

What is Population Genetics?

How breeders are like chefs

Imagine you are one of several chefs that cook from a common pantry. You each have your own styles of cooking, your preferences for spices, your tastes for dessert. To keep the pantry stocked with every ingredient each of you might possibly need, there is a pantry monitor whose job it is to replenish stock of anything running low, throw stuff out that is going bad, keeping the weevils out of the flour, and so forth. If that pantry monitor doesn't do their job, one of the chefs could finish off the last of the sugar on a wedding cake and nobody will be able to make desserts. Or the weevils do contaminate the flour, and you would be willing to scoop out a few little bugs but one of the other chefs throw the whole thing out.

Running a kitchen and pantry like this is a lot like breeding pedigree dogs. You each want to produce puppies to suit your individual goals, but you and all the others in your breed share a common gene pool. If the gene for some essential biochemical pathway is inadvertently lost - perhaps the last copy of that allele was in a puppy that was spayed - then it's gone forever for everybody. If a disproportionate number of puppies are born with the gene for some disease, it's not unlike a weevil outbreak in the flour. You might try to work around it, but some other breeder might decide to throw everything out. In fact, maintaining the health of the gene pool is in everyone's best interests. But there is no "gene pool monitor." Nobody is tending the pantry.

Mendelian vs Population genetics

Most dog breeders are knowledgeable about Mendelian genetics - the inheritance of traits through the independent assortment of alleles passed down from the parents; that is, the genes in an individual. Population genetics is about the pantry - the collection of genes in your breed, which are the raw materials you have available to create the sort of dog you envision. Population genetics provides the tools breeders can use to maintain the health of the gene pool, which is essential to maintain the health of a breed. With Mendelian genetics, you can use breed knowledge and DNA tests to win the next battle and produce puppies with less risk of genetic disease, but without population genetics you'll probably lose the war because you have no way to manage disease in the breed.

Population genetics is about the breed

Population genetics is concerned with the frequency and distribution of alleles in a breed. Understanding and managing the genetic health of a population of animals is essential for breeding healthy animals and to maintain breed type. Failure to recognize the importance of population genetics is the reason why the number of genetic disorders in dogs continues to increase. Many breeds have lost the genetic diversity in the genes of the immune system (MHC DLA) that are essential to protect the animal from the constant onslaught of bacteria, viruses, and other pathogens in the environment that could produce sickness or even death. Without genetic management, an entire breed can lose a single allele that is essential for a vital biochemical pathway, as was done in Dalmatians with the loss of a gene that controls urinary uric acid (the gene was successfully reintroduced into the breed by an outcross to a pointer). Genes that are fundamental to breed type can inadvertently be lost- a breed can be plagued by bad fronts or inappropriate temperament if the genes for those traits are lost from the gene pool. Population genetics is about managing the raw materials breeders use to produce healthy dogs of correct type.

Population genetics for dog breeders

Understanding population genetics is essential for managing the genetic health of a breed and consequently for the control of inherited disease. Things like the size of the population, number of animals used for breeding and the number of offspring they have, bottlenecks (from disease, popular sires or kennels etc), and the number of founders of the original population. The long-term consequences of individual and collective breeding strategies on the health and gene pool of a breed; and how DNA tests for particular diseases or components of a disease, should be included in a carefully planned and managed strategy for the breed to avoid further limiting an already small gene pool.

by Carol Beuchat PhD