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RCVS ACCREDITED PRACTICE CORE STANDARDS

Myostatin Gene Explained by Morven Coutts BVMS DBR MRCVS.

From the very beginning of domestication of cattle, we have been selecting animals for traits which we feel are desirable e.g. growth rates, calving ease, docility or being polled. Historically this has been done by eye and using family histories but now, as technology advances and we understand more about the genetic makeup of each breed of cattle, we can use DNA samples to identify desirable or harmful traits and therefore improve the breed.

In order to fully understand how the use of genetics can influence a breed trait, first, it is important to understand a few of the common terms used when discussing genetics:

Gene - a gene is a sequence of DNA in every animal that controls the expression of a particular trait. Some traits are controlled by more than one gene. An animal has 2 copies of each gene; one comes from the dam, the other from the sire. These copies can be identical or different.

Trait - a particular visible characteristic, e.g. red coat colour

Homozygous – where both copies of a particular gene are the same

Heterozygous – where both copies of a particular gene are different

Dominant gene - a dominant gene is more influential than the other copy of the same gene e.g. polled gene. Only 1 copy of a dominant gene is enough for the trait to be expressed in the animal.

Partial Dominance – where one copy of a gene has an effect on the trait expressed but to a lesser degree than if the gene was dominant

Recessive gene – a recessive gene can only influence expression of a trait if both copies of the same gene are both recessive e.g the horned gene

Mutation – when the DNA code for a gene gets distorted and results in a change in how the gene is expressed as a trait.

Carrier – an animal that has one copy of a mutated gene and one normal gene. The relative dominance of the gene will determine whether the gene is expressed or not.

What is Myostatin?

Myostatin is a growth factor protein that controls and regulates the growth of skeletal muscle in all mammals. The myostatin gene controls the production of this protein. When there is a mutation of the gene, the myostatin protein is not produced and so muscle growth is not regulated, resulting in the classic “double muscling” trait.

In cattle, nine different mutations of this gene exist; some are breed specific and others are seen across the different breeds. Each mutation can exert partial dominance on gene expression. The myostatin gene is also capable of pleiotropy which means that it has an influence on other traits too, specifically pelvic size, milk production and fertility. Many of the myostatin mutations have a detrimental influence on these other traits which will result in animals being born which have smaller pelvic size, lower milk production and reduced fertility.

In the Salers breed, two mutations of the gene have been identified in the UK population:

NT821: this mutation is not desirable. It is only carried by a small proportion of the breed but is the most common mutation seen in samples submitted from Salers breeders in the UK. Animals that carry 2 copies of this mutation will have increased muscle mass (double muscling) and good feed conversion efficiency however it is also associated with higher birth weights and increased risk of calving difficulties. If an animal carries only one copy of the mutation, these traits will be expressed to a lesser degree.

F94L: It is responsible for an increase in muscle size and feed conversion efficiency with no reported side effects of associated calving difficulties, lowered fertility and reduced longevity. Animals with 2 copies of this mutation will express these traits readily. If an animal has only one copy of the mutation, it will express these traits to a lesser degree.

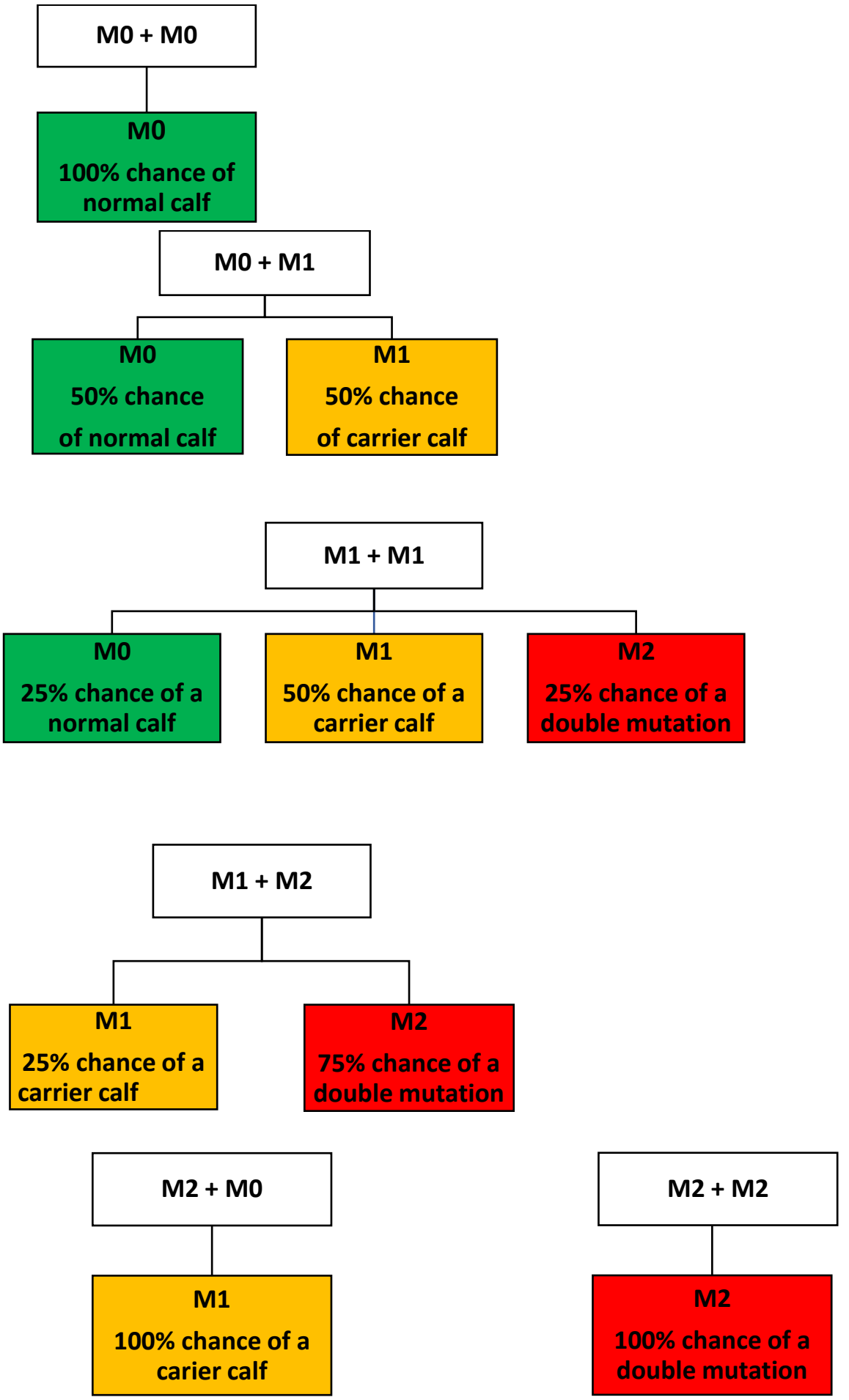
It should be noted that research into these gene mutations is still relatively new and there is still a lot that is not known about the full effects of these genes and the potential consequences of any gene mutation.

How could this affect your herd?

In order to minimise the risk of having the undesirable NT821 myostatin mutation gene in your herd it is important to consider how genes are passed on. All animals have 2 copies of the myostatin gene, but only one copy is passed on from a sire or dam to its offspring. Which gene gets passed on to the offspring is random but each has a 50% chance of being passed on. This means that the chances of an undesirable mutation being passed to the next generation will depend on whether each parent carries none, one or two copies of the mutant gene. The coding used in bull proofs is as follows:

M0 – both genes are the normal myostatin gene
M1 – one copy of a mutated myostatin gene, one normal myostatin gene. A “carrier animal".
M2 – two copies of a mutated myostatin gene.

Below are diagrams that give the likelihood of a calf carrying a mutation depending on the myostatin genes carried by the sire and dam. The more copies of mutated genes in a mating increase the chances of the mutation passing on to the next generation and spreading through the breed.


M0 + M0
M0
100% chance of normal calf
M0 + M1
M0
50% chance of normal calf
M1
50% chance of carrier calf
M1 + M1
M0
25% chance of a normal calf
M1
50% chance of a carrier calf
M2
25% chance of a double mutation
M1 + M2
M1
25% chance of a carrier calf
M2
75% chance of a double mutation
M2 + M0
M1
100% chance of a carier calf
M2 + M2
M2
100% chance of a double mutation