
**Celebration of Belgians**

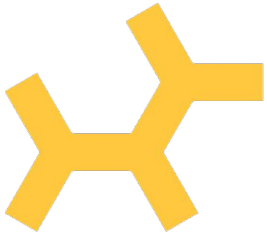
April 12th & 13th, 2018

Erin Chu, DVM, PhD | Senior Veterinary Geneticist

Embark Veterinary, Inc. | chue@embarkvet.com

## Talk Outline

- Introduction to Embark
- Breeding decisions in the age of personalized genomics
- Preliminary Belgian data: Traits, Health, and Inbreeding
- Embark Discovery: Endless potential
- Example partnership: Doberman Diversity Project



# embark

Whos and whats

**Embark |** Whos and whats

- Founded in 2015 by Adam and Ryan Boyko
- Comprehensive, direct-to-consumer dog DNA testing service
- A high density DNA microarray (“SNP chip”) that queries 200,000+ sites
- Immediate and actionable health, trait, and ancestry information
- Unprecedented potential for future discovery`
- Research partners with the Cornell University College of Veterinary Medicine

**Embark |** Whos and whats

- Single cheek swab
- Ancestry: Paternal and Maternal Lineage, Breed Diversity
- Health: 160+ mutations associated with disease*
- Traits: K Locus, A Locus, E Locus, Coat Length, Curl, Shedding, etc…
- Genetic Coefficient of Inbreeding
- DLA Diversity

# **Embark** | Whos and whats

PNAS Proceedings of the National Academy of Sciences of the United States of America

## Genetic structure in village dogs reveals a Central Asian domestication origin

Laura M. Shannon, Ryan H. Boyko, Marta Castelhano, Elizabeth Corey, Jessica J. Hayward, Corin McLean, Michelle E. White, Mounir Abi Said, Baddley A. Anita, Nono Ikombe Bondjengo, Jorge Calero, Ana Galov, Marius Hedimbi, Bulu Imam, Rajashree Khalap, Douglas Lally, Andrew Masta, Kyle C. Oliveira, Lucía Pérez, Julia Randall, Nguyen Minh Tam, Francisco J. Trujillo-Cornejo, Carlos Valeriano, Nathan B. Sutter, Rory J. Todhunter, Carlos D. Bustamante and Adam R. Boyko

Jan 2016


Nov 2017

**Embark |** Who we are

The Embark team is diverse, experienced, and full of energy, with branches all over the United States.

## **Genetic Testing** | Direct to consumer options

Canine

FERAGEN
Labor für genetische Veterinärdiagnostik

VetGen

OPTIGEN for the genetic advantage

INSTITUTE OF CANINE BIOLOGY

embark

Human

INVITAE

Quest Diagnostics®

ancestryDNA™

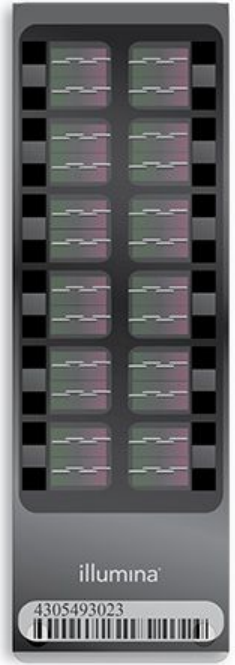
23andMe

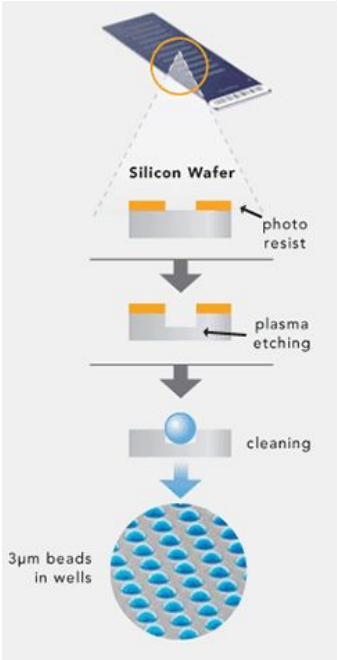
Helix™

*Single Mutation or Limited Array Testing*

*Big Data + Research-Grade Platform*

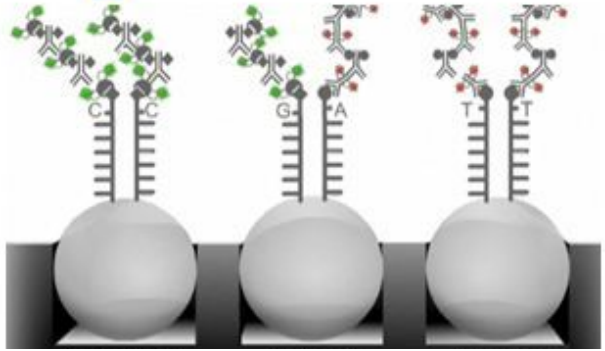
# **Embark** | What we do

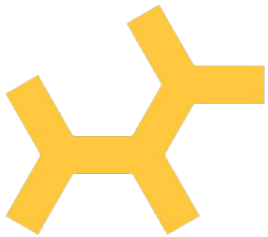



Type I vWD (example)

| GG | GA | AA |
|---|---|---|
| “Clear” | “Carrier” | “At Risk” |





# embark

Breeding decisions in the age of personalized genomics

**Embark |** Whos and whats

- Single cheek swab
- Ancestry: Paternal and Maternal Lineage, Breed Diversity
- Health: 160+ mutations associated with disease*
- Traits: K Locus, A Locus, E Locus, Coat Length, Curl, Shedding, etc…
- Genetic Coefficient of Inbreeding
- DLA Diversity

**Genetic Results** | How do we interpret health testing?

**Type I von Willebrand Disease** causes abnormally low levels of von Willebrand Factor, which is exposed when small blood vessels are damaged.

**Genetic Results** | How do we interpret health testing?

**Type I von Willebrand Disease** causes abnormally low levels of von Willebrand Factor, which is exposed when small blood vessels are damaged.

- **MOI: Autosomal Recessive**
  - GG = “Clear,” likely to have normal vWF levels
  - GA = “Carrier,” likely to have normal vWF levels
  - AA = “At Risk,” likely to have below-normal levels of von Willebrand Factor

**Genetic Results** | How do we interpret health testing?

**Type I von Willebrand Disease** causes abnormally low levels of von Willebrand Factor, which is exposed when small blood vessels are damaged.

- **MOI: Autosomal Recessive**
  - GG = “Clear,” likely to have normal vWF levels
  - GA = “Carrier,” likely to have normal vWF levels
  - AA = “At Risk,” likely to have below-normal levels of von Willebrand Factor

- **Interpretation → Risk does not guarantee clinical status**
  - Point of care: vWF ELISA or BMBT
  - Since the vWF that *is* present is totally normal in composition, many dogs show zero clinical signs during short or routine clinical procedures

**Genetic Results** | How do we interpret health testing?

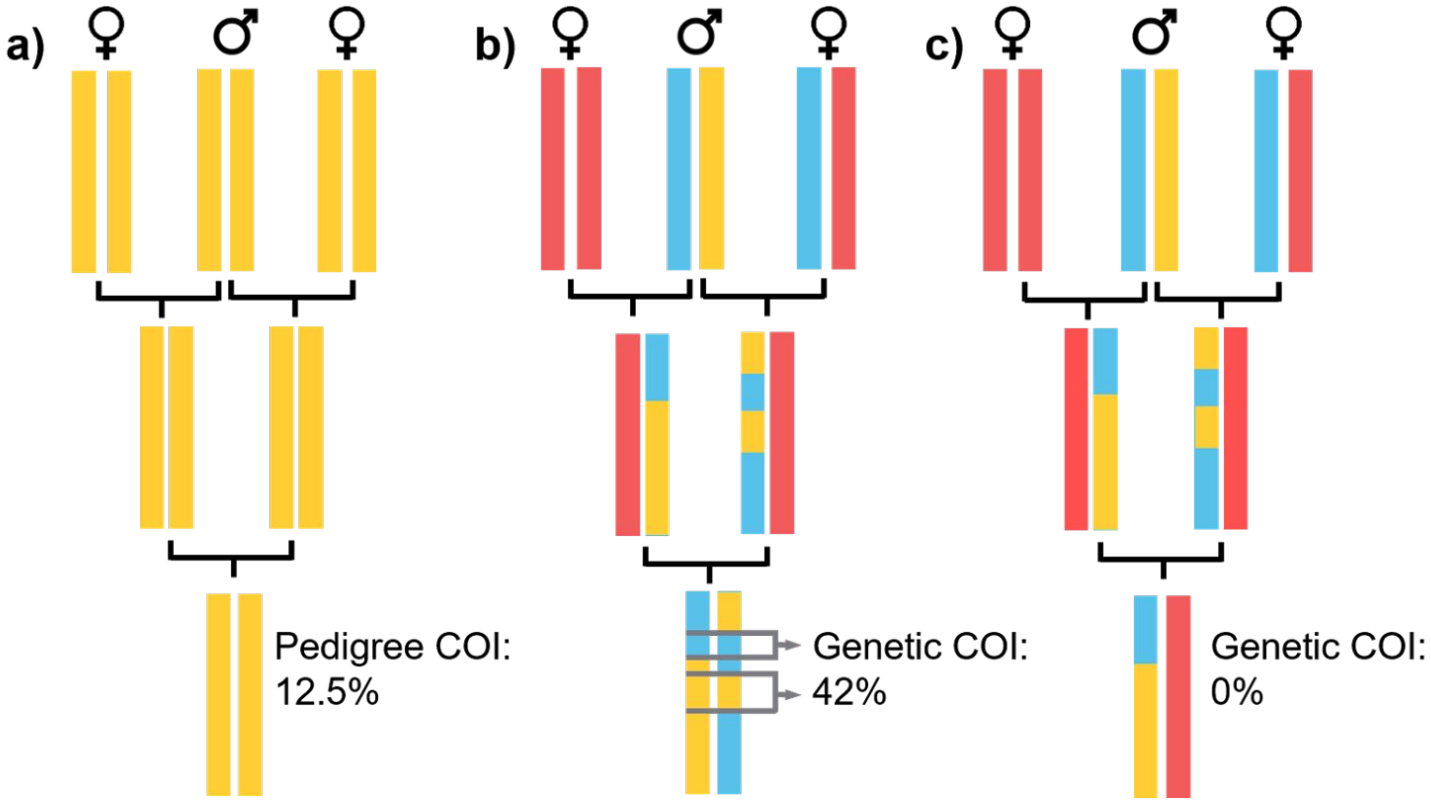
**Not all disease mutations are created equal.**

- **The clinical relevance of some disease-associated mutations depends heavily on breed**
  - Degenerative myelopathy (SOD1A)
  - Dilated cardiomyopathy (DCM1)

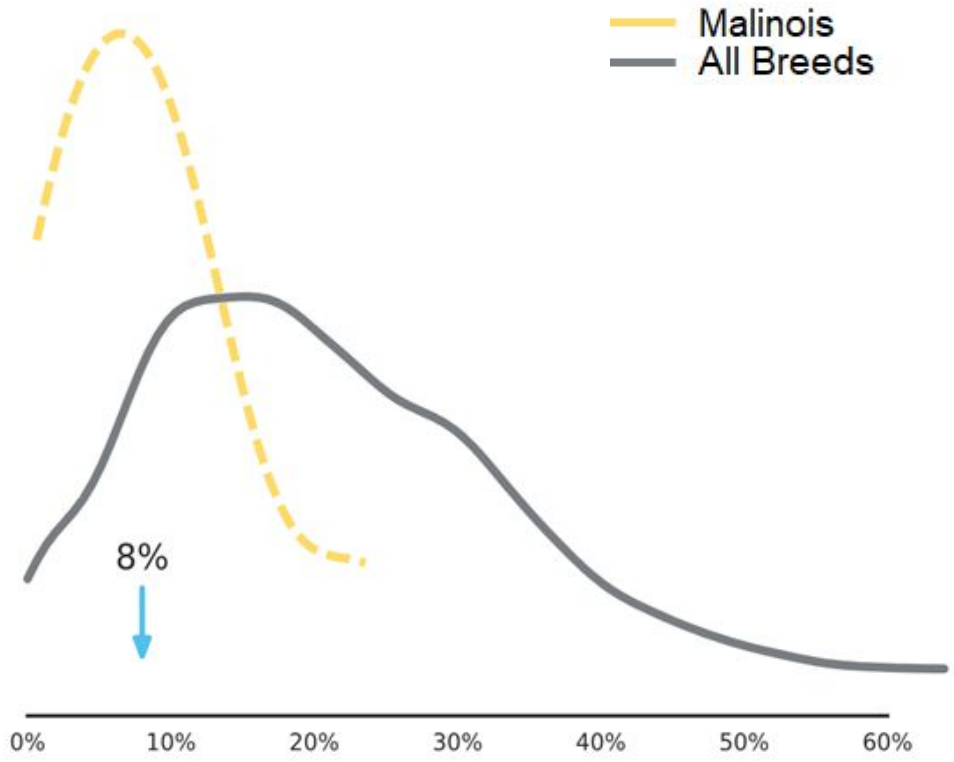
- **Others have only been characterized in some breeds**
  - Golden Retriever PRA 1 (TTC8)
  - Canine Multifocal Retinopathy 3 (cmr3)

- **Others have been defined in a single population of dogs, but have not associated with disease in others**
  - German Shepherd Hip Dysplasia (Europe vs. United States)

# **Inbreeding** | Pedigree vs. Genetic COI



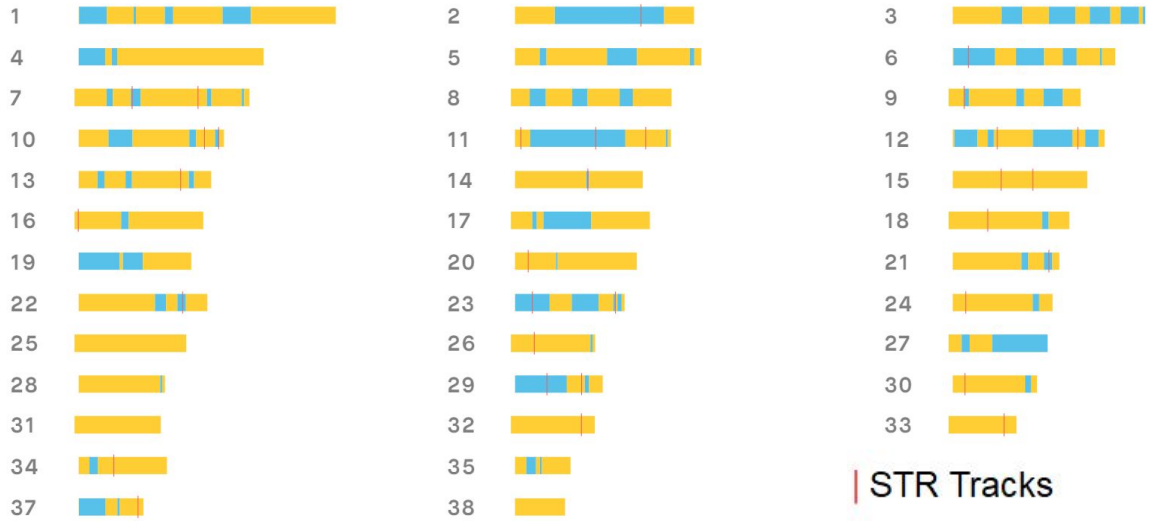
**Inbreeding** | Pedigree vs. Genetic COI

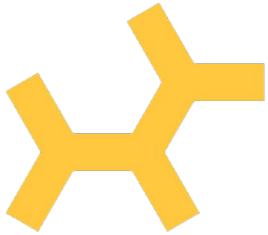


# **Inbreeding** | Inbreeding By Chromosome

## Inbreeding by Chromosome *BETA*

We analyzed the areas of inbreeding across your dog's genome. Below is a graphical representation of your dog's inbreeding, displayed chromosome by chromosome. Any inbred areas appear in blue, while outbred areas appear in yellow.





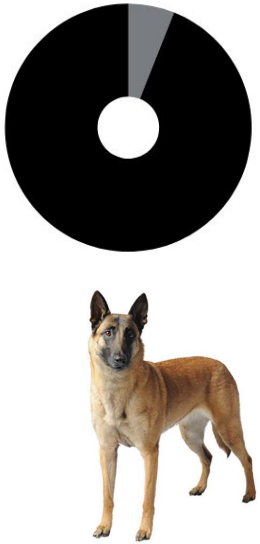
embark

Preliminary Belgian data

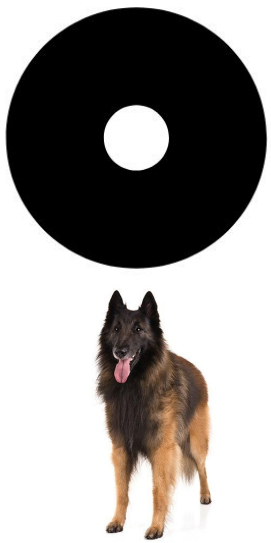
# Preliminary **Belgian Data** | Health and Trait Frequency

## E Locus

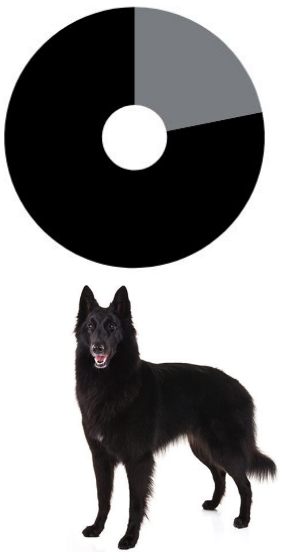
Malinois



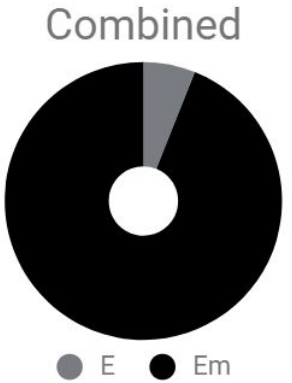
Tervuren



Sheepdog



Combined



# Preliminary **Belgian Data** | Health and Trait Frequency

## K Locus

Malinois

Tervuren

Sheepdog

Combined

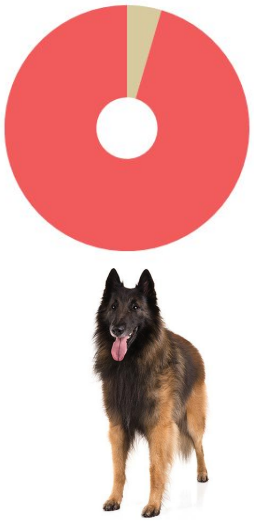
# Preliminary **Belgian Data** | Health and Trait Frequency

## A Locus

Malinois

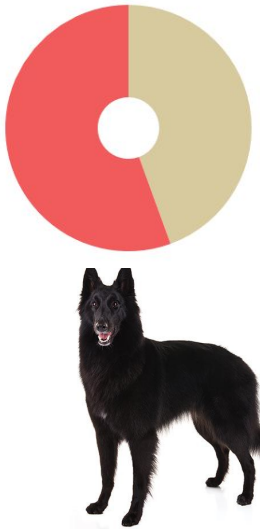


Tervuren

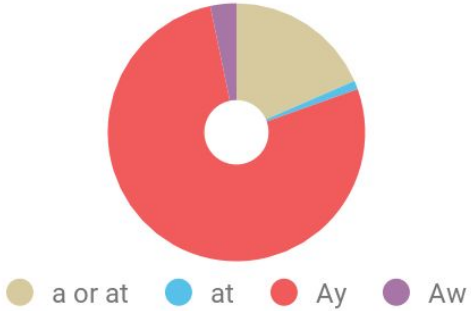




Sheepdog

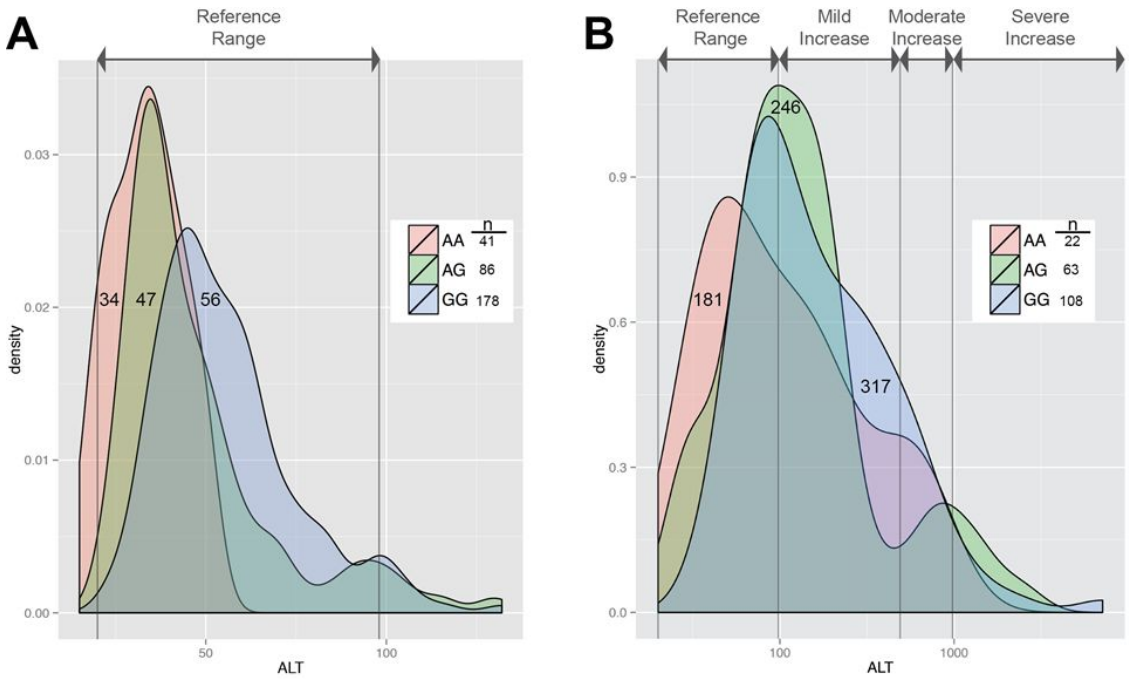


Combined



# Preliminary **Belgian Data** | Health and Trait Frequency

## Alamine Aminotransferase

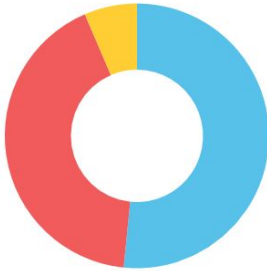



Whjte *et al*, 2015.

# Preliminary **Belgian Data** | Health and Trait Frequency

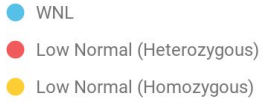
## Alamine Aminotransferase

Malinois

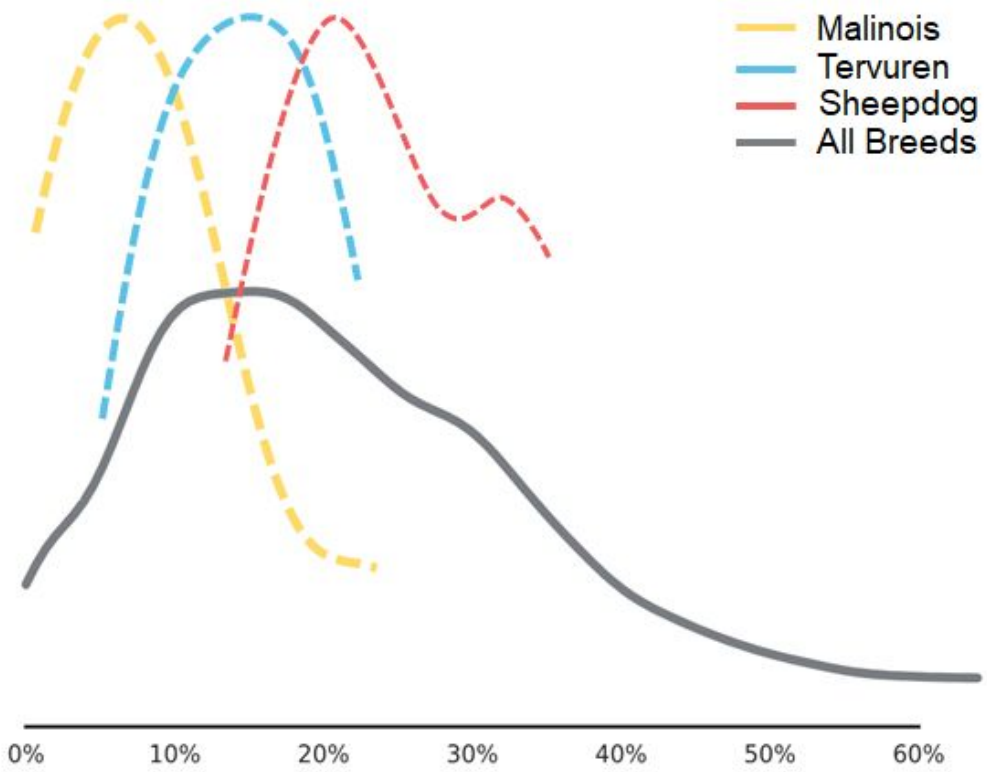


Tervuren

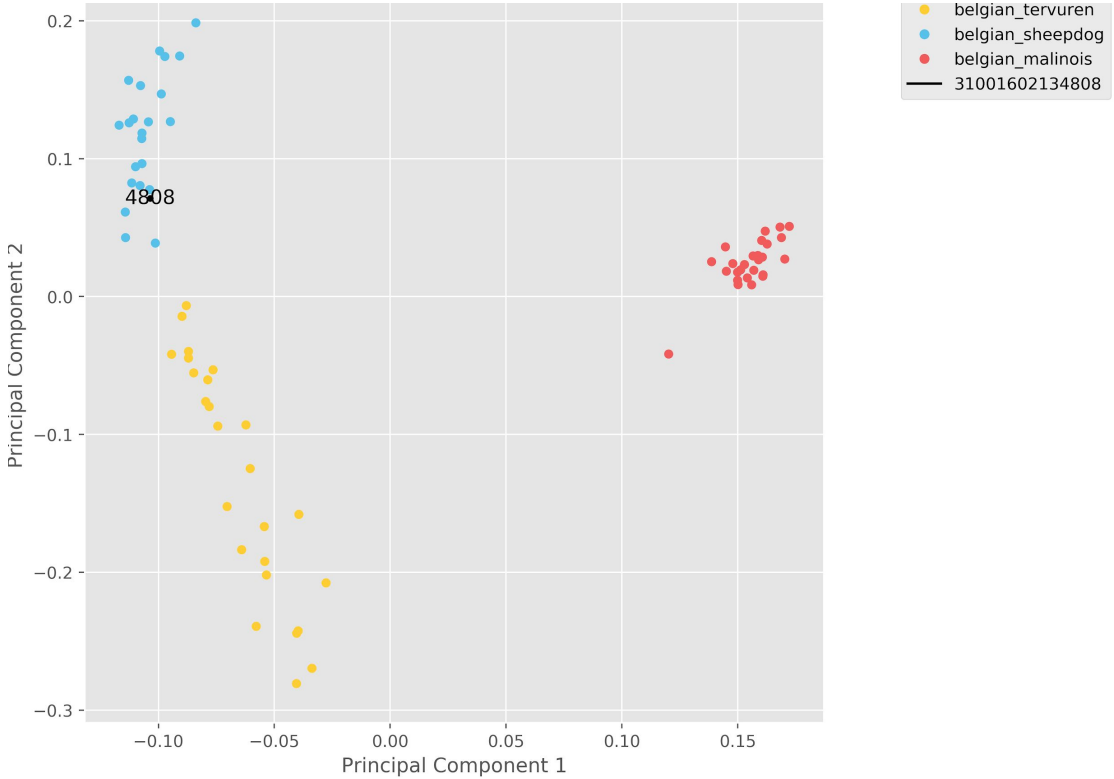
Sheepdog



# Preliminary **Belgian Data** | Genetic COI



# Preliminary **Belgian Data** | Principal Components Analysis



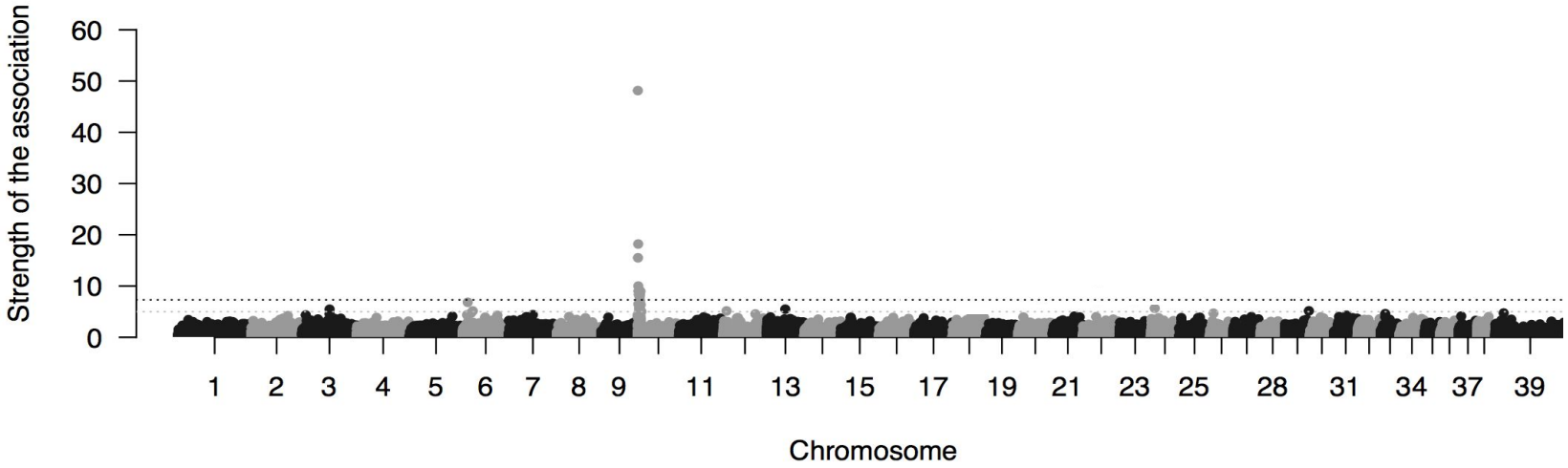

embark
Discovery

**Embark Vet** | Discovery

Genome-Wide Association Study (GWAS) ask:

For a focal **phenotype**,

*how strongly associated* are particular **genotypes**?



**Embark Vet** | Discovery

Genome-Wide Association Study (GWAS) ask:

For a focal **phenotype**,
*how strongly associated* are particular **genotypes**?

IN PROGRESS

**DOGGIE PARTS**

From head to toe

OPEN SURVEY

IN PROGRESS

**MEDICAL**

Medical history survey

OPEN SURVEY

IN PROGRESS

**GENERAL BEHAVIORS**

Unlock the mysteries of dog behavior

OPEN SURVEY

# **Embark Vet** | Discovery

## Eye color

This question is about eye color. Some dogs have 'solid' eye color. Some dogs have mixed eye colors—this is known as heterochromia. Here are some examples:

Complete Heterochromia

Sectoral Heterochromia

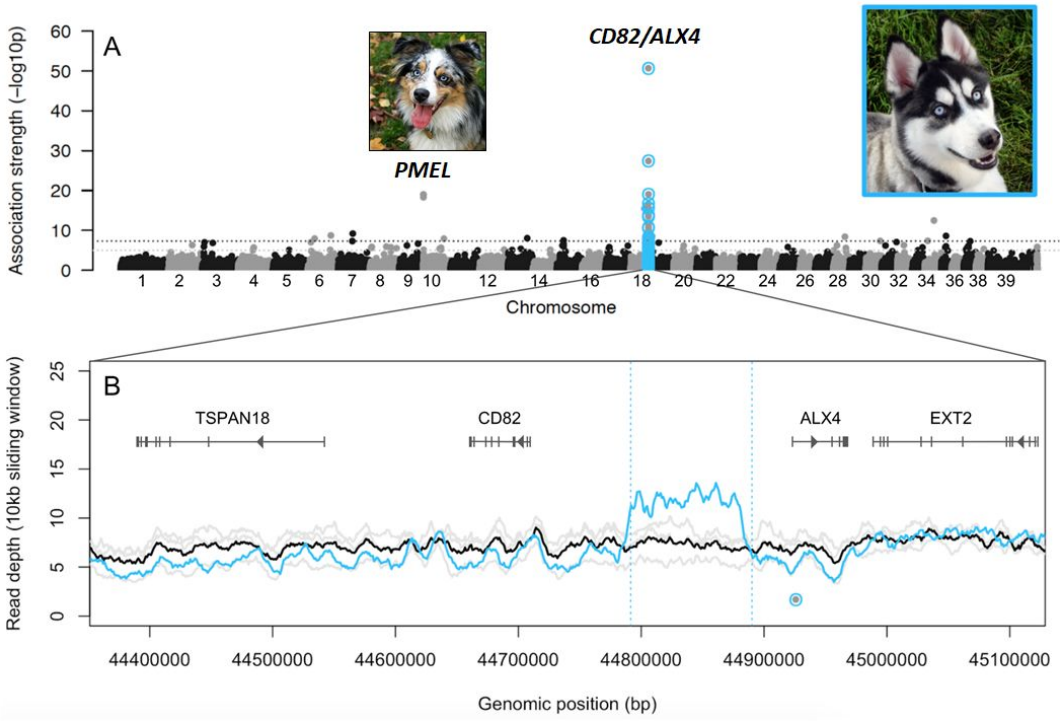
Blue

Amber

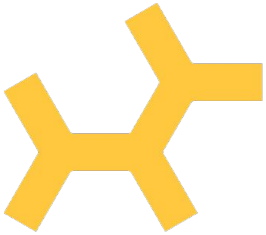
Light Brown

Brown

Dark Brown / Black




Deane-Coe *et al*. In revision.



embark

Partnership Example: The Doberman Diversity Project

**Doberman Diversity Project** | Paws up

# **Doberman Diversity Project** | Matchmaker Tool

## BOONE

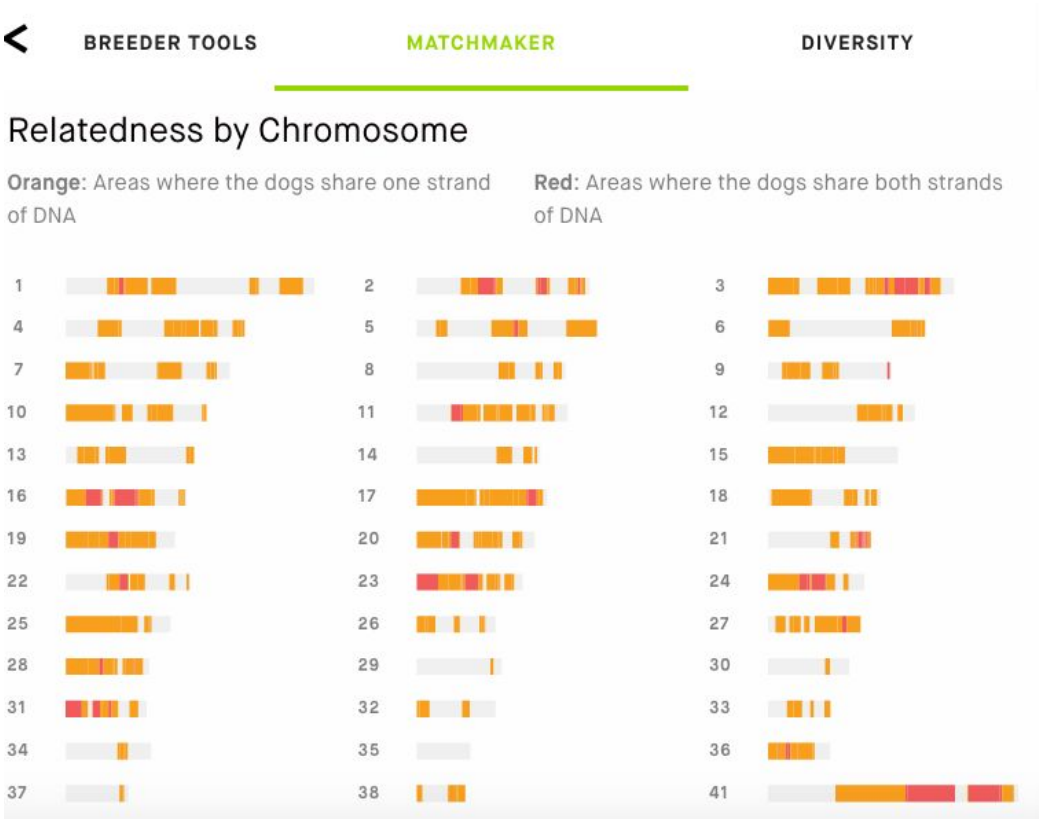
Change dog ▾ SELECT

PLEASE NOTE: The Matchmaker is being released to Doberman breeders as a Preview for comments and feedback. During this Preview, features and data in the Matchmaker tool, **including the CoI numbers, are subject to change at no notice**.

Previous 1 2 3 4 5 ... 17 Next

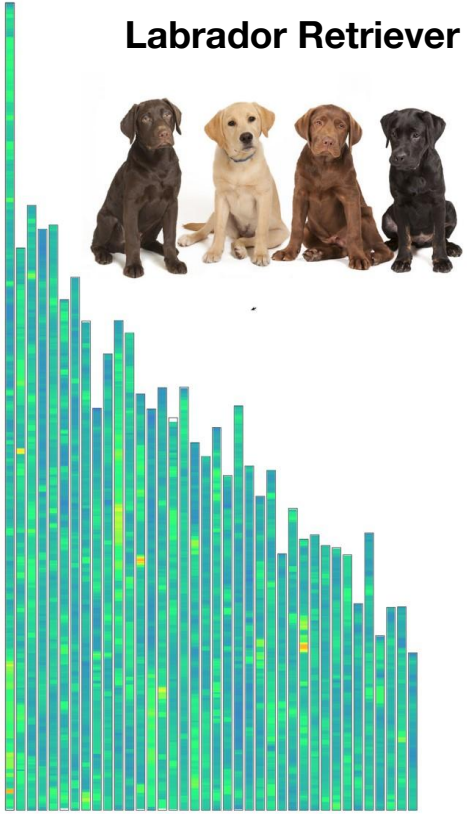
| | Name | VWF | SOD1 | PDK4 | Other Health | Location | Average Litter Size | # Litters | Age | Expected Offspring COI % | Expected Offspring Colors |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Edit | **Boone** | **N/A** | **Clear** | **Clear** | | **0 miles** | **n/a** | **n/a** | **2 yrs 0 mths** | | |
| View | **Kleo** | 🔒 | 🔒 | 🔒 | 🔒 | Unknown | n/a | n/a | 1 yrs 1 mths (est.) | 32 | 🔒 |
| View | **Ziva** | Carrier | Clear | Clear | | Unknown | n/a | n/a | 4 yrs 4 mths (est.) | 35 | Bb DD |
| View | **ARIES** | Clear | Clear | Clear | | Unknown | n/a | n/a | 1 yrs 9 mths (est.) | 35 | BB DD |
| View | **Yulianna** | Clear | Clear | Clear | | Unknown | n/a | n/a | 0 yrs 6 mths | 32 | BB / Bb DD |

# **Doberman Diversity Project** | Relatedness by chromosome

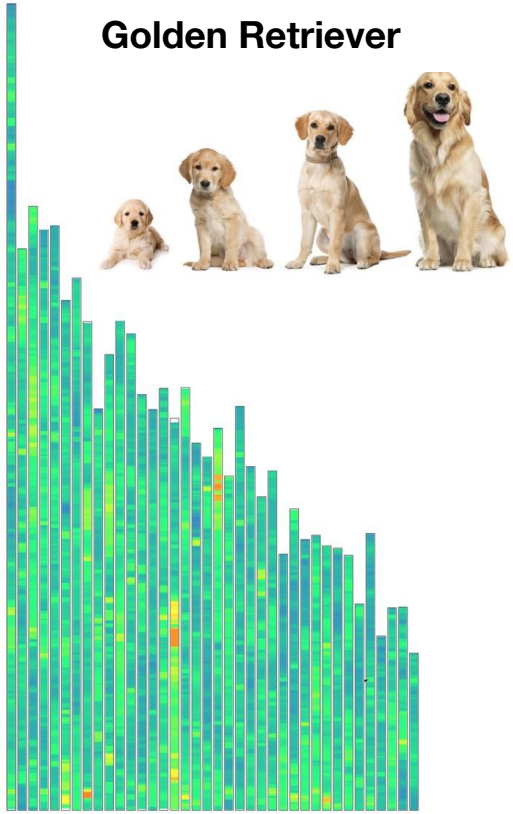


## **Doberman Diversity Project** | Fixed runs of homozygosity

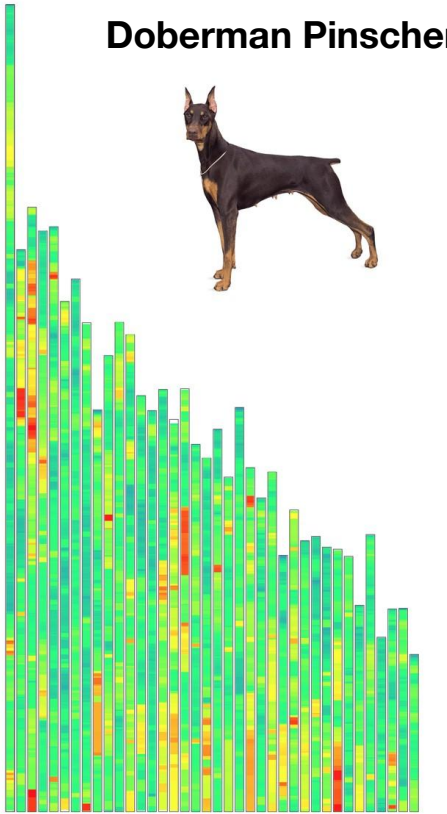
**Labrador Retriever**



**Golden Retriever**



**Doberman Pinscher**



Adam Boyko & Aaron Sams

**Embark Vet** | Committed to collaboration

DOBERMAN DIVERSITY PROJECT™

The SCA Rescue & Health Foundation Inc

The Schipperke Club of America Rescue & Health Foundation, Inc.

Mongolian Bankhar Dog Project

CANINE COGNITION CENTER DUKE

**Embark Vet |** Committed to collaboration

## What can we do at the breed club level?

- Reduced pricing (bulk)
- One on one tailoring to breed club needs
  - Breed-specific surveys and web pages
  - Quarterly reports on breed stats for health, traits, participation
  - Priority for breed-specific research endeavors
- Access to our breeder specialist team for questions or discussion
- Embark seminars, webinars, and Q&As

# **Genetic Results** | Embark profile demo

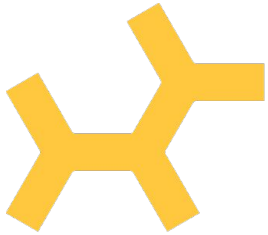

**Celebration of Belgians**

April 12th & 13th, 2018

Erin Chu, DVM, PhD | Senior Veterinary Geneticist
Embark Veterinary, Inc. | chue@embarkvet.com

embarkvet.com/breeders

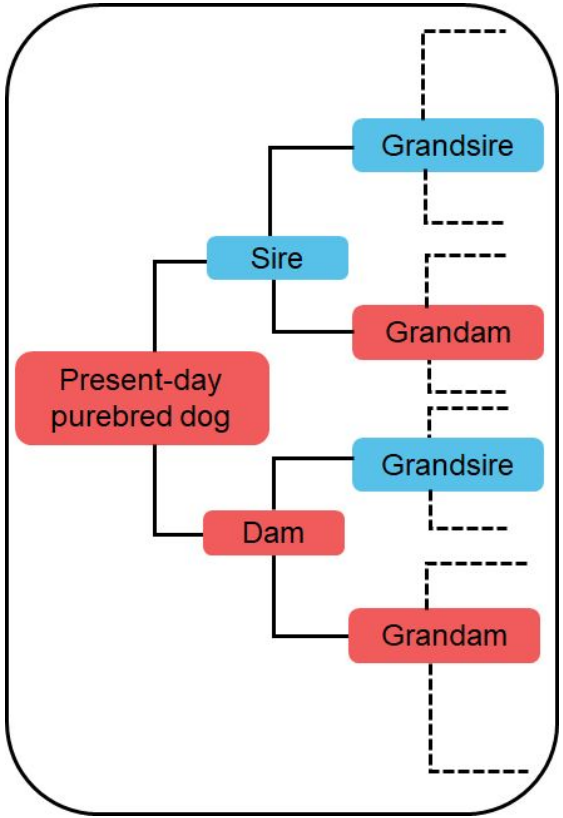
**BELGIANSHOW** for show pricing (through Sunday)

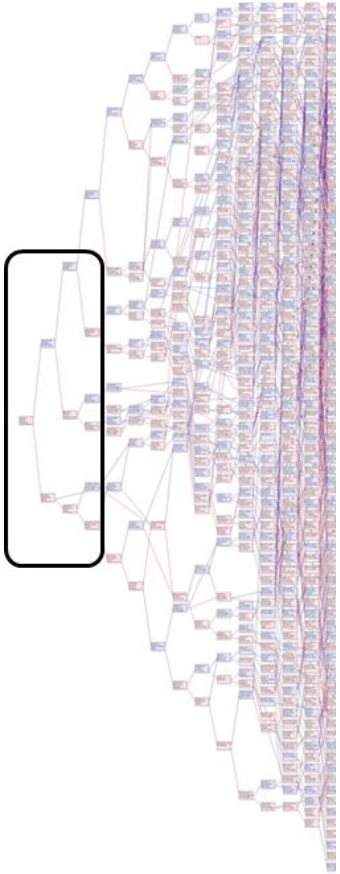


embark

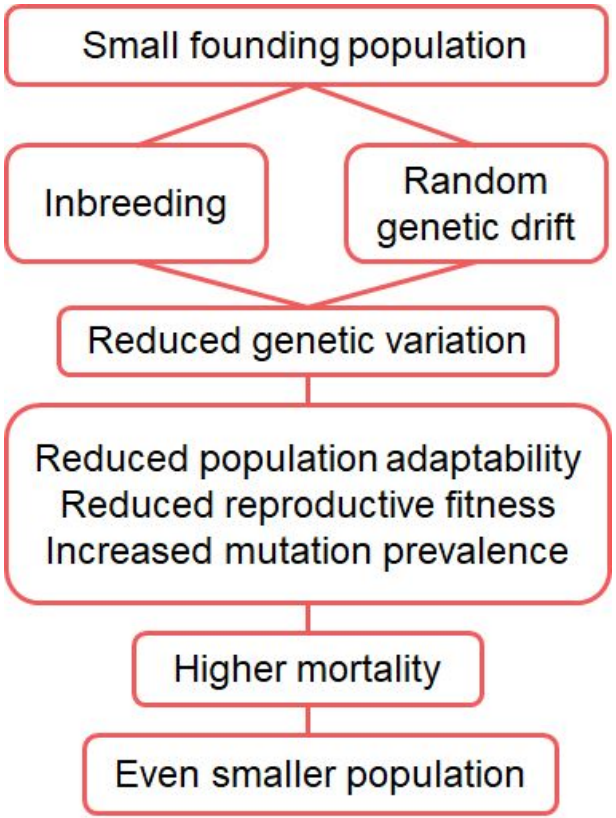
Supplementary

# **Inbreeding** | A light discussion

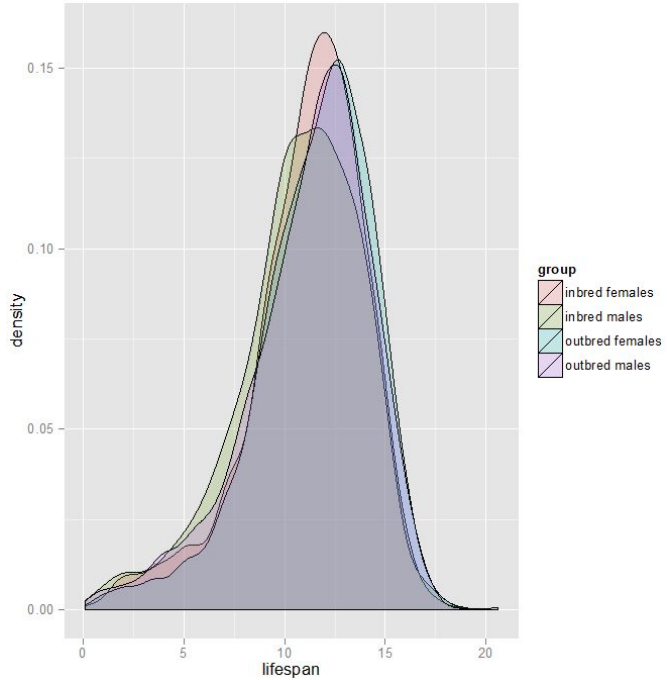


# **Inbreeding |** The Good, The Bad, and the Ugly

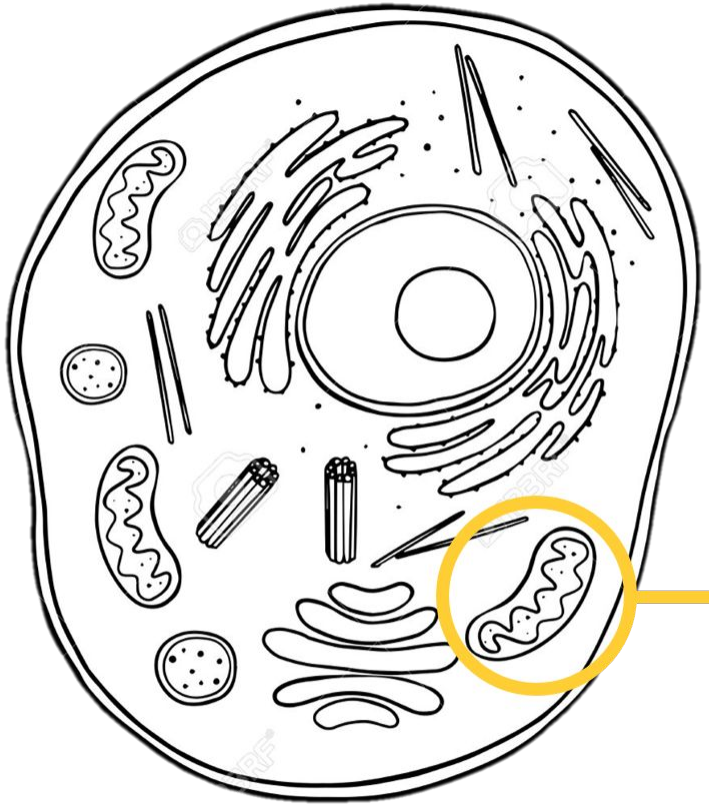



In Golden Retrievers, COI is **inversely correlated** to lifespan



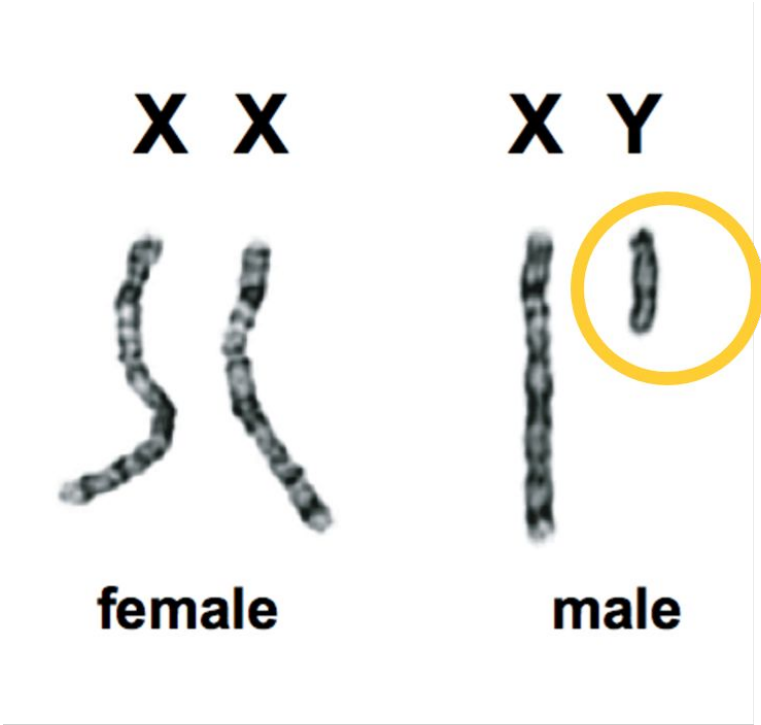

Adam Boyko

# **chrY and mtDNA** | Paternal and maternal lineages



Mitochondria possess their own small genomes, termed **mtDNA**, and are passed from dam to offspring. Males do not transmit mtDNA.

# **chrY and mtDNA** | Paternal and maternal lineages




The Y chromosome is required to send embryos along the “male” program. Males transmit the Y chromosome to male offspring only.