Gene Modifications due to Incomplete Dominance

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: (1) Four-O' clock Plant, Mirablis jalapa

Parents	Pure Red RR	×	Pure White WW	
F1 Generation	RWRW 100% Hybrid Pink			
Gametes	RW	×	RW	
F2 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	×	Pure White Cow
	Genotype	RR		WW
	Gametes	R, R		W, W
	Genotype	RW Hybrid Roan		RW Hybrid Roan
	Gametes	R, W		R, W

F_2 Progeny	RR	RW	RW	WW
	Pure Red	Hybrid Roan		Pure White
	1	: 2 :		1

Thus in above crosses, the F_2 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 complete 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 blend of Pp will produce hornless condition.

Parents	Phenotype	Hornless White Cow ×	Horned Red Bull
	Genotype	PPWW	ppRR
	Gametes	PW, PW.	pR, pR
F1 Progeny	Genotype	PpWR	PpWR
	Phenotype	Hornless Roan	Hornless Roan
	Gametes	PW, pW, PR, pR	PW, pW, PR, pR

F2 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

F2 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 ~~cross~~ 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 blood 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 & do not interfere with the expression of each other.

Eg

Genotypes	Phenotype (Blood group)
I^AI^A, I^Ai	A
I^BI^B, I^Bi	B
I^AI^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^AI^B	I^AI^B
I^B	I^AI^B	I^AI^B

100% children will have blood group AB

2) If two persons with blood AB marry!

	I^A	I^B
I^A	I^AI^A	I^AI^B
I^B	I^AI^B	I^BI^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^Ai	I^Ai
O^i	I^Ai	I^Ai

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^Bi	I^Bi
O^i	I^Bi	I^Bi

100 % children with blood group B

→ Lethal Genes (Lethal factors)

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 <u>lethal genes</u> or <u>lethal factors</u>

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
F1 Genotypes	CC, Cc, Cc, cc	
Phenotypes	creeper (Dies)	creeper creeper normal (Survive)

Ratio creeper : normal = 2 : 1

Abnormal F2 ratio

Q ② A cross showing inheritance of dominant lethal genes in yellow mice.

Parents	Phenotypes	Heterozygous yellow male	× Heterozygous yellow female
	Genotypes	Yy	Yy
	Gametes	Y, y	Y, y
F1	Genotypes	YY, Yy, Yy, yy	
	Phenotypes	Dies, Yellow (Yy, Yy), non-yellow (yy)	
	Ratio	Yellow : nonYellow = 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 where as polygenes/multiple genes co-operate to produce a/single trait.

Eg: Gene 1, Gene2, Gene 3] Phenotypic trait

Polygenes

Gene [Phenotypic trait 1, " " 2, " " 3

Pleiotropy

eg ① In Drosophila, the homozygous recessive genotype ww makes the wings vestigeal, 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 hairs & eyes, pigmented patches on skin.