

# The Red & White Gene in Canadian Holsteins

The Holstein breed is unique in that it includes a separate sub-population of animals with a Red & White coat colour instead of the traditional Black & White. The mode of transmission of the single gene responsible for the original (i.e.: “true”) Red & White Holstein is well understood and a DNA test exists to identify Black & White animals that are carriers. Two other sources of red coat colour at birth have been identified and are known as “Black/Red” and “Variant Red”. Research is ongoing in Canada to clearly identify the mode of transmission for the genes associated with these changes in coat colour and ideally find a DNA test for each to accurately test for carriers. Given the increased interest in Red & White Holsteins, a recent study at Canadian Dairy Network (CDN) took a closer look at the true Red & White gene in Canada.

## Mode of Transmission

The true Red & White gene in Holsteins has a simple mode of expression in itself. The two forms of this gene are labelled as “B=black” and “r=red”. Use of the uppercase “B” denotes that this is the dominant form, when present, which always produces a Black & White coat colour. The lowercase “r” is used to represent that this form of the gene is recessive, which means that the animal is Red & White only if it has two copies of this form of the gene and no “B”. When combined together through mating, there are only three possible genotypes that an animal can have for the true Red & White gene, labelled as “B/B”, “B/r” and “r/r”, as shown in Figure 1.

Figure 1: Schematic Diagram of Mating Results for Coat Colour in Holsteins Associated with the True Red & White Gene

		BULL		BULL		BULL	
		BLACK (B/B)		BLACK *RC (B/r)		RED (r/r)	
BLACK COW (B/B)	♀ ♂	B	B	B	r	r	r
	B	B/B Black	B/B Black	B/B Black	B/r Black	B/r Black	B/r Black
	B	B/B Black	B/B Black	B/B Black	B/r Black	B/r Black	B/r Black
BLACK COW *RC (B/r)	♀ ♂	B	B	B	r	r	r
	B	B/B Black	B/B Black	B/B Black	B/r Black	B/r Black	B/r Black
	r	B/r Black	B/r Black	B/r Black	r/r RED	r/r RED	r/r RED
RED COW (r/r)	♀ ♂	B	B	B	r	r	r
	r	B/r Black	B/r Black	B/r Black	r/r RED	r/r RED	r/r RED
	r	B/r Black	B/r Black	B/r Black	r/r RED	r/r RED	r/r RED

Source: Adapted from a schematic diagram produced by the Canadian Red & White Holstein Club

When providing information about coat colour, Holstein Canada uses two distinct fields of information. The first is a simple reflection of the visible colour of the animal, which is either “B&W = Black & White” or “R&W = Red & White”. The second field is the designation assigned regarding the animal’s genetic makeup, or genotype, as described in Figure 1. Black and White animals may have a genotype of \*RF indicating that the result of the DNA test has shown that they are “Red Free” and do not carry the true Red & White gene. Other Black and White animals may have a genotype of \*RC to indicate that they are a carrier of the true Red & White gene, for which there is a 50% chance that they will pass on to their progeny. For animals that are visibly Red & White because they carry two copies of the “r” gene, no genotype is published. Other animals that were born Red & White because of the “Black/Red” and “Variant Red” genes may have a genotype of \*BRC or \*VRC, respectively, but such animals may not carry the true Red & White gene unless they also show the \*RC genotype.

## Gene Frequency

A recent study at CDN analyzed all pedigree and coat colour codes to estimate the frequency of the gene responsible for the true Red & White coat colour in the Canadian Holstein population. In this analysis, codes associated with the Variant Red (\*VRC) or the Black Red (\*BRC) genes were not considered since the responsible genes are independent from the true Red & White gene. Figure 2 shows the trend by birth year of the percentage of Canadian Holsteins that are carriers of the true red gene. As expected, the presence of this gene in Canada was very low for animals born prior to 1967 but increased steadily to reach over 20% for birth years from 1981 to 1989 inclusively. Following a slow decline in the gene frequency during the 1990s, a regained interest in the selection for the true Red & White gene is visible for heifers born since 2004.

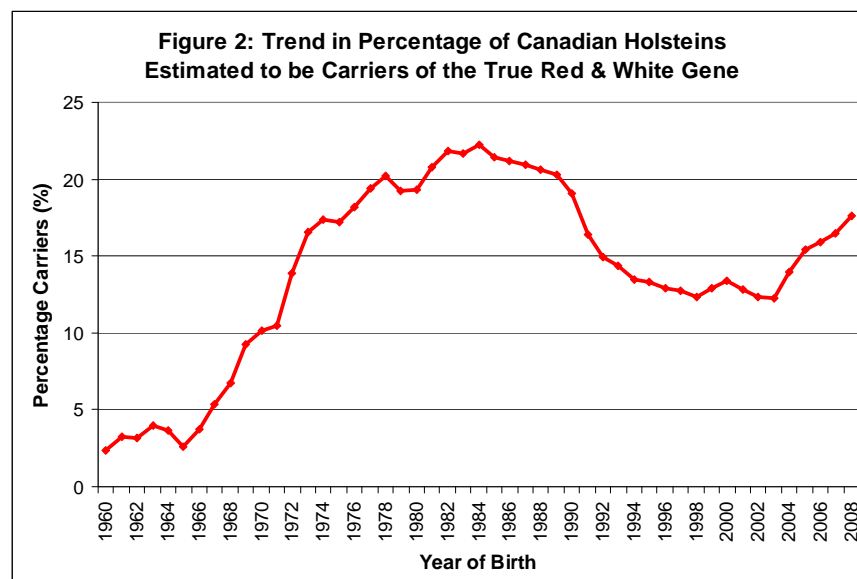
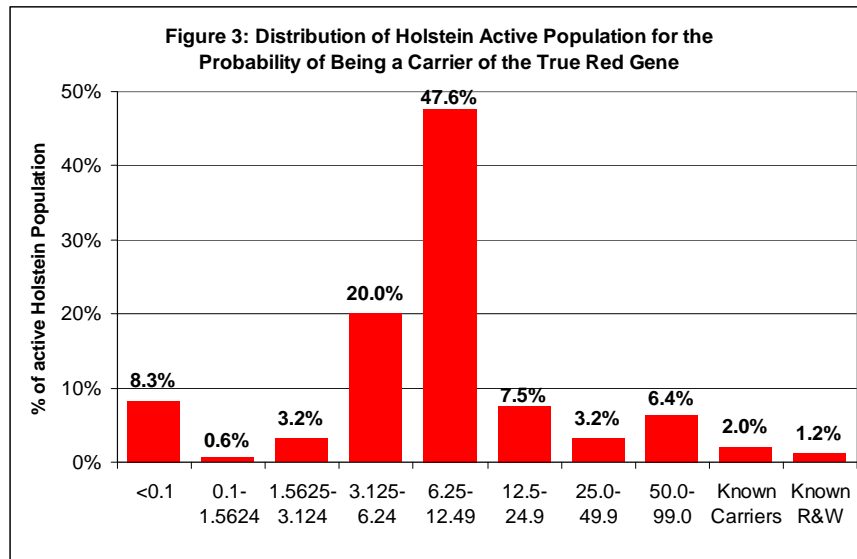


Figure 3 shows the distribution of Holstein heifers and cows that are currently active in the Canadian population according to the probability of being a carrier of the true Red & White gene. Animals included in the last two categories, namely “Known Carriers” or “Known R&W” only include animals that have been officially designated with the appropriate genotypes and phenotypes by Holstein Canada. Similarly, a portion of the animals in the category with a probability level less than 0.1% are those animals officially identified by Holstein Canada that are not carriers of the Red & White gene (i.e.: \*RF animals), with the other animals receiving a calculated percentage that is below the 0.1% level. Overall, it is estimated that 12.65% of the active Holstein population are carriers of the true red gene and another 1.18% are homozygous recessive and show the true Red & White coat colour. This translates to an overall gene frequency in the Canadian active Holstein population of 7.51%.



## Summary

The frequency of the true Red & White gene in the Canadian Holstein active population is estimated at 7.51% with an increasing trend for animals born since 2004. Nearly half of all Black & White animals have a likelihood between 6.25% and 12.49% of being a carrier of the true red gene. This partly comes from a regained interest in Red & White Holsteins but is also likely due to the increased frequency of genetically superior Black & White bulls and cows that are carriers of the true red gene.

In the future, it may be desirable for CDN to provide the estimated probability that each animal is a carrier of the true red gene to identify the most likely females to be mated to R&W or Red-Carrier sires for producers aiming to increase the frequency of Red & White animals in their herd. Similar probability values could also be published by CDN for genetic recessives, such as CVM and BLAD, to use in mating programs to reduce the negative consequences associated with the fact that some known carrier sires are still being offered to Canadian producers.

Author: Brian Van Doormaal  
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