

# Gene Modifications due to Incomplete Dominance ①

The expression of heterozygous alleles of a gene as a blend (mixture) of parental traits in the hybrid is termed Incomplete Dominance. It produces hybrids distinguishable from parents. The hybrids produced by crossing two homozygous individuals do not resemble either of them but are midway b/w them. Incomplete Dominance is also called as Partial Dominance, blended Inheritance & Intermediate Inheritance.

eg: 'Four-o' clock Plant, Mirabilis jalapa

Parents	Pure Red RR	X	Pure white WW	
F <sub>1</sub> Generation	RWRW 100% Hybrid Pink			
Gametes	RW	X	RW	
F <sub>2</sub> Progeny	RR Pure Red	, RW Hybrid Pink	, RW Hybrid Pink	, WW Pure white
Ratio	1 : 2 : 1			

eg ② Short-horned cattle:

Parents	Phenotype	Pure Red Bull	X	Pure White Cow
	Genotype	RR		WW
	Gametes	R, R		W, W
	Genotype	RW		RW
	Gametes	Hybrid Roan R, W		Hybrid Roan R, W

F <sub>2</sub> Progeny	RR	RW	RW	WW
	Pure Red	Hybrid Roan		Pure White
	1	2	1	1

Thus in above crosses, the F<sub>2</sub> ratio is 1:2:1 in incomplete dominance in contrast to do complete dominance ratio 3:1

A dihybrid cross in which one trait is completely dominant over other & the other trait is incompletely dominant

A cross b/w Hornless white cow & Horned Red Bull  
 Hornless condition (PP) is completely dominant over horned condition (pp)  
 white coat colour (WW) is incompletely dominant over red coat colour (RR)  
 i.e why mixture of WR will produce Roan coat colour. and on the other hand ~~mix~~ blend of Pp will produce hornless condition.

parents

Phenotype	Hornless white cow	x	Horned Red Bull
Genotype	PPWW		ppRR
Gametes	PW, PW		pR, pR
Genotype	PpWR		PpWR
Phenotype	Hornless Roan		Hornless Roan
Gametes	PW, pW, pR, pR		PW, pW, pR, pR

1 progeny

2 progeny

Gametes ↓	PW	pR	pW	pR
PW	PPWW Hornless white	PpWR Hornless Roan	PpWW Hornless white	PpWR Hornless Roan
pR	PpWR Hornless Roan	ppRR Hornless Red	PpWR Hornless Roan	PpRR Hornless Red
pW	PPWW Hornless white	PpWR Hornless Roan	ppWW Horned white	ppWR Horned Roan
pR	PpWR Hornless Roan	ppRR Hornless Red	PpWR Horned Roan	ppRR Horned Red

## F<sub>2</sub> Phenotypic Ratio

Hornless White : Hornless Red : Hornless Roan : Horned White : Horned Red : Horned Roan  
3 : 3 : 6 : 1 : 1 : 2

Thus, in above cross the Mendel's Dihybrid ~~ratio~~ ratio changes to 3:3:6:1:1:2 from 9:3:3:1

## → Codominance :

Equal expression of both the alleles of a gene is called codominance.

Principle of codominance is illustrated by human blood groups.

There are 4 blood groups in human population A, B, AB & O.

These letters refer to a glycoprotein substance called an antigen present on the surface of RBC. People with blood group A produces A antigen, those with blood group B produces B antigen, those with AB <sup>Blood</sup> group produces both the antigens & those with O blood group produces neither.

The 4 phenotypes A, B, AB, O are produced by 3 different alleles  $I^A$ ,  $I^B$  and  $i$  of a gene.

The allele  $I^A$  determines the formation of glycoprotein A & the allele  $I^B$  determine the formation of glycoprotein B.

The allele  $i$  does not produce any glycoprotein & is recessive to the other two alleles.

The alleles  $I^A$  &  $I^B$  are equally dominant <sup>(3)</sup> & do not interfere with the expression of each other.

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Genotypes	Phenotype (Blood group)
$I^A I^A, I^A i$	A
$I^B I^B, I^B i$	B
$I^A I^B$	AB
$ii$	O

The alleles  $I^A$  &  $I^B$  are said to be codominant, because both are expressed in the phenotype AB.

Examples :

1) If a person homozygous for blood group A marries a person homozygous for blood group B

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

100% children will have blood group AB

2) If two persons with blood AB marry!

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

Ratio : 1 : 2 : 1  
A : AB : B

3) If a person homozygous for blood group A marries a person homozygous for blood group O.

	$I^A$	$I^A$
$O^i$	$I^A i$	$I^A i$
$O^i$	$I^A i$	$I^A i$

100% children with blood group O

4) If a person homozygous for the blood group B marries a person homozygous for blood group O

	$I^B$	$I^B$
$O^i$	$I^B i$	$I^B i$
$O^i$	$I^B i$	$I^B i$

100% children with blood group B

→ Lethal Genes (Lethal factors) (4)

Various species of animals & plants are known to possess certain genes which determine phenotypic traits as well as influence the viability of the individuals having them.

eg. *Drosophila* with vestigial wings & white eyes are less viable than the wild type.

Some genes when homozygous produce such a serious effect that the organism is unable to live. Such genes which make an organism having them inviable are known as lethal genes or lethal factors.

eg. (1) A cross b/w 2 creeper chickens, showing inheritance of dominant lethal genes

Parents	Phenotypes	Creeper	Creeper
	Genotypes	CC	Cc
	Gametes	C, c	C, c
F <sub>1</sub>	Genotypes	CC, Cc, Cc, cc	
	Phenotypes	<u>Creeper</u> <u>Creeper</u> <u>Creeper</u> <u>normal</u>	
		Dies	Survive
Ratio		Creeper: normal = 2 : 1	

Abnormal Ratio

Q2 A cross showing inheritance of dominant lethal genes in yellow mice.

Parents Phenotypes  
Genotypes  
Gametes  
F<sub>1</sub> Genotypes  
Phenotypes  
Ratio

Heterozygous yellow male  $\times$  Heterozygous yellow female

	$Yy$	$Yy$
$Y, y$	$YY$	$Yy$
	$Yy$	$yy$
Offspring	$\frac{YY}{\text{non-yellow}}, \frac{Yy}{\text{yellow}}, \frac{Yy}{\text{yellow}}, \frac{yy}{\text{non-yellow}}$	

Yellow: non-yellow = 2:1

Lethal genes are of 3 types:

- 1) Absolute lethal genes: The genes which cause the death of a carrier individual in the embryonic stage.
- 2) Sub-lethal or semilethal genes: Certain genes cause the death of the carrier individual b/w the time of birth & the attainment of reproductive age.
- 3) Delayed lethal genes: Certain genes cause the death of the carrier individual after the attainment of reproductive age.



→ Pleiotropy!

Most genes influence not only the traits generally associated with them but also many other traits.

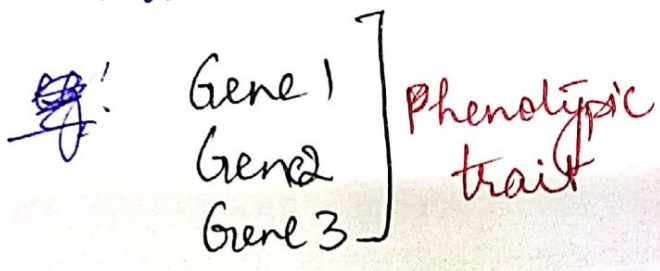
The multiple effect of a gene is called pleiotropy & the gene having multiple effect is called pleiotropic gene.

A pleiotropic gene may cause a very evident expression of its specific phenotypic trait (major effect) & a less evident expression of its other traits (secondary effect).

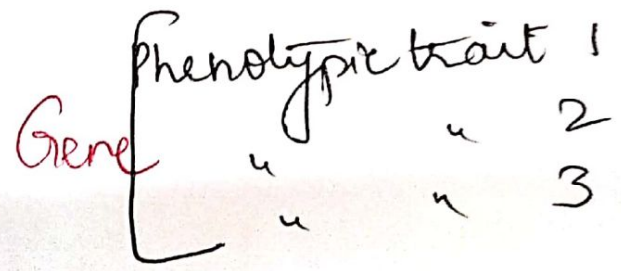
Pleiotropic versus multiple genes:

They both are antagonistic in action.

The pleiotropic gene influence more than one phenotypic traits whereas polygenes/multiple genes co-operate to produce a single trait.



Polygenes



Pleiotropy

eg) In *Drosophila*, the homozygous recessive genotype *ww* makes the wings vestigial, & affects other traits such as

i) tiny hind wings called balancers

ii) certain bristles

iii) structure of reproductive organs, lower egg production & shortens life span

② In human, the gene that causes an inborn disease phenylketonuria in homozygous recessive state is pleiotropic. Its major effect is the accumulation of amino acid phenylketonuria in the tissues that damages the brain & causes the disease. Its secondary effects include short stature, excessive sweating, nonpigmented hair & eyes, pigmented patches on skin.