

Inbreeding and Genetic Diversity

- **Genetic Diversity:** refers to the extent of variation that occurs within a closed population within a species. Genetic diversity is important because it strengthens the ability of species and populations to resist inherited diseases, other diseases and other stresses.
- **Coefficient of Inbreeding (COI):** a way of calculating how closely related a dog's parents and their relatives are. This is especially important if planning a mating between two dogs, as it can give a statistical value of how genetically similar any puppies produced could be.
- **Pedigree COI:** this measure of COI calculates the degree of relationship over just a few generations (usually between 5 – 10), and ignores relationships further back in the pedigree. This can be misleading, and so a more meaningful COI includes as many previous documented generations as possible.

<https://www.thekennelclub.org.uk/health-and-dog-care/health/getting-started-with-health-testing-and-screening/inbreeding-calculators/>

- **Genetic (Genomic) COI /DNA COI** – this looks at all the generations of a breed's development, and so has a higher standard of accuracy than pedigree COI.

<https://www.instituteofcaninebiology.org/blog/inbreeding-of-purebred-dogs-determined-from-dna>

- **Cross-breeding:** mating between two dogs of different breeds. This may be with the intention of producing a 'new' type of dog, or to bring new genetic material into an existing breed.
- **Out-cross:** Out crossing usually refers to breeding to an unrelated dog within the same breed, with the aim of bringing in new genes. However, because dogs within many breeds are all closely related due to lack of genetic diversity, in many cases it has become increasingly difficult to do a 'true' out-cross. High levels of inbreeding will impact health, for example causing reduced longevity and fertility, and increasing levels of inherited disease. Consequently, some breeders, with the guidance of geneticists and other experts, are redefining an out-cross as a cross-breed to another breed. This introduces new genes. Subsequent generations can then be bred with other dogs of the original breed again. In this way breeders can increase genetic diversity but maintain the characteristics of the original breed.
- **Back-cross:** breeding back to the original breed from an outcross
- **In-breeding:** the 'art' of mating closely related dogs together to fix in their genetic make-up the qualities or conformation (body shape) the breeder is looking for and the 'breed standard' requires. Extreme inbreeding, such as parent to child or brother to sister, is now banned by most kennel clubs internationally, including the (UK) Kennel Club. NB

'breed standard' is the official Kennel Club written description of the physical shape, size, colour, and coat type of the breed.

- **Line-breeding:** This generally means mating related dogs in order to ensure consistency of a physical trait or temperament trait while trying to avoid serious problems that result from more extreme in-breeding.
- **'Popular sire' syndrome:** when one male dog fathers an excessive number of litters, often because this dog is very successful in the show ring or has certain desirable physical features. Particularly in numerically small breeds, heavy use of a popular sire can seriously reduce genetic diversity in subsequent generations. For good population health, breeders should seek to use a wide range of parent dogs and include health testing results relevant to that breed in their selection criteria.

Why do we need to understand this?

Many breeds were built with very limited foundation dogs. The line breeding (inbreeding) performed over the last 100 years over successive generations, together with the popularity of certain male dogs, has often reduced the available genetic material and therefore genetic diversity in a given breed.

So, although dogs of a breed all look very similar and can have similar behavioural characteristics (often referred to as "breeding to type"), there can be detrimental effects on health, such as increasing the likelihood of genetic diseases which can reduce quality of life and longevity. Reduced genetic diversity can also affect the immune system with increased susceptibility to infection and immune mediated disease. Conversely, increasing genetic variation gives so called hybrid vigour. Reduced genetic diversity can also affect reproduction, leading to reduced fertility and litter size.

Outcrossing can also be a solution to issues of extreme conformation such as those highlighted in the recent Norwegian court ruling which found that breeding English Bulldogs and Cavalier King Charles Spaniels breached the Nordic Country's existing Animal Welfare Act because these breeds are very predisposed to health problems due to selective breeding. Commenting on this ban, the World Small Animal Veterinary Association and the British Small Animal Veterinary Association have stated that *'Breeding should promote traits that provide robust animals with good function and health.'* and *'Health focused breeding and husbandry practices are the means to improve the health of purposely bred animals. The selection of breeding dogs and cats must avoid the extreme conformation that predisposes to disease and poor welfare.'*

Further information on COI

<https://www.thekennelclub.org.uk/health-and-dog-care/health/getting-started-with-health-testing-and-screening/inbreeding-calculators/>

<https://www.instituteofcaninebiology.org/blog/coi-fags-understanding-the-coefficient-of-inbreeding>

Links to projects

Genetic Rescue of the Highly inbred Norwegian Lundehund:

https://www.mdpi.com/2073-4425/13/1/163?fbclid=IwAR3QEeLa-FeXQd4sT3g0gVZ5k3LhH4Kz84bNCEUrgZFfZZ7YwQhPbp61_g

[Irish Red & White Setter](#) (Irish KC)

[Wetterhoun](#) (Dutch KC)

Doberman Preservation Project

<https://www.dobermanpreservationproject.com/the-project.html>

Bernese Mountain Dog Vitality Project

<https://www.bmdvitalityproject.org/>

Additional links

<https://www.instituteofcaninebiology.org/blog/lush-on-linebreeding>

<https://journals.biologists.com/dmm/article/9/12/1445/4004/Whole-genome-sequence-SNP-chips-and-pedigree>