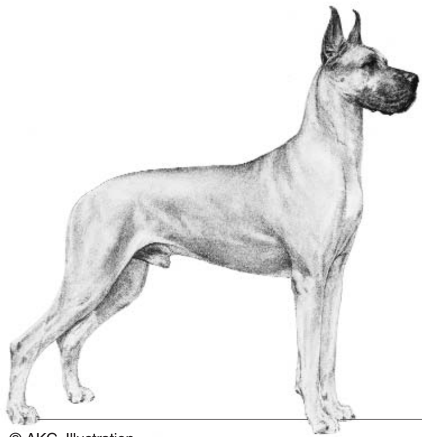

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PURINA Pro Club

Great Dane Update

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Researchers Learn About Coat Color in Great Danes

If breeders could predict canine coat color, they would be able to make breeding decisions much easier. Through techniques such as DNA testing and gene mapping, scientists are learning insightful information about coat color in dogs that challenges long-held beliefs. Even so, the genetic complexity of canine coat color is filled with surprises.

Early Coat Color Studies

Nearly 50 years ago in 1957, Clarence Little wrote "The Inheritance of Coat Color in Dogs." His text, which became a classic on coat color, contains information Little obtained from breeders and from his own cross-breedings of dogs of different coat colors. Little developed several hypotheses on the number of genes and alleles that determine coat color.

Little labeled the positions, or loci, of coat color on paired chromosome as: A for agouti, B for brown, C for albino, D for blue dilution, E for extension, G for graying, M for merle, R for roaning, S for white spotting, and T for ticking.

Little's work continues to provide valuable reference material to scientists today; however, new technologies are helping to enrich understanding about coat color genes. At the University of Saskatchewan in Saskatoon, Canada, and Stanford University in California, researchers have found that Little's E locus contains three alleles — red (e), black (E) and the variant that causes masking (E^M) — rather than the four alleles — red, black, mask and brindle — that Little described. It appears that Great Danes are either E or E^M and do not carry e.

The finding by Sheila Schmutz, Ph.D., professor of animal and poultry science at the University of Saskatchewan and her colleagues is significant for breeders of dogs in which masking is important, such as in brindle and fawn Great Danes. Schmutz's group refers to Little's E locus as the melanocortin receptor 1 gene (MC1R), named for the gene's protein. "Our MC1R studies are a good example of how DNA studies are proving Little both right and wrong," Schmutz says.

THROUGH TECHNIQUES SUCH AS DNA TESTING AND GENE MAPPING, SCIENTISTS ARE LEARNING INSIGHTFUL INFORMATION ABOUT COAT COLOR IN DOGS THAT CHALLENGES LONG-HELD BELIEFS.

Understanding Coat Color Genes

"In a few breeds of dogs, a black mask appears to be a fixed trait, but that's not the case with Great Danes," Schmutz says. "In Danes, masking is a dominant trait that, when present, is visible on dogs with fawn and brindle coats. However, the dominant mask trait also can be carried by black or blue Great Danes and harlequins and merles — it's just not noticeable in these dogs because of their dark coloring or spotting pattern."

Little's work, which came before DNA testing, is based on hypothesized alleles at hypothesized loci to fit data obtained from coat colors and patterns of dogs from various breeds and litters, Schmutz says. "DNA research has shown that there are more genes involved than those hypothesized by Little and that the actual number of alleles at genes he discussed is more for some genes and fewer for other genes. We are far from identifying all the genes involved in dog coat color using DNA, but there seems to be many more than Little predicted."

For breeders trying to determine the genes carried by dogs for upcoming litters, they should keep in mind that no gene acts in isolation. "All dogs have all these genes. In some breeds, the alleles are fixed, meaning all dogs are homozygous for the same allele," she explains. "As a rule of thumb, the more coat colors that occur in a breed, the more genes that are needed to explain the genotype and phenotype."

Genetic Color Testing

While DNA testing for black and brown color traits has been possible for a number of years in a few breeds, this test has been expanded to include many breeds including Great Danes. Only within the past few months has

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Breeders Can Contribute to Genetic Studies

What traits are involved in producing spotting or floppy ears or dew claws? Researchers such as Sheila Schmutz at the University of Saskatchewan in Saskatoon, Canada, can benefit from information from breeders on litters of puppies. Here is the type of information that Schmutz seeks from breeders.

- Detailed description of family members. A helpful listing would include: Ranger, sire, 4 years old, black & white spotted; Sally, dam, 3 years old, solid black; puppy No. 1, male, solid black; puppy No. 2, female, black & white spotted.
- DNA samples taken when puppies are less than 4 weeks old.
- A photo of each puppy, parents and grandparents, if possible.

For information on how to participate in research, go to Schmutz's Web page, *http://skyway.usask.ca/~schmutz/mapping.html*. For further information about the genetics of coat color in dogs, go to *http://skyway.usask.ca~schmutz/dogcolors.html*.

Coat Color

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DNA testing become available for the masking trait. Now a breeder can test her black-masked fawn to determine if she is homozygous for black mask and thereby know in advance that all the pups she will have, irrelevant of the sire chosen, will also have a black mask. Alternatively if the bitch tests heterozygous for mask, the breeder may choose to search out a sire that is homogenous for black mask.

Dominant & Recessive Genes

Understanding coat color genetics begins with basic biology. Inside each cell are genes, tiny biochemical structures that carry traits from one generation to the next. Made up of deoxyribonucleic acid (DNA), genes are strung together to form long chains of DNA in chromosomes. The DNA contains the blueprint of genetic information for directing protein synthesis or production. The proteins are then used to make cells, tissues and organs. Gene expression is the process by which a cell makes a protein according to the instructions carried by a gene.[1]

Chromosomes generally occur in pairs that resemble each other in size and shape. Each species of animal and plant has a characteristic number of chromosomes. Humans typically have 46 chromosomes arranged in 23 pairs, while dogs have 78 chromosomes and 39 pairs.[1] Most genes also occur in pairs. Alleles, or copies of genes from each parent, are located at the same locus and are contained in matching chromosomes. Some hereditary traits are determined by a single pair of genes, but many others, called polygenic traits, are influenced by a number of pairs of genes.[1]

Some alleles are dominant and others are recessive. A dominant allele conceals the effect of its recessive partner, meaning the dominant allele is expressed but not the recessive allele. A trait that results from a recessive allele is evident only in an individual that has two recessive alleles for that trait.[1]

This is where genetics becomes interesting — and at times frustrating for dog breeders. The simplest example is that of a male and female dog that are both homozygous for black, which means both dogs carry dominant genes for black coloring as opposed to blue. Using Little's terminology, this would be DD. A diagram called a Punnett square shows that the puppies in a litter from these two dogs will not only be black but will also carry genes for black:

	D (sperm)	D (sperm)
D (egg)	DD	DD
D (egg)	DD	DD

If either of the dogs is heterozygous, meaning it carries a dominant gene for black (D) and a recessive gene for blue dilute (d), all the puppies will be black, but it is probable that half of the litter will carry genes for black and the other half for both blue and black. In this example, the male carries the recessive gene for blue:

	D (sperm)	d (sperm)
D (egg)	DD	Dd
D (egg)	DD	Dd

Now when one of the black puppies carrying the recessive blue gene is mated with a bitch that also carries both dominant black and recessive blue genes, this is where surprises can occur:

	D (sperm)	d (sperm)
D (egg)	DD	Dd
d (egg)	dD	dd

Such a mating of two heterozygous parents has a 25 percent probability of have a blue puppy. Carrying out the examples, a Dd mated with a dd would produce a 50 percent probability of puppies being black but carrying the blue trait and 50 percent probability of the puppies being blue. Mating two blue dogs always produces blue puppies, since all of the genes are recessive.

Fortunately, not all dogs are either black or blue. But the more complex the coloring, the more alleles are involved and the more possibilities for variations in the genes passed from litter to litter. In the case of the black Great Dane mated with the harlequin, the Punnett square would have to be much larger, with many more squares, as this breeding involves a much more complex situation. A Punnett Square would probably have to include at least four pairs of alleles, as the inheritance of the harlequin pattern, the merle pattern, and the fawn and black coat colors would have to be diagrammed.

Breeder Contributions

Dog breeders can contribute to genetic research on coat color as well as other traits, Schmutz says. She attributes much of the coordination of Great Dane DNA studies currently under way to J.P. Yousha, owner of Chromadane Kennel in Texas and Chairman of the Health and Welfare Committee of the Great Dane Club of America. Yousha also helped Schmutz to understand the terms many Dane owners use when describing their dogs' coat colors and patterns.

"If breeders keep careful records of traits in their parents and pups, these can be used to determine how traits are inherited," she says. For information on how to participate in research, please visit Schmutz's Web site at *http://skyway.usask.ca/~schmutz/mapping.html.* ■

[1] Hedrick PW, Weaver RF. Heredity. World Book Online Americas Edition. *http://www.worldbookonline.com/ar?/na/ar/co/ar253940.htm.* May 2003.

Purina Pro Plan Introduces Canned Entrées

Purina Pro Plan brand dog food has a new look: 15 canned entrées loaded with the same type of high-quality ingredients as *Pro Plan* dry dog food. Available starting in July 2003, *Purina Pro Plan* brand dog food Canned Entrées offer dog owners a palatable and nutritious food alternative.

The *Pro Plan* Canned Entrées come in a range of formulations for puppies, large-breed puppies, adult dogs, large-breed adult dogs, senior dogs and dogs with special nutritional needs. Just like *Pro Plan* dry dog foods, the canned entrées are made with real meat, fish, poultry and/or vegetables.

Formulated with ideal protein-to-fat ratios like the *Pro Plan* dry formulas, *Pro Plan* Canned Entrées are scientifically calculated based on the calories from protein needed for a dog's life stage and breed size. These ratios are formulated to help dogs build and maintain lean muscle mass without excess body fat and to help them stay stronger longer.

Purina Pro Plan brand Canned Entrées are available in pet specialty stores, from veterinarians and feed dealers. For additional information about *Pro Plan,* please contact a *Pro Plan* customer service representative at 1-800-PRO-PLAN (1-800-776-7526). ■