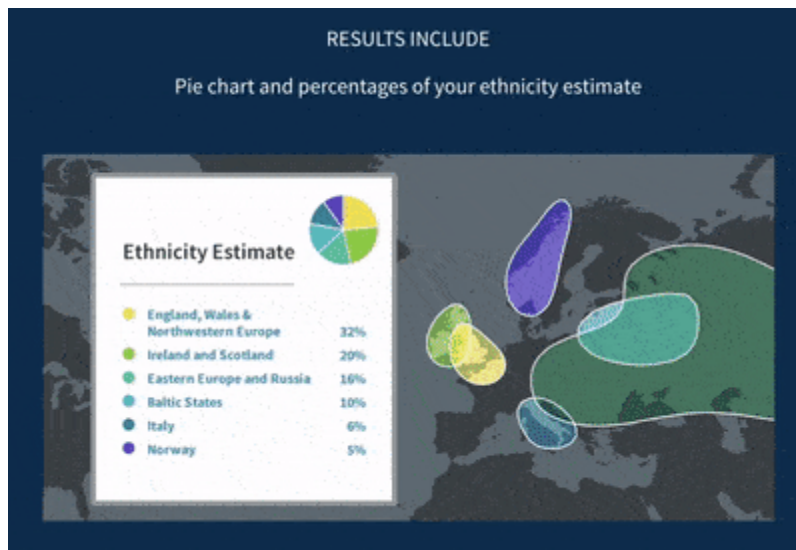
In addition, they assure customers that the third-party testing labs they partner with, Quest Diagnostics Inc. and Illumina, do not store their DNA samples with their name or other identifying information that could trace the sample back to them. Consumers should note, however, that [experts](#) have [shown](#) that “genomic data is highly distinguishable” and could be re-identified to an individual even when the sample has been anonymized.

Ancestry gives customers the choice to consent to participate in their research projects, namely the [Human Diversity Project](#). This project is separate from their regular services, and declining to participate does not affect or diminish a customer’s access to AncestryDNA’s services.

As part of Ancestry’s commitment to putting DNA data ownership in the hands of their customers, they offer the choice to have all genetic information deleted if so wanted. This can include the destruction of biological samples (customers’ spit), which can only be done by directly contacting Member Services. However, this option is unavailable if the customer agrees to Ancestry’s [“informed consent to research”](#)

Online Resources

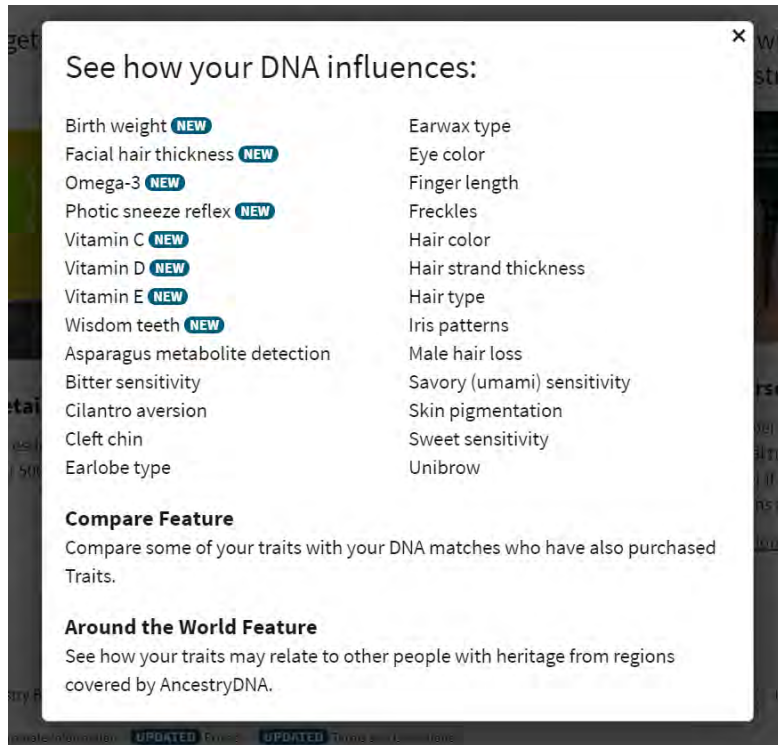
Navigating AncestryDNA's main page and other online resources can be frustrating. This is caused, in part, by how several of their links to more information — “What your results will include,” “See a sample community,” and “See a match list” — all lead to the same slideshow:



Screenshot of Ancestry.com's results slideshow. August 20, 2019.

Some of the slides are so similar to other images on the main page that it doesn't really provide additional insight into what results will look like.

“Explore AncestryDNA Traits” is similarly vague. It contains a list of the 26 traits that will appear on a customer's report, but not what they mean. For example, while “cleft chin” and “earlobe type” are self-explanatory, others like “Omega-3” or “Vitamin C” are less clear.




Screenshot of Ancestry.com's list of "DNA traits." August 20, 2019.

Overall, there's very little information about what DNA is, how it can be used to determine ancestry connections and history, and how AncestryDNA's algorithms work. Clicking through on the sixth question at the bottom of the main page leads to explanations about their ethnicity breakdown, although it still mostly just offers vague information.

Details about the new estimates

Why are you updating customers' ethnicity estimates? 

How do you calculate these estimates? 


What makes the latest results more precise? 

Larger Reference Panel


We've added 13,000 more samples to our reference panel, which increases our ability to identify and find the genetic signature of a region within one's DNA.

Improved Algorithm

A new algorithm analyzes longer segments of genetic information in combination with analysis of DNA samples from Ancestry's expanded proprietary population reference panel.

What is a reference panel? 

What are the regions you have added? 

How much will the new version cost? 

Screenshot of Ancestry.com's FAQs section. August 20, 2019.

Nevertheless, it's great that Ancestry explains — albeit not on their main page — that ethnicity estimation is not 100% accurate and set, but that it's dependent on Ancestry's own proprietary algorithms:

"Analyzing DNA to estimate a person's ethnicity is at the cutting edge of science — and in a field that is evolving rapidly, there will always be developments and improvements we can make. [...] results are as accurate as possible for where the science is today."

We strongly recommend that consumers navigate the company's comprehensive [FAQ](#) section.

[Read Full Review](#)

[VISIT SITE](#)

23ANDME REVIEW



Best For Health Reports

In 2017, [23&Me](#) became the first and only direct-to-consumer DNA test [authorized by the FDA](#) to offer genetic risk reports to customers. They are partnered with the Illumina Global Screening Array, a CLIA-certified lab, that has conducted the actual genotyping of 23&Me's more than 5 million customers.

With the FDA authorization, 23&Me can offer health predisposition and carrier risk reports for variants in the BRCA1 and BRCA2 genes, for celiac disease, late-onset Alzheimer's disease, Parkinson's, and cystic fibrosis, among others.

Services Offered

In the United States, including all territories and armed forces locations, customers have two purchasing options with 23&Me, an Ancestry Service for \$99 and a Health+Ancestry Service for \$199.

Ancestry Service

Unlike AncestryDNA, 23&Me's ancestry service offers a sizeable breakdown of the maternal and paternal haplogroups (based on Y and mitochondrial DNA). However, when it comes to looking at more recent, immediate family ancestry, records, and family members, 23&Me has been described as more limited.

"The result was much more macro — big picture — than what I was originally thinking. I was thinking that it might be more focused on 'you have such number of cousins and in these types of locations.' But it really traces you back to your roots and a very long time ago."

- Greg Powel, CEO of ConsumersAdvocate.org

Indeed, the attraction of 23&Me's ancestry service is the connection to a deeper history from thousands of years ago. While AncestryDNA compares customer's genes against their 43 region reference panel, 23&Me boasts over 1,000 regions worldwide.

There is a relative finder tool that customers can opt-in or out of, however there's no option to create family trees. Nonetheless, they offer the option to compare relatives' genotype percentages against each other to see how "different ancestries have traveled through the generations."

Health Service

As mentioned, the 13 health predisposition reports and 44 carrier status reports are the best reasons to use 23&Me. As part of their health service, the company also offers 8 wellness reports and 37 traits report.

Because of the sensitive, controversial, and complex nature of genetics, and in order to comply with FDA mandates, 23&Me includes detailed explanations for some of the genetic research they conduct and what it means for customers.

For example, their Type 2 Diabetes page explains what the condition is and who is at risk, as well as provides references to external research that support's 23&Me's own data. In the "carrier status" section, they go into detail about what the ARSACS disorder is, how it presents, and how they test for it, and they provide a [document](#) on the details of the analytical performance of the test.

In addition, health, carrier risk, and wellness reports often include disclaimers about the inherent limitations of DNA testing.

Limitations

- Does **not test** for all possible variants for the condition.
- Does **not report** if someone has two copies of a tested variant.

Important things to keep in mind

These associations were observed in 23andMe research participants of European descent, whose demographics and lifestyles may not be representative of the general population. Our analysis accounted for the effects of age and sex, but other genetic and non-genetic factors may also influence how these habits affect your weight and health.

Our analysis did not include all possible lifestyle factors, and those that were included may not be independent of one another. For example, people who exercise frequently might also tend to have healthy diets. This means that the effect of one habit on your weight may depend in part on your other habits. And don't forget that a healthy lifestyle is important for your overall health, regardless of your weight.

Always consult with a healthcare professional before making any major lifestyle changes. This test does not diagnose any health conditions or provide medical advice.

Screenshot of 23andme.com's disclaimers of limitation. August 20, 2019.

The most thorough explanation, however, is the "BRCA Education" page, which breaks down the key terms in genetic research, and explains how variants or changes in the BRCA1 and BRCA2 genes can result in a person developing cancer.

23&Me explicitly declares that their reports should not be used as diagnostic tools because they're not comprehensive, that not everyone who has a variant associated with the risk of developing cancer will actually develop it, that not everyone who tests negative for these variants will never develop cancer, and that customers who are worried about their health should consult their doctor or a genetic counselor.



Screenshot of 23andme.com's BRCA1/BRCA2 disclaimer. August 20, 2019.

Consumers need to remember, overall, that the same can be said for all health predisposition reports. 23&Me's commitment to transparency and their open encouragement that consumers seek out expert advice through [genetic counselors](#) is commendable.

Privacy & Security

23&Me's privacy FAQ on their main page makes it clear that while there are assurances they can give regarding how the company will and will not use customers' genetic data — not sharing non-anonymized information with third parties, supporting [GINA laws](#), and having specific guidelines for children and at-risk individuals — there are some areas where customers themselves are solely responsible for how they share their information. In addition, they explain that although they will not willingly provide information to law enforcement agencies, they might be required to do so under subpoena or court order.

Moreover, 23&Me emphasizes that customers control a lot of how their genetic data and personal information (from both themselves and family members) is shared by either connecting to other users, connecting to social media, or connecting to other apps, blogs, and forums. For instance, customers can order and send gifts to friends and family, but they have to provide 23&Me with some personal information about them. Similarly, customers can refer and share other people's information to 23&Me who will assume consent was given for the referral until the person requests to be removed from their database.

Most importantly, 23&Me is open about what kind of information they share with third-parties, specifically aggregate information that has been de-identified. Nonetheless, as we mentioned in AncestryDNA's company review, scientists have shown that anonymized DNA data can be re-identified.

Online Resources

Out of all the companies we reviewed, 23&Me's website was the most scannable and intuitively organized. Their explanations of the science and research behind their genetic tests and reports are simple but not simplistic.

Not only does 23&Me explain in detail how they arrive at the predispositions and risk factors in their reports, the Our Science section in their "How it works" tab also expands on key terminology in layman's terms. In addition, as mentioned above, they demonstrate a commitment to transparency and customer education by referencing external science and health journals, as well as openly admitting the limitations of genetic research in several of their pages and reports. Not only this, but they also put their own research up for scrutiny through publication in several top-tier peer-reviewed journals.

We were most impressed by the company’s inclusivity and customer care when it comes to transgender customers. In their [accounts and registration](#) FAQs, 23&Me directly addresses the question — and after a lot of research they are the only DTC DNA company we’ve been able to find who openly does this — of whether transgender individuals can do a DNA test as well as how they can manage the registration process, their personal information, and what others can see through the DNA Relatives feature. This commitment to ensure that a group that has been historically marginalized has control over their genetic information is noteworthy.

[Read Full Review](#)

[VISIT SITE](#)

ORIG3N FITNESS AND NUTRITION KIT REVIEW

ORIG3N 

Best For Variety of Products

While most direct-to-consumer DNA testing companies offer ancestry and health reports, [Orig3n](#) focuses on lifestyle and behavioral traits, providing a range of unique products.

Orig3n is currently only available in the United States, except in Maryland; some restrictions also apply in New York.

The company purports that information such as fitness potential, intelligence, and physical appearance can be garnered from genetic analysis. We strongly recommend taking these claims with a grain of [salt](#); Orig3n themselves [make it explicit](#) that these tests are not intended to diagnose or even “determine who you are.”

Services Offered

Orig3n offers 19 separate products, with the 20th on their website being a bundle deal of two of their products. Kits range in price from \$29 to \$149, with their bundle being \$249.

ORIG3N  PRICE RANGES					
\$29	\$39	\$49	\$79	\$99	\$149
Superhero	Joint Care	Weight & Hunger	Behaviour	Beauty	Nutrition
ALDH2 Deficiency	Hair	Metabolism		Run	Fitness
Lactose Intolerance		Vitamins		Child Development	US Ski & Snowboard
Caffeine Tolerance		Skin Aging			
		Skin Health & Appearance			
		Recovery & Renewal			

 consumersadvocate
DECISIONS MADE EASY

Orig3n's low prices mean that customers have more freedom to pick and choose which kits they would like to try out.

Orig3n claims that their DNA tests can determine information such as whether a person is a "risk-taker," an "endurance athlete," or "empathetic." Consumers should note that while

Orig3n utilizes genetic research that has suggested connections between specific genes and certain traits and characteristics, much of that research is still in its early stages. Using it to reach conclusions about a given individual is, therefore, [problematic](#).

We have contacted experts in the field of genetics to inquire about specific genes singled out by Orig3n and asked them to confirm if those genes can be used in these ways.

For example, we spoke with Professor Simon Fisher, who discovered the FOXP2 gene that Orig3n now singles out as an indicator of an “uncanny ability to produce and understand speech and language” in their Superhero kit. This is what he had to say about it:

“It is well established that when FOXP2 is damaged by a rare mutation, this usually leads to a severe form of speech and language disorder. But, moving beyond these effects in pathology, I’m not aware of any convincing evidence of variations of this gene enhancing a person’s ability to learn a language (be it their native tongue or a second language).”

- Simon Fisher, Director of the Department of Language and Genetics at the Max Planck Institute for Psycholinguistics

We discuss experts’ take on the differences between genomic research and direct-to-consumer DNA tests in our methodology section, and how their input influenced our company reviews.

Privacy & Security

Orig3n’s [Privacy Policy](#) is surprisingly short, focusing exclusively on how they collect information, their security measures, and the standard warning that third-party websites that advertise on the page can have very different privacy policies.

For a slightly more comprehensive policy, customers need to go to their “Genetic Information and Platform” [section](#) — a separate policy document. The most notable clause in this document concerns the sharing of genetic information with third parties, specifically by email, posting to social media and other websites through Orig3n’s app or by printing hard copies of information.

As stated by other companies, customers are responsible for their choice(s) to share their genetic data these ways, and Orig3n is not responsible for how those third parties use the information.

Customers should further note that Orig3n does not destroy DNA samples, or rather, they “reserve the right to retain or destroy” it. Customers can request that the sample be destroyed by email or mail, but Orig3n can choose not to do so at their discretion.

Online Resources

Despite the many products sold by Orig3n, navigating their website is very easy, straightforward, and intuitive. The company divides the information for each kit in two: a short description, and a short breakdown of the aspects they look at for that kit, which includes the genes they analyze.

[Read Full Review](#)

[VISIT SITE](#)

HOMEDNA REVIEW

HomeDNA™

Easy At-Home Genetic Testing

Best for Range of Options

HomeDNA offers the most direct-to-consumer DNA testing options that we could find. Most companies focus on one or two services (like AncestryDNA, 23&Me, or MyHeritage), or on a range of unique products (like Orig3n), but HomeDNA offers the most individualized range of genetic test options.

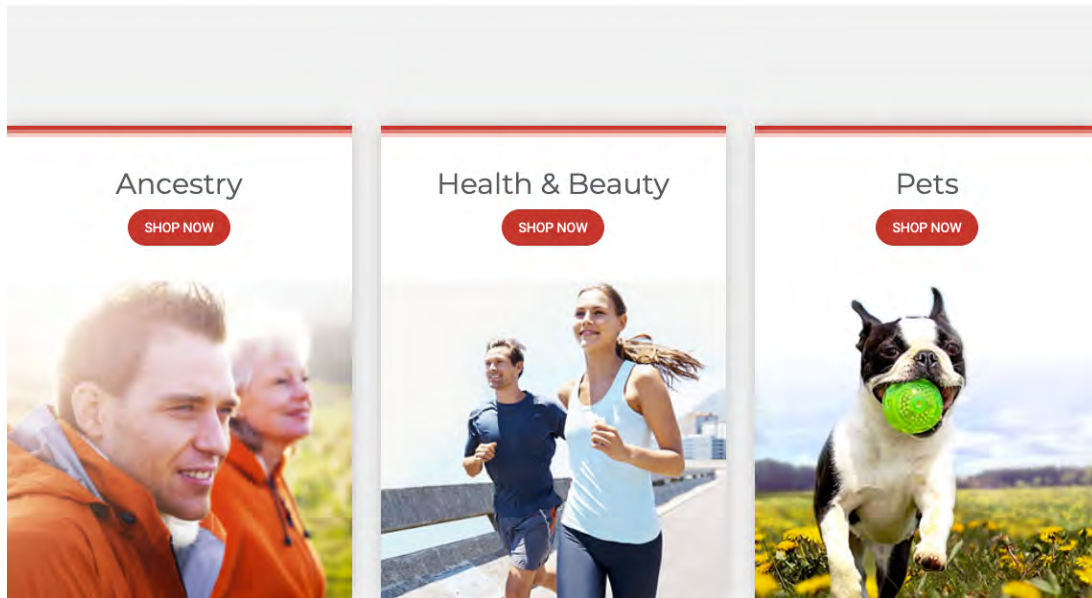
The company is a subsidiary of the [DNA Diagnostic Center](#), one of the largest and most accredited DNA laboratories in the world, famous for offering paternity and relationship testing.

HomeDNA is also the only company we could find that offers an Asian-tailored edition of the DNA test intended to address the lack of precision of other DNA kits for this demographic.

Services Offered

Because of the sheer number of tests offered, navigating HomeDNA's website can be very confusing. Ahead, we have tried to make sense of all of the different options, listing them by price and type of service offered.

Find HomeDNA in Stores



Screenshot of HomeDNA.com's product categories. August 20, 2019.

HomeDNA's tests fall into one of three categories: Ancestry, Health & Beauty, and Pets. It should be noted that the "health" portion of the "Health & Beauty" tests does not include genetic risk or carrier risk reports. On the contrary, they are more on a par with 23&Me's "Wellness" reports.

Ancestry Tests

GPS Origins Algorithm Raw Data Upload (\$39) - This service allows customers to upload the raw DNA data files obtained from other companies, specifically Ancestry and National Geographic. In the past, customers could upload data files from 23&Me and FamilyTree as well, but recent changes in those companies algorithms have made their files incompatible

with HomeDNA. It's unclear whether the results are comparable to the full "GPS Origins Ancestry Test."

HomeDNA Starter (\$69) - Instead of examining customers' DNA against over 80,000 markers, this starter test only looks at 100+ DNA markers. HomeDNA compares these markers against their contemporary populations' reference panel across 4 regions.

DNA Origins Maternal Lineage (\$69) - This is a specialized test that only focuses on the mitochondrial DNA passed from mother to child. This kind of test can be used to trace one single matrilineal ancestry thousands of years to a particular "haplogroup." As we explain in our [Helpful Information](#) below, customers should note that while this kind of test is highly accurate — as this DNA is inherited virtually unchanged and unshuffled — it is also only tracing one single ancestor at each generation as opposed to the other hundreds of ancestors in a person's genome.

DNA Origins Paternal Lineage (\$69) - Like the Maternal Lineage test, this DNA kit offers to identify and trace the origins of the Y chromosome through the male line. This test is, of course, only available to customers who have a Y chromosome and are biologically male, since biologically female individuals carry two X chromosomes instead.

GPS HomeDNA Advanced (\$124) - This test shares many similarities to the GPS Origins Ancestry Test described below, though it seems to lack many of the more dynamic online features listed in that one. In addition, this test is not available online; it can only be purchased through a retail store. If consumers want to buy this particular test, they need to use the "Find a Store" button.

Origins Ancestry Test (\$199) - This test examines a person's autosomal DNA at over 80,000 locations and 41 regions around the world and against more than 1,000 reference populations. HomeDNA claims that this test has the capacity to "target" a person's DNA

origins down to the town or village it comes from — a tall claim given that migration mixing usually makes this [level of precision](#) difficult. In addition to a breakdown of DNA origins, this test also offers detailed stories about migration routes, wars, and famines that can explain admixture. It should be noted that this test does not include Y and mitochondrial DNA analysis.

GPS Origins African Edition (\$199) - This is one of the few African-specific genetic tests on the market, beside AfricanAncestry.com. It offers to compare customers' DNA against 11 gene pools tied to the African continent, tracing its origins to as far back as 2,000 years.

GPS Origins Asian Edition (\$199) - Like the African Edition, this version of HomeDNA seeks to fill a gap in the market for Asian-specific DNA testing. Other direct-to-consumer tests have been criticized for how their limited reference panels result in vague, imprecise reports when it comes to customers from non-European origins.

Health & Beauty

Skin Care (\$99) - With this product, HomeDNA claims to be able to offer a personalized skincare regimen that suits each customer. The company examines 28 genetic markers that they have associated with specific skin aging categories, from collagen quality to skin sensitivity. Their science section, however, does not adequately explain just how they are interpreting genes or even which genes they're focusing on. That said, there is evidence [to suggest](#) a connection between key SNP markers and skin aging, although consumers are advised to remember that there are many, if not more, external [non-genetic factors](#) that influence aging and skincare.

Food & Pet Sensitivity (\$99) - With this test, HomeDNA offers customers the opportunity to learn if their genes suggest they have a variety of allergies and sensitivities, from gluten and

lactose intolerance to peanut and pet dander allergies. This product is not available in New York and Maryland because of their stricter state [regulations](#).

Healthy Weight (\$119) - This test claims to offer individualized diet and exercise strategies according to customers' genetic makeup. Like the food and pet sensitivity test, this kit is not available in New York and Maryland. Similarly to skincare, [concerns](#) have been raised regarding the [scientific validity](#) behind the purported connection between DNA and dieting.

Paternity (\$164) - This is HomeDNA's most popular DNA kit, and it is the one that ostensibly put them on the commercial direct-to-consumers genetic map back when it used to be called "Identigene." The website includes instructions of the steps to take if using the test for legal purposes like in child support or child custody cases, and they offer 1-day and same-day results for additional fees. This kit can only be purchased in stores.

Pets

Finally, HomeDNA offers three kits for pets — specifically dogs and cats. All three of these tests include "Life Plans", which entail suggestions designed to "optimize" a pet's wellness according to their DNA profile.

- Mixed-Breed Dog Identification - \$125
- Cat DNA Health Screen - \$125
- Dog DNA Health Screen - \$125

Privacy & Security

HomeDNA offers slightly more privacy and data security than other direct-to-consumer DNA test companies because they don't offer a relatives matching feature or enable third-party apps and social media applications to access customer data.

That said, like other companies, their laboratories can and will use anonymized customer data. In addition, in their privacy terms and conditions, they explicitly state that they reserve the right to disclose customer information to their affiliates, service providers, and business partners unless restricted from doing so by the customer. Moreover, “regardless of any choices” made by customers, HomeDNA’s parent company, DNA Diagnostics Center (DDC), “may disclose information if it believes in good faith that such disclosure is necessary” in a number of situations.

Finally, although the company does not allow “any third parties that push content” to their site, they may directly link to third party websites, which may collect information on customers.

Online Resources

The prominent downside to HomeDNA is its online resources — the website is outdated and the information can be confusing. That's why we considered it best to list all of their products, their prices, and descriptions in our review in an attempt to help consumers navigate them.

The difference between, for instance, the \$124 “HomeDNA Advanced Ancestry Test” and the \$199 “GPS Origins Ancestry Test” is not readily apparent as both include similar descriptions. The difference between them is that the “Advanced” test can only be purchased in stores.

Overview

Pinpoint your DNA!

Your GPS Origins kit contains easy-to-follow instructions, cheek swabs for collecting your DNA samples, and a postage-paid envelope for returning your samples to our lab (U.S. customers only). Using a DNA sample you provide through a simple cheek swab, our qualified laboratory tests more than 80,000 unique genetic markers. Cross-checking that information across dozens of gene pools and more than 1,000 reference populations, we use your DNA to create a detailed report about where your family's DNA originated and how your own unique DNA signature migrated over time. This can help you answer questions about your family's history, shed light on the origins of certain family traits, and help you better understand who you are.

This advanced autosomal test is so targeted, it may even indicate the town or village where groups of your ancestors from different cultures met—building a vibrant picture of the migration journeys that formed your deep genealogical heritage.

- New ancestral tracking technique pinpoints your genetic genealogy
- 80,000 autosomal genetic markers tested, 1,000+ reference populations and 41 gene pools analyzed
- Simple and painless cheek swab to collect your DNA sample
- Highly-accredited lab with privacy-protected service and expert staff; your DNA is **not** sent to a third-party lab

Kit Contents:

- Easy-to-follow instructions
- Cheek swabs for DNA collection
- Postage-paid envelope for returning samples to the lab (U.S. customers only)

Results Back:

- Within 6 weeks

Overview

Pinpoint the History of your DNA!

HomeDNA™ Advanced Test for Ancestry is an innovative analysis that takes you deep into your family history, often back 1,000 years or more—with a high level of specificity that you never thought possible. This next-generation autosomal DNA test combines the latest genetic research with a new ancestral tracking technique to pinpoint more precisely where your most recent DNA signature began and how it changed over time.

The process works a lot like the GPS system in your car. For this test, a unique algorithm uses various points in your own DNA data combined with data from 41 gene pools and over 1,000 reference population groups to pinpoint precise geographic locations where the last three major changes occurred in your family's DNA. Your results also include your personal gene-pool percentages. Where are you from?

- 80,000 autosomal genetic markers tested, 1,000+ reference populations analyzed, and 41 gene pools analyzed
- Results show your personal gene-pool percentages plus the most recent DNA migration routes for both your maternal and paternal lines
- Simple and painless cheek swabs to collect your DNA sample
- Highly-accredited lab with privacy-protected service and expert staff; we are the lab and you can rest assured your samples are never sent to a third party

Kit Contents:

- Complete instructions
- Cheek swabs for DNA collection
- Postage-paid envelope for returning samples to the lab (U.S. customers only)

Results Back:

- Within 6 weeks

Screenshot of HomeDNA.com's product overviews. August 20, 2019.

Customers might also wonder whether the “GPS Origins Algorithms” version that enables them to upload raw DNA data from other companies for only \$39 is comparable to the “GPS Origins Ancestry Test” since the details of each are slightly different.

Your 3-Part Results Report:

- Identifies your top three ancestral origins (the gene pools or ancestral communities that contributed significant portions of your genetic makeup) and shows the percentages of DNA you inherited from each. The report is much more detailed than a simple “ethnicity test”
- Contains maps illustrating the two most important migration journeys and describes how your ancestors’ circumstances changed as they crossed continents to find better lives
- Provides a summary page of helpful links to discover additional information to reveal your ancestral origins

This DNA heritage test:

- Identifies when and where your DNA formed by matching the populations that came together to create genetic line leading to you
- Traces the migration route of your DNA back to where it originated from and dated the age of your DNA signature. It does this for both your maternal and paternal lineages indicating where your DNA began

Test Results Include:

- Dynamic online experience featuring an interactive map, allowing you to zoom into your GPS pinpoints—revealing towns and cities
- Downloadable PDF report that can be shared with family and friends
- Your online and printable results feature:
 1. Maps of your top three ancestral origins (the gene pools or ancestral communities that contributed to significant portions of your genetic makeup) along with the percentages of DNA you inherited from each
 2. A comprehensive gene-pool profile with DNA percentages that goes well beyond basic ethnicity tests
 3. A detailed map illustrating your maternal and paternal migration journeys with descriptions on how your ancestors’ circumstances may have changed as they crossed territories and continents to find better lives

Screenshot of HomeDNA.com's results description. August 20, 2019.

Answers to these questions can be found in their FAQs but might be confusing at first and require careful combing through the information for each kit.

[Read Full Review](#)

[VISIT SITE](#)

MYHERITAGE REVIEW



Best For Affordability

[MyHeritage](#) is an Israeli-based direct-to-consumer DNA company that offers both ancestry reports and health/genetic risk reports. Because of the similarities in their products and its position on the direct-to-consumer genetic testing market, comparisons to AncestryDNA and 23&Me are inevitable.

In comparison to the two biggest DTC DNA companies, MyHeritage is generally more affordable, though their reports contain key differences with those of its competitors.

It should also be noted that, unlike 23&Me, MyHeritage is not FDA-approved or has been cleared to offer genetic health risk (GHR) tests, and concerns regarding this have been raised. We will discuss this further below.

Services Offered

Like 23&Me, MyHeritage offers both ancestry and health risk reports. Like AncestryDNA, though, MyHeritage's ancestry report provides ethnicity estimates — which 23&Me does not.

Also, like 23&Me, MyHeritage outsources laboratory duties to the CLIA-certified Illumina. Their usage of the same laboratory, however, does not mean MyHeritage's results will be identical to 23&Me's because both companies' interpretation algorithms are proprietary and different.

Finally, MyHeritage's DNA kits are available in all countries except Israel, the state of Alaska, and some French territories. The health kit is prohibited in Israel, France, Germany, Austria, Switzerland, and in the states of NY, NJ, and RI. Prohibitions on DTC genetic testing is [common](#) in certain states.

Ancestry Reports

For \$79, MyHeritage's ethnicity breakdown compares customers' autosomal DNA against their reference panel ("Founder Populations Project") of over 5,000 participants across 42 regions. These participants were selected from MyHeritage's members based on their family trees.

Although they have one less region and a smaller reference panel than AncestryDNA, MyHeritage's algorithm offers a slightly more detailed ethnicity breakdown.



Screenshot of MyHeritage.com's ethnicity breakdown. September 3, 2019.

In addition, like AncestryDNA and unlike 23&Me, MyHeritage offers the option to create family trees and supplement one's research with documents and records, including marriage certificates and census data, that can make tracing family members and ancestry history easier.

It should be noted, however, that a subscription to MyHeritage is required in order to access those records beyond the 14-day trial. Subscription plans range from \$79 for the Premium plan to \$189 for the complete plan. A Basic plan is also available for free, but it has a 250-person limit to the number of people that can be added to a family tree.

Most noteworthy, however, is the option to upload raw DNA data from other providers for free. This allows customers to compare their genetic results as run by different algorithms.

Health Reports

MyHeritage's Genetic Risk Reports, priced at \$199 (it includes the Ancestry kit), claim to be more thorough and comprehensive than other genetic health reports because they examine a "combination of variants on multiple genes" as opposed to specific isolated variants.

The company's risk reports inform customers whether they have a "decreased average, or increased genetic risk for developing certain health conditions," though they simultaneously acknowledge that these reports cannot tell a person whether they "have or will develop a condition."

A standard report includes 27 genetic risk and carrier status reports, polygenic risk reports for heart disease, breast cancer, and type 2 diabetes, and risk reports for 15 variants of the BRCA1 and BRCA2 genes associated with breast cancer. Polygenic risk scores are only currently available to customers from European ancestry. Concerns about the accuracy of polygenic tests, however, have been [raised](#), particularly because of their [limitations](#) when it comes to [health disparity](#).

In addition, MyHeritage's lack of FDA approval/authorization has been [met with criticism](#) and accusations of loophole exploitation, although the company does remind customers that

their health reports are not complete, are not equivalent to medical diagnoses, and don't account for non-genetic environmental factors.

Privacy & Security

Like other DTC DNA companies, MyHeritage assures their customers that their personal information will not be shared with third parties, partners, or sponsors. That said, they also acknowledge that they will disclose personal information in circumstances including if required by law, in the event that the company is acquired by another company, or to third parties contracted by MyHeritage to perform various tasks, from processing payments to physician oversight consultants.

Screenshot of MyHeritage.com's login page. August 20, 2019.

As with any DNA service that has a matching feature, personal information can also be shared with DNA Matches if this feature is enabled by the customer.

It should be noted that MyHeritage was the victim of a [cybersecurity incident](#), which resulted in a [data breach](#) in October 2017, and which was not discovered until June 2018.

Online Resources

After navigating MyHeritage's webpage, we found it to be on a par with that of AncestryDNA in terms of containing the bare minimum of information, especially for subjects as complicated as DNA testing, ancestry, and genetic health risks.

There's a lot of marketing lingo ("get the most diverse ethnicity breakdown"), vague assurances of the company's scientific standards ("we use advanced technology"), and occasional mentions of the actual technology used ("microarray-based autosomal DNA testing" and the "the Illumina OmniExpress-24 chip"). Explanations of exactly how many generations they consider to be representative of a population or what makes a population's DNA sequence "unique" would be useful.

Locating information on the site also proved difficult. Finding the subscription costs, for example, required external Google-searches, as the information could not be easily found through the website itself. Instead of having a subscription page that lays out all of the different available plans, MyHeritage's main page highlights their 14-day free trial. There aren't any links to how much the service costs after the 14-day trial period without signing up first.

[Read Full Review](#)

[VISIT SITE](#)

AFRICAN ANCESTRY REVIEW



AFRICAN ANCESTRY
TRACE YOUR DNA. FIND YOUR ROOTS.

Best For Tracing African Ancestry

[African Ancestry](#) is the only direct-to-consumers DNA test kit on the market designed especially for customers of African descent. The company boasts a 30,000 sample reference panel, far bigger than AncestryDNA's 13,000 sample database and 23&Me's 5,000 sample database.

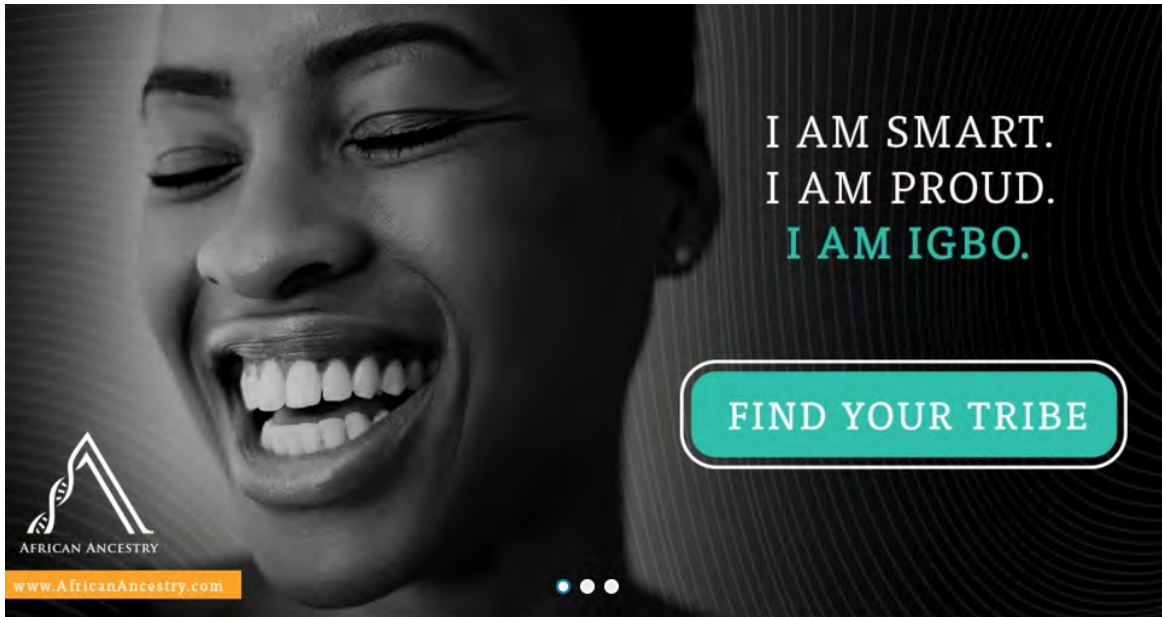
The company's database size is important because, the bigger the reference panel, the more accurate and precise their population estimates can be. This enables African Ancestry to estimate DNA origins to specific tribes and populations in the African continent.

As a result of over 240 years of slavery in the United States as well as historic colonial displacement throughout the African continent, it can be [very difficult](#) for many people of African descent to trace their [DNA origins](#) and ancestral roots in comparison to those of European descent.

Services Offered

African Ancestry offers two main services along with several special package deals. It should be noted, however, that these are the most expensive DNA kits we have found

currently on the market. In addition, they are available exclusively to customers of African descent.



SHOP AFRICAN ANCESTRY



Screenshot of AfricanAncestry.com's products. August 20, 2019.

MatriClan/PatriClan Test Kits

These two kits, \$299 each with a \$25 discount if bought together, provide customers with breakdowns of either their mitochondrial or Y-DNA, respectively. By looking at portions of the gene code that are inherited practically unchanged from generation to generation, these

tests can determine, fairly accurately, the origins of maternal and paternal ancestry lines to specific ethnic groups.

It should, of course, be noted that neither test can guarantee that the results will be African. This is because, out of all of the ancestors in each generation, a person's mitochondrial and YDNA is only passed down two people at a time (see our [Helpful Information](#) section for a more detailed explanation).

This means that a person could have many African ancestors, but if their mitochondrial DNA or Y chromosome did not originate in Africa, the service will not be able to trace their roots to the African continent. If this occurs, African Ancestry will inform customers which continent their DNA originates from, but not the country or group.

Finally, customers should remember that only biological males carry a Y-chromosome, therefore biologically female customers cannot take the PatriClan test (though they can ask a male family member like a father or brother to take it instead).

Keepsake Boxes & Special Packages

African Ancestry has three additional deals:

- The African Ancestry Keepsake Box (\$359) - This box is designed as a display item that can be paired up with either the MatriClan or PatriClan test. It includes a softcover journal where customers can put their "Certificate of Ancestry."
- Family Celebration Package (\$679) - This package contains both ancestry tests, six additional personalized certificates, and four African Ancestry t-shirts, which reflect either the country of ancestry or the company map logo design.

- African Ancestry Keepsake Box for Existing Family Member Version (\$69) - This is the same box as the \$359, but it's available for someone who has already taken one of the MatriClan or PatriClan tests.

Privacy & Security

African Ancestry's [Privacy Policy](#) is one of the simplest in the DTC DNA test industry, amounting to only 3 pages in comparison to the more common 15-page average. This means that there's less legal jargon in African Ancestry's policy, but at the same time, there's room for loopholes or potential misinformation.

The policy states, for instance, that cookies cannot be linked to personally identifiable information, though that [depends](#) on how personal data is defined. Similarly, they say that "IP addresses, [...] are not linked to personally identifiable information," yet this is [debatable](#). Most confusingly, they mention the Netscape Navigator — a browser from the 1990s that has not been updated since 2008 — and Internet Explorer — a browser that Microsoft has been in the process of replacing since 2015 — as examples of browser security, and they cite SSL encryptions as proof of their data security measures. This is also [debatable](#).

Like most direct-to-consumer DNA companies, African Ancestry points out that, if required by law, they will disclose customers' personal information. In addition, they state that following links to other websites put the burden of responsibility on the consumer, naturally. Finally, they say that, as part of their website's operations, "it is necessary for us to supplement the information we receive with information from third party sources." However, they don't explain why or to which third party sources.

Nonetheless, African Ancestry is one of the few DNA companies that automatically destroys DNA samples after a report has been supplied, adding a layer of security.

Online Resources

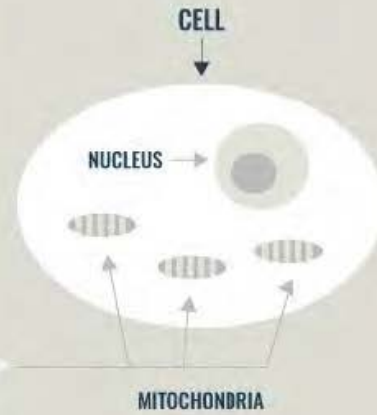
African Ancestry's website is very easy to navigate, in part because they only have two main services. Explanations of the science behind genetic testing, however, are a little simplistic at times.

For example, when explaining "how it works," the website states that "you share the same mtDNA as your mother, grandmother, great grandmother and so on. Therefore, your results are the same for your siblings, maternal aunts and uncles, maternal cousins, [...and] for your children."

This can lead to confusion; maternal cousins only share mitochondrial DNA with each other if their mothers are sisters (not brother and sister). Similarly, a father and daughter do not share mitochondrial DNA.

WHAT IS MITOCHONDRIAL DNA AND HOW IS IT PASSED DOWN?

Unlike most of our DNA, **Mitochondrial DNA** is not in our chromosomes or even in the nucleus of our cells, it's in our cells' cytoplasm. Each person's mitochondria come from the cytoplasm of the mother's egg. The father's sperm cells also contain mitochondria, but they are not inherited by his offspring.



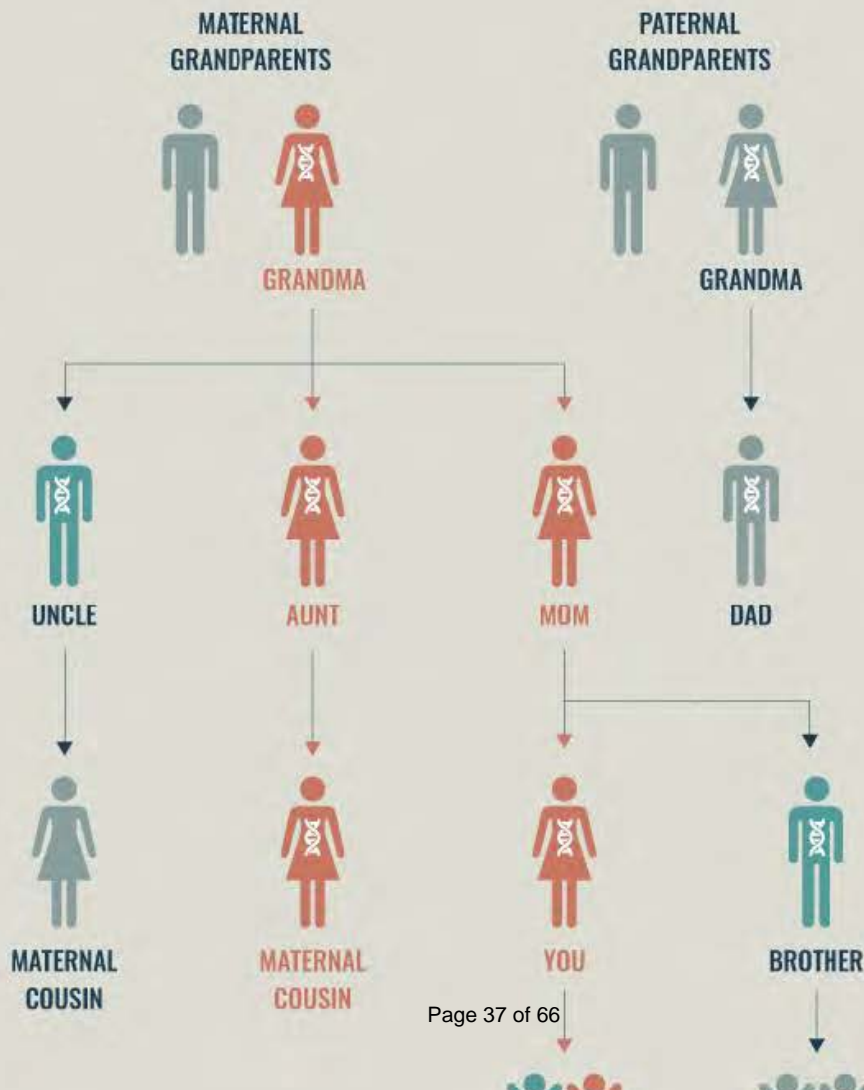
Shares your DNA



Shares your DNA, but can't pass it along



Does not share your mtDNA



[Read Full Review](#)[VISIT SITE](#)

MORE INSIGHT INTO OUR METHODOLOGY

Early in our research for this vertical, it became painfully evident that there's a gap between genomic research and direct-to-consumer DNA testing. It is not our intention to suggest that commercial DNA testing companies are being purposefully misleading in their marketing and product information, yet we felt it necessary to point out that there are several areas — from the complexity of the science to privacy concerns, to questions regarding the usage of terms like “ethnicity” or “identity” — whose over-simplification can result in confusion or misunderstanding.

We spoke with experts in genetics, medicine, sociology, and psycholinguistics from the University of Washington, UC Berkeley, the National Society of Genomic Counselors, and the Max Planck Institute. All of them echoed similar warnings regarding the limitations of genetic testing and emphasized that we are not yet at a point where we can reach 100% definitive conclusions about a single individual's gene code.

For example, Amy Sturm, the president from the National Society of Genetic Counselors, explains how genetic, non-genetic, and unknown factors all play a part in a person's health profile:

"It's really an interplay between your genetics, your family history, your environmental risk factors, and probably certain risk factors that, quite frankly, we just don't understand or know about yet."

Similarly, when discussing ancestry, Professor Troy Duster from UC Berkeley argues that:

"Genetic tests cannot give us any qualitative, reliable data across different empirical sites or companies with different databases. They cannot give us definitive answers about our admixture — about our percent ancestry. They cannot do that."

Professor Simon Fisher, director of the psycholinguistics department at the Max Planck Institute and one of the scientists who identified the FOXP2 gene implicated in speech and language pathways, further highlights the complexity of genetics and explains that:

"In the decade and a half since we discovered the gene, we've learned a great deal about its functions (albeit with plenty of mysteries remaining) and I don't want to diminish the value of such work, but it will always be only one piece of a complex puzzle."

And this is all just focusing on the science behind genetic testing and not on the other controversial aspects of DTC genetic testing. Because of this, we decided to have more expansive [Helpful Information](#) and [What to Watch Out For](#) sections that tackle, as succinctly as possible, several of the more pressing issues in the interest of consumer awareness.

At the same time, of course, we are also aware that we are not qualified to determine whether a company's research and proprietary algorithms are scientifically valid or not. We have neither access to these algorithms or the proprietary science behind it, nor are we scientists ourselves capable of evaluating it. We reference — and link — as thoroughly as possible to articles by experts that discuss these issues at length.

Therefore, for our company reviews, we focused instead on the services companies offer, the privacy policies available on their websites, and the overall ease of navigation and informativeness of their online resources.

PRODUCTS & SERVICES

Ancestry and Health reports are the two most common types of test on the market. Because of this, we gave priority to companies that offer products related to these two areas and excluded ones that do not, with the notable exception being Orig3n, which does not offer ancestry testing at all.

Within these two categories, however, different companies offer different products, services, and methods of examining customers' DNA. Some companies conduct autosomal testing in order to determine family matches and ethnicity, while others focus on YDNA and mtDNA in order to find customers' deep-history haplogroup.

Similarly, when it comes to health reports, some companies offer a risk assessment that examines variants in the gene code in order to identify if a customer has a potential predisposition towards certain genetic conditions. Other companies, on the other hand, focus more on "wellness" or physical traits.

In addition, companies often add extra features or products. These can include building family trees and having an updatable relatives-matching tool, as well as being able to download/upload raw data files to/from other companies for a lower price or having access to documents through paid membership. We considered all of these against the price ranges when deciding which companies to feature and which ones to cut.

All companies provide customers with an online account that lets them access their results as soon as they're available. Most companies will not send genetic results through the mail for security reasons.

Finally, we considered the size of the database and users to be a significant factor when comparing direct-to-consumer DNA companies. Larger databases and reference panels enable companies to tweak their algorithms and make them more accurate. Conversely, one of the biggest obstacles facing consumers from non-European backgrounds is the limited amount of samples in these databases.

PRIVACY & SECURITY

Arguably, the biggest concern in direct-to-consumer DNA testing is [data privacy](#) and [security](#). As we discuss in our [What to Watch Out For](#) section, worrying problems include, 1) how much control do customers have over their own data, 2) whether customers are unable to access certain features unless they relinquish private genetic data, 3) whether they are automatically opted-in to sharing their data, 4) how much information is shared with third parties, 5) the transparency of the terms and conditions, and 6) whether companies allow customers to request that their DNA samples and all related data files be destroyed.

In addition, we looked into whether DNA companies are currently partnered with pharmaceutical companies, for instance, and what steps they are taking to ensure their clients' genetic data is not misused. As we note in the company reviews and in the [What to Watch Out For](#) section, even anonymized genetic data has been shown to be re-identifiable. This is particularly worrisome when considering that some companies have experienced [data breaches](#) in the past.

Finally, we were surprised to find that not only do many companies retain the right to use customers' data as [they please](#), they also retain the rights to [change the terms](#) and conditions at any time after a person has purchased a product and sent in their DNA sample.

ONLINE RESOURCES

The more we researched the complexity of DNA testing, the more critically we looked at the online resources of various DTC companies, examining how transparent they are in discussing both the benefits and limitations of genetic testing. We believe that consumers should be well-informed through clear explanations that neither downplay nor hyperbolize DNA tests.

Companies that openly offered insight into their scientific process impressed us more than those with little information and a lot of promises regarding their “advanced science.”

COST & AVAILABILITY

We originally divided this into a separate, labeled section in each company review, but later integrated it into the product overview for the sake of readability. Nonetheless, it was an important evaluating factor when comparing different DNA testing companies.

We particularly focused on the costs versus services, whether there were discounts available, and whether additional features incurred further costs (such as through a membership or subscription fee). In some cases, we were able to obtain international costs as well, which we included in the reviews.

Likewise, we made sure to inform consumers of whether or not the product is available in their state or country. Given differences in the regulatory agencies around the world, some DNA tests are not available in some countries. This is particularly **common** with health test, as some states and many countries do not allow direct-to-consumer genetic testing because of the potential medical misuse/misunderstanding they could cause.

HELPFUL INFORMATION ABOUT DNA TESTING

DNA 101: WHAT IS DNA?

DNA stands for “deoxyribonucleic acid,” the name of a chemical chain that carries the genetic information of our parents and their parents, and so on. It contains the information needed to build different types of proteins that control different things in the body.

DNA is extremely [complex](#); the rungs on the chemical chain — structured as a double helix — are called “base pairs,” and there’s over [3 billion](#) of them across the 23 chromosome pairs in the nucleus of each cell in the human body (for a total of [6 billion](#) over the 46 chromosomes). These base pairs make up about [20,000-25,000](#) genes, which instruct cells on how to build at least 90,000 proteins throughout all 30 trillion cells in the human body.

A single chromosome, therefore, contains hundreds to thousands of genes. A [single gene](#) can have anything from 27,000 to 2 million base pairs.

Chromosomes come in two types of pairs: “autosomes,” which are identical, as found in chromosomes 1-22), and “allosomes,” which can be different (as found in the 23rd pair). Allosomes determines the organisms’ sex (everyone has one pair of these, either YX for males or XX for females).

DNA that comes from chromosomes is found in the nucleus of every cell, but this isn’t the only type of DNA direct-to-consumer companies can use to identify ancestry. The mitochondria in cells also carry DNA. Unlike most nuclear DNA, mtDNA is passed practically unchanged from mother to child.

A common misconception is that DNA is like a blueprint for a human body. Instead, DNA chains are a coded list that instructs cells on how to build proteins. One of our interviewees, Professor Simon Fisher from the Max Planck Institute’s Department Language and Genetics, sent us this [handy explanation](#).

What's the Big Deal?

The human genome — the complete set of nuclear DNA — is 99.9% identical for all humans. It's the 0.1% that contains enough differences to make us into unique individuals. Understanding how information is passed on through genes, how genes instruct proteins, and how proteins translate into specific processes in the human body, can help us know ourselves better.

Scientists have identified that certain proteins are linked to specific conditions, diseases, or health risks. Certain proteins, for example, are responsible for the production of the [hormone insulin](#). Mutations, changes, and variations in the genes that instruct cells to build this protein can cause a variety of disorders.

Different direct-to-consumer DNA companies have developed algorithms based on these variations. None of them analyze a person's entire, complex genome. Instead, they focus on [markers or locations](#) on the gene code that have been associated with certain populations or conditions.

Most commercial DNA kits offer two kinds of tests: ancestry and health.

Understanding Ancestry Testing

Analyzing DNA is not as easy as reading a history book. It's not even as easy as reading science-heavy articles about the chemical composition of DNA.

In order to determine a person's ancestry, companies offer different types of tests:

- Autosomal tests: these tests focus on autosomes 1-22 plus the X chromosome.
- Y-DNA tests: these tests focus on the Y chromosome (if male), which is used to trace patrilineal ancestors because it's passed practically unchanged from fathers to sons.

- mtDNA tests: these tests focus on mitochondrial DNA, which is used to trace matrilineal ancestors because it's passed practically unchanged from mothers to their children.

LIMITATIONS OF AUTOSOMAL TESTS

DNA Mixing

The autosomal DNA passed on by our parents is a mix of their DNA, and their parents' DNA, and so on. The amount of ancestors doubles with each previous generation. That means DNA from only the last two hundred years can already be a mixture of 510 people (less if ancestors appear multiple times in a [family tree](#)).

Most ancestry testing, however, compares specific DNA markers ([alleles](#)) against those of existing, contemporary populations determined to have remained, historically, in the same place for a long time (each company's reference panel). A company like Ancestry, for instance, uses algorithms to find which "ethnicity assignments" return the "[highest probability](#)" matches.

This statistical matching, however, is limited by the natural genetic mixing that has historically occurred throughout many populations. Europeans, for example, are historically comprised of mixtures of populations from the region now known as [Turkey](#), the ancient Roman Empire, and [Northern Africa](#). Within the last 2,000 years, Britain alone has experienced immigration and [genetic mixing](#) from the Romans, various Germanic tribes, and the Middle East.

In a [2015 article](#), Jonathan Kahn, a law professor at Northeastern University who has written extensively on genomics and race, writes:

“The estimates provided by diverse commercial enterprises [...] are premised on a notion of static populations that have not migrated or mixed over time. [...] But] the idea that there are somehow ‘pure’ types of African, European, or Asian DNA is a fiction [...]”

This [article](#) in the American Journal of Human Genetics echoes that:

“[O]nly a small fraction of ancestors are represented by each given genomic segment in an individual, [...] so one can only ever have limited information on the origins of a given individual's ancestors.”

This is why some experts, like Professor Troy Duster from UC Berkeley, question the usage of admixture percentages:

"Here's the problem in a nutshell, in order to have something called 'percent admixture' – percent white, percent black, percent whatever, percent Italian, percent Jewish – you'd have to have something called one hundred percent. Either in theory or in fact, you have to have some notion of a hundred percent. Otherwise, you tell someone that they're 16% European, and 18% Native American, and so forth, it's hardly replicable because you don't have something called 100%."

Imprecise or Changeable Terminology

Direct-to-home DNA testing companies often use the term “ethnicity” when providing reports and statistical probability breakdowns for ancestry, health, and traits. Their usage of the term, however, varies, and it is often left undefined. AncestryDNA’s [White Paper](#), for example, does not define “ethnicity” in its glossary, but in its usage throughout, the term is synonymous with “regions,” “populations,” or even “nationalities.”

However, some have [questioned the wisdom](#) and utility of the term “ethnicity” — a socially constructed concept based on self-identification — when discussing a biological

component, DNA, especially in [health contexts](#). Part of the difficulty arises from the often-contradictory nature of available definitions and its [overlap](#) with other [socially-constructed](#) and controversial terms like “race.”

This is further complicated by the facts that 1. there are no clear-cut ethnicities because most populations in the world [are mixed](#) to some degree, 2. socially constructed concepts like “ethnicity” and “race” have, historically, resulted in bias and discrimination, and 3. an overlap between modern ethnicity labels [might not correspond](#) to historical population names or locations.

DNA can certainly reveal a lot of information about where our genes come from. However, it’s important to understand that companies are only providing estimates based on DNA [similarities](#) to other contemporary populations. When an ancestry report says a person is 2% Scandinavian, it does not mean a specific, unique chunk of their DNA can come only from Scandinavia. Instead, what this percentage means is that certain portions of their genes have been [statistically similar](#) to those from contemporary Scandinavian populations.

“[T]hese tests do not really tell you where your ancestors came from. They say where DNA like yours can be found on Earth today.”—[Scientific American](#)

This is why an individual can take multiple DNA tests from different companies or multiple tests with the same company, and get [different results](#), and why identical twins have also been documented as having received [slightly different reports](#).

Database Size

The size of the databases also has to be taken into account. As [Scientific American explains](#), several companies “use both preexisting datasets as well as some reference

populations that they have recruited themselves.” [ScienceNews.org](#) cite anthropological geneticist Deborah Bolnick, saying:

“Who the companies say you are depends — in large part — on those reference populations, Bolnick says. For instance, you may carry a pattern of SNPs found in people in both southern France and in Italy. If, by chance, the French people a company sampled had that SNP pattern but none of the Italians in the company’s database did, “they may infer that you have French ancestors and not Italian because of who they do and do not have in their database,” Bolnick explains.

The Genetic Resource Center for the National Congress of American Indians [explains the limitations](#) of making probability estimates based on database comparison and the problem of using this to identify certain ethnic groups:

“[T]hese results are limited by the information in current databases, many of which do not contain a lot of information for particular groups (AI/ANs among them). This limitation in the data can produce problems for tribes and individuals seeking information as results may not be accurate or even possible to generate given limited availability of comparative data.”

Companies like HomeDNA and African Ancestry are currently trying to address some of these limitations for African and Asian populations. As [ScienceNews.org comments](#), *“some groups, including aboriginal populations in Australia and big parts of Africa and Asia, are mostly absent from companies’ databases.”*

LIMITATIONS OF Y-DNA & MTDNA

Y-DNA and mtDNA are currently the most *“authentic and useful tests for ancestry,”* according to Dr. Troy Duster, professor of sociology at UC Berkeley. They are, as he

told us, “definitive” and “*replicable.*” However, [research suggests](#) that “*lineage-based genetic estimates [...] reflect only a fraction of any person's total genetic ancestry.*”

Y-DNA tests can only trace one patrilineal ancestor at each generation because only one ancestor (a father) passed the Y chromosome to the next (his son). That means that, increasingly, at each further past generation, an individual has more and more ancestors that contributed to their genetic makeup, but which can't be reliably identified by tracing their genes.



Mitochondrial DNA tests are similarly limited; only the mother's mother's mother's mother's (etc.) mitochondrial DNA was passed on, meaning only one line can be traced. The paternal grandmother's line for any individual cannot be traced.



Understanding Health Reports

Like with ancestry testing, interpreting DNA in order to understand an individual's health risks, is a [complicated business](#). Amy Sturm, president of the National Society of Genetic Counselors, explained how genetic analysis takes place:

"There is a "reference for the "normal" human DNA code" and, based on research that has been done looking at people with certain traits or conditions or diseases, we know that there are certain genes, that if they have a change in them – a genetic variant – that it would be associated with a certain trait or condition or disease. And so, with the DNA being analyzed in the laboratory, the scientists are looking for changes in the "normal" DNA code that they know is associated with a trait or condition."

She warns, however, that *“it’s usually not a simple 1-1 correlation”* because *“there are other genetic factors and environmental factors that likely play a role in that complexity, and we don’t have all of those even have those figured out yet.”* Thus, whether a person takes a direct-to-consumer DNA test or a full test with a [genetic counselor](#), it’s important they understand that *“it is more of a ‘risk’ conversation.”*

Scientific & Clinical Validity

The [American Journal of Human Genetics](#) highlights that *“the scientific claims of companies that choose not to disclose the contents of their proprietary databases cannot be assessed; therefore, the reliability of the information they provide to consumers cannot be verified.”* This is problematic because, as professor Duster told us in our interview, *“replicability is the key element in scientific study.”* However, some direct-to-consumer DNA testing companies are *“not opening this up to investigation by other scientists saying ‘ok, you can come in and look at our data and see if you can do a replication study.’”*

[Ruth Saunders](#), a law graduate from Queen Mary University of London, echoes prof. Duster’s concerns in her 2010 article on the legal implications of DTC genetic testing and the lack of regulatory agencies enforcing scientific validity:

“The lack of regulation governing the quality of the genetic testing services is a serious concern because a genetic test is only useful to health when its analytical and clinical validity and clinical utility is assured.”

Moreover, consumers should be aware that [false-positive](#) results can and do [occur](#).

WHAT TO WATCH OUT FOR WHEN BUYING DNA TESTS

MANAGE YOUR EXPECTATIONS

Commercial DNA testing companies often promote themselves through commercials that feature customers with [uplifting stories](#) and [extremely happy results](#). Unexpected [positive](#) results are certainly one of the biggest draws of this industry, but it's important to remember that they are not necessarily the norm.

Don't Expect Amazing Results Right Away

One common thread across all of our interviewees was that it took a while for the “interesting” results to come up.

“[At first], we just had the estimate genetics. And it was just like that for a while. And every once in a while, somebody would pop up, and it was a cousin that everybody knew, ” said Erin Dull, who found her half-sister through AncestryDNA.

Adam Lind, one of our employees, similarly described his own experience with AncestryDNA:

“I got my results back at the beginning of March 2018. And at first, I was like, 0 for 1 – there was no Native American, which is what I wanted to know. But there was a lot of UK DNA, like Irish – and I didn't know that – the Irish, specifically – but there was English, Scottish, and some Western European. And I knew that I had a grandfather from Belgium. So, everything seemed copacetic.”

Be Prepared for the Possibility of Big Surprises

Amy Sturm, president of the NSGC, gave us the following advice regarding managing expectations:

"There are many things people need to think about. You might learn something that you're not prepared to learn. You need to be prepared for this going in. You need to think through for yourself "Am I the type of person that would prefer 'ignorance is bliss'? Do I really not want to have family secrets unraveled or unveiled to me?" And if so, you might not want to take one of these tests. It depends on the person. It's just something you really have to think about before you spit in that tube."

We spoke to three people who discovered that they had a half-sister, that their father was not their biological father, and that they were at risk of developing breast cancer. These are life-altering scenarios. That said, all three of our interviewees were happy to be aware of these truths about their DNA.

Erin Dull, who discovered her half-sister through AncestryDNA, told us: *"My life changed. It's the best thing that ever happened to me. Meeting my niece and nephew and having a sister is the greatest thing that ever happened to me."*

Similarly, our colleague Adam describes his experience of finding his biological father positively: *"He's as excited to know me as I am him. There's this feeling of 'make up for the lost time.' I'm absolutely elated."*

Our colleague Sara Altchule, who tested positive for the BRCA 2 gene mutation associated with breast cancer, said to us that, although it was a traumatic experience, she considered it to be *"the best decision I could have ever made."* She documented her experience over several blog posts [here](#).

Not Everyone Has a Life-Changing Experience

Although we interviewed three people who experienced amazing or life-changing results, ranging from discovering close family members to a high predisposition towards conditions, this is not necessarily the common outcome. For example, another one of our employees who used 23&Me also commented that he'd yet to receive any surprising or unexpected results despite having used the service several months ago.

Not Everyone Will Respond Positively

Two common threads we found through our interviews were either the *"don't open that can of worms"* warning, or the *"if the connection is beyond 1st cousin, I'm not interested"* admission. For example, Erin, one of our interviewees, told us of a friend who had used Ancestry to find her dad. Although he was glad to connect with her, some in the extended family were not, essentially saying *"we don't know you; you're not a part of this family; we don't want to talk about it."*

"There's only one member of the family who's interested; the rest don't even want to talk about it. [One even warned] not to open that can of worms."

This warning is often associated with the potential discovery of family secrets or information that can create an *"epistemological crisis,"* as professor Duster put it. *"Not all biological parents want to be found,"* explores this [article](#) on the identity impact these tests can have and many are wary of. Indeed, Ancestry's support center has threads on managing [surprising family members](#) and [regretting](#) using the service.

On the other hand, some matched family might not want to reply or form a relationship because the connection is vague to them. Adam described his own experience:

"The only reason I reached out was because it said 'father.' I think, anything above 'first cousin,' and I would eventually reach out, but other than that, I'm not interested. Like,

someone who has an ancestor that neither of us has ever met? I'm not interested. If someone reached out to me, I would email them back, but I had no interest in reaching out to anybody."

THE "IDENTITY" ISSUE

Personal identity is a complex concept influenced by many different factors. But concerns have been raised by experts in bioethics, sociology, anthropology, and genetics about the marketing claims of some DNA testing companies. "Some ads for testing companies reinforce the link between DNA and identity," writes [ScienceNews.org](https://www.sciencenews.org). For example, AncestryDNA's main page claims "You could be Irish"; 23&Me promises they'll help customers "discover what makes you, you;" MyHeritage boasts you can discover "where you really come from."

Hina Walajahi, from the [National Institute of Health](https://www.nih.gov), warns:

"While this hyperbolic 'it-will-change-your-life' marketing strategy is not unique to DTC genetic ancestry companies, it is distinct in the way it draws upon public faith in science and scientific authority to validate a causal relationship between genetic ancestry and personal identity."

Prof. Duster explores the powerful draw of these claims:

"People have a thirst to believe; there's a real desire to know one's ancestry. For example, because of the history of slavery and because their history was erased, many African Americans in particular have a strong interest in tracing their ancestry back to Africa, in ways people from Europe don't quite have that because they had grandmothers and grandfathers to tell tales about what percent ancestry there is and so on."

But some people are anxious and thirsty for this kind of information, so they're inclined to believe it as true because that's what they want to believe. This can lead to epistemological crises about who they are."

These crises are not uncommon, as [this testimony](#) demonstrates. However, some, like Prof. Duster, challenge placing nature (DNA) above nurture, arguing that:

"This notion that, somehow, the DNA that you discover — your 'real' biological mother or father — is who you really are is an extraordinary leap away from the idea that you are, in part, the social networks that brought you up and that are around you."

Our CEO, Greg Powel, puts it best:

"I think the notion of your self-conception evolves over the course of your life. You're shaped by a combination of your experiences and the people around you and your genetic make-up and who you are. I think that's who we are as people."

As Amy Sturm from the National Society of Genetic Counselors wisely told us: *"DNA is not destiny."*

PRIVACY & DATA SHARING ARE TWO OF THE BIGGEST CONCERNS RIGHT NOW

Most major direct-to-consumer DNA testing companies have clauses in their Privacy Terms intended to assure customers that their genetic data will not be shared or sold without their consent. In an effort to ensure this, these companies anonymize customers' DNA samples, removing identifiable information like name and address when the sample is sent to the lab.

However, experts warn that “genomic data is highly distinguishable”, and that even “a sequence of 30 to 80 SNPs [single-nucleotide polymorphisms, a.k.a. markers or variations] could uniquely identify an individual.” In other words, anonymized genetic data can be re-identified:

“[A]s demonstrated by multiple recent studies, the risk of re-identification is strongly present. It was shown, in multiple independent studies, that it is possible to learn the identities of people who participate in research studies by matching their data with publicly available data. Fida K. Dankar, et al. in [Human Genomics](#).”

In addition, many DNA matching services are unavailable or limited if consumers do not willingly give up some of their privacy. For example, Ancestry’s DNA Matches [reminds](#) customers that *“if you choose not to see your DNA matches or be listed as a match, some of the features included in your Ancestry subscription may not be available.”*

Privacy and data security concerns have been raised by other consumers, the media, politicians, and experts. These range from genetic data being [sold](#) or shared with [pharmacological companies](#) for the development of pharmaceuticals, to the potential risks of health or life [insurance companies](#) obtaining consumers’ genetic information and using it to raise their premiums or deny them services. This is because *“[genetic data provides](#) sensitive information about genetic conditions and predispositions to certain diseases such as cancer, Alzheimer’s, and schizophrenia.”*

In her [article](#) *Privacy of Information and DNA Testing Kits*, Shanna Mason points that submitting to genetic tests are not only *“exposing themselves to the risk of their genetic information getting into the wrong hands, but are also exposing information about shared familial risk.”* Mason’s article explores topics like genetic discrimination, and where the HIPAA and GINA privacy laws come into play.

Nonetheless, consumers are responsible for keeping up-to-date with how privacy terms and conditions are changed or modified over time, and continuing to use the services is treated as acceptance of these changes.

16. General Practices Regarding Use and Storage

You acknowledge that 23andMe may establish general practices and limits concerning use of the Services, including without limitation the maximum number of days that Personal Information and Services content will be retained by the Service, the maximum disk space that will be allotted on 23andMe's servers on your behalf, and the maximum number of times (and the maximum duration for which) you may access the Services in a given period of time. You acknowledge and agree that 23andMe has no responsibility or liability for the deletion of or failure to store any messages, other communications, or other content maintained or transmitted by the Services; or for the loss of Genetic Information due to malfunction or destruction of data servers or other catastrophic events. **You further acknowledge that 23andMe reserves the right to change these general practices and limits in its sole discretion.**

17. Modifications to Service

23andMe reserves the right at any time and from time to time to modify or discontinue, temporarily or permanently, the Services (or any part thereof) with or without notice. You acknowledge and agree that (i) modifications may result in a delay in computations for some of the 23andMe features or Services, and (ii) 23andMe shall not be liable to you or to any third party for any modification, suspension, or discontinuance of the Services.

The Software that you use may from time to time automatically download and install updates from 23andMe. These updates are designed to improve, enhance, and further develop the Services and may take the form of bug fixes, enhanced functions, new software modules, and completely new versions. You agree to receive such updates (and permit 23andMe to deliver these to you) as part of your use of the Services.

You acknowledge that 23andMe may offer different or additional technologies or features to collect and/or interpret Genetic Information in the future and that your initial purchase of the Service does not entitle you to any different or additional technologies or features for collection or interpretation of your Genetic Information without fee, and that you will have to pay additional fees in order to have your Genetic Information collected, processed, and/or interpreted using any future or additional technologies or features.

Screenshot from 23andme.com's Terms of Service. August 20, 2019.

26. Changes to the Terms of Service

23andMe may make changes to the TOS from time to time. When these changes are made, 23andMe will make a new copy of the TOS available on its website and any new additional terms will be made available to you from within, or through, the affected Services.

You acknowledge and agree that if you use the Services after the date on which the TOS have changed, 23andMe will treat your use as acceptance of the updated TOS.

Screenshot from 23andme.com's Terms of Service. August 20, 2019.

Privacy & Law Enforcement Ramifications

Additional concerns have also been raised concerning several aspects of law enforcement, including, but not limited to, the use of DNA databases to potentially racially [profile](#) suspects, the use of DNA databases in [forensics](#), laws that allow police

and federal officials to retain DNA samples even from non-charged suspects or acquitted individuals, and the general [wide misunderstanding](#) in legal situations of the limits of genomics.

Consumers also should be aware that DNA companies are [legally obligated](#) to submit data and documentation if faced with a warrant or subpoena. Moreover, some companies are openly [working in tandem](#) with law enforcement institutions, and “[there aren’t any regulations to stop it.](#)”

KEEP AN EYE ON THE KIT’S EXPIRY DATE

Many direct-to-consumer DNA kits have expiry dates because of the stabilizing solution they contain. This solution or buffer is what prevents bacterial contamination during the shipping process.

Expiry dates are different for different companies, be it because they’re being overly cautious, or because their kits have longer lifespans than others. Of the ones we used with our DNA volunteers, only AncestryDNA did not have a clear expiry date on the kit itself. Those that did had very different dates, even though we requested them all at the same time:

23&Me	14 months
Orig3n	25 months
GPS Origins from HomeDNA	32 months
MyHeritage	44 months

We recommend that customers mail in their DNA samples at least within a year of receiving their kits in the mail.

FAQS ABOUT DNA TESTING

Why have my ethnicity estimates changed after the latest update?

Direct-to-consumer DNA testing companies produce results based on how closely your DNA matches those from their reference database. As their reference database and their client base grow, companies are better able to refine their estimates.

What a company might have classified initially as a representative sample of one population group might later be discovered to be less representative of that group, and vice versa.

Because of this, some companies like AncestryDNA offer regular updates of their reports that better identify their consumers' DNA estimates.

If my health report says I'm at risk for cancer, Parkinson's, or Alzheimer's, does that mean I'll definitely get it?

Direct-to-consumer DNA test health reports cannot and should not be used as diagnostic tools. DNA testing companies look for specific genetic variants and markers that have been linked to particular conditions. Those variants and markers, however, are still being studied and researched by scientists, medical researchers, and geneticists.

A person might be at risk of a particular condition because they carry a specific marker, but how it manifests—if at all—is more complex. People who are concerned with whether they might be genetically at risk for specific health conditions should speak with their medical practitioner or genetic counselor.

Genetic counselors are best qualified to interpret a risk assessment report, discuss what it means in relation to an individual's medical and family history—which a DTC test does not account for—and offer personalized guidance.

Can I see family or relative matches without sharing my own information?

Companies that offer family trees, matching, or finding services of any kind give customers the choice of whether or not to make their profiles “findable” by other relatives.

If a customer chooses to keep their profile private, they will be unable to use most “matching” features. Most companies give customers the freedom to customize what kind of information is visible to their family matches, but some level of information sharing is fundamental to this feature.

Why do my estimates show a DNA percent for this country when all my ancestors come from another country?

DNA testing companies attempt to find which contemporary populations' DNA their customers' DNA most closely matches. This can be distinct from where a person's ancestors actually come from.

A person might have inherited DNA markers that have been associated to a particular contemporary population through one ancestor, even though many of their known ancestors come from a different place. Indeed, it can even be possible for siblings to inherit different genetic markers that have been associated with different populations in different proportions to each other.

For example, two siblings can have the same Italian grandparent, but that does not mean both siblings have $\frac{1}{4}$ Italian DNA. DNA reshuffling can result in one sibling having more genetic markers inherited from that Italian grandparent than the other.

In addition, a person has a vast pool of ancestors—a number which doubles each generation back. In short, an individual can have a percentage estimate because they inherited particular markers from one of their many ancestors that does come from a particular population—even though the person is unaware of it. Or they can have a percentage estimate because the genetic variance has currently been associated as representative of a population, even though it's shared with several other populations.

How can I make sure my genetic data will be 100% secure?

No website, company, or data storage method is 100% secure. Companies can have multiple levels of security, from data encryption to assurances that third-party apps have no access to customer information, but ultimately, any company, device, or website can be hacked.

In addition, genetic research is so profitable at the moment, especially for the development of pharmaceuticals and medical treatment, that direct-to-consumer DNA companies have a vested interest in establishing partnerships with external laboratories, companies, and researchers.

The larger DNA testing companies give customers some measure of control over the privacy and security of their information by giving them the option to opt in or out of research projects. However, most also make it clear that anonymized DNA samples will likely be used in genetic research regardless.

Why can't I receive a paternal haplogroup assignment if I'm a woman?

Paternal haplogroups are determined using Y-DNA, which comes from the Y chromosome, which is passed from father to son. Biologically female individuals do not carry a Y chromosome. Instead, they have two X chromosomes.

Nonetheless, women can find their paternal haplogroup by asking a male family member (father, brother, or uncle) to take a Y-DNA test for them. Note that a female customer cannot ask her son to take the Y-DNA test for her because her son will not share her father's Y chromosome, but his father's one.

Can I use DNA testing kits if I'm transgender?

Yes, though transgender consumers should be aware that certain information, such as whether their test included have a paternal haplogroup or not, can allow others to deduce their genetic sex if shared through a relative-matching feature.

As of the writing of this vertical, we could only find one company, 23&Me, that directly addressed this question and enabled customers to register with the sex with which they identify. After submitting their DNA sample, transgender customers will likely receive a notification asking them to confirm their genetic sex, which is done solely as part of the company's quality procedure (to make sure the laboratory correctly identified the chromosomes). Customers can indicate that the difference between their genetic sex and profile identity was expected, and results will be computed.

23&Me gives them complete control over their profile and over the information shared. We could not determine if other companies offer similar options, although companies like

AncestryDNA and MyHeritage do not offer tests based on Y-DNA, and might therefore not be applicable.

Who can't take DNA tests?

Consumers who have received a bone marrow transplant are unable to take a direct-to-consumer DNA test because their sample, which includes white blood cells, will also have some DNA from their marrow donor.

Some companies also recommend that customers who have had a blood transfusion recently avoid submitting a sample for at least 7 weeks after the transfusion.

<https://www.consumersadvocate.org/dna-testing>