MULTIPLE ALLELES

Definition:

Three or more alternative genes representing the same locus in a given pairs of chromosomes.

or

Genes which have more than two alleles.

Sets of alleles contains 3, 4, or even 20 alleles.

Multiple Alleles in Rabbits

Full Colour (Agouti):

This is the wild rabbit and its body is **brownish grey** in colour. The dominant gene **C** is responsible for the brown coat colour. This dominant gene undergoes mutation to give rise to three mutant alleles $\mathbf{C^{ch}}$, $\mathbf{C^{h}}$ and **c** located in the same locus. These mutant alleles express different shades of coat colours and are recessive to dominant allele C.

In some rabbits, the coat is **silvery grey** in colour. The mutant allele C^{ch} is responsible for the production of silvery grey coat colour. This mutant allele is dominant to other mutant alleles C^{h} and c.

3. Himalayan:

In these individuals, the extremities such as ears, nose, tips of limbs are coloured, while the rest of the body is white. This type of pigmentation is known as **acromelanism**. The mutant allele for Himalayan is C^h. This mutant allele is dominant to the mutant allele **c**

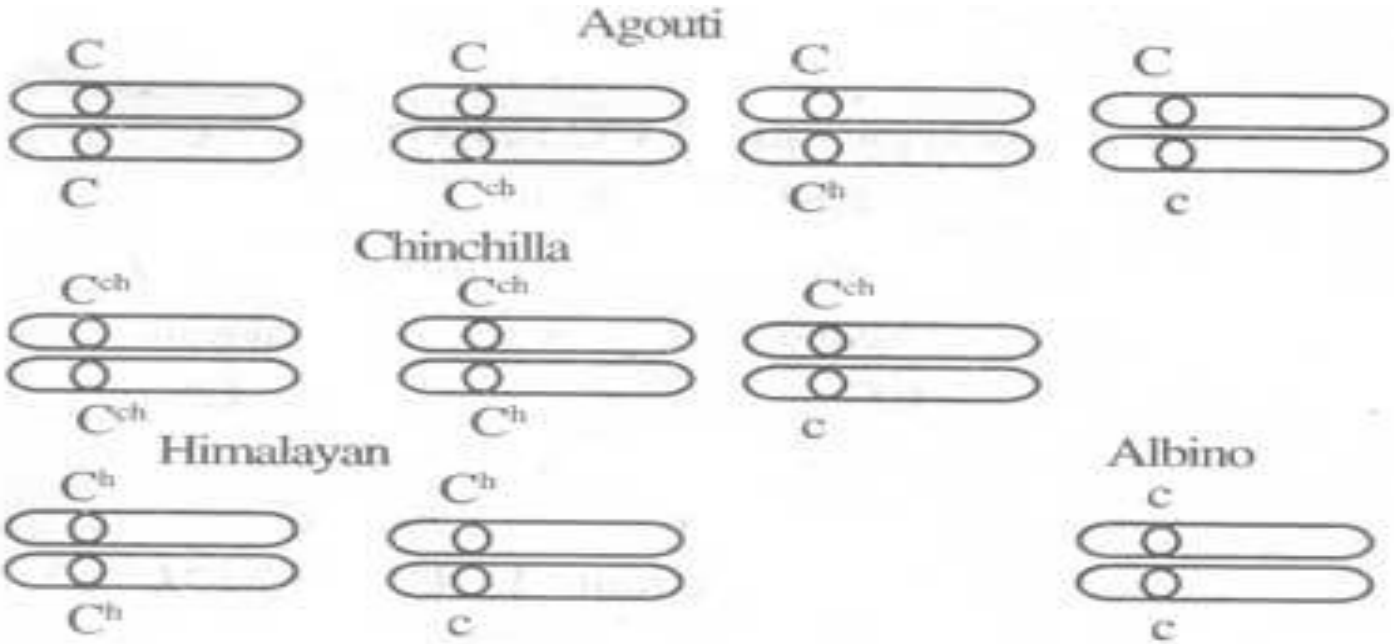
4. Albino:

From these individuals the pigments are completely absent.

The allele for albino coat is represented as **c**

ALLELE	PHENOTYPE
C	Rabbit with full coloured coat
C^{ch}	Rabbit with light gray coat
C^{h}	**Himalayan Rabbit:** white body with dark ear tips, nose, paws and tail
c	Albino
Order of dominance $C > C^{ch} > C^{h} > c$	

Phenotype	Genotype
Full colour (wild type)	**CC or Cc^{ch} or Cc^{h} or Cc**
Chinchilla (mutant)	**$C^{ch}C^{ch}$ or $C^{ch}c^{h}$ or C^{ch} c**
Himalayan (mutant)	**$C^{h}C^{h}$ or $C^{h}c$**
Albino (mutant)	**cc**



	F1	F2
Coloured X Albino	= Coloured	3 Coloured : 1 Albino
Coloured X Himalayan	= Coloured	3 Coloured : 1 Himalayan
Himalayan X Albino	= Himalayan	3 Himalayan :1 Albino

The ABO blood system

- In 1900; **Karl Landesteiner** discovered blood groups.
- This is controlled by a **tri-allelic gene**
- It can generate **6 genotypes**

- The alleles control the production of **antigens** on the surface of the red blood cells
- Two of the alleles are **codominant** to one another and both are dominant over the third

- Allele I^A produces antigen **A**
- Allele I^B produces antigen **B**
- Allele **i** produces **no** antigen

Genotypes	Phenotypes (Blood types)
$I^A I^A$	A
$I^A i$	A
$I^B I^B$	B
$I^B i$	B
$I^A I^B$	AB
ii	O

Note:

- Blood types A and B have two possible genotypes – homozygous and heterozygous.
- Blood types AB and O only have one genotype each.

ABO phenotypes			
	I^A	I^B	I^O
I^A	A	AB	A
I^B	AB	B	B
I^O	A	B	O

AB X AO

	A	B
A	AA	AB
O	AO	BO

1/4 Type AB
1/4 Type B
1/2 Type A

AO x BO

	A	O
B	AB	BO
O	AO	OO

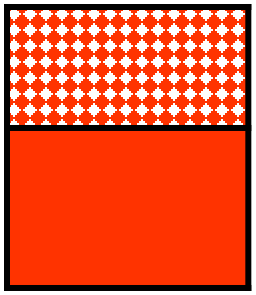
1/4 Type AB
1/4 Type B
1/4 Type A
1/4 Type O

Phenotype (Blood Type	Genotype	Antigen on Red Blood Cell	Safe Transfusions	
			To	From
A	$I^A I^A$ or $I^A i$	A	A, AB	A, O
B	$I^B I^B$ or $I^B i$	B	B, AB	B, O
AB	$I^A I^B$	A and B	AB	A, B, AB, O
O	ii	none	A, B, AB, O	O

Donor-recipient compatibility

Recipient

Donor Type	A	B	AB	O
A				
B				
AB				
O				



= Agglutination

= Safe transfusion

Note:

- **Type O blood may be transfused into all the other types = the universal donor.**
- **Type AB blood can receive blood from all the other blood types = the universal recipient.**

Blood groups of parents	Blood groups of children may occur	Blood groups which do not occur in children
O X O	O	A, B, AB
O X A	O, A	B, AB
A X A	O, A	B, AB
O X B	O. B	A, AB
A X B	A, B, AB, O	-------
O X AB	A, B	O, AB
A X AB	A, B, AB	O
B X AB	A, B, AB	O
AB X AB	A,B, AB	0

M – N blood Types

- In 1927; **Karl Landesteiner & Levine** discovered M & N antigens.

Parents	Offspring's
M X M	**M Type**
N X N	**N Type**
M X N	**MN Type**

Blood groups of parents	Blood groups of children may occur	Blood groups which do not occur in children
M X M	M	N, MN
M X N	MN	M, N
N X N	N	M, MN
M XMN	M, MN	N
N XMN	N, MN	M
MN XMN	M, N,MN	-------

Rh Blood Antigens

What is the Rh factor?

RH factor is a protein of the red blood cell plasma membrane that behaves as an antigen in blood transfusions triggering a humoral (antibody-based) immune response.

Karl Landesteiner & Weiner discovered Rh antigens.

Rhesus monkey blood was injected in to rabbits
Rabbits produced antibodies against monkey cell.
Antiserum tested against human blood,
it angulated 85 % RBC & but failed in 15 %.

	Genotype
Rh +ve	**RR & Rr**
Rh –ve	**rr**

How are the antibodies against the Rh factor formed?

Anti-Rh antibodies are made by humoral immune response. When an Rh- individual makes contact with the Rh factor this is recognized as foreign (antigen), the primary immune response begins and small amounts of anti-Rh antibodies and memory B lymphocytes are made. In future contact with the antigen there will already be circulating antibodies and memory immune cells prepared to create an intense and effective attack against the Rh factor.

ERYTHROBLASTOSIS FETALIS : Hemolytic disease of the newborn.

The mother of new born has Rh- blood. This mother when generating her first Rh+ child makes contact, possibly during delivery, with Rh+ red blood cells of the child and her immune system triggers the primary immune response against the Rh factor.

In the next gestation in which the fetus is Rh+ the mother will already have much more anti- Rh+ antibodies in her circulation; these antibodies cross the placental barrier and gain the fetal circulation causing fetal hemolysis (destruction of the red blood cells of the fetus).

Pseudoallelism : Proposed by R. A. Fisher

These genes are so close on the chromosome that they ordinarily move & act as one gene.

Example in Drosophila eye colour

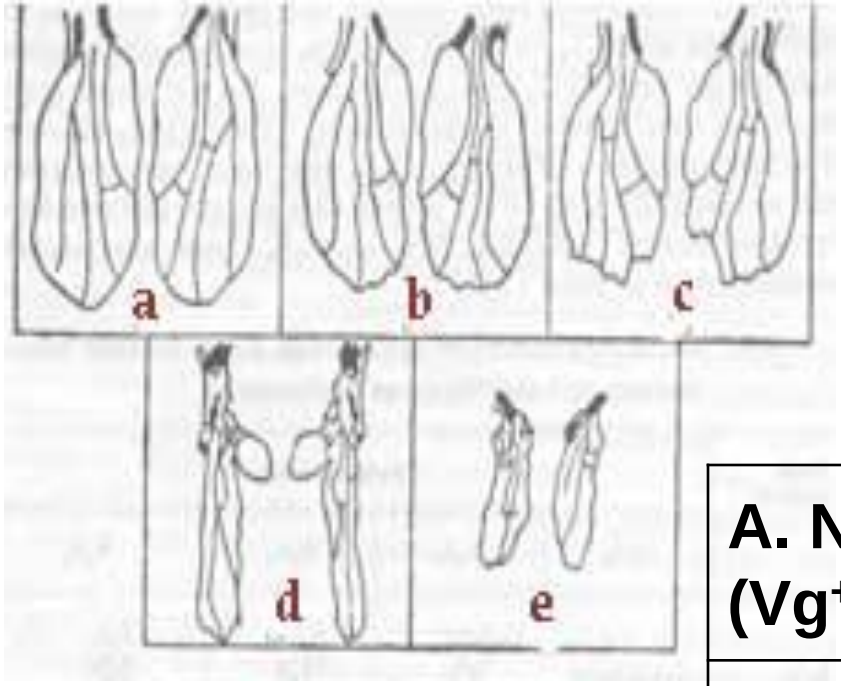
The colour of Drosophila eye is governed by a series of sex-linked gene which cause the hue to vary from

red or wild (w^+ or W) (w^{co}), blood (w^{bl}), eosin (w^o), cherry (w^{ch}), apricot (w^a), honey (w^h), buff(w^{bf}), tinged (w^l), pearl (w^p), ivory (w^l) to white (w).

All of these were considered, on the' basis of F_2 ratios, to form a multiple allelic series, wild being dominant to all others and white recessive to all:

W or w^+ > w^{co}> w^{bl} > w^c> w^{ch}> w^a > w^{bf} > w^t > w^p> w^l >w.

Wings of Drosophila : In D. melanogaster case of a multiple allelism - wing characteristics. In this case a progressive series of wing abnormalities was recognised, ranging in size from no wing at all to a normal wing.



A. Normal Wings (Vg^{+})	**B. Nicked (vg^{ni})**
C. Notched (Vg^{no})	**D. Strap (Vg^{st})**
E. Vestigial (Vg)	