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Understanding Incomplete Penetrance in Canine Genetics: What Breeders Need to Know

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As a dog breeder, understanding the genetic underpinnings of the traits and health conditions in your breed is essential. One concept that often causes confusion is **incomplete penetrance**. This genetic principle can complicate breeding decisions and the interpretation of **DNA test results**. Let's break it down with an example and explore how it might affect your breeding program.

What Is Incomplete Penetrance?

Penetrance refers to the proportion of individuals with a specific genotype who exhibit the expected phenotype. When a genetic trait shows **complete penetrance**, every dog that inherits the associated genotype will express the trait or condition. However, with **incomplete penetrance**, not all individuals with the genotype show the expected phenotype. In other words, a dog might carry the genetic variant but never show signs of the associated condition.

Example: Degenerative Myelopathy (Common Variant) (DM)

One well-known example of incomplete penetrance in dogs is **Degenerative Myelopathy (Common Variant) (DM)**, a progressive neurological disorder that affects the spinal cord. DM is associated with genetic variants in the **SOD1 gene**.

In most breeds, DM follows an autosomal recessive inheritance pattern, meaning that:

- **Clear dogs (N/N)** have no copies of the genetic variant.
- **Carriers (N/DM)** carry one copy but are not typically affected.
- **At-risk dogs (DM/DM)** have two copies of the genetic variant and are at risk of developing the disease.

However, DM also exhibits incomplete penetrance. Not every dog with the **DM/DM** genotype will develop clinical signs of the disease. This variability can be influenced by factors such as:

- **Environmental conditions**
- **Modifier genes** that may suppress or exacerbate the expression of the disease
- **Age** (DM tends to have a late onset)

Why Is This Important for Breeders?

Incomplete penetrance complicates breeding decisions in two key ways:

1. Misinterpretation of Test Results

A genetic test might reveal that a dog is **DM/DM**, placing them in the "at-risk" category. However, this does not guarantee they will develop DM. If this distinction isn't understood, breeders might unnecessarily exclude valuable dogs from their breeding programs, potentially narrowing the gene pool and inadvertently increasing the risk of other genetic issues.

2. Risk Management

When planning breedings, it's crucial to consider not just the risk of producing affected dogs, but also how incomplete penetrance might impact the actual expression of the condition. Breeding a **DM/DM** dog to a **N/N** clear dog will produce 100% carriers (**N/DM**), which will not be affected but might pass on the genetic variant to their offspring.

Best Practices for Breeders

1. Consult DNA Test Results Wisely

Use genetic testing as a tool but not the sole basis for breeding decisions. Evaluate the dog's overall health, temperament, and conformation alongside genetic information.

2. Educate Your Puppy Buyers

If you sell puppies that are carriers or at-risk for a condition with incomplete penetrance, provide clear explanations. Help them understand that a genetic risk does not always equate to disease.

3. Maintain Genetic Diversity

Avoid eliminating all dogs with at-risk genotypes from your breeding program. Instead, aim to balance health priorities while preserving genetic diversity.

4. Collaborate with Veterinary Professionals

Work closely with veterinarians and geneticists to interpret DNA test results and tailor breeding strategies that support the long-term health of your breed. The AKC Canine Genetic Counseling Center is also available to help interpret results.

Conclusion

Incomplete penetrance underscores the complexity of genetics and why breeders should take a holistic approach to breeding decisions. By understanding this concept, you can make informed choices that benefit not only individual dogs but the future of your breed as a whole.

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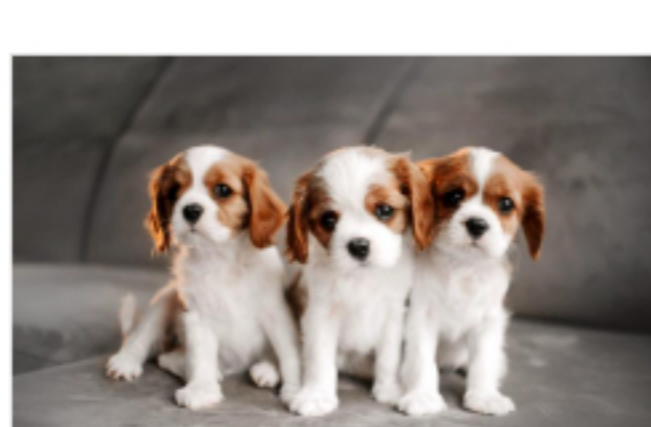
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