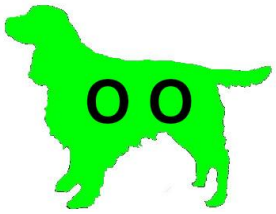
AN EXPLANATION OF HOW AUTOSOMAL RECESSIVE GENETIC DISEASES ARE INHERITED IN THE ENGLISH SPRINGER SPANIEL

- All of the genes inherited by dogs are contained within 39 different sets of chromosomes. Within those sets of chromosomes, there are thought to be between 20,000 – 30,000 different genes.
- Any chromosome between number 1 and 38 is called an ***Autosome*.** The 39th chromosome determines the sex of the dog.
- The genes responsible for diseases such as **Cord1 PRA, Fucosidosis** and **Phosphofructokinase Deficiency (PFK)** in the English Springer Spaniel are inherited as ***Autosomal Recessive Traits***. This means that (a) they are not linked to the chromosome that determines the sex of the dog, and that (b) **two abnormal (mutant) copies of the gene must be present** in order for a dog to be clinically affected by the disease.
- Chromosomes (and therefore genes) are inherited in pairs, with one copy of each being inherited from each parent.
- With all diseases that are inherited as simple autosomal recessive traits, every dog can be classified **genetically** in one of three ways:



O = Normal Copy of Gene
O + O = CLEAR

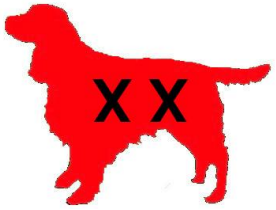
GENETICALLY CLEAR

This dog has inherited TWO NORMAL COPIES (one from each parent) of the gene associated with a particular disease. It will not itself have the disease and it cannot pass on a mutant copy of the gene to its offspring.

X = Mutant Copy of Gene
X + O = CARRIER

GENETIC CARRIER

This dog has inherited ONE NORMAL COPY of the gene from one parent and ONE MUTANT COPY from the other parent. A Carrier will not itself have the disease, but *(statistically)* it will pass on a MUTANT copy of the gene to approximately HALF its offspring.



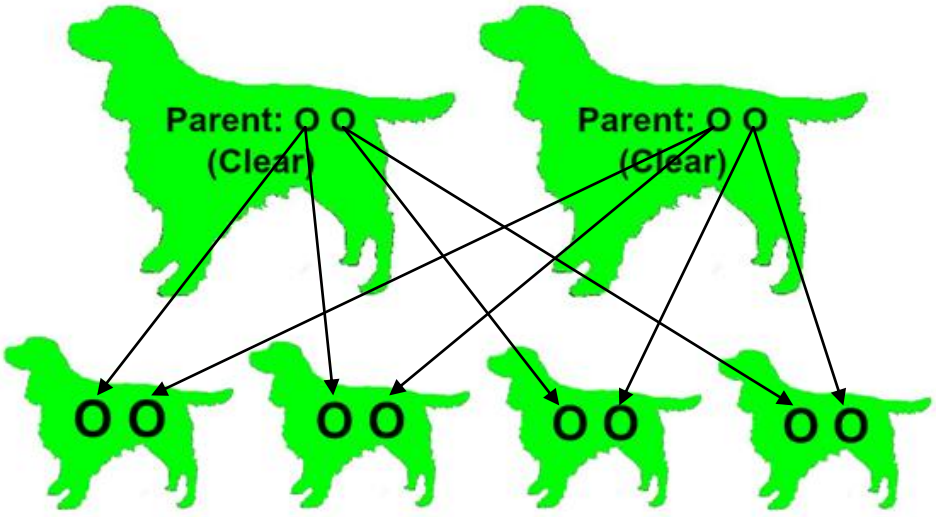
X + X = AFFECTED

GENETICALLY AFFECTED

This dog has inherited TWO MUTANT COPIES of the gene (one from each parent). It will usually suffer from the disease (although clinical signs may not always develop during its lifetime). GENETICALLY AFFECTED dogs will ALWAYS pass on a MUTANT copy of the gene to their offspring.

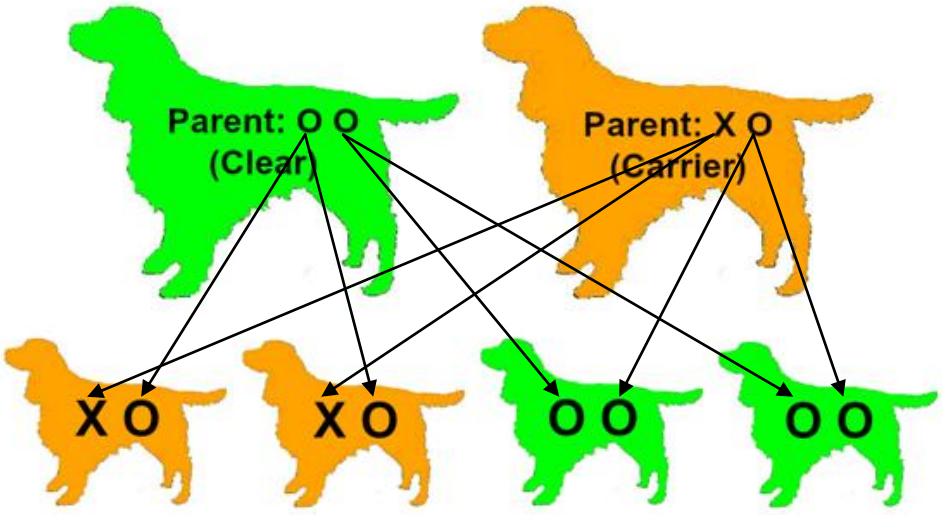
- The following diagrams **show what CAN and WILL happen *statistically*, and they illustrate the 'risks' involved with each of the six possible mating combinations.**
- ***'Statistically'*** means what will happen ***'on average'***. For example, if two Carriers are mated together, ***statistically*** a quarter of the litter will be genetically CLEAR, half of the litter will be CARRIERS and the remaining quarter will be AFFECTED.
- **Any one individual mating can vary enormously from the statistical averages – this is where the element of 'chance' comes into it, rather like the tossing of a coin. For example, a litter of 8 puppies should, *statistically*, be made up of 50% dogs and 50% bitches. Yet we all know that in any one litter, this can vary greatly, and it is perfectly possible to have a litter containing 8 dogs and no bitches, or vice versa. On average, though, over the course of thousands of litters, the numbers would even out in line with the statistical probabilities, and the same is true of genetically inherited diseases.**

1. **Mating two genetically CLEAR dogs together:**



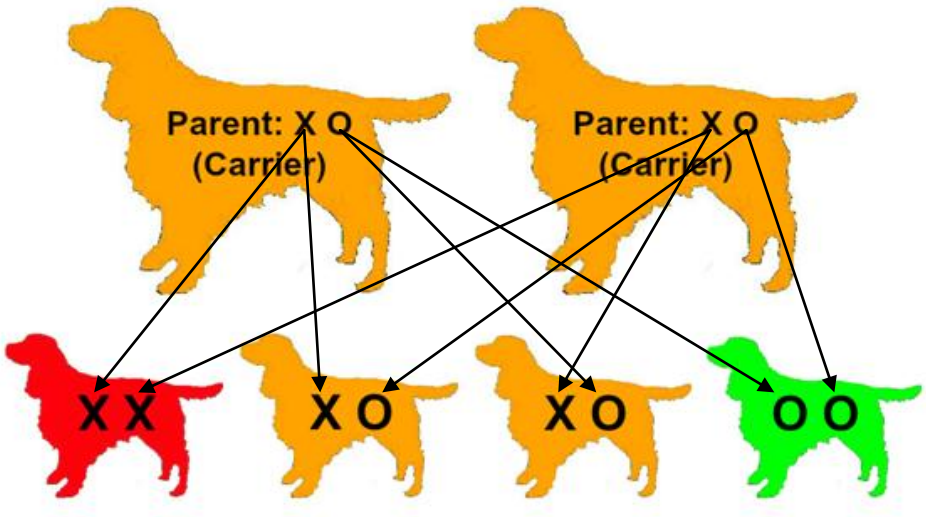
The above example shows that, whatever combination of genes each puppy inherits, because both parents are genetically CLEAR, they can only pass on a normal copy of the gene to each puppy. Therefore **every puppy will automatically inherit TWO NORMAL COPIES, making them ALL genetically CLEAR**.

2. **Mating a CLEAR to a CARRIER:**



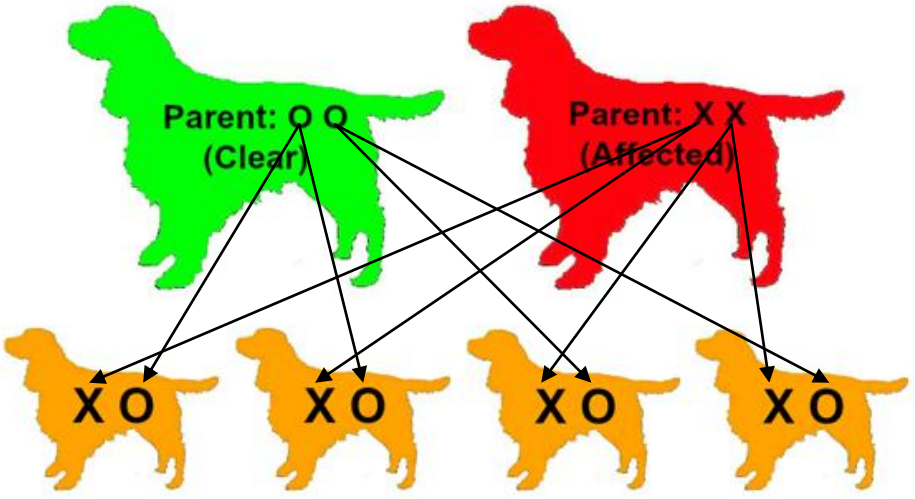
The above example shows that when a CLEAR is mated to a CARRIER, statistically **half** of the litter **will be CLEAR** (having inherited TWO normal copies of the gene), and **half** the litter **will be CARRIERS** (having inherited ONE normal copy and ONE mutant copy).

3. **Mating a CARRIER to another CARRIER:**



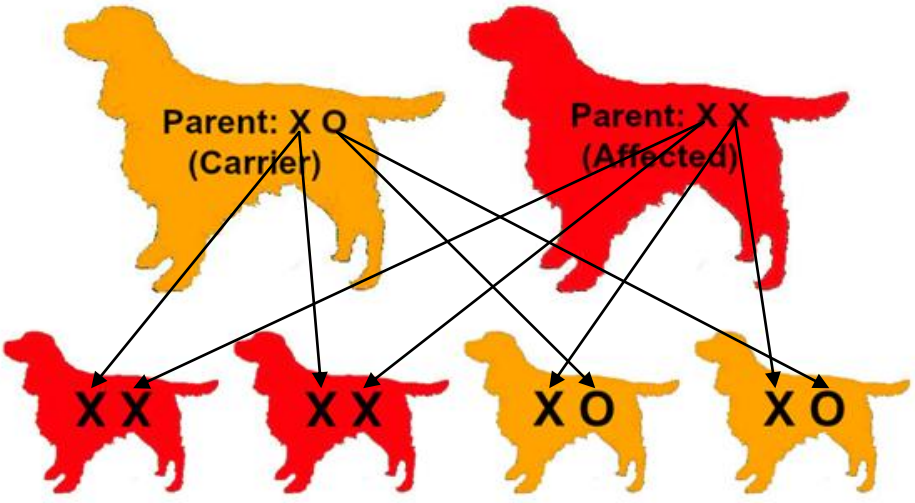
The above example shows that when TWO CARRIERS are mated together, statistically **half** of the litter **will be CARRIERS** (having inherited ONE normal copy of the gene and ONE mutant copy), **a quarter will be CLEAR** (having inherited TWO normal copies), and **a quarter will be AFFECTED** (having inherited TWO mutant copies).

4. **Mating a CLEAR to an AFFECTED:**



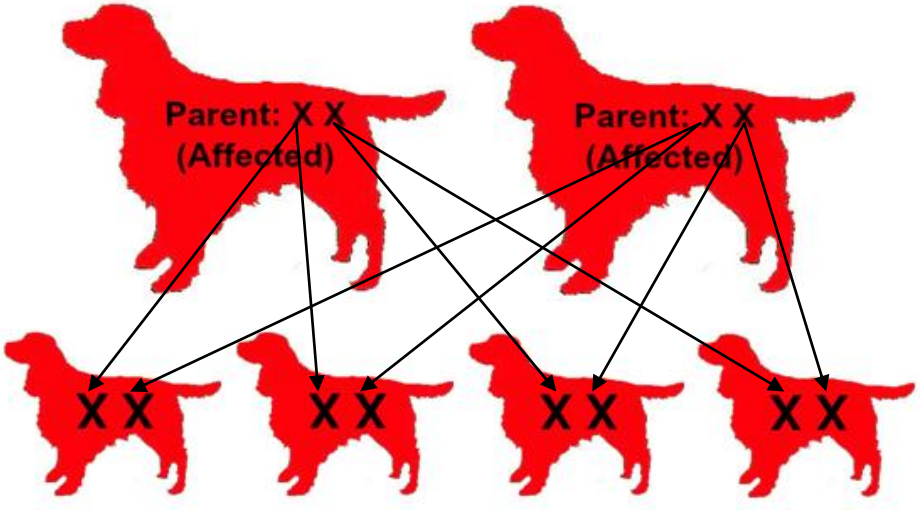
The above example shows that when a CLEAR is mated to an AFFECTED, **all** the puppies **will be CARRIERS**, having inherited ONE normal copy of the gene from the CLEAR parent and ONE mutant copy from the AFFECTED parent. Note that ALL the offspring of an AFFECTED parent will automatically be at least CARRIERS even if mated to a CLEAR.

5. **Mating a CARRIER to an AFFECTED:**



The above example shows that when a CARRIER is mated to an AFFECTED, statistically **half** the litter **will be CARRIERS** (having inherited ONE normal copy of the gene from the CARRIER parent and ONE mutant copy from the AFFECTED parent). The other **half** of the litter **will be AFFECTED** (having inherited TWO mutant copies, one from each parent).

6. **Mating two AFFECTED dogs together:**



This final example shows that when two AFFECTED dogs are mated together, **all** the puppies will inherit TWO mutant copies of the gene and they will therefore **ALL** be **genetically AFFECTED**.

WHAT DOES ALL THIS TELL US?

- **There are THREE UNSAFE mating combinations that could produce AFFECTED dogs:**

  a) **CARRIER TO CARRIER**
  b) **AFFECTED TO CARRIER**
  c) **AFFECTED TO AFFECTED**

- **It also tells us that AFFECTED dogs can NEVER be produced PROVIDED at least ONE parent is genetically CLEAR.**

- ***Ethical Guidelines for Breeders*** in respect of Fucosidosis and Cord1 PRA have been agreed by all the UK ESS Breed Clubs in an effort to give guidance to breeders on how best to eliminate the risks of breeding affected dogs, whilst still breeding for quality, type and temperament.

- **Further information is available from the HEALTH CO-ORDINATORS:**

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