A Bark Stronger than A (Science) Bite

If you were to look at a German shepherd and a gray wolf, and then a German shepherd and a pug, which pair would you think were more closely related? Probably the wolf and German shepherd, but looks can be deceiving. As we have learned, all three animals are members of the same species, *Canis lupus*, but the German shepherd and pug are more closely related, as they are members of the subspecies *Canus lupus familiaris.*

Figure 1. Don't Judge a Dog by its Cover. Despite what it looks like, German shepherds (top) are more closely related to pugs (right) than to gray wolves (left).
Source: Wikimedia Commons (Gray Wolf, German shepherd, pug).

The sometimes stark physical differences among domestic dogs are possible because of the phenotypic plasticity of the gray wolf genome. **Phenotypic plasticity** refers to the ability of a genome to generate different phenotypes depending on the environment, or in the case of dogs, on human preferences and artificial breeding. Some animals do not have that much phenotypic plasticity. Consider cats, for example. We have many breeds of domestic cat, but there isn't near the variety of sizes, body shapes, and traits as there are among domestic dogs.

As you know, physical traits are the result of interactions between genes and the environment. We know the "environment" in the case of domestic dogs is human preference, but what about the genes? What are some of the genetic differences that are responsible for our friendly and totally un-wolf like dogs? We're just beginning to uncover the details.

A group of Swedish scientists led by Erik Axelsson at Uppsala University took DNA from 12 wolves from across the world and 60 dogs from 14 diverse breeds (including Golden Retrievers, pugs, and Dalmatians). Using a technique called **whole-genome sequencing**, the scientists "read" the genomes and put them side-by-side to look for differences. This process is much like comparing a text that has been written in American English or British English: both use the same basic letters, but some key differences in vocabulary or how words are spelled make the dialects distinct. "Colour," "lift," and "visualise" in British English become "color," "elevator," and "visualize" in American English.

While comparing all these different genomes, the scientists wanted to focus on differences that existed between wolves and dogs. If there was a variation, for instance, that was present in all domestic dog breeds but not the wolf, then it was likely a change caused by domestication. But a variety present in only some of the domestic dog breeds but not others, is more likely a result of the artificial breeding process than domestication.

The scientists found that when they looked for categories of genes that differed between wolves and dogs, two groups stood out: "nervous system development" and "digestion." The first category was not surprising. Many of identified genes are responsible for how the brain develops at a young age. It is very likely that these genes are at least partially responsible for why domestic dogs are friendlier and more outgoing than wild wolves.

The second group of genes, in the "digestion" category, was more surprising. Many of the genes that were different between wolves and dogs were involved in the digestion of complex carbohydrates. For example, let's look at how wolves and dogs express amylase, an enzyme that breaks down starch. Amylase is present in human saliva: If you hold rice, crackers, or bread in your mouth for a while before swallowing, it starts to taste sweet. That's because amylase is breaking the starch down into sugars! Wolves and domestic dogs have amylase, too. **Figure 2** shows data collected by the researchers that compares *how much* amylase is expressed (left) and how *active* the amylase is (right) in wolves and domestic dogs. As you can see from the data, domestic dogs produce more amylase and the amylase is more active.

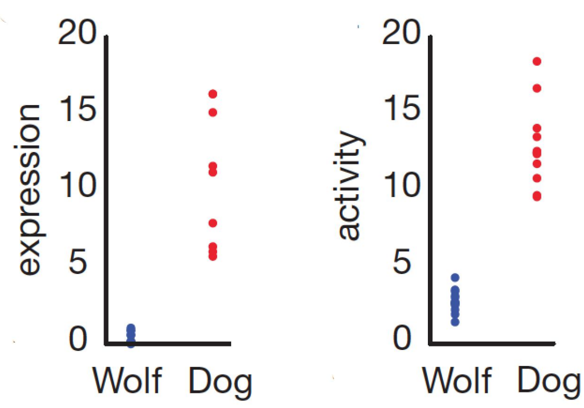

Figure 2. Amylase Expression and Activity. Domestic dogs express more of the gene that codes for amylase (left). Dogs also express amylase that is more active than wolf amylase (right). *Source:* Adapted from Axelsson *et al.* 2013.

These differences hold true for many other genes that help dogs digest starch and other sugars. Does this make sense? If we think about human diets, then yes! Dogs have evolved the ability to eat a diet that is more like humans'. Was this on purpose? That is, did humans purposefully select and breed dogs that thrived on human-like diets? Or was this simply a passive byproduct of humans choosing the behavioral traits we know and love in dogs? Because this is an example of artificial selection, we can ask these questions, but we are not yet sure of the answers. However, the traits that make dogs more like us sure don't hurt in making them our closest companions!

References

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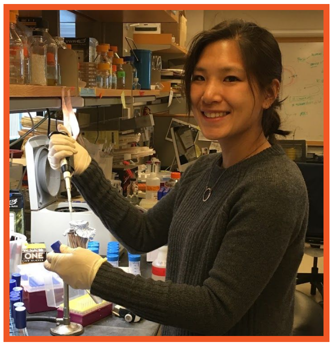

Katherine J. Wu is a microbiologist and science journalist who likes bacteria, chocolate, long runs, and weird stories about reproduction, but ideally not all at the same time. She completed her PhD at Harvard University, studying the microbes that cause the lung disease tuberculosis. She has since traded the life of practicing research for writing about research.

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