EMBARK VETERINARY, INC.

GENETIC ANALYSIS REPORT FOR BELGIAN SHEEPDOGS

APRIL 2020

ABOUT EMBARK

Embark is the only DNA service provider to combine high quality DNA testing with breed-specific targeted research. This unique approach, developed in partnership with Cornell University College of Veterinary Medicine, uses a high-resolution testing platform incorporating over 200,000 genetic markers across the genome, providing each owner with in-depth, actionable, genetic results for their dog while simultaneously accelerating research discovery for the health of their breed.

We invite you to join us in our mission to end preventable disease in dogs by encouraging dog breeders and owners to make full use of canine genetic health testing. To learn more, please visit embarkvet.com/breeders/.

RESEARCH METHODOLOGY

The report can be used by breeders, breed clubs, health organizations, and individual dog owners to better understand the occurrence of genetic variants known to impact risk for health conditions; informed diversity measures, and genotype frequencies of traits within a breed population. Importantly, key data can be further evaluated to identify trends within the breed over time.

Data referenced in this report were generated based upon dogs currently genotyped by Embark whose owners have consented to participate in research. This report does not necessarily represent the global genotype frequencies for this breed.

- Frequency of detected genetic health risk variants relevant to the breed*
- Frequency of genetic health variants detected within the breed that may not have been directly studied yet, to inform early detection
- Frequency of coat color trait alleles
- Genetic coefficient of inbreeding (COI) statistics and population distributions
- DLA diversity assessment

**Genetic conditions relevant to a breed are determined primarily by peer reviewed research studies that indicate known variants/mutations may influence the chances of an individual dog, of a specific breed, developing certain health conditions. See this Embark resource for a detailed explanation*

Embark encourages all organizations to share this report with members and constituents to assist in educating the canine community about the importance of genetic health overall, and for this breed in particular. Please contact breeders@embarkvet.com with any questions or comments about these data, or use our contact form here.

This report reflects data collected as of: 04/07/2020

Number of dogs genotyped by Embark included in this report: 351

Note: Not all dogs genotyped by Embark may be represented in this report due to qualifying criteria such as owners not providing consent to participate in research. This report may include both registered and unregistered dogs from varied registration bodies and multiple countries.

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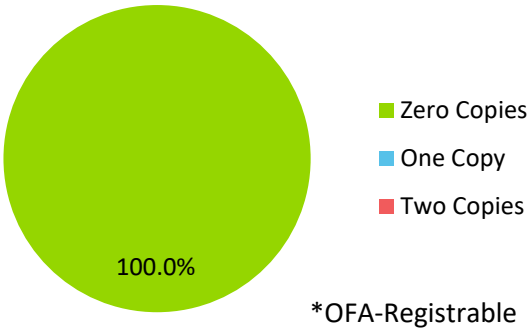
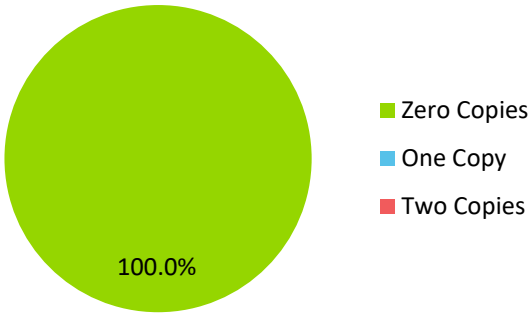
Degenerative Myelopathy, DM (SOD1A)*

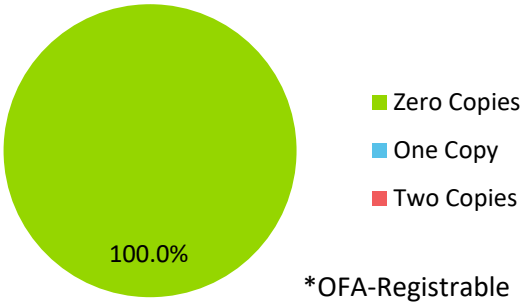


*OFA-Registrable

Mucopolysaccharidosis Type VII, Sly Syndrome, MPS VII (GUSB Exon 3)

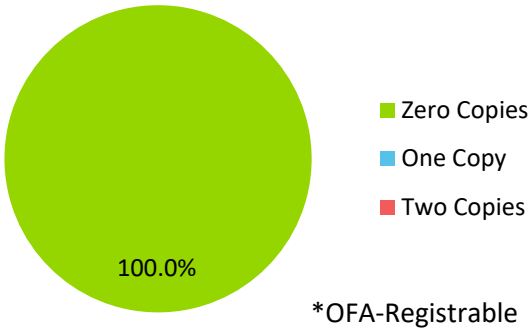


Spongy Degeneration with Cerebellar Ataxia 1, SDCA1, SeSAME/EAST Syndrome (KCNJ10)*



*OFA-Registrable

Spongy Degeneration with Cerebellar Ataxia 2, SDCA2 (ATP1B2)*

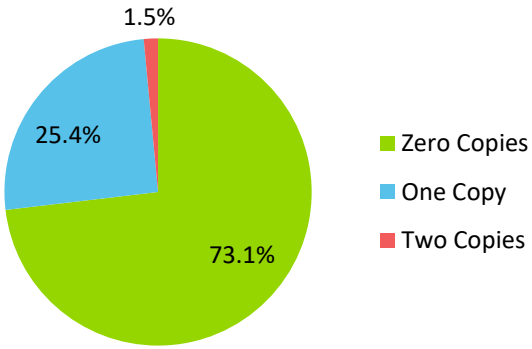


*OFA-Registrable

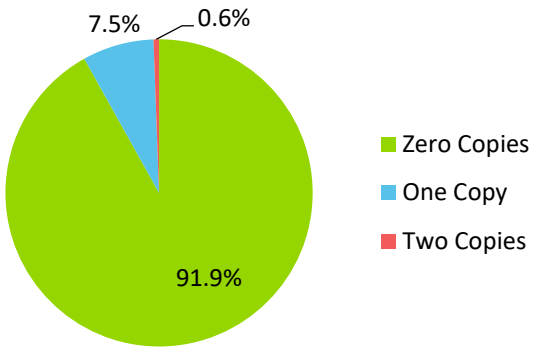
GENETIC HEALTH REPORT | Additional Conditions

This section includes all other conditions where at least 1% of tested dogs of this breed have one or two copies of the variant. Research studies for the listed conditions have been based on dogs of other breeds, and some of these conditions may be more relevant to this breed than others.

Bald Thigh Syndrome (IGFBP5)



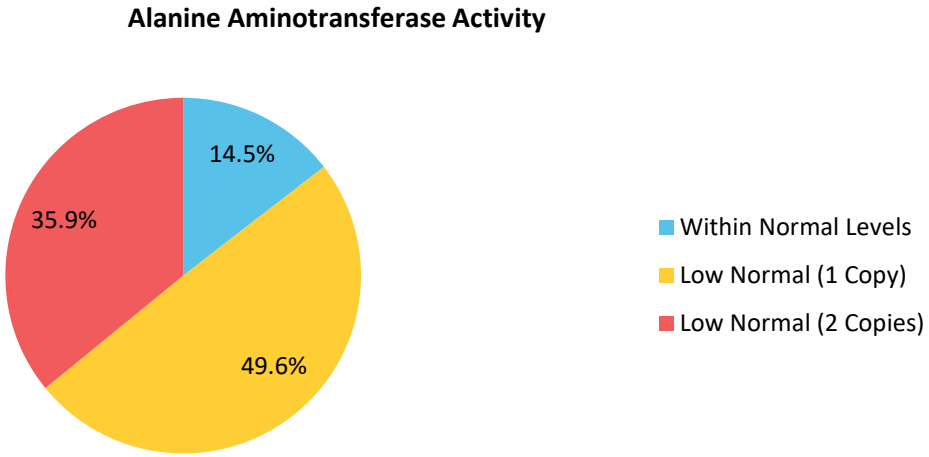
Dilated Cardiomyopathy, DCM1 (PDK4)



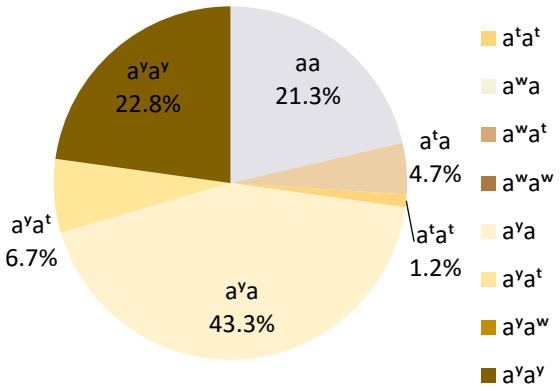
Alanine Aminotransferase (ALT)

Because this variant is inherited in a codominant manner, both heterozygotes (one copy of the variant) and homozygotes (two copies of the variant) can be clinically affected by this variant.

While this variant does not have any effects on liver function or health (for which ALT is a commonly used biomarker), it does tend to cause dogs to have a lower resting ALT activity: As such, dogs with this variant may need to have their "normal" reference range adjusted accordingly.



A Locus



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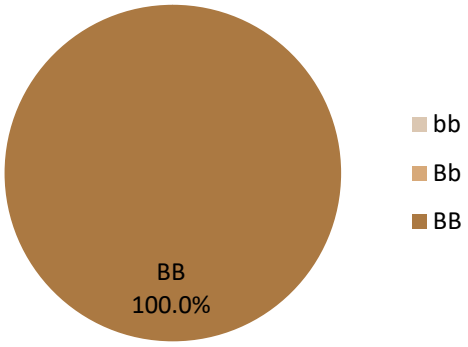

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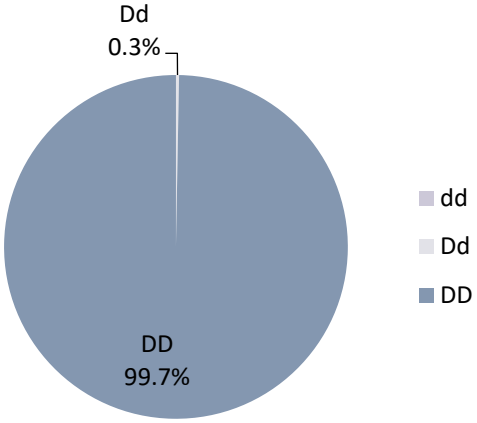
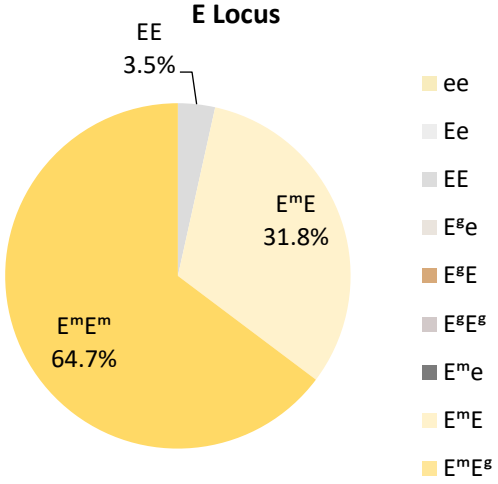
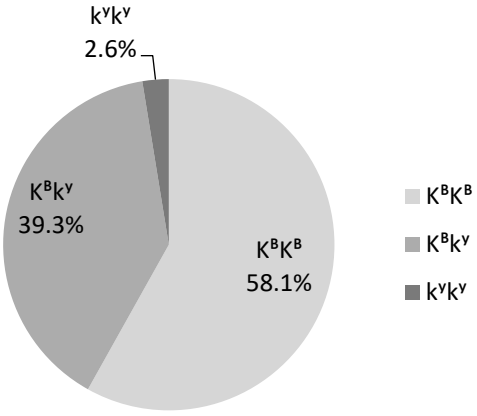


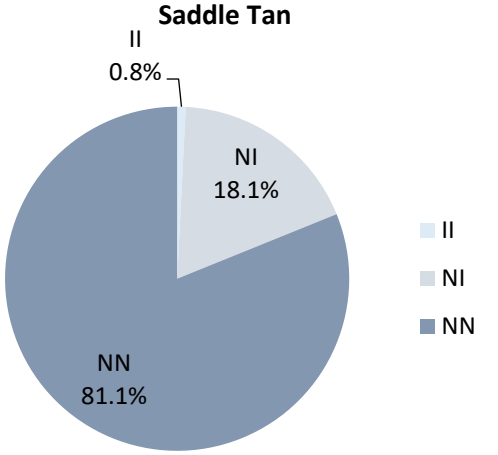
E Locus



K Locus



Saddle Tan



COI STATISTICS

Inbreeding is a measure of how closely related a dog's parents are - the higher the number, the more closely related the parents.

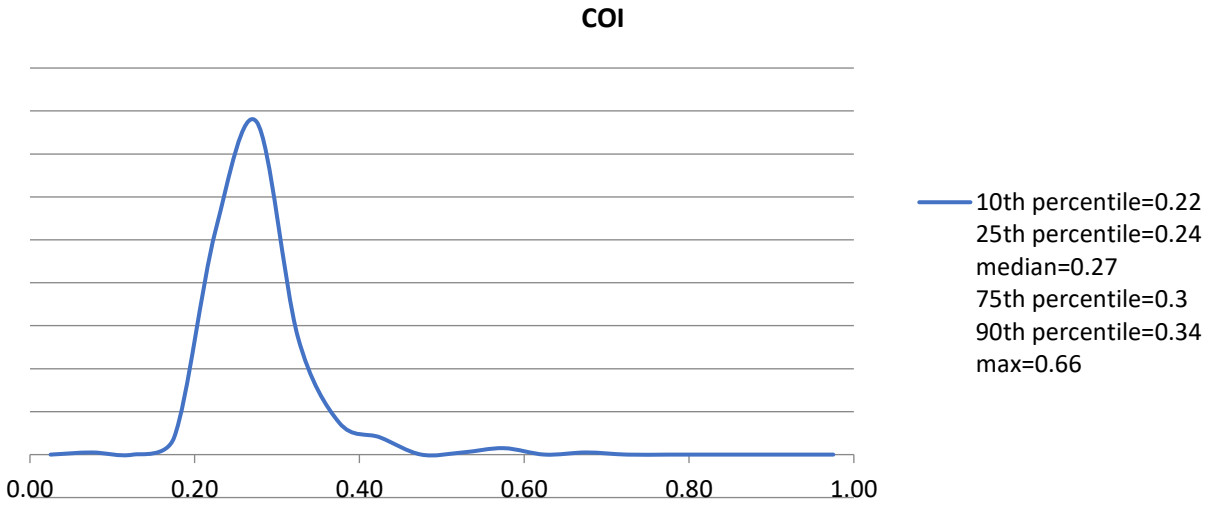
A dog's level of inbreeding is scientifically known to impact dog health and longevity. On average, dogs that are less inbred tend to live longer, healthier lives. Embark's scientists are working to better understand the impacts of inbreeding on all aspects of canine health and longevity to help contribute to our mission of ending preventable disease in dogs.

Separately, the report also includes diversity in the Major Histocompatibility Complex (MHC) region (also known as the Dog Leukocyte Antigen, or DLA, region) of the genome. Some studies show that lower diversity in that region is correlated to certain autoimmune diseases. Embark scientists continue to investigate this region to provide even greater detail in the future.

INBREEDING

Genetic coefficient of inbreeding (COI) is the most accurate method for measuring inbreeding. Unlike pedigree-based COI calculations, genetic COI directly evaluates each dog's DNA to identify the proportion that results from inbreeding. Embark's genetic COI assesses over 200,000 genetic markers and can detect generations of inbreeding that cannot be accounted for with typical pedigree documentation. Genetic COI is more precise than tests using fewer markers - ultimately providing more information to better understand a dog's genetic health and to guide strategic breeding crosses to mitigate inbreeding depression.

This chart represents the distribution of the COI within this breed. Dogs above the 75th percentile are more likely than dogs below the 25th percentile to have shorter lifespans, smaller litters, and a higher incidence of heritable illness. We recommend genetic testing of breeding dogs prior to mating to assess the expected average litter COI and to consider a preference for pairings that would produce litters with a lower COI.



DLA DIVERSITY

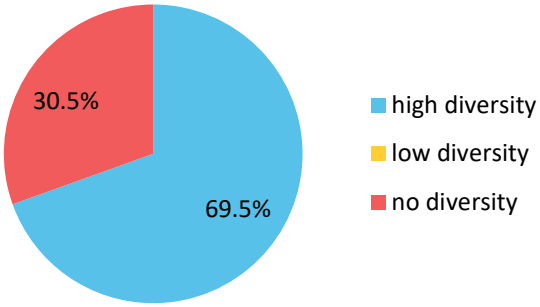
Gene: DRB1

A Dog Leukocyte Antigen (DLA) gene, DRB1 encodes a major histocompatibility complex (MHC) protein involved in the immune response. Some studies have shown associations between certain DRB1 haplotypes and autoimmune diseases such as Addison's disease (hypoadrenocorticism) in certain breeds, but these findings have yet to be scientifically validated.

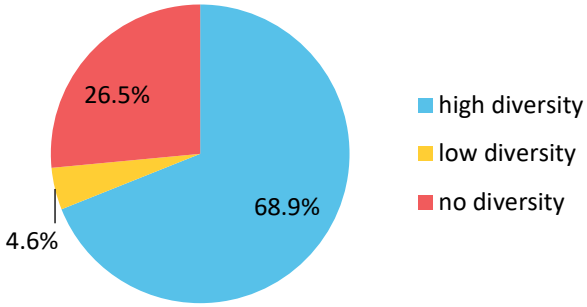
Gene: DQA1 and DQB1

DQA1 and DQB1 are two tightly linked DLA genes that code for MHC proteins involved in the immune response. A number of studies have shown correlations of DQA-DQB1 haplotypes and certain autoimmune diseases; however, these have not yet been scientifically validated.

DLA Diversity (DQA1 & DQB1)



DLA Diversity (DRB1)



Embark Veterinary, Inc., is committed to our mission of ending preventable disease in dogs. Preserving genetic diversity while breeding away from heritable disease is key to this mission, and every breed club and organization that joins in this effort brings us closer to this reality. Together we can accelerate the pace of discovery and develop new tests to improve canine health.

This report is one of the many resources and services provided to support breed clubs and health organizations. Partnership benefits also include discounted pricing, educational, breed relevant content, and live presentations focused on genetic health delivered by leading experts.

Please contact breeders@embarkvet.com for more details about partnering with Embark or to learn more about the information included in this report.