Breeding Strategies To Avoid Producing Dogs Affected With Progressive Retinal Atrophy.

The Mutation

Scientists at the Animal Health Trust (AHT) have identified the mutation that causes progressive retinal atrophy (PRA) in the miniature long-haired Dachshund (MLHD). The mutation alters the DNA of a gene that is involved with the normal functioning of the retina.

PRA in the MLHD is a recessive disease – this means that a dog has to inherit two copies of the mutation for it to be **affected** with PRA. If a dog has one copy of the mutation and one normal copy of the gene it is a **carrier**. Carriers never develop PRA but will pass the mutation to about half of their offspring. If a dog has two normal copies of the gene it is said to be **clear** of PRA. Clear dogs will never develop PRA and cannot pass the mutation to any of their offspring.

Gamete Production

Each dog carriers two copies of the PRA gene. If it carries:

- two normal copies (N N) it is **clear** of PRA
- one normal copy and one mutated copy (N M)it is a **carrier** of PRA
- two mutated copies (M M) it is **affected** with PRA

When a dog produces gametes (either eggs or sperm, depending on whether it is a male or female) one copy of the gene passes into each gamete. Every egg & sperm inherits one of its parents two copies of the gene, the copy that it inherits is entirely random. Therefore, a **carrier** (N M) will pass the normal gene to approximately half of its gametes and the mutant gene to the other half of its gametes. A **clear** dog (N N) will pass a normal copy of the gene into all its gametes (because it only has normal copies to pass) and an **affected** (M M) dog will pass the mutated copy to every one of its gametes (because that is all it has to pass) **Figure 1**.

Which Dogs Can Be Mated Safely?

Upon fertilisation an egg and a sperm unite and the resulting embryo inherits the two copies of the PRA gene that were present in the egg and the sperm. Whether the resulting puppy will be affected with PRA depends on which two copies of the PRA gene it inherited from its parents. **Figure 2** illustrates the outcome of the six mating different combinations that are possible. The following combinations of dogs can **NOT** produce any affected puppies:

Clear X Clear
Clear x Carrier
Affected x Clear

However, mating a clear with a carrier will result in half the puppies being carriers, so any dogs wanted for breeding should be tested to determine their PRA status. All the puppies resulting from an affected x clear mating will be carriers. There is no need to test these puppies, but they should only be mated to tested clear dogs.

It is important to remember that the gametes inherit copies of the PRA gene **AT RANDOM**. Therefore, the proportions given in **figure 2** are approximate. For example, if a carrier x carrier mating results in 4 puppies, on average we would expect 1 to be clear, 1 to be affected and two to be carriers. But not every litter will produce exactly that outcome. It is possible (although less likely) for the same two carriers to produce four affected puppies – just as it is possible to toss a coin four times and get four heads, although it is more likely you would get two heads and two tails.

Figure 1. Gamete production

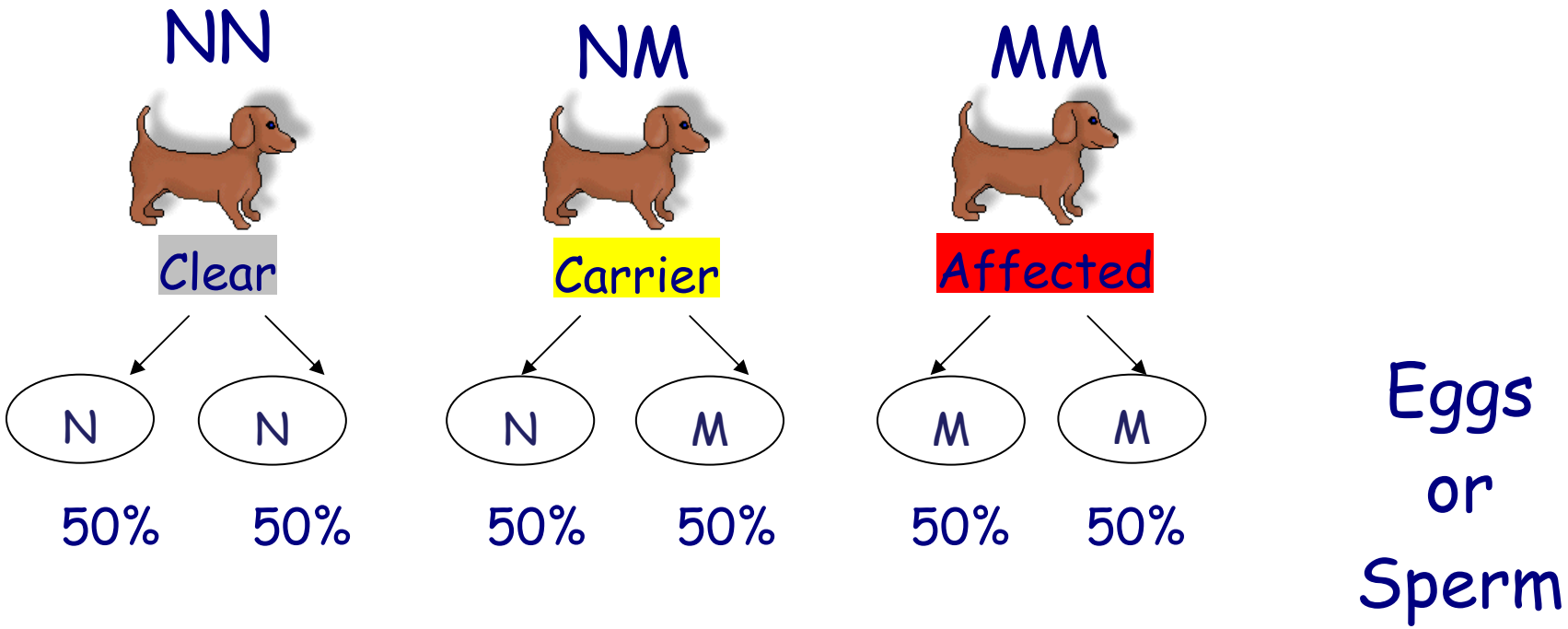
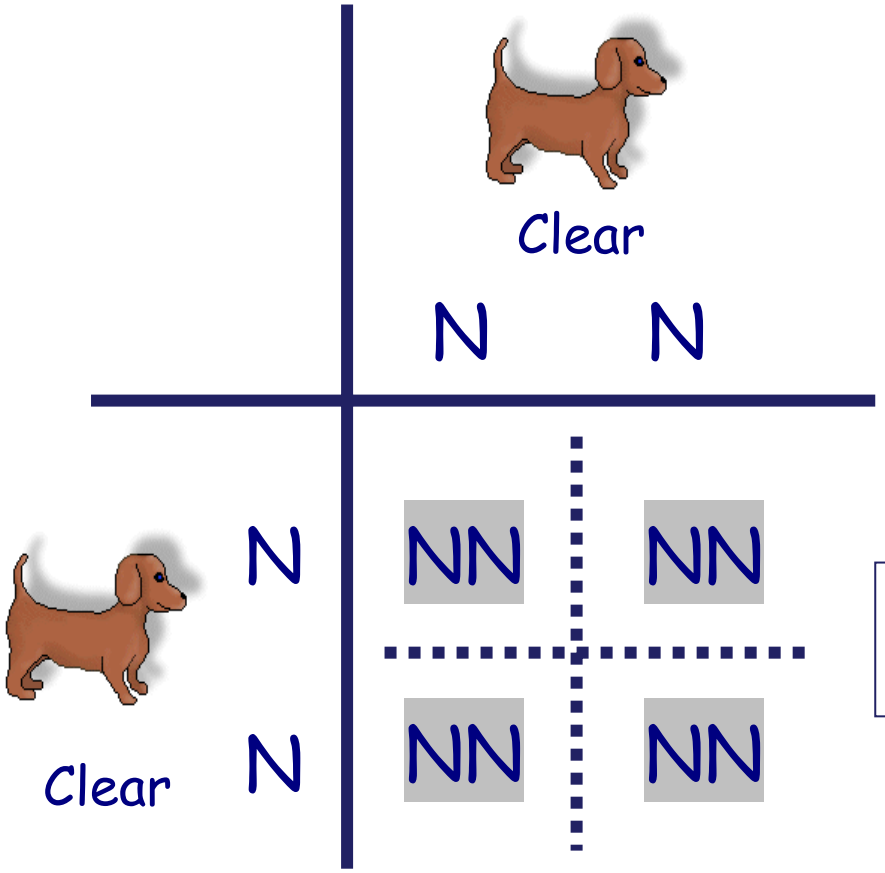
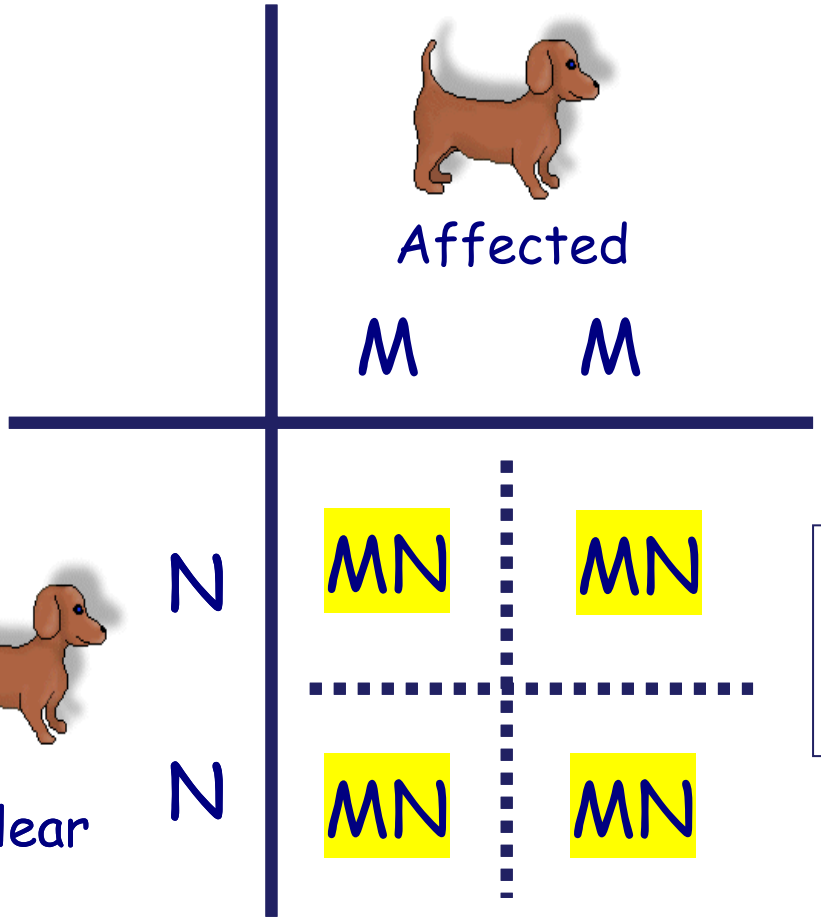


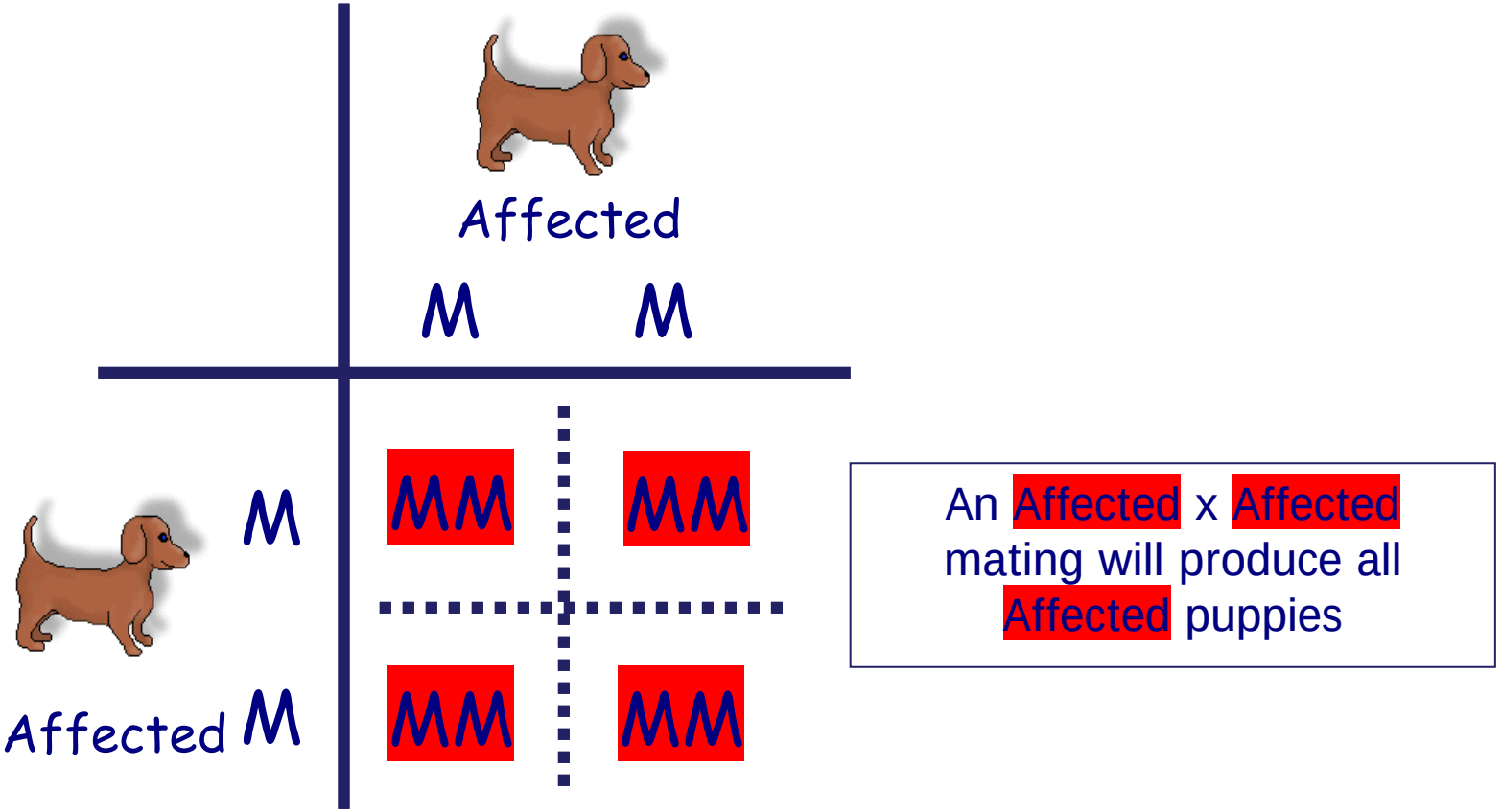
Figure 2. Mating Outcomes



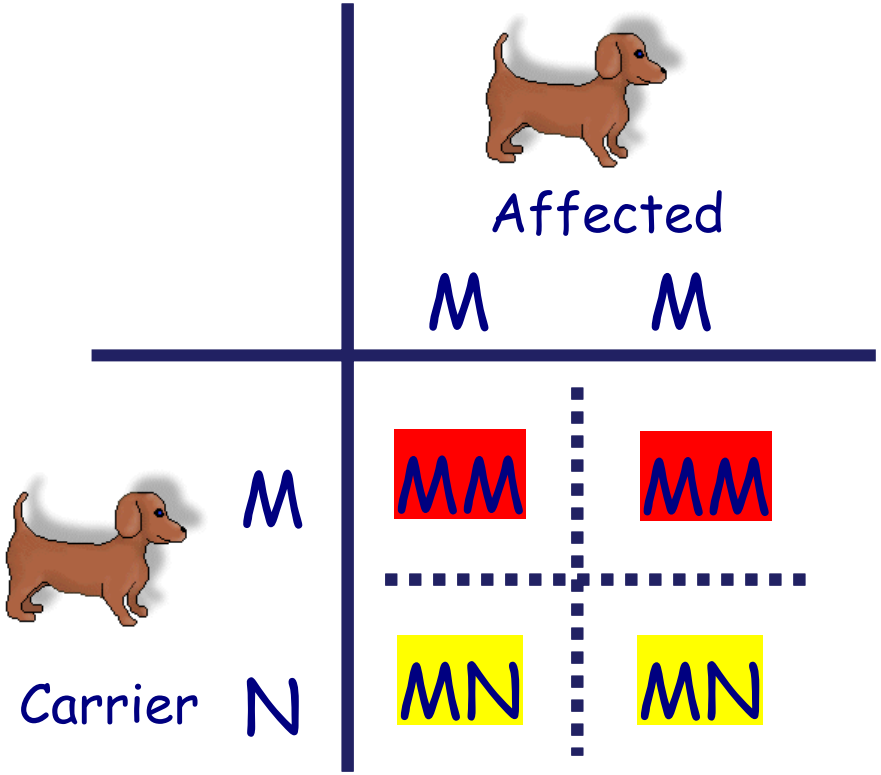
A Clear x Clear mating will produce all Clear puppies



An Affected x Clear mating will produce all Carrier puppies

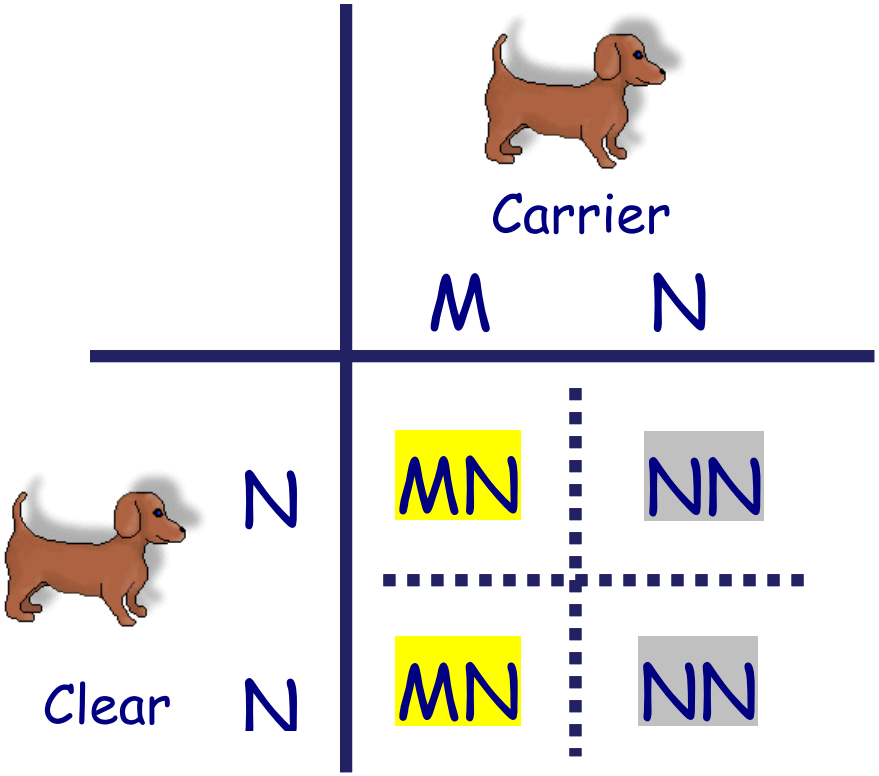


An Affected x Affected mating will produce all Affected puppies



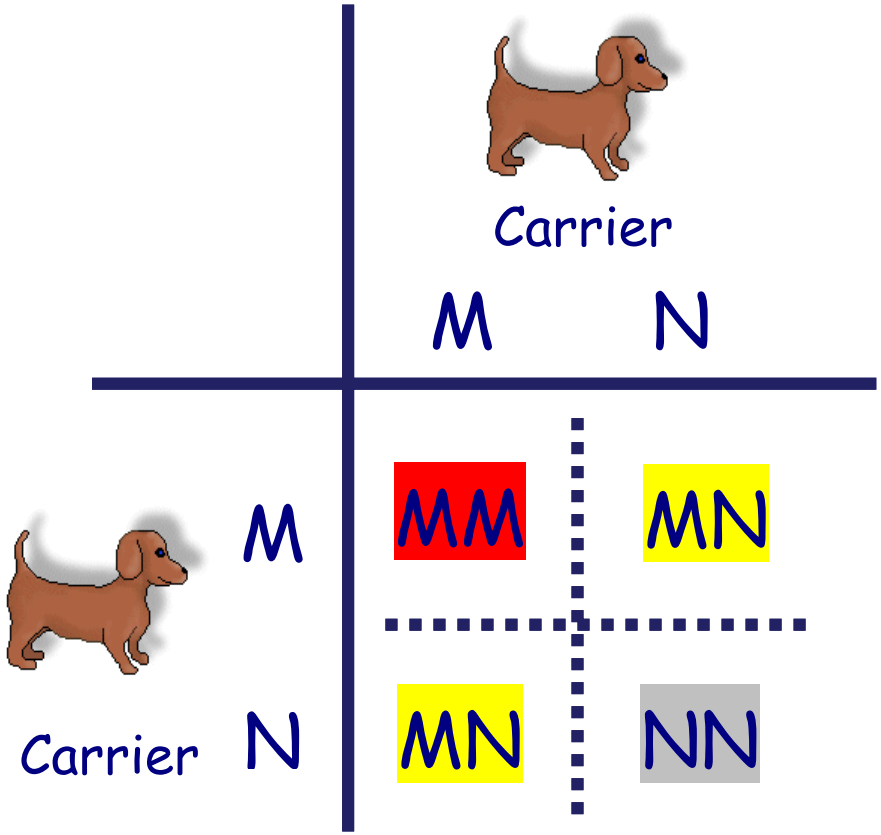
An Affected x Carrier mating will produce

½ Affected puppies
½ Carrier puppies



A Carrier x Clear mating will produce

½ Carrier puppies
½ Clear puppies



An Carrier x Carrier mating will produce

¼ Affected puppies
¼ Clear puppies
½ Carrier puppies