

By the Numbers

► by Association Staff

Visualize a simple recessive

The adage “A picture is worth 1,000 words” could never be more true than during a discussion about recessive inheritance. An escape from genetic textbook content is possible when illustrating a simply inherited recessive gene.

Fig. 1: Mating results of two animals that are carriers of a simple, autosomal recessive gene for red coat color

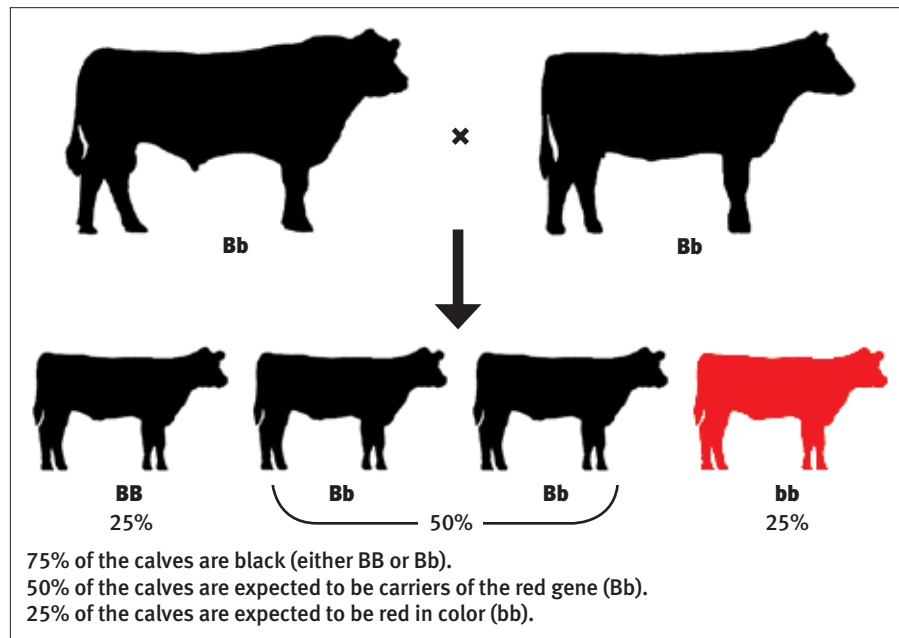
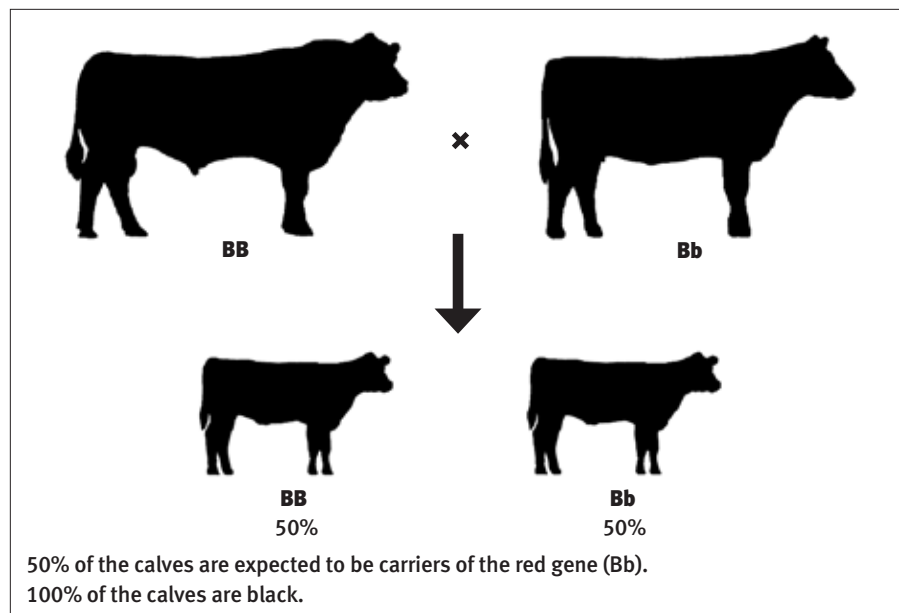


Fig. 2: Mating results of a noncarrier bull mated to a carrier female of a simple, autosomal recessive gene for red coat color



Easy example

Black/red coat color is the classic example of this inheritance pattern. Red coat color in Angus is controlled by simple autosomal inheritance. The term ‘autosomal’ signifies that sex chromosomes are not involved and that results are expected in equal frequencies for both genders.

As a reminder, genes are the basic unit of genetic inheritance and are inherited singly, not as pairs.

Genes are located on chromosomes. Cattle have 30 pairs of chromosomes. The sire contributes one chromosome to each pair, and the dam contributes one chromosome to each pair. So, a calf receives a random sample half of each of its parents’ genes. This contribution of genetic material from the sire and dam forms the genotype of the individual.

The term phenotype is used to describe what we can measure and observe about an animal — red or black coat color or height, for example. It has two components, the genotype and the environment.

In the case of a simple recessive trait, the gene for the trait has two variations, or alleles — a dominant allele and a recessive allele. For notation, the capital “B” represents the dominant allele for coat color and the lowercase “b” signifies the recessive allele. Black is the dominant phenotype and can mask the recessive red phenotype.

The animals termed as homozygous contain identical alleles (BB or bb). Since red color in Angus cattle is inherited as a simple autosomal recessive, the three potential genotypes can be denoted as BB, Bb or bb, where the BB and Bb genotypes produce a black phenotype and the bb genotype produces the red phenotype.

A BB animal is black in color and will always pass on or transmit the B allele to future offspring, which will be black since black is dominant. A bb animal is red in color and is homozygous recessive, always transmitting the recessive gene b to future offspring.

In contrast, the heterozygote, Bb, will pass B half the time to progeny and b half the time. The Bb animal is black in color because black is dominant, but it is considered a carrier of the recessive gene, b. To display the red color, the animal must be homozygous for the recessive gene (bb).

To better understand the results of mating animals that are recessive carriers, consider the mating of two heterozygote animals, Bb × Bb (see Fig. 1). The mating of these two carrier parents has the potential to produce three genotypes — BB, Bb and bb.

We would expect 75% of the resulting calves to be black in color (BB and Bb genotypes) and 25% to be red (bb genotype). The red calves fully express the recessive trait with their coat color.

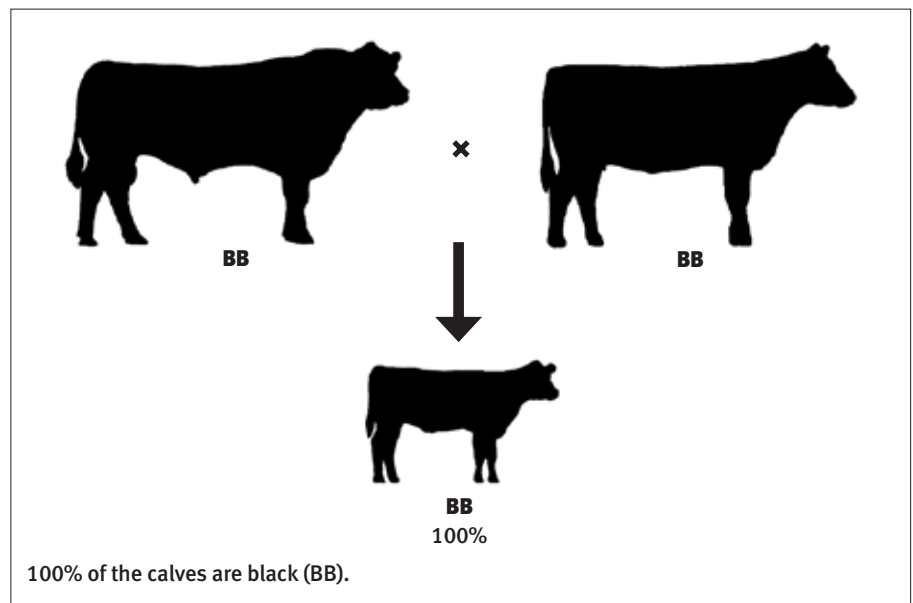
Fifty percent of the calves resulting from the mating of two carrier parents are expected to be carriers (Bb) and will not express the red gene in their phenotype. The calves will be black. Visibly, you won't be able to tell the difference between the carrier (Bb) and the homozygous black (BB) calves.


As another example, Fig. 2 presents the mating of a noncarrier bull to a carrier female. In this case, all calves produced from the mating are black, but 50% of the calves will be carriers of the red gene.

In the last example, all resulting calves are black in color. The mating of two noncarriers, or homozygous dominant bull and cow, has no resulting red calves or carrier calves (see Fig. 3).

Although simplistic, the figures help create an image of what to expect from potential carrier matings in the case of a simple,

Fig. 3: Mating results of a noncarrier bull mated to a noncarrier female



autosomal recessive gene, the phenotypes expressed, and the potential genotypic frequencies of the resulting calves. Understanding the mode of inheritance on a trait, and how to manage the matings with known genotypes, provides a better opportunity for producers to most effectively utilize the technology available today. 

Editor's Note: "By the Numbers" is a column by Association performance programs staff to share insights with Angus members about data collection and interpretation, the National Cattle Evaluation (NCE), genetic selection, and relevant technology and industry issues. If you have questions or would like to suggest a topic for a future column, contact Sally Northcutt, director of genetic research, or Bill Bowman, director of performance programs, at 816-383-5100.