DNA Testing For Genetic Defects

By Larry Keenan, RAAA Director Of Breed Improvement

Pick up any livestock oriented publication and it won't take long to find an article that mentions genetic defects. One must realize that genetic defects are not a new phenomenon, and certainly not the end of cattle production as it exists today.

Although not scientifically documented until the early 1900's, genetic defects have likely existed since the domestication of cattle. In previous years, when a genetic defect was identified the only means of attempting to control the defect was to eliminate the entire line of cattle. Fortunately, a cattle producer's "toolbox" now includes DNA technology, which offers a more accurate and economically viable way of controlling genetic defects, while preserving valued traits of economic relevance to the beef industry.

In order to grasp the "big picture" regarding genetic defects, it is imperative to understand their inheritance pattern. To begin, every gene that an animal possesses contains one allele contributed by the sire and one allele contributed by the dam. So, 2 alleles = 1 gene. For genetic defects to be expressed, the animal must receive a genetic defect allele from each parent. This is depicted in Figure 1, where A = Normal allele and a = genetic defect allele. So, if an animal has at least one Normal allele they will not express the genetic defect. Basically, the Normal allele will override the genetic defect allele's impact on the animal. These animals are called "Carriers". However, if an animal possesses two genetic defect alleles, the genetic defect will be expressed.

Figure 1.

AA ⟶ 2 Normal Alleles = Normal Appearing

Aa ⟶ 1 Normal & 1 Defect Allele = Normal Appearing Carrier

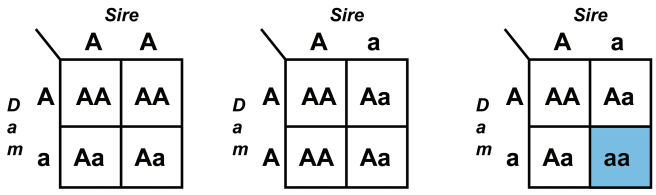
aa ⟶ 2 Defect Alleles = Genetic Defect Expressed

To better understand the inheritance of genetic defects, and how they can go unnoticed for several generations, study the matings depicted in Figure 2. The four squares represent the expected results when:

- an AA sire is mated to an Aa Carrier dam
- an Aa Carrier sire is mated to an AA dam
- an Aa Carrier bull is mated to an Aa Carrier dam.

Note, the only mating that produces a genetic defect animal is when a Carrier is mated to a Carrier – shown by the shaded square. Additionally, only 25% of the time does this mating produce offspring that express the genetic defect.

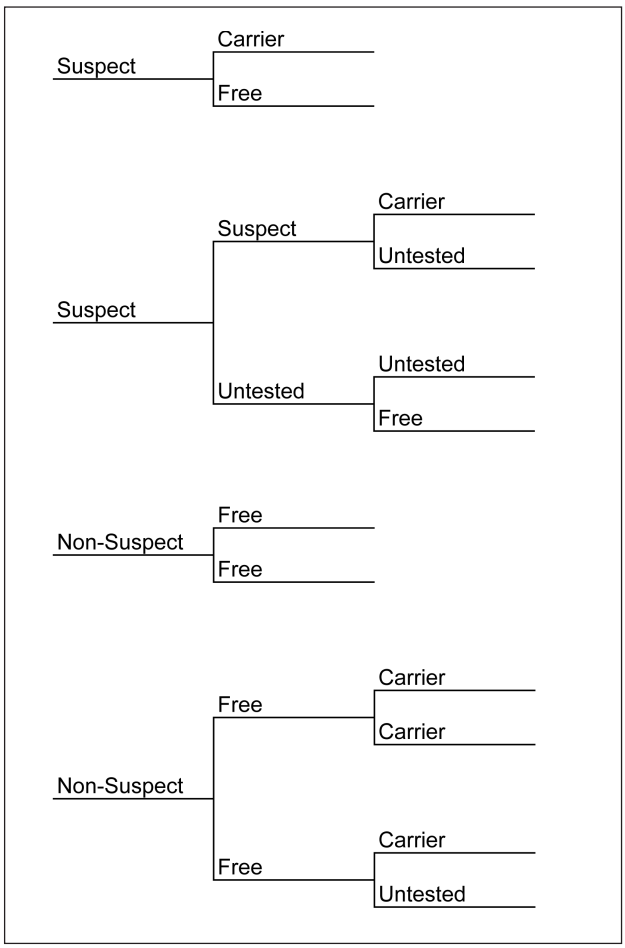
Figure 2.



In the past, we could only identify Carriers through the production of genetic defect calves. However, with the development of a DNA test we can simply "test" an animal to determine if they are a Carrier or Free of a particular genetic defect. When such a test becomes available, some may rush to test all of their animals for the particular genetic defect. However, there is a more sensible, economical approach. In reality, the only animals that need to be tested are Suspect animals – animals that have the potential to be a Carrier based on their pedigree. To be more specific, animals containing a Carrier animal in their pedigree without an intervening tested Free ani-

mal. Figure 3 provides various pedigree scenarios and the resulting Suspect or Non-Suspect status of the animal in question.

Figure 3.



Moving forward, RAAA will provide tools to assist producers in identifying Suspect animals. It is important to understand that an animal's Suspect status may change as related animals are tested. For example, if an animal is Suspect due to their paternal grandsire being a confirmed Carrier, they will be reclassified as a Non-Suspect if their sire is tested Free (given their dam is Free or Non-Suspect).

DNA tests for genetic defects provide an accurate means to take advantage of superior animals who have tested free, but are derived from bloodlines associated with a genetic defect. Such DNA tests are simply another method to achieve the goal of complete genetic description of cattle. The acceptance and exploitation of such tools will increase the reliability of supplying beef industry customers with problem free, profit enhancing genetics. ■