

Basics of animal breeding

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The origin of today's domesticated animals are wild animals. Their domestication is the result of thousands of years of human achievement.

The character of traits is based on genetic and environmental influences. The process of inheritance, the transmission of hereditary factors from one generation to the next and therefore the carriers of these factors must be located in the cells. The hereditary factors are transmitted as germ cells while fertilisation to the offspring.

The germ cells of the male are called sperms and that of the female ova. Sperms are formed in testes of males and ova are formed in ovaries of females.

One of the main components of a cell is the nucleus. The nucleus contains the chromosomes.

Different species have different numbers of chromosomes, dogs have 78 chromosomes in each cell, 39 pairs (see table 1). Dogs and other sexually reproducing species have two different cell types, the body cells or somatic cells and the germ cells or gametes. Body cells, which are diploid contain 2 of each chromosome, a set of pairs. One set of chromosomes from the mother and one from the father. Germ cells are haploid and contain only a set of single chromosomes.

Table 1: Number of chromosomes for different species

Species	diploid number	haploid number
Fruit Fly	8	4
Cat	38	19
Dog	78	39
Horse	64	32
Pig	38	19
Hare	46	23
Cow	60	30

Germ cells are produced by a process called meiosis of a diploid cell. During this process the diploid body cell is transformed to two haploid germ cells.

In figure 1 you can see a very simple representation of the meiosis. Every dog has 39 pairs of chromosomes in each body cell. One chromosome of each pair comes from the father and the other one from the mother.

In this case you can see only the first three chromosomes. The sire has three from his father (red ones) and three from his mother (black ones). After meiosis in this sperm the chromosome 1 and 2 are from the father and number 3 from the mother. For the dam it is the same. The green chromosomes are from the father and the blue from the mother. In the ovum only the chromosome 2 is from the father.

The selection of the chromosomes is totally random. So you can imagine how many different possible combinations can exist. The chance to get a identical germ cells is nearly impossible. That is the reason why each puppy in a litter is different from the others.

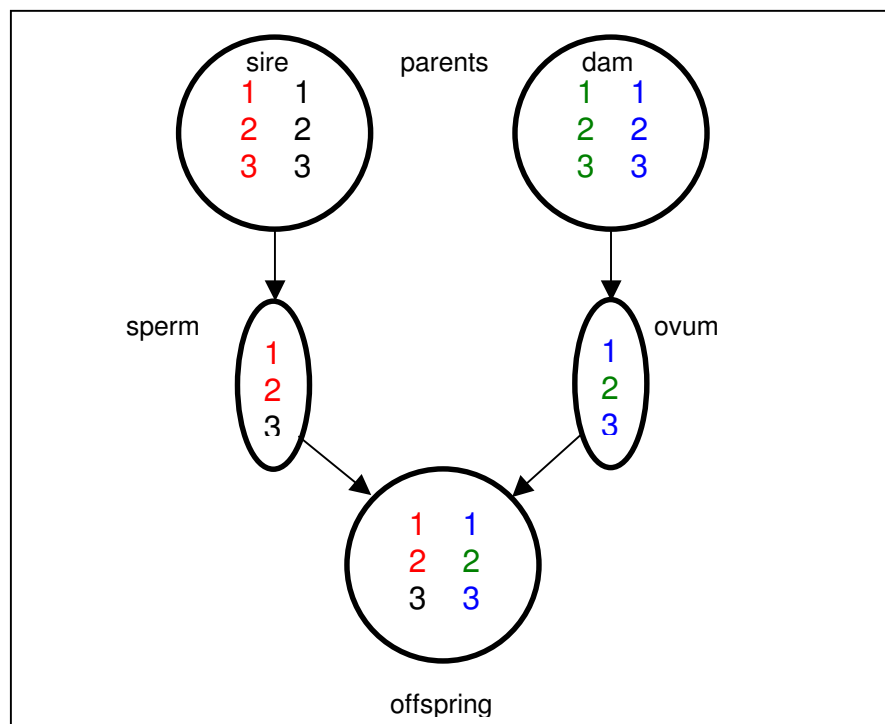


Figure 1: Each sire and dam have a pair of chromosomes (here: 1, 2 and 3) in each cell. Only one of each chromosomes is transmitted over the sperm or ovum to the offspring. Which chromosome of each pair is given to the offspring is random. Dogs have 39 pairs of chromosomes.

The union of two germ cells, the sperm and the ovum at fertilization produces a zygote, a cell which can develop an individual, with the usual diploid number of chromosomes, the beginning of new life. The new set of pairs of chromosomes, the offspring is a combination of exactly 50 percent of the father's and 50 percent of the mother's chromosomes. All genetic information is written on the chromosomes and the genetics of an animal is already determined, when the sperm and the ovum are combined. This is fixed from the very beginning of the development of an animal and cannot be changed anymore. Everything that can influence an animal from now on are only factors that affect it from the outside.

Chromosomes are divided into sex-specific chromosomes, which are responsible for the sex of an animal, and other chromosomes, the autosomes. Females carry two of the same sex-specific

chromosomes, called the X-chromosomes. Males carry two different sex-specific chromosomes, one X-chromosome and one Y-chromosome. Only one of these is transmitted from each parent to the offspring. The mother can only transmit a X-chromosome, but the father can transmit either a X- or a Y-chromosome. As sperm cells can only contain one of them it is random, if the father transmits a X- or Y-chromosome and the offspring is male or female.

Chromosomes are the carriers of the hereditary factors, the genes. Simply they can be compared with pearls tied up on a string. One gene represents a section of the chromosome. Between the genes are regions, that do not contain any information. Genes control the development and the behavior of the organism. They encode the information necessary to construct the chemicals (proteins etc.) needed for the organism to grow and function. The genes encode which eye color, coat color or body size the dog has and in the genes it is written if the dog will have a good racing performance or not.

Because all chromosomes are located as pairs in each body cell, all genes are also always present as pairs of genes. Each gene on a chromosome has its own "partner" on the other chromosome. These pairwise genes are called the 'two alleles' of a gene. A dog in which the two copies of a gene are identical is said to be homozygous for that gene. A dog which has two different alleles is said to be heterozygous.

Genes can be dominant or recessive. The term dominant gene refers to the allele that causes the phenotype, the total physical appearance and constitution or a specific manifestation of a trait, such as size or eye color. If a genetic trait is dominant, a person only needs to inherit one copy of the gene for the trait to be expressed. For example the eye color "brown" is dominant. If a human is heterozygous for the eye color and has e.g. one allele for brown and one for blue eyes the eye color will be brown. The brown allele is dominant and the blue one recessive. But there exist as well other types of dominance: codominance, incomplete dominance.

Some genes have more influence on the animal than others. Some characteristic traits are influenced by only one major gene, e.g. the eye-colour. Some are influenced by a few number of genes, e.g. the coat colour. Most characteristics are influenced by a very high number of genes, each of them with only a small contribution. These traits are called multi-locus based traits. They do not appear in a few classes, as grey – blue – brown – green or black – dun – blue – brindle - fawn, they show a wide range of differences. The high number of genes cause a high variety. An example is the body size, which is the result of thousands of genes all influenced by different factors from the outside. The body size can be measured in inches or centimetres and you find in a Greyhound population the whole range of size from 24 to 30 inches with all sizes in between. You may even find smaller or taller dogs. The more exact you measure, the more steps you get. It is no longer possible to qualify the size (e.g.: 5 sizes), it is quantified. That means, you can measure a mean value and a variance. Traits, which can only be quantified are called quantitative traits. And this makes the genetic theory for these traits so difficult. It is an own topic within the science of genetics and is called 'Quantitative Genetics'.

Quantitative traits are the most interesting in modern animal breeding, because they are of high importance for the breeder. Typical examples are:

- body size
- body weight
- racing speed
- daily gain
- litter size

Although it is only possible to measure litter size in whole numbers (1 – 2 – 3 – 4 – 5 .. pups per litter), it is also a quantitative trait and not treated as a trait that occurs in classes. For each breeder it is important to know something about the inheritance of quantitative traits.