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"Study of MHC Class II Genes of Bearded Collies Reveals Narrow Diversity"

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1. Introduction to the immunogenetics of humans and dogs
Mammals, including people and dogs, have an immune system. It keeps them free (immune) from disease most of the time by fighting invaders including bacteria and viruses.

Perhaps the most important genes involved with the immune system are called the Major Histocompatibility Complex (MHC). These genes determine tissue type (histo=tissue). In other words, exactly which gene forms we inherit from our mother and father determine what tissues our immune system will see as "self" and leave alone, and what tissues will be seen as "foreign" if transplanted, and thus attacked.

Although there are more than 100 MHC genes, genetic diversity is often measured by counting the number of gene forms (or variants) for three key genes called the MHC Class II genes. Each gene has variations as determined by the exact sequence of DNA in the gene. Each variant is also known as an allele.

If all of the people in any one country had the DNA sequences of their MHC II genes determined, scientists would know exactly how much genetic diversity was present in their population. If there were only one or two variants for each gene, many successful transplants would be likely. On the other hand, if one of those variants brought on a vulnerability to disease under some circumstances, there could be many sick people.

Although there are three MHC Class II genes, they are not inherited individually. Because they are located together on one chromosome (the long rod-shaped string of DNA that can be seen under the microscope when a cell divides; chromo=colored, some=body), the process that produces an egg or sperm cell produces two units of three genes, with each unit called a haplotype (haplo=single, as in a single unit).

In other words, a woman's egg cell will get the haplotype of her mother or her father. The variants from her two parents will not recombine to produce new haplotypes. This is due to how sex cell production occurs. Unfortunately, it has the result of acting against increasing genetic diversity.

If something goes wrong with the immune system of an individual so it sees one or more body tissues as "foreign," it will attack them, no longer recognizing them as part of the body. The result is autoimmune disease.

Many different autoimmune diseases occur in humans, and many of the same diseases occur in dogs. It has been known for decades that certain variants of MHC Class II genes are associated with increased risk for autoimmune diseases in people. For at least systemic lupus erythematosus, a person who carries two copies of that same at-risk variant is not only at higher risk for disease, but also for more severe disease.

Many canine autoimmune diseases have been linked to genes in the MHC, although the volume of research is much less than what has been established to date in humans.

Veterinary researchers call the MHC region in dogs the DLA region (dog leukocyte antigen) region. (Note: leuko= white, cyte= cell, and antigen= marker that is recognizable by the immune system. Thus, DLA genes code for immune markers on white blood cells.)

In 2006 Finnish researchers started work on the genome (gene makeup) of dogs with the goal of identifying genetic defects responsible for inheritable diseases. As the authors note, "The results are often applicable to human diseases, as the genetic causes of many diseases are common between humans and dogs. The genetic diversity of small dog populations has also been studied, because loss of genetic diversity is associated with many diseases, such autoimmune diseases."

Terms: Here are some major terms used in the article; they are listed in the order they first appear in the article.

Major Histocompatibility Complex (MHC): the genes that determine tissue type (histo=tissue). They code for the cell markers that the body's immune system uses to recognize "self" from "foreign."

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Matador: tight linebreeding or inbreeding

Dog Leukocyte Antigen (DLA): the MHC region in dogs. Note: leuko= white, cyte= cell, and antigen= marker that is recognizable by the immune system. Thus, DLA genes code for immune markers on canine white blood cells in the same way a human's genes code for immune markers on their white blood cells.

MHC Class II genes: the three genes located on a single stretch of DNA that are most often used to measure genetic diversity in a population. In dogs, the genes are DRB1, DQA1, and DQB1.

Haplotype: the unit of three MHC Class II genes that is inherited from one parent (haplo=single, as in a single unit). For dogs, each haplotype will have one variant of each of the three genes, DRB1, DQA1, and DQB1.

Allele: any single variant of a gene based on exact DNA sequence.

Chromosome: the long rod-shaped string of DNA that can be seen under the microscope when a cell divides (chromo=colored, some=body).