

Multiple Alleles

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Multiple allele is the existence of more than two alleles for a gene. Multiple alleles occur and are maintained within a population, any individual possesses only two such alleles (at equivalent loci on homologous chromosomes). For example the ABO blood group system, and the human-leukocyte-associated antigen (HLA) genes are the example of multiple alleles.

The ABO Blood Group

Another multiple-allele system is at the locus for the ABO blood group. This locus determines your ABO blood type and, like the MN locus, codes for antigens on red blood cells. The three common alleles for the ABO blood group

locus are: I^A , which codes for the A antigen; I^B , which codes for the B antigen; and i , which codes for no antigen (O). We can represent the dominance relations among the ABO alleles as follows: $I^A > i$, $I^B > i$, $I^A = I^B$. The I^A and I^B alleles are both dominant over i and are codominant with each other. AB phenotype is due to the presence of an I^A allele and an I^B allele, which results in the production of A and B antigens on red blood cells. An

Phenotype (blood type)	Genotype	Antigen type	Antibodies made by body
A	$I^A I^A$ or $I^A i$	A	B
B	$I^B I^B$ or $I^B i$	B	A
AB	$I^A I^B$	A and B	None
O	ii	None	A and B

individual with genotype ii produces neither antigen and has blood type O.

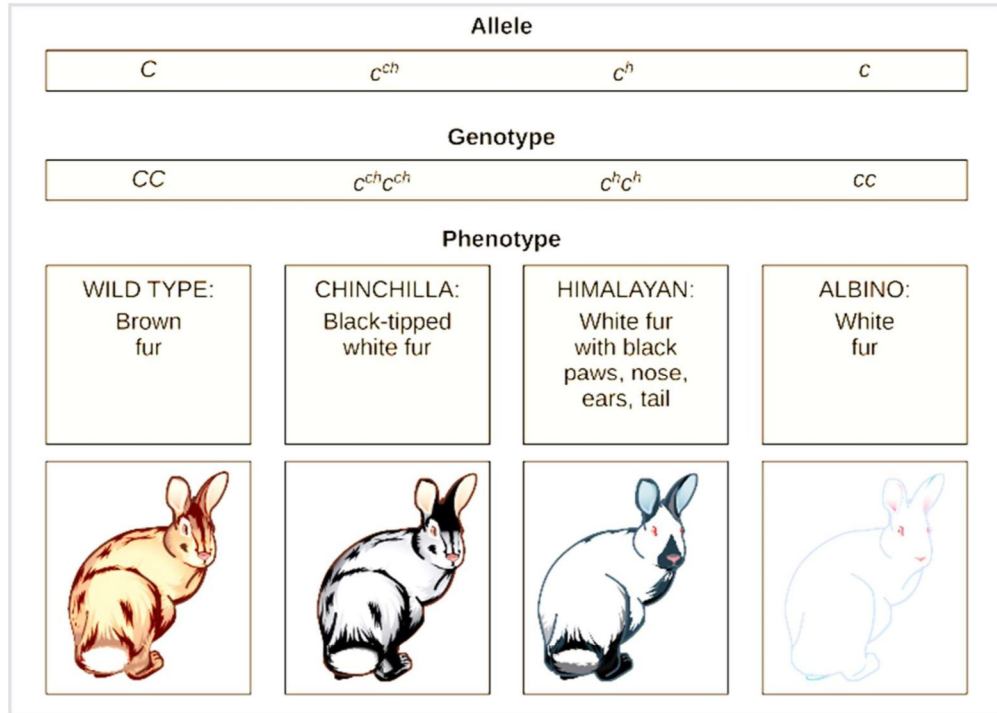
Antibodies are produced against any foreign antigens. For instance, a person having blood type A produces B antibodies, because the B antigen is foreign. A person having blood type B produces A antibodies, and someone having

blood type AB produces neither A nor B antibodies, because neither A nor B antigen is foreign. A person having blood type O possesses no A or B antigens; consequently, that person produces both A antibodies and B antibodies. The presence of antibodies against foreign ABO antigens means that successful blood transfusions are possible only between persons with certain compatible blood types.

Another example of multiple alleles is coat color in rabbits. Here, four alleles exist for the *c* gene.

Rabbits	Genotype	Phenotype
Wild-type version	C^+C^+	Brown fur
Chinchilla	$c^{ch}c^{ch}$	Black-tipped white fur
Himalayan	$c^h c^h$	Black fur on extremities and white fur elsewhere
Albino, or "colorless"	cc	White fur

In cases of multiple alleles, dominance hierarchies may exist. Here, the wild-type allele is dominant over all the others, chinchilla is incompletely dominant over Himalayan and albino, and Himalayan is dominant over albino.



Four different alleles for the coat color (C) gene rabbit.