

# DNAdots™

Simple explanations  
of modern genetic technologies

# Dog DNA testing

## What it is:

### Learning more about your dog through their DNA

You might have heard of direct-to-consumer DNA tests that give information on a person's ancestry. These tests work by comparing regions of DNA that vary across human populations and can provide you with information about where in the world your ancestors are from. Now there are similar tests for our canine companions! The same techniques can determine a dog's breed ancestry: what breeds a dog is descended from. These tests can also explain the genetic basis of certain physical traits, like fur color.

Humans have selectively bred dogs for thousands of years, resulting in hundreds of distinct dog breeds. Most breeds were founded from small groups of dogs with specific desirable traits. Closely related dogs were mated to generate more dogs with the desirable characteristics, and now for generations, many dogs have only reproduced with other members of their specific breed. This type of controlled breeding resulted in dogs of the same breed being very similar in their DNA, and clearly different from other breeds. This genetic similarity makes it easy to identify a purebred dog's breed based on DNA alone. But not all dogs are purebred; when looking at the DNA of a mixed-breed dog, scientists search for matches to sequences that identify a specific breed. Such unique identifiers can reveal a mixed-breed dog's ancestry.

## How it works:

### Comparing genetic markers from many dog breeds

Dog breed identification relies on a type of genetic marker known as a single nucleotide polymorphism, or SNP (pronounced 'snip'). When comparing stretches of DNA between individuals of the same species, most of the DNA will be identical. But occasionally, a single base (an A, T, C, or G) will be different. These single-base differences are what we call SNPs.

Because dogs of the same breed tend to be closely related, they have similar combinations of SNPs, which are different from those carried by other breeds. The dog genome is close to 2.5 billion base pairs long, and scientists have catalogued millions of SNPs, many of which are associated with specific breeds. Scientists can compare some of the millions of SNPs to identify combinations that are only present in dogs of the same breed. These genetic profiles work almost like a genetic signature shared by all dogs of the same breed.

When you send your dog's DNA to be tested, the company will compare your dog's DNA at specific SNP locations and then use complex algorithms to estimate your dog's breed ancestry. If a stretch of DNA has SNPs that are most common in Dalmatians, it is assumed that that stretch of DNA was originally inherited from a Dalmatian ancestor. If another stretch matches SNPs found in Siberian Huskies, it is assumed that that stretch of DNA was originally inherited from a Siberian Husky ancestor, and so on. The breed ancestry results are then reported as percentages (Figure 1).



### Mixed Breed

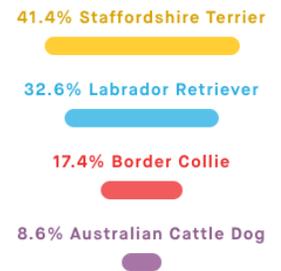


Figure 1. Lucy is a mixed-breed dog. Genetic testing from one company estimated her ancestry as a mix of Staffordshire Terrier, Labrador Retriever, Border Collie, and Australian Cattle Dog.

## How reliable are the results?

### It depends...

While it is fairly straightforward to identify SNPs that are particularly common or uncommon in specific dog breeds, the reverse, accurately matching stretches of an individual dog's DNA to specific breeds, can be much more difficult. For a purebred dog or a dog that is a recent mix of two breeds, these percentages are easy to calculate. For example, a Labradoodle whose parents were a Labrador Retriever and a Poodle should be easy to identify as 50% Labrador and 50% Poodle. But for a dog that is a mix of many breeds, things get more complicated. The more generations between your dog and its purebred ancestors, the smaller and more broken up those identifiable stretches of DNA become.

Many dogs have complex ancestry and may only have distant ancestors that were purebred; some dogs may have ancestry that is not from a particular breed at all. This complexity can result in different testing companies reporting different breed makeups for the same mixed-breed dog (1). There are several reasons for possible discrepancies. First, each company uses its own set of genetic markers to identify a dog's breed ancestry. Generally, testing for more genetic markers should give more accurate results, but not all companies report how many markers they use. Additionally, each company uses different algorithms to estimate a dog's breed ancestry based on their genetic profile. As a result, if you do choose to get your mixed-breed dog's DNA tested, consider the resulting breed percentages as a best guess at your pet's ancestry.

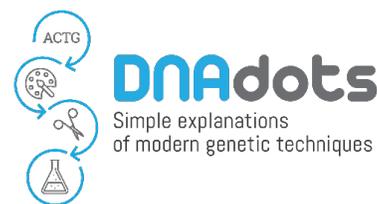
Some dog DNA tests also give you information about the genetic underpinnings of your dog's appearance, like their coat color or fur length. They may even reveal behavioral traits that have been linked to specific genes. Many dog DNA tests also give you information about your dog's health. While we know that dogs can develop numerous diseases with a genetic component, we still do not fully comprehend the underlying genetic causes of most inherited diseases. Largely, a DNA test can tell you that your dog has a genetic marker associated with a disease, but that only means your dog is at risk, not that they will develop that disease for sure.

Scientists and veterinarians have raised warnings about using direct-to-consumer DNA testing to assess a pet's health because there are currently no standards or regulations on pet genetic testing (2). Further, it can be difficult for pet owners to interpret the results of such tests. Some dog genetic testing companies meet with pet owners to explain health screening results and clarify the difference between being at risk for disease and actually being sick, but this is not always the case.

The bottom line is that if you want to test your dog's DNA, you should do some research to compare different companies. Several independent assessments of the best dog DNA tests are available online. And keep in mind that no matter what breed your dog is descended from, all dogs are very good dogs.

### Learn more:

- "Personal Genetic Ancestry Testing." DNAdot [Link](#).
- "What we can and can't learn from our pets' DNA." Science News for Students [Link](#).
- "Why dog genetic testing isn't so simple." Video from Chemical & Engineering News – Speaking of Chemistry [Link](#).



## Questions

### Review:

1. Why are dogs of the same breed so genetically similar?
2. What is a SNP?
3. Why might two tests from different companies give you different breed ancestry results for the same dog?
4. Besides ancestry, what other information can these tests sometimes provide?
5. What aspect of giving genetic health results directly to consumers concerns many scientists and veterinarians?

### Critical thinking:

1. Two mixed-breed dogs from the same litter can receive accurate breed ancestry results that give different breed percentages. Explain why siblings might have different breed ancestry makeup even though they share the same ancestors.
2. There are still many heritable traits in dogs where scientists do not know the genes involved. Genetic testing companies can use the data they collect to identify genes responsible for various traits in dogs (3, 4). Many of these discoveries relate to phenotypes related to a dog's appearance. Why do you think it might be easier to link genes to a dog's appearance compared to other heritable traits, like genetic disease or behaviors like herding?

### Discussion:

1. When you give a DNA sample to a testing company, they own the data they get from that sample. Some companies are using the large amounts of genetic information they collect to make new scientific discoveries. However, the testing companies are not prohibited from selling the data, for example, to other groups who make pet care products. How do you feel about giving a private company your dog's genetic information? Should there be limits on what they can do with it?

**Answer key:** Available to teachers upon request: [dnadots@minipcr.com](mailto:dnadots@minipcr.com)

### Citations:

1. Chemical & Engineering News – Speaking of Chemistry. (2019) Why dog genetic testing isn't so simple. <https://www.youtube.com/watch?v=1QpsfBo7yoE>
2. Moses, L., Niemi, S., and Karlsson, E. (2018). Pet genomics medicine runs wild. *Nature* 559, 470–472.
3. Kawakami, T., Jensen, M.K., Slavney, A., Deane, P.E., Milano, A., Raghavan, V., Ford, B., Chu, E.T., Sams, A.J., and Boyko, A.R. (2021). R-locus for roaned coat is associated with a tandem duplication in an intronic region of USH2A in dogs and also contributes to Dalmatian spotting. *PLOS ONE* 16, e0248233.
4. Deane-Coe, P.E., Chu, E.T., Slavney, A., Boyko, A.R., and Sams, A.J. (2018). Direct-to-consumer DNA testing of 6,000 dogs reveals 98.6-kb duplication associated with blue eyes and heterochromia in Siberian Huskies. *PLOS Genetics* 14, e1007648.