



What is Genetics?

Genetics is the study of genes, inheritance and variation in living things. It is particularly important to dog breeders as a little understanding about genetics helps breeders to avoid inherited conditions, plan for desirable traits in their litters and preserve the genetic diversity of the breed for the future.

What are genes?

Genes are the instructions found inside all living cells which tell the cell what to do. Genes are found on the long strands of DNA which make up the chromosomes found inside the nucleus of every living cell. In dogs there are 39 pairs of chromosomes (78 in total) in normal body cells, 1 of each pair comes from the sire and the other from the dam. These 39 pairs of chromosomes contain approximately 50000 genes and all of these genes together are the instructions for a dog.

What is a mutation?

When a new cell is made, either during development/growth or to replace a worn out cell in an adult dog, the DNA has to be copied exactly. As we said before, DNA is a code and is made up of sequences of 4 different chemicals repeated many thousands of times. If an error is made when the code is being copied, it may alter the way in which a gene works. This is called a mutation. Once a mutation has occurred then it can be passed on to the next generation. Luckily the majority of mutations that occur have little or no negative effect on the dog, however, very occasionally a

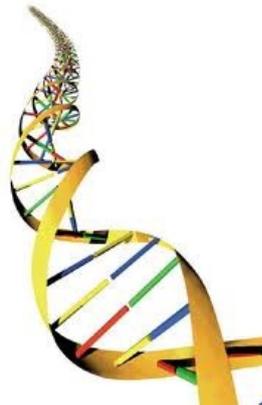
mutation can occur which can cause harm to the individual. This is where inherited conditions come from and it is this aspect of genetics which is particularly important in dog breeding.

How are genes passed on?

In Dogs each sperm cell has 39 individual chromosomes and each egg cell has 39 individual chromosomes, so when the sperm cell fertilises the egg cell, the pairs join up and the fertilised egg cell then has the correct number (78) of chromosomes. When sperm or egg cells are made, each one gets a random selection of chromosomes, so an individual sperm for example will have some chromosomes (and therefore genes) which came from that dog's sire and some from his dam. This allows for variation within the species and explains why every puppy in a litter will be slightly different to its litter mates as a different sperm cell fertilises each egg cell.

So how do genes give rise to characteristics (traits)?

As dogs have 2 copies of each chromosome (one from the sire and one from the dam), they also have 2 copies of each gene. Most characteristics are controlled by many pairs of genes, but some characteristics are controlled by just 1 gene pair. These are fairly simple for us to understand and to predict what will be passed on to the next generation. It is important to realise that genes can exist in different versions, called alleles, for example, gene A might be the gene





that controls whether a dog has the dapple pattern or not. There are 2 versions of this gene, 1 that says the dog will be dappled and 1 that says it won't. In this example only 1 copy of the dapple version is needed for the dog to have the dapple pattern in its coat. All Dachshunds have 1 or other version of this gene, it just depends which versions they have as to whether they will show this characteristic.

So how do I predict what my puppies will inherit?

To start with you need to know what versions of different genes the parents have, then you can predict the probability of each puppy having a certain trait. Let's start with what sex the puppies will be. Sex is determined by one pair of chromosomes, male dogs have one X chromosome and one Y chromosome (XY), and bitches have two X chromosomes (XX). So in a male's sperm they can either have an X chromosome or a Y chromosome. In the female's eggs they can only have an X chromosome. When a sperm cell fertilises an egg cell there is a fifty-fifty chance of the sperm having an X chromosome or a Y chromosome. Therefore there is a 50% chance that each puppy will be male and a 50% chance that each puppy will be female. We all know of dogs that appear to sire more dogs than bitches or visa versa, but if the dog sires a lot of puppies the percentages should balance out. The Dachshund Breed Council has produced fact sheets about some of the inherited disorders that can affect Dachshunds, and these should be referred to for more specific information

about the individual conditions and how they are inherited.

What is genetic diversity?

Genetic diversity refers to the total number of genetic characteristics in a species. It is important that species have a large genetic diversity to allow them to adapt to changing environmental conditions. Obviously in our pet dogs the environment isn't going to change significantly in any great hurry, however it is still essential to maintain as large a genetic diversity as possible to reduce the chances of a bad mutation becoming so widely prevalent in the breed that it might be impossible to eradicate it. Inbreeding reduces the genetic diversity of a breed and increases the chances that a dog will inherit the same (possibly bad) version of a gene from both parents.

How can we measure how inbred a dog is?

Geneticists use the "Coefficient of Inbreeding" as a measure of how inbred a dog is and how likely it is to have inherited the same versions of genes from both its sire and dam. This takes into account how many times the dog has common ancestors on both sides of the pedigree and is obviously a fairly complicated mathematical equation. The lower the average Coefficient of Inbreeding for a breed, the more genetically diverse a breed is and therefore the lower the chance of bad mutations being impossible to eradicate.

So where can I find out the Coefficient of Inbreeding for my Dachshund?

The Kennel Club created a website called Mate Select

(www.kcmateselect.org.uk), which is a



unique tool to help dog breeders to manage the level of genetic diversity in their own breed. The website enables breeders (and all owners of Kennel Club registered dogs) to find out the Coefficient of Inbreeding for an individual dog so long as it is registered in the United Kingdom by The Kennel Club, see the overall breed average and see the Coefficient of Inbreeding for a planned litter. If an individual dog (or its parents) have had any health tests then these are also accessible from this website.

What are the average Coefficients of Inbreeding for the different Dachshund varieties?

The current (as of May 2011) Coefficients of Inbreeding for the different varieties are:

- Long-haired Dachshunds - 8.6%
- Smooth-haired Dachshunds - 8.2%
- Wire-haired Dachshunds - 6.7%
- Mini Long-haired Dachshunds - 7.6%
- Mini Smooth-haired Dachshunds - 8.1%
- Mini Wire-haired Dachshunds - 11.3%

What do these values actually mean?

An Inbreeding Coefficient of 12.5% means that there is a 1 in 8 chance that a dog will inherit the same version of a gene from the same dog that appears in both the sire's and dam's pedigree. Examples of matings with a Coefficient of Inbreeding of 12.5% are grandfather/granddaughter or half siblings. Some matings would have a higher Coefficient of Inbreeding and the Kennel Club will not register puppies from certain matings (mother/son, father/daughter, or brother/sister), as they consider the Coefficient of Inbreeding (at least 25% for each of these matings) to be too high and the chances of inherited conditions being

passed on too high.

Therefore, based on the current Coefficient of Inbreeding data all Dachshund varieties have on average less than a 1 in 8 chance of an individual inheriting the same version of a gene from the same common ancestor.

It is important to remember however that there will be some individuals in a breed who have a much higher Coefficient of Inbreeding than the breed average and they will have more chance of having inherited bad mutations from its common ancestors.

How can I help reduce the Coefficient of Inbreeding for my variety?

By using the Kennel Club's Mate Select website you can see what the Coefficient of Inbreeding for your planned litter will be, and this will help you to decide if this breeding is a good idea or not. It also allows you to check on the parents' health tests to determine if the sire and dam are compatible in terms of passing on known inherited conditions.

How do the Coefficients of Inbreeding for Dachshunds compare to other breeds?

Typically, the larger the population of a breed the lower the Coefficient of Inbreeding (COI). However, if a breed has had an influential sire then this will increase the Coefficient of Inbreeding (not too much of a problem so long as he didn't carry any bad mutations).

For comparison, some of the numerically larger breeds such as Labrador Retrievers have a COI of 6.4%, Border Terriers - 8.7%, Border Collies - 3.4%, Beagles - 10.4% and GSD - 3.2%. So Dachshunds are fairly average compared to many of the more popular breeds.



OK, so I've found out what the Coefficient of Inbreeding for my planned litter will be, I've checked out the health tests of both parents and I understand the basics of how characteristics are inherited. Where can I find out more?

The Dachshund Breed Council produces the following fact sheets which explain more about how different inherited conditions are passed on:

- Dachs-Facts PRA
- Dachs-Facts Laforas
- Dachs-Facts Dapple

All three can be downloaded from the Breed Council website.

The Kennel Club Mate Select website has a lot of information about genetic diversity, Coefficients of Inbreeding, health tests etc. on it. All breeders (new and experienced) should be taking note of the information on there to help plan their future litters.

Speak to experienced breeders who understand breed type and can explain to you what you need to improve in your own dogs, listen to their advice and act on it. They may not totally understand the genetic side of breeding but they will have knowledge of different dogs in the pedigrees and be able to tell you about their virtues and failings. Many of these characteristics are controlled by many different genes and therefore trying to predict whether puppies will inherit these virtues or failings is virtually impossible, but they are important to bear in mind when trying to improve breed type or

correct a constructional fault.

There is a wealth of information about genetics on the internet, some is excellent and some is not. Unfortunately, many websites which try to explain how specific characteristics are inherited (such as colour) are very complicated and can leave people more confused than they were to start with.

The Dachshund Breed Council aims to make this information available to breeders in an informative and simplified way to enable the majority of dog breeders to use the information in a constructive manner. If you have any questions regarding genetics please contact the Dachshund Breed Council who will be able to help you further, or look on www.uk-dachshund-health-report.org.uk.

References

- www.kcmateselect.org.uk
- www.dachshundbreedcouncil.org.uk
- www.uk-dachshund-health-report.org.uk
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Written by Helen Geeson BSc (Hons) PGCE
(Breed Council H&W Sub-Committee)