

MULTIPLE ALLELES

INTRODUCTION

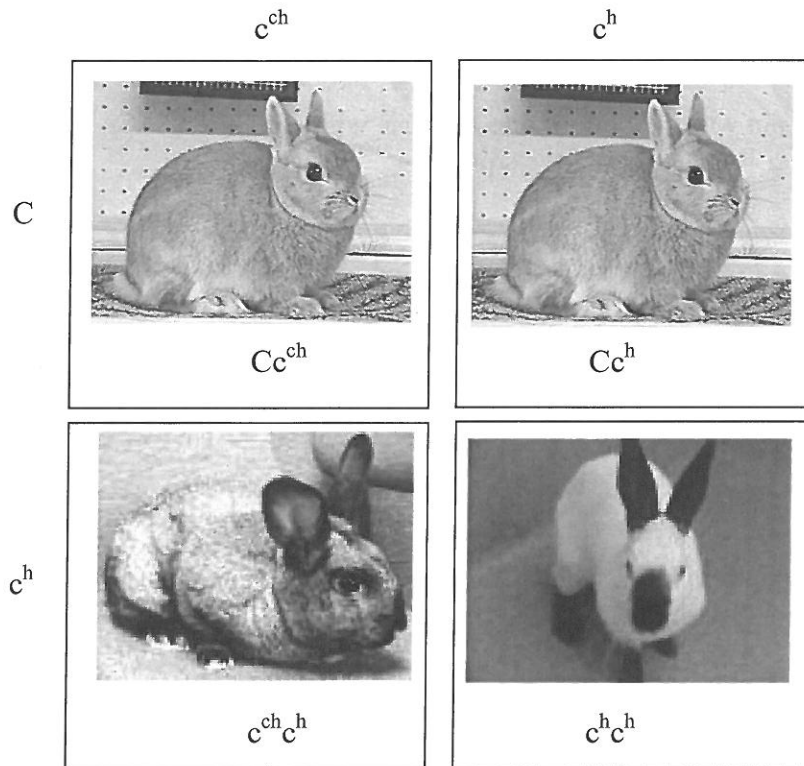
Mendel thought that each gene had two alleles: dominant or recessive. We now know that most genes have more than one allele. If three or more alleles are found in the population, we say these genes have multiple alleles.

EXAMPLE

Coat color in rabbits is inherited as a series of multiple alleles. In the case of rabbits, there are four alleles and each one is expressed with a different phenotype. Look over the summary table below:

phenotype	allele	pattern of inheritance
dark gray coat	C	dominant to all other alleles
chinchilla	c ^{ch}	dominant to Himilayan and to white
Himilayan	c ^h	dominant to white
white	c	recessive

Suppose you cross a chinchilla rabbit (c^{ch}c^h) with a dark gray rabbit (Cc^h). What are the possible offspring?



genotype ratio: 1 Cc^{ch} : 1 Cc^h : 1 c^{ch}c^h : 1 c^hc^h
 phenotype ratio: 2 dark gray : 1 chinchilla: 1 Himilayan

PROBLEMS

1. What happens when you cross a dark gray (Cc) and a white rabbit?

genotype ratio: _____

phenotype ratio: _____

2. A chinchilla rabbit is mated with a Himilayan. Some offspring are white. What are the parent genotypes? Answer by completing the square.

genotype ratio: _____

phenotype ratio: _____

3. Would it be possible to obtain white rabbits if one rabbit is white and the other is chinchilla? Answer by completing the square.

genotype ratio: _____

phenotype ratio: _____

4. Would it be possible to obtain Himilaya rabbits if one rabbit is Cc^{ch} and the other is $c^h c$? Answer by completing the square.

genotype ratio: _____

phenotype ratio: _____

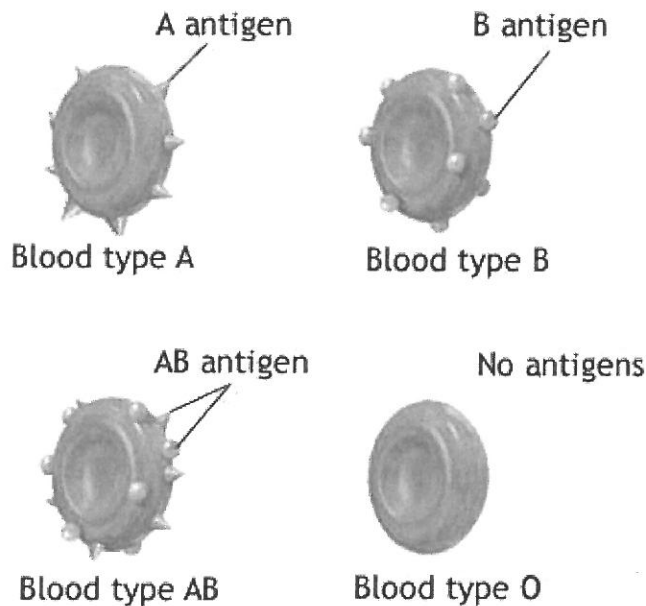
EXAMPLE

Human blood is classified into four groups, based on the antigen on the surface of the blood cell. An antigen is a protein that acts as a signal, enabling the body to recognize foreign substances that enter the body. When foreign substances enter the body, the antigens respond by producing antibodies. In fact, the word antigen means “anti-body producing substance.”

Human blood types are controlled by the three alleles I^A , I^B , and i . The alleles I^A and I^B are codominant (both are expressed together) and both are dominant to the i allele. Use the table below to learn the blood genotypes.

blood type	antigen	genotype
A	A	$I^A I^A$ or $I^A i$
B	B	$I^B I^B$ or $I^B i$
AB	A and B	$I^A I^B$
O	none	ii

Memorize this table!



Suppose a father is heterozygous for type A blood. A mother is homozygous for type B blood. What are the possible blood types of their children? Answer by completing the Punnett square.

	I^A	i
I^B	$I^A I^B$	$I^B i$
I^B	$I^A I^B$	$I^B i$

genotype ratio: 2 $I^A I^B$: 2 $I^B i$

phenotype ratio: 2 type AB blood : 2 type B blood

PROBLEMS

1. Suppose a father is heterozygous for type A blood. A mother is heterozygous for type B blood. What are the possible blood types of their children? Answer by completing the square.

genotype ratio: _____

phenotype ratio: _____

2. A father has type A blood. A mother has type AB blood. Based on the genotypes of their children, is the father $I^A I^A$ or $I^A i$? _____

Offspring genotypes: $1 I^A I^A : 1 I^A i : 1 I^A I^B : 1 I^B i$

3. A father has type B blood. A mother has type O blood. Based on the genotypes of their children, is the father $I^B I^B$ or $I^B i$? _____

Offspring genotypes: $2 I^B i : 2 ii$

4. Suppose a type A father and a type O mother have children. Half of their children turn out to have type O blood. What was the father's genotype? _____
