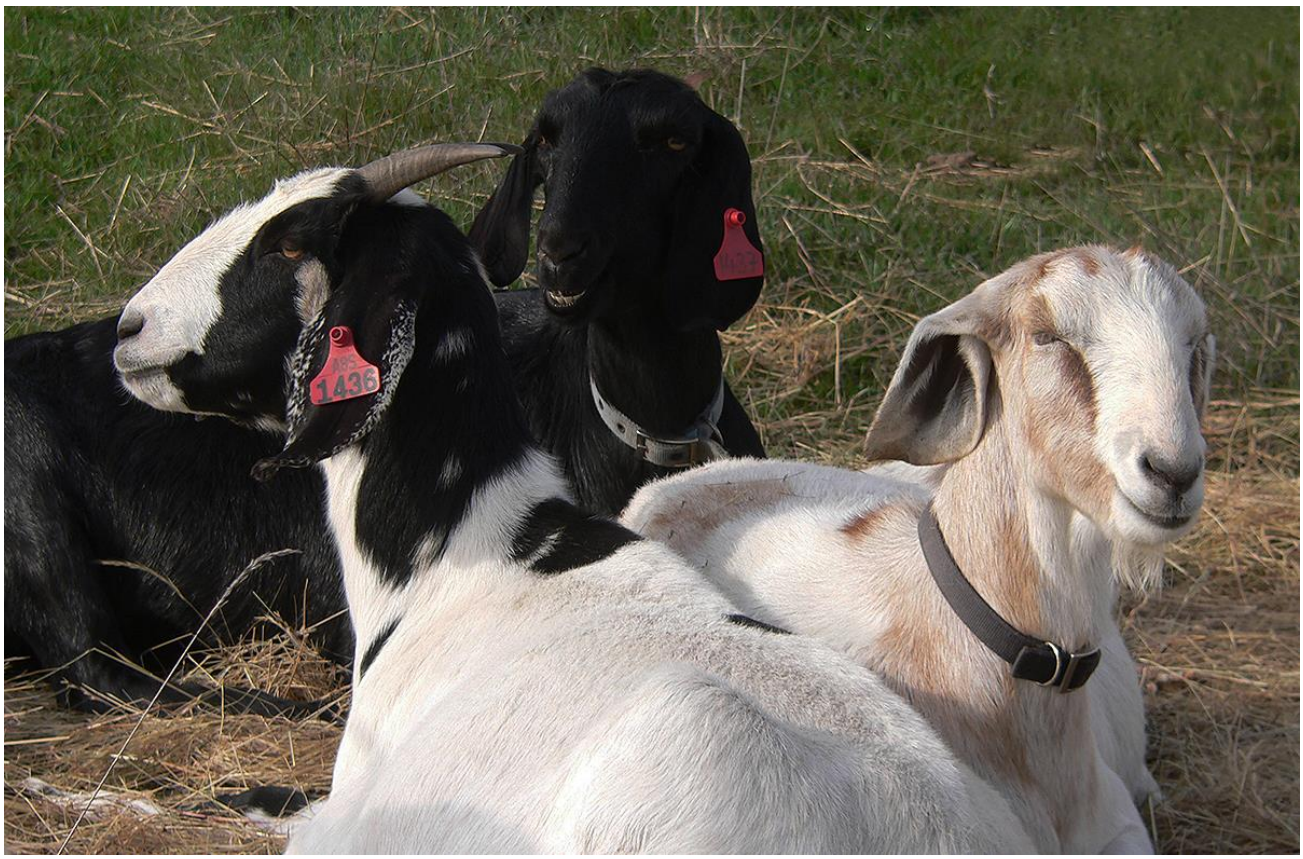
Genetics of polled and horned goats



Jamaica" (1435, right), "Jazz" (1437), and "Jacky" (1436) are sisters. Their mother ("Humpty", H085) is polled, their father "Emmett", RK6-60) has horns. "Jamaica" and "Jazz" are polled.

The information about how an animal (or a plant) is built, its "blueprint", is stored in the chromosomes in the nucleus of the cells. The number of chromosomes varies for different organisms. Goats, for example, have 29 chromosomes, whereas humans have 23 chromosomes. The information for an individual feature is called a gene. Normally, there are two sets of similar chromosomes in every cell, which both contain the entire "blueprint" of the organism. Consequently, every gene for a certain feature exists twice in every animal. However, there are two exceptions to this rule: One exception are the sex-chromosomes. Only the females have two similar chromosomes (the X-chromosomes), whereas the sex chromosomes of the males, the X- and the Y-chromosome, are slightly different. The other exception are the eggs of the female and sperms of the male, which both only contain one set of chromosomes.

The gene which is responsible for the horns of a goat works, like most other genes, like a switch with two positions: One position of the switch is for "horns", the other position is for "polled". The two genes for "horns" or "polled" can, like all other genes, be identical on both chromosomes. If this is the case, the animal is HOMOZYGOUS for this particular gene. Or the two genes can be different, then the animal is HETEROZYGOUS for this gene.

The effect the two (identical or different) genes have on the growing animal (i.e. how they are "expressed"), depends on their strength. The gene on the one chromosome can be stronger than the gene on the other chromosome. In this case the stronger gene, which is called DOMINANT, will be expressed, whereas the weaker one, called RECESSIVE, will be suppressed. For example, if the gene on one chromosome is for "black", and the gene on the other chromosome is for "white", and "black" is dominant over "white", the outcome will be black. Alternatively, both genes can be of similar strength, called INTERMEDIATE. The outcome of two intermediate genes will be a mix of both genes. If "black" and "white" are intermediate, the outcome will be grey.

To understand the basic principles of genetics, it is also important to know the difference between the "genotype" and the "phenotype" of an animal. The genotype is the sum of all genetic information stored in the chromosomes of an animal, whereas the phenotype is the physical appearance of an animal. Only those genes which are expressed contribute to the phenotype. The recessive genes which are not expressed, because they are suppressed by the dominant genes, don't contribute to the phenotype, but they are still part of the genotype.

As mentioned earlier, eggs and sperms contain only one set of chromosomes. If the buck is homozygous for a certain feature, then all his sperms carry the identical gene. However, if the buck is heterozygous, then 50% of his sperms carry one version of the gene, and 50% of the sperms carry the other version. The same applies for the eggs of the doe. Upon fertilisation, the chromosomes of the egg and the sperm fuse, resulting again in a pair of chromosomes, one coming from the sire, the other one coming from the dam.

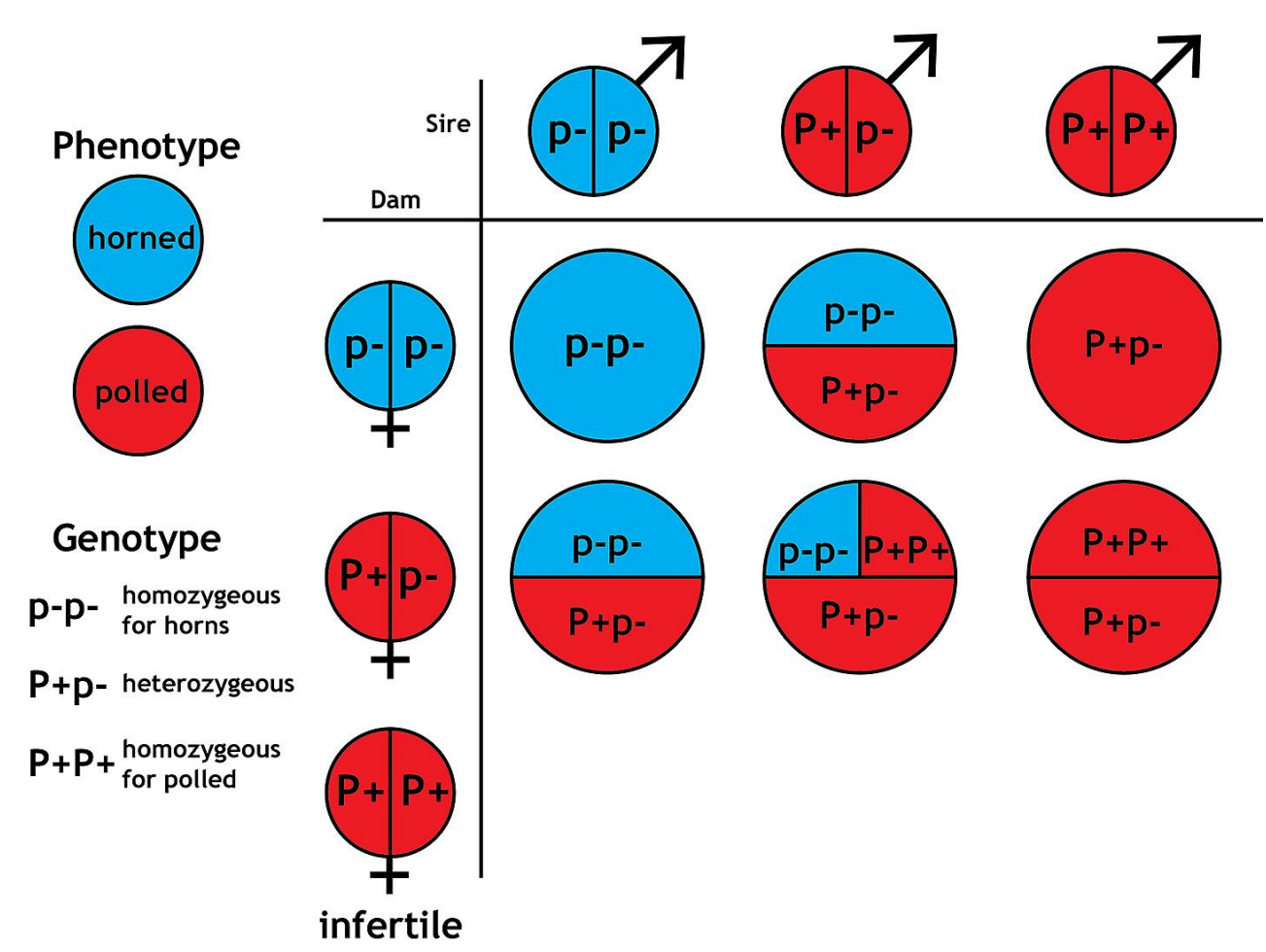
The gene for "polled" is dominant over the gene for "horns, the latter is recessive. To reflect this different strengths, a capital P with a plus sign (**P+**) will be used in the following text for "polled", whereas a lower case p with a minus sigh (**p-**) will be used for "horns".

Because "polled" (**P+**) is dominant over "horns" (**p-**), all goats which carry at least one **P+** gene, hence the homozygous ones (**P+ P+**) as well as the heterozygous ones (**P+ p-**) are polled, and only those goats which are homozygous for "horns" (**p- p-**) have horns.

Many dairy goat farmers prefer goats without horns. Because the gene "polled" is dominant, this goal could be easily achieved by breeding for polled goats. The dominant "polled" gene would quickly spread in a goat herd. However, unfortunately this is not possible, because the gene for "polled" is closely linked to a recessive gene that creates hermaphrodites (inter-sexes) in

females. These hermaphrodites, which are homozygous for "polled" (**P+ P+**), are infertile female goats with both male and female sexual organs. Male goats, which are homozygous for "polled" (**P+ P+**), on the other hand, are fertile, and all their offspring will be polled.

The outcome of breeding "polled" x "horned" goats is simple arithmetic. Five combinations are possible:



Phenotype and genotype of horned and polled goats, and statistical probability for horned and polled offspring.

1) If the buck is homozygous for polled (**P+ P+**), and the dam is heterozygous for polled (**P+ p-**), all kids will be polled. 50% will be homozygous (**P+ P+**), and 50% will be heterozygous. 50% of the female kids (those which are **P+P+**) are infertile.

2) If the buck is homozygous for polled (**P+ P+**), and the dam has horns (**p-p-**), all kids will be polled, but all kids will be heterozygous (**P+ p-**). There will be no infertile kids.

3) If both the buck and the dam are polled but heterozygous for polled (**P+ p-**), 25% of the kids will have horns (those which are homozygous for **p-**), and 75% will be polled. 50% of the kids will be heterozygous (**P+ p-)**, and 25% homozygous (**P+ P+**). 12.5% of the kids (the female **P+P+** homozygous ones) will be infertile.

4) If one parent is polled, but heterozygous (**P+ p-**), and the other parent is horned (**p- p-**), 50% of the kids will be polled, and 50% will be horned. All polled kids will be heterozygous (**P+ p-**), and there will be no infertile kids.

5) If both parents are horned (homozygous for **p- p-**), all kids will also be homozygous for horns (**p- p-)** and will have horns. Kids from horned parents cannot be polled!

Because all **P+ P+** females are infertile, it is not possible to produce kids with them.

The reader must bear in mind that these above mentioned percentages of polled or horned kids that can be expected represent the likelihood, or statistical probability, for them to occur. The bigger the herd (or the data set), the closer will the outcome be to the predicted percentage. In a small herd, however, the percentage of polled or horned kids may differ quite substantially from the theoretical value. In our herd, for example, where all polled goats are descendants of "Sophie" (D149), substantially more polled kids (59%) than kids with horns (41%) were born from polled parents (see Table below).

1st Generation				2nd Generation				3rd Generation				4th Generation				5th Generation			
Tag	Name	Sex		Tag	Name	Sex		Tag	Name	Sex		Tag	Name	Sex		Tag	Name	Sex	
D149	Sophie	F	P	F077		M	H												
				F078	Graciella	F	P	H085	Humptie	F	P	1435	Jamaica	F	P	1601	Leopard	M	H
																1602		F	P
												1436	Jacky	F	H				
												1437	Jazz	F	P				
												1520	Camo	M	H				
												1521		M	P				
								H086	Dumptie	F	P	1438		M	H				
												1439		F	H				
												1512		M	P				
								1301	Poppy	F	H								
								1302	Lily	F	H								
								1454	Camo	M	P								
								1455	Snowden	M	P								
								1623	Cocco	F	P								
								1624	Stella	F	P								
				G083	Rebecca	F	P	1523	Rebel	M	P								
				H094	Hannah	F	H												
				1354	Tina	F	H												
				1355	Ike	M	P	1515	Keira	F	H								
								1516		M	H								
								1517		M	H								
								1532	Tess	F	P								
								1533	Tom	M	P								
								1534	PK	M	P								
								1637		M	H								
								1638	Libby	F	P								
								1643		M	P								
								1644		M	H								
								1645	Lucy	F	H								
								1646		M	P								
								1647		M	P								
								1648		M	P								
				1526	Kite	M	P												
				1527	Knight	M	H												
				1716		M	P												
				1717		M	H												
				1718		F	P												