CPIQ

Consumer Privacy & Identity Quarterly

Online DNA Services

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The Data in your DNA: Genetic Breakthroughs Bring Privacy Risks

The headlines about DNA—deoxyribonucleic acid, the genetic instructions that define all living organisms—appear daily:

"DNA Test Helps Adopted Man Find Birth Mother"

"New DNA Test May Determine Risk of Prostate Cancer"

"After Decades Behind Bars, Man Exonerated of Murder by DNA Evidence"

"Patients Use Pharmacy DNA Tests to Determine Best Medications."

Since 23andMe introduced at-home DNA testing in 2007, the global popularity of DNA testing has ushered in a new era of biotech innovation. Online DNA services (ODSs) let individuals easily peek inside their genetic code.

While DNA testing has existed for decades, the speed and accuracy of the technology has significantly improved. Consumers are no longer interested in only learning sterile facts about their genetics, such as the name of the gene that makes their eyes green (EYCL1, for the curious). Individuals pay hundreds of dollars for at-home tests because they long to learn more about themselves, everything from family histories and ancestral homelands to the possible IQs of their children and how genetics might influence their own health. Some law enforcement agencies are being empowered to collect DNA from all arrestees and have used public DNA indexes to identify suspects even from decades-old unsolved cases.

The influx of genetic information has allowed scientists to develop new tests for the microscopic strands of DNA that make us, well, us.

A small amount of saliva can determine someone's relative risk of developing cancer, match them to a distant relative, or help them locate the country from which their family originated. A swab on the cheek of a newborn baby can determine the presence of genes that may contribute to the development of hundreds of diseases. Today, companies are developing technology to use DNA to identify individuals quickly on-the-fly, in a manner similar to fingerprints. Tomorrow, scientists may be able to "edit" genes to make people resistant or immune to diseases or perfect the use of DNA as a data storage device, similar to today's external hard drives but capable of cramming terabytes of data into just a few strands.

But the rosy headlines above are not the only ones:

"Wait for Legal Protection Before Testing Your DNA"

"Your Privacy Can Be Threatened by Your Distant Relatives' 23andMe Test"

"Is Your Genetic History Worth the Privacy Risk?"

Experts are warning consumers about a growing number of privacy risks, including genetic theft—the acquisition and testing of DNA without consent—weak legal protections, and privacy policies that allow companies to share genetic information with partners. Additionally, legal loopholes could allow discrimination by employers and insurance companies who uncover negative information in DNA tests.

In this issue of the Consumer Privacy & Identity Quarterly, we explore the inner-workings of DNA testing, review the privacy issues surrounding genetic material, and highlight the latest ways DNA is being used by law enforcement and doctors. In Futures, we take a look at developing trends in the space, including research partnerships that could lead to new therapies—and lead to new privacy breaches.

Top 5 Online DNA Services

Since 2007, online DNA services have emerged with different features, costs, and focuses. Here are the top five most used ODSs.

1 ancestryDNA®

of DNA Users Tested: **10M+** Cost: **$99**
Website: **www.ancestry.com**

Ancestry conducts Autosomal DNA testing analyzing all 23 pairs of chromosomes. Its focus is connecting family, building a family tree and uncovering one's family origins and geneology.

2 23andMe®

of DNA Users Tested: **5M+** Cost: **$99**
Website: **www.23andme.com**

23andMe conducts Autosomal analysis, YDNA and MtDNA (low resolution) analysis. Its focus is providing general ancestry information as well as health and wellness reports.

3 FamilyTreeDNA

of DNA Users Tested: **1M+*** Cost: **$79+**
Website: **www.familytreedna.com**

FamilyTreeDNA conducts Autosomal analysis, YDNA and MtDNA (high resolution) analysis. Its focus is Paternal Ancestry (via YDNA)/heritage and Maternal Ancestry (via mtDNA).

4 MyHeritage DNA

of DNA Users Tested: **1.75M+** Cost: **$69**
Website: **www.myheritage.com**

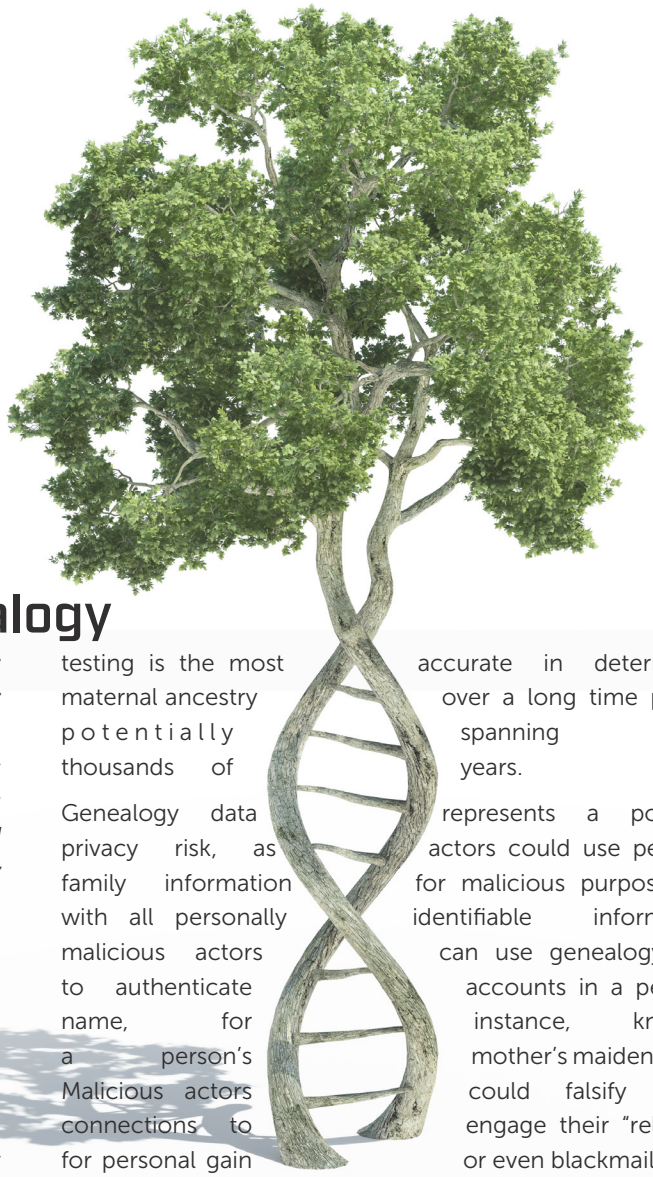
MyHeritage conducts Autosomal analysis. Its focus is providing general ancestry information and discovering one's family history.

5 [GEDmatch]

of DNA Users Tested: **929,000*** Cost: ***Free**
Website: **www.gedmatch.com/login1.php**

GEDMatch conducts Autosomal analysis. Its focus is providing general ancestry information and discovering one's family history by allowing users to upload raw data from 23andMe and Ancestry DNA to run through its algorithm to make ancestry determinations and be matched to relatives.

*Some or all of these users are not tested users; they are ingested from other services.



Branching Out

Getting to Know Your Genealogy

Living in a "melting pot" like the United States means that Americans have more complex genealogies than they might even know. The history of humanity is one of migration and cultural interaction, leaving every person's ethnic background with numerous layers. Understanding one's family tree used to require poring through records and family stories, which were often unreliable or hid family secrets. DNA analysis has led to a revolution in genealogy, allowing new scientific backing to what was once based on word of mouth.

Online DNA Services (ODSs) such as AncestryDNA, MyHeritage, Family Tree DNA, and LivingDNA, allow consumers to explore their genealogy and heritage and connect with lost relatives. Results are typically received within six to eight weeks, providing users with an online interactive overview of their genealogical history and migration patterns. Some ODSs even offer social networking services, allowing users to connect with potential genetic relatives.

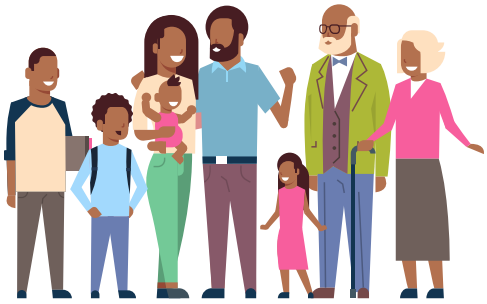
Genealogy services employ three different DNA tests: Autosomal, Y-DNA, and mitochondrial DNA (mtDNA) testing. Autosomal DNA testing surveys a person's entire genome on both maternal and paternal sides by testing the first 22 pairs of chromosomes, or autosomes, but not the 23rd gender chromosomes, X and Y. This test does not differ between males and females. Because this test is so broad, it is more accurate in identifying immediate relatives than more distant relatives.

Y-DNA and mtDNA focus specifically on the paternal (Y) and maternal (X) lines of lineage, respectively. Y-DNA testing tends to more accurately determine surname history, given that it traces back the ancestors from one's father's side. MtDNA testing is the most accurate in determining maternal ancestry over a long time period, potentially spanning back thousands of years.

Genealogy data represents a potential privacy risk, as actors could use personal family information for malicious purposes. As with all personally identifiable information, malicious actors can use genealogy data to authenticate accounts in a person's name, for instance, knowing a person's mother's maiden name. Malicious actors could falsify family connections to engage their "relatives" for personal gain or even blackmail. Users should consider these risks before sending their DNA to these services for analysis or participating in any ODS-related social networking services.

ODS data storage is also a concern. While no major ODS has yet had its DNA data stolen, hackers have targeted the services, stealing user account data. Moreover, ODSs share their databases with third-party entities, such as partnered companies and universities that focus on finding cures and treatments for neurodegenerative diseases or other advanced medical research. Before deciding to consent to sharing DNA or opting out, consumers should carefully consider who will have access, and what will it be used for specifically. DNA should be treated the same as the rest of one's personal data. By carefully reviewing terms of service agreements, opting out of third-party sharing, and using different passwords for accounts, one can safeguard ODS information, and protect one's identity, as well as the identities of family members.

How much DNA is shared between family?



Every human being shares 99.9% of his or her DNA with every other human being. The tiny fraction that is left is shared within families. The closer the relation between two people, the more DNA they share. As a new family members are added, the amount of DNA shared changes based on their relationship. For instance, while a child and a parent share 50% of their DNA, a child and their grandparent share only 25%. The same can be understood with half-siblings. Half-siblings share one parent instead of two thus they only share 25% of their DNA as opposed to 50%. Below is a breakdown of how much of this 0.1% family members share Members of the same family share a certain amount of DNA between each other:

	FAMILY RELATIONSHIP	
~100%		IDENTICAL TWIN
50%		PARENT CHILD FULL SIBLING FRATERNAL TWIN
25%	GRANDPARENT GRANDCHILD AUNT/UNCLE	NIECE/NEPHEW HALF SIBLING
12.5%	FIRST COUSIN HALF-AUNT/HALF-UNCLE	HALF-NIECE/HALF-NEPHEW
6.25%	HALF-FIRST COUSIN	FIRST COUSIN ONCE REMOVED
3.13%		SECOND COUSIN

Evolution to Revolution

The Past and Future of DNA Research

In a single generation, exploration of DNA has changed everything we know about ourselves and has given us the ability to, literally, rewrite who we are.

OK, that is a lot to digest in the first sentence of an article, particularly when, if you're like most people, you know very little about those tiny molecules that are the building blocks of all life.

But keep that ending in mind as we start at the beginning.

Deoxyribonucleic acid is a complex molecule that contains the genetic information necessary for all living organisms to survive and reproduce. DNA, which is inherited from an organisms' parents, carries specific biological instructions within segments called genes that determine all inherited characteristics, including height, eye color, and hair color. About 99.9% of the DNA in all human beings is identical, but the variant 0.1% is enough to produce billions of unique individuals. No two people share the exact same DNA, not even identical twins.

In a single generation, exploration of DNA has changed everything we know about ourselves and has given us the ability to, literally, rewrite who we are.

In 1984, British geneticist Alec Jeffreys discovered that that the variations present in the 0.1% of DNA not shared by all human beings could be used to positively identify individuals from samples of their skin, hair, and bodily fluids. Jeffreys used his "DNA fingerprinting" technique to help police in Britain catch a rapist and murderer, and cleared an innocent suspect. That case—the first in which DNA evidence was used to capture, identify, and convict an individual—laid the foundation for forensic science and all modern DNA testing.

DNA continues to be an important factor in criminal investigations and government proceedings, making it possible to swiftly exclude or identify criminal suspects, establish paternity or maternity, and determine if foreign individuals are related to US citizens for immigration purposes.

But following other advances—including DNA sequencing (determining the order and type of genetic information carried in DNA) cloning animals, and mapping the entire human genome (linking genes to specific traits)—online DNA services (ODSs) have uncovered many uses for DNA that go beyond the courtroom.

ODSs combine features of traditional DNA testing and analysis companies with those of social networking services (SNSs). The services, including 23andMe and AncestryDNA, provide do-it-yourself home kits and analyze saliva samples mailed to them by users. The results, which can take a couple of months to complete, are detailed and allow users to analyze their genomes to:

Determine Their Ancestral Homelands

A user's DNA is compared with a "reference panel" made up of other users in publicly available databases. Algorithms compare hundreds of thousands of DNA segments against common genetic variations, allowing an ODS to estimate a person's ethnic background or the countries from which a family tree may originate. The information is typically presented as percentages. For instance, a report might say an individual is 50% African, 30% Eastern European, and 20% Australian, which would mean 50% of the sampled pieces of their DNA match a group the ODS has labeled African. Reference panel data can be self-reported or verified by an ODS.

Find Distant Relatives

ODSs will compare an individual's DNA to other users in their databases to find those who share a specified number of DNA segments of a given length. On average, relatives share a greater number of segments than non-relatives. The number of identical segments can also be used to predict the relationship (parent, sibling, first cousin, second cousin, etc.) Close relatives share more segments than distant relatives.

Identify Genetic Traits and Health Risks

A user's genome will be analyzed to determine if he or she carries genetic markers associated with risks for developing cancer or other diseases. The presence of a genetic marker indicates a greater risk but does not guarantee an illness will develop. Likewise, the absence of a marker does not mean an individual will not develop a disorder.

Experts caution users that ODSs are not always accurate. The size and quality of reference panels can vary, impacting results of ethnicity testing, and ODSs keep the algorithms they use for analysis secret, meaning they cannot be independently checked for errors.

Novel Uses

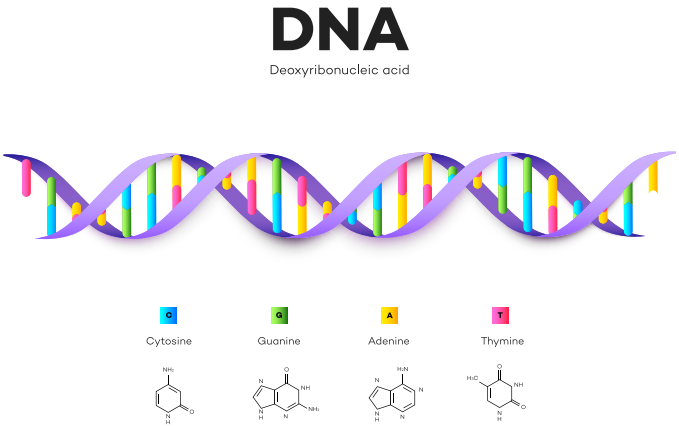
Researchers are developing even more novel uses for DNA testing and analysis. With Rapid DNA, genetic sampling may eventually become as routine as fingerprinting. Rapid DNA, deployed at the FBI and a growing number of police departments, is a fully automated system that can develop a DNA profile from a swab in less than two hours. Widespread adoption, and continued speed improvements, could result in DNA being used for on-the-fly identification.

Criminal profiling is another relatively new area of research. Companies, including Faception and Facetrom, both based in Israel, claim the ability to determine an individual's personality characteristics based on their facial features. The theory is based on the idea that behavioral characteristics, such as a person's propensity for criminal or antisocial behavior, can be traced to their DNA.

Nebula Genomics is offering to sequence a user's genome and store DNA on a blockchain, a system in which encrypted data is split and stored on multiple computers in a decentralized network. The blockchain will function as a genetic marketplace and users can earn digital currency by allowing researchers access to their anonymized genome.

Even more ambitious, in Nov. 2018, a scientist in China claimed to have produced the first genetically edited babies. Gene editing involves identifying genes associated with specific traits, typically diseases, and altering or removing them. The Chinese scientist's claims have not been verified, however, gene editing has been performed on crops, including creating mushrooms that do not turn brown and tomato plants that bear more fruit.

Gene editing in human beings, as the Chinese scientist claims to have done, is a potentially scary prospect to many people who are pleased that the Chinese government tightened rules for such research. But as DNA technology improves, similar advances and abuses seem destined to become a part of consumers' everyday lives. Consumers would do well to keep the limitations—and potential pitfalls—of genetic testing in mind.



DNA FACTS

Deoxyribonucleic Acid (DNA) and Ribonucleic Acid (RNA) are the two types of nucleic acids that make up the code for genetic information.

RNA

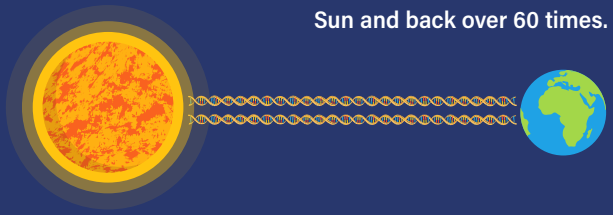
RNA is a single-helix molecule built from four nucleotides: adenine (A), uracil (U), guanine (G), and cytosine (C).

DNA is a double-helix molecule built from four nucleotides: adenine (A), thymine (T), guanine (G), and cytosine (C).

DNA

All human beings share 99.9% of their DNA in common.

If you put all the DNA molecules in your body end to end, the DNA would reach from the Earth to the Sun and back over 60 times.



Gene therapy is undergoing revolutionary developments!

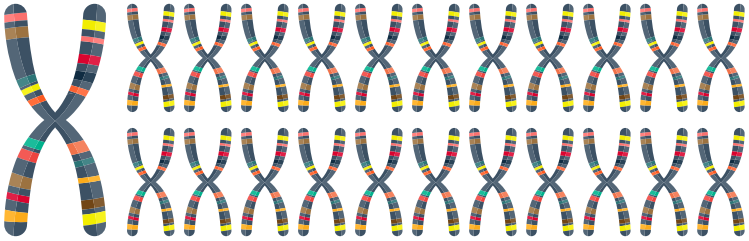
Swiss pharmaceutical company Novartis has developed a treatment for spinal muscular atrophy type 1, the leading cause of genetic infant mortality, by replacing a missing or defective gene with a functional copy.

In 2018, researchers at London's Francis Crick Institute successfully changed the sex of male mice to female by removing parts of its genetic code.

HOW TRAITS COME FROM GENES

Traits are passed on from one generation to the next (and sometimes skip generations) from parents to offspring and future generations after.

Every person has 23 pairs of chromosomes and these 23 chromosomes are passed down from each parent. This means 23 chromosomes come from the mother and 23 from the father.



The parents also pass down one sex chromosome (x or y) each to their offspring which determines the biological sex of the offspring. All together an offspring receives 46 individual chromosomes, or 23 pairs.

These chromosomes will then make up the genetic composition of the offspring, which will develop into genetic traits. Geneticists draw a distinction between phenotypes and genotypes.

phenotype

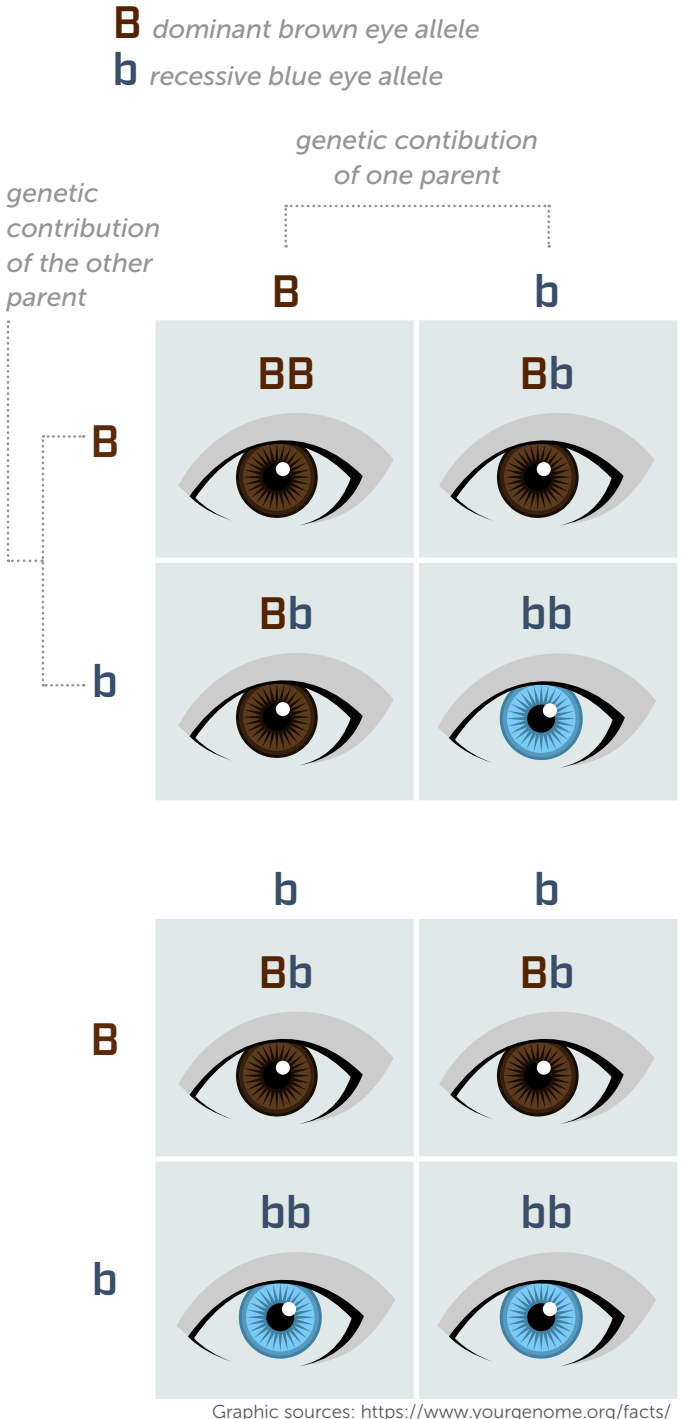
an organism's inherited genetic information

genotype

the physically manifested traits determined by genetic information

Genes are not all the same. Some come in dominant variants, and others are recessive. These variants express themselves differently, based on trait dominance.

For instance a parent with a dominant brown eye trait (BB) and a parent with a recessive blue eye trait (bb) will have an offspring with brown eyes (Bb), but with the possibility of blue eyes in a future generation depending on mating and genes.



Graphic sources: https://www.yourgenome.org/facts/what-are-dominant-and-recessive-alleles and https://www2.palomar.edu/anthro/mendel/mendel_2.htm

Dominant Trait in Humans	Recessive Trait in Humans
A blood type	O blood type
Abundant body hair	Little body hair
Astigmatism	Normal vision
B blood type	O blood type
Baldness (in male)	Not bald
Broad lips	Thin lips
Broad nose	Narrow nose
Dwarfism	Normal growth
Hazel or green eyes	Blue or gray eyes
High blood pressure	Normal blood pressure
Large eyes	Small eyes
Migraine	Normal
Mongolian Fold	No fold in eyes
Nearsightedness	Normal vision
Rh factor (+)	No factor (Rh -)
Second toe longest	First or big toe longest
Short stature	Tall stature
Six fingers	Five fingers
Webbed fingers	Normal fingers
Tone deafness	Normal tone hearing
White hair streak	Normal hair coloring

Table source: http://www.sciencebrainwaves.com/dominant-and-recessive-genes-in-humans/

DNA Advances Outpace Laws, Privacy Policies

DNA testing is a field of medical dreams and a minefield of privacy nightmares.

While national laws—including the Health Insurance Portability and Accountability Act (HIPAA) and the Genetic Information Nondiscrimination Act (GINA)—provide protections against discrimination and unauthorized data sharing, HIPAA does not cover at-home testing, leaving consumers at the mercy of a patchwork of state laws and corporate privacy policies that can change at any time.

Privacy Policies

Many ODSs anonymize user data, but genetic information can still be sold to researchers, typically with users' opt-in approval. Most companies do not claim ownership of DNA samples, but they may claim ownership of valuable information they uncover about your genome, such as unique DNA sequences that contribute to cancer.

Additionally, individuals can be de-anonymized easily by using data for relatives that may also use a service. A study published in Nov. 2018 by *Science Magazine* found that 60 percent of white Americans—even those who did not take a DNA test themselves—could be identified using information from DNA databases combined with basic demographic data, including location, age, and sex.

National laws needed

Legislators in some states, including California, Maryland, and Montana, are proposing or have passed new laws to protect genetic information. However, experts say new federal laws are needed to provide blanket protection for consumers.

ODSs are using their data for purposes other than what consumers wanted. In July 2018, GlaxoSmithKline made a $300 million equity investment in 23andMe with the goal of using DNA testing to develop new drug therapies. Family Tree DNA also disclosed in January 2019 that it is allowing FBI agents to search its genealogy database.

Protect yourself

Experts advise consumers to:

* **scrutinize privacy policies and avoid companies with questionable practices.**
* **opt out of research or third-party data sharing.**
* **ensure that DNA samples are destroyed after testing.**
* **request that all data be deleted after downloading analysis results.**

The Incomplete Truth Behind At Home Health Tests

In addition to genealogy services, some ODSs offer health risk reports. By looking at the variants within an individual's genetic code, scientists are able to identify mutations that can cause diseases such as Alzheimer's and cancer. These identified mutations are compiled onto a report and provided as a part of the ODS' health package. By testing the health risks of individuals through genetics, consumers can be more aware of genetic predispositions and potential risks. This testing is not a determination of a person's overall health, nor is it a diagnosis.

For instance, ODSs typically test for three mutations, known as single-nucleotide polymorphisms (SNPs): two in breast cancer susceptibility protein type 1 (BRCA1) and one in breast cancer susceptibility protein type 2 (BRCA2). Other than BRCA1 and BRCA2, nearly 200 more SNPs have been linked to altered breast cancer risk. Additionally, scientists have identified numerous mutations in several genes with unknown effects on breast cancer risk: these mutations are dubbed "variants of unknown significance (VUS)." Because of this, even an individual who tests negative for the three BRCA SNPs could have a mutation that increases breast cancer risk that is either not included in the test or is not yet well understood.

Beyond the health-related services of DNA test providers, consumers can send this test data to third-party DNA data analysis services, such as Promethease, for further health risk analysis. These services do not test DNA themselves, but rather receive raw data that other ODSs provide and conduct analysis beyond what testing companies offer. To write their reports, third-party DNA data analysis services find scientific studies that mention the genetic variants a customer carries and make inferences about the health risks of carrying those variants.

Genetics is only one part of a person's health; lifestyle is also important. The risk for conditions like cancer depends on complex interactions between genes and lifestyle factors. Researchers have not identified all the genes responsible for these conditions or determined how factors such as diet or exercise influence the expression of those genes. Even diseases caused by a single gene, such as cystic fibrosis, can be influenced by other genes that can affect, for example, the condition's severity. Moreover, in many cases, gene variations are only slightly associated with risk, or evidence of association is limited.

These capabilities come with privacy concerns. As with all health information, DNA-related health information can reveal intimate details about consumers' personal and family information that they might not want revealed. A key concern is how this information can be used to discriminate against individuals if, say, health or life insurance companies could determine premiums or deny coverage altogether based on perceived health risks.

Consumers should understand that DNA analysis is a new field, so they should not make decisions based on this analysis without consulting their physicians. Genetic information repositories are becoming valuable assets for companies, which share this data with other companies and researchers. Users should take care when using these services to ensure that they are reputable and limit information-sharing.

The Absolute Power of an Inexact Science

Solving Cold Cases with ODSs

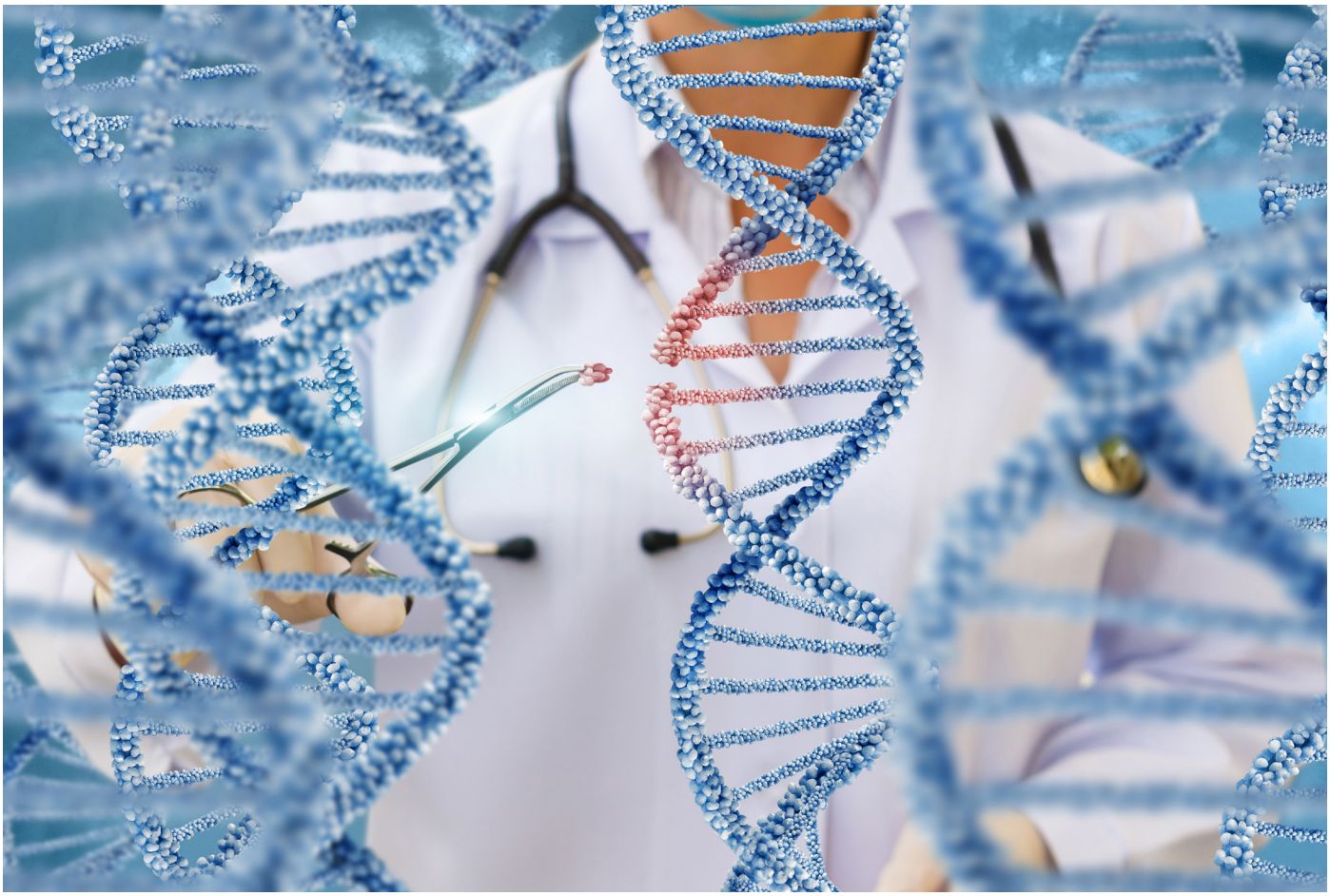
After committing at least 13 murders and as many as 50 rapes between 1974 and 1986, the Golden State Killer evaded police for decades, despite law enforcement having DNA samples from a rape kit.

In the 32 years since his last crime, DNA science and data records collection improved markedly. By 2018, investigators had more than just DNA samples at their disposal; they had access to GEDMatch, an ODS that allowed police to upload and analyze DNA data files and locate relatives of the alleged killer. Police narrowed the familial matches to one suspect, who was arrested in April 2018. This investigation was the first high-profile glimpse into the future of criminal justice: using public DNA databases to solve cold cases.

While police have used DNA to solve crimes since 1986, ODSs have enabled new advances. In previous years, forensic scientists could compare DNA samples against those of suspects or victims and look for matches. Today, some ODSs allow police to conduct more extensive investigations, comparing DNA samples to broad swaths of the population.

However, DNA profiling is an inexact science with several shortcomings, which increase with ODS-enabled methods. DNA databases could be susceptible to penetration by hackers, leading to false positives or negatives. Furthermore, using the DNA profiles of innocent relatives of an alleged criminal to find that criminal could potentially violate those individuals' rights.

ODS-enabled DNA analyses have aided arrests related to horrific crimes, but the future is unknown. Repressive governments could use ODSs to target dissidents, or courts could limit the use of these methods to protect civil liberties. No matter what the future holds, forensic analysis illustrates the true power of DNA databases.



What's Next?

Future Uses for DNA Data

DNA testing and analysis has exploded in popularity and effectiveness over the last couple decades, and the future has even more products and services in store. Each of these developments has implications for privacy.

Law enforcement is likely to continue using data from DNA testing to catch criminals and break cold cases such as the Golden State Killer case. New York state is considering a proposal to use other databases including the DNA records held by genealogy services for when DNA databases held by the criminal justice system do not yield close matches. Whether law enforcement continues to utilize DNA databases or is restrained due to civil liberties concerns is unclear, especially in other countries.

Researching health predispositions and development of drugs targeting disease progression is leading to connections between pharmaceutical companies and ODS companies. For instance, the pharmaceutical company GlaxoSmithKline (GSK) and 23andMe have partnered to develop medicine based on genetic data. This trend could lead to improved medicine, but also increased privacy concerns. Every transfer of data to a new company could lead to new possibilities for hacking or leaks of said data.

"Designer babies"—editing or modifying the genes of embryos to add or remove physical characteristics—was fanciful thinking in the 1980s, but could become commonplace in the future.

Most personal services offer some degree of risks to users' privacy and identity. ODSs are unique in that they threaten the privacy and identity of people who do not even use them. In the future, a majority of Americans will be identifiable based on their relatives alone, even if they have not submitted their DNA for analysis. The potential threats to privacy and identity are unprecedented. Whether they worsen, or new privacy laws and technologies protect this data, is yet to be seen.

Test Your DNA Knowledge

Do you remember what you learned about DNA & Online DNA Services in this issue? Test your knowledge with this quick quiz!

1. DNA is an acronym for what?
   - **A.** Dinonuclear acid
   - **B.** Deoxyribonucleic acid
   - **C.** Doxycycline aminos
   - **D.** Dinosaur acid

2. British geneticist Alec Jeffreys discovered that that the variations present in the 0.1% of DNA not shared by all human beings could be used to positively identify individuals from samples of their skin, hair, and bodily fluids in what year?
   - **A.** 1981
   - **B.** 1982
   - **C.** 1983
   - **D.** 1984

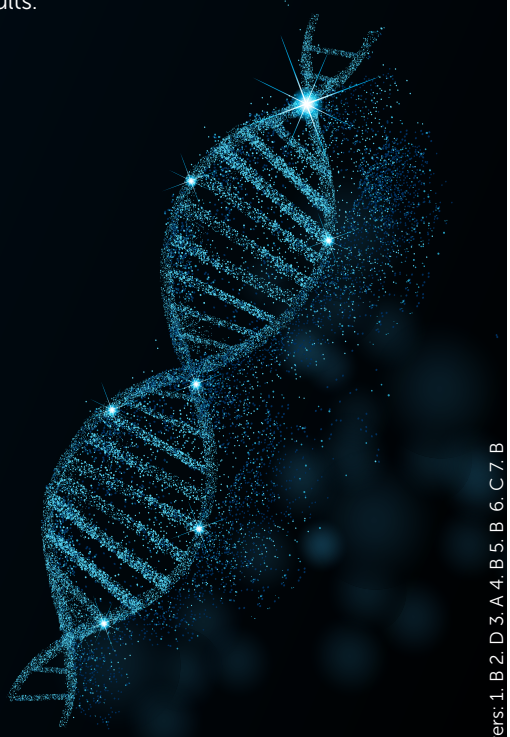
3. In November 2018 a Chinese scientist claimed to have produced the first genetically edited
   - **A.** Human Baby
   - **B.** Elephant Baby
   - **C.** Amazonian Eggplant
   - **D.** Crocodile Egg

4. True or false: the Health Insurance Portability and Accountability Act (HIPAA) and the Genetic Information Nondiscrimination Act (GINA) provide protections against discrimination and unauthorized data sharing.
   - **A.** True
   - **B.** False

5. Which of the following are the three types of DNA tests that Genealogy services provide?
   - **A.** Autosomal, X-DNA, and Mitochondrial DNA
   - **B.** Autosomal, Y-DNA, and Mitochondrial DNA
   - **C.** Manosomal, Y-DNA, and Mitochondrial DNA
   - **D.** Autosomal, Y-DNA, and Sinocondrial DNA

6. Rapid DNA is a fully automated system that can develop a DNA profile from a swab in less than
   - **A.** 30 minutes
   - **B.** 4 hours
   - **C.** 2 hours
   - **D.** 5 hours

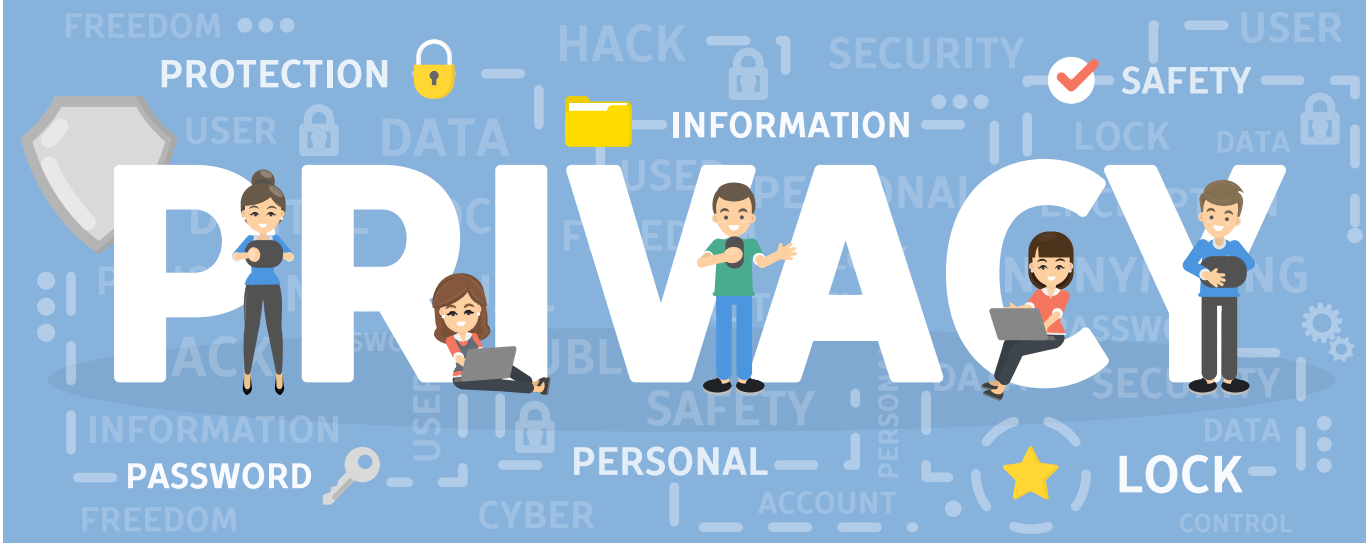
7. Which of the following is NOT an effective way to protect your privacy when using an Online DNA Service?
   - **A.** Scrutinize privacy policies and avoid companies with questionable practices.
   - **B.** Opt into all research or third-party data sharing.
   - **C.** Ensure that DNA samples are destroyed after testing.
   - **D.** Request that all data be deleted after downloading analysis results.



Answers: 1. B 2. D 3. A 4. B 5. B 6. C 7. B

The Last Word

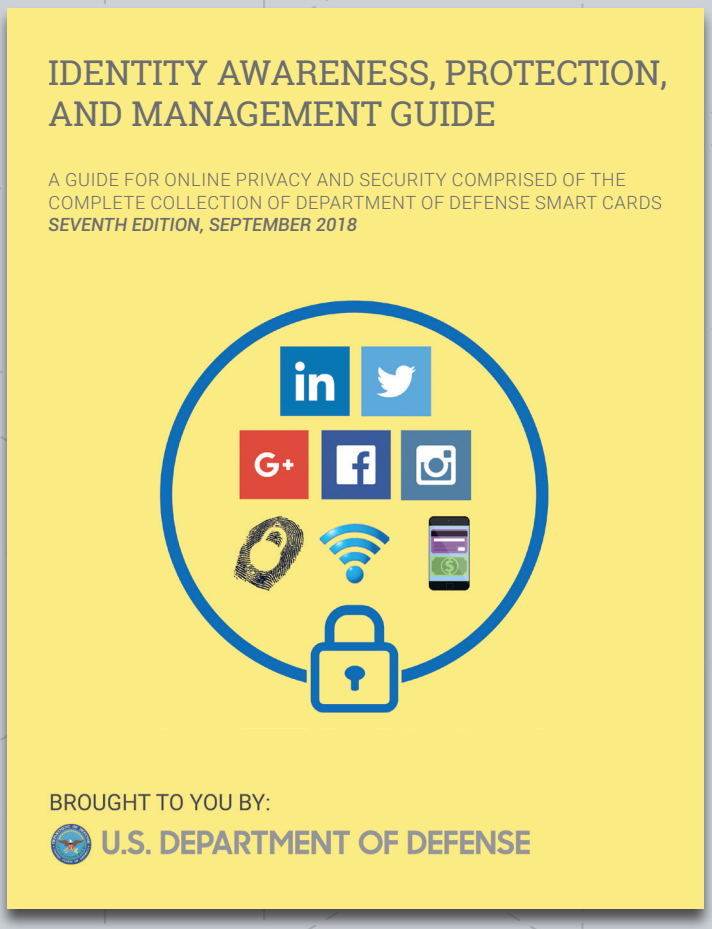
Advancements in DNA testing present unique opportunities and challenges for individuals, doctors, law enforcement, corporations, and legislators. Consumers are enthusiastic about the promises of genetic testing—learning more about themselves and their families and uncovering gene mutations that could be linked to diseases—but they must be educated about the privacy risks. DNA technology is progressing rapidly, and it is paramount that laws keep up to mandate transparency and protect the privacy of consumers. Until then, it is crucial that consumers protect themselves by thoroughly reading privacy policies, limiting data sharing, and deleting data when appropriate.



In the Next CPIQ...

In the digital age, communicating with family, friends, and work colleagues is faster and easier, but it is not safer. Accepting friend requests from people who sort of look familiar or clicking a text message link to a cat video that appears to be from your daughter could let hackers and identity thieves snoop on private conversations and steal sensitive information. The next issue of CPIQ will explore the privacy risks of the latest communication trends, from social media to video chat apps and services that connect children with deployed parents, and give advice on keeping them—and your personal data—safe.

For more detailed information on protecting and managing other key elements of your identity footprint online please check out the:



IDENTITY AWARENESS, PROTECTION AND MANAGEMENT GUIDE