Genetics (Unit-1)

✓ Epistasis :

When one gene interferes on expression of another gene ~~of~~ on another, locus is called epistasis. (diff. locus of same chromosome

Expressed - epistasis

Suppressed - hypostasis.

✗ Gene interaction :

According to Mendel, genes are functioning independently of each other i.e. each of 7 traits (character) considered was controlled by a single gene. But many traits of an organism are determined by the complex contribution of many different genes. When two or more different genes (non-allelic) influence the outcome of single trait, this is known as a gene interaction.

The first case, of two different genes interacting to affect a single trait was discovered by William Bateson and Reginald Punnett in 1906. They discovered an unexpected gene interaction when they studied crosses involving ~~the~~ (sweet pea) Lathyrus odoratus. When they crossed true breeding purple ~~colored~~ flowered plant to a true breeding white flowered plant, the F_1 generation was all purple ~~colored~~ flowered plants, and the F_2 generation (produced by self fertilisation of the F_1 generation), contained purple and white flowered plants in a 3 : 1 ratio. But when they crossed two different varieties of white flowered plants than all F_1 generation plants had purple flowers. When these purple flower plants were allowed to self fertilised, the F_2 generation contained purple and white flowers in a ratio — 9 purple : 7 white.

Types of Epistasis :

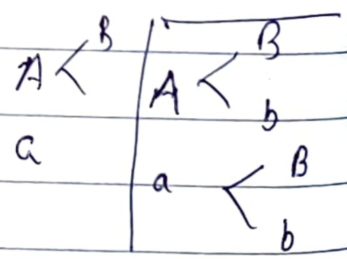
1. Dominant epistasis

When the dominant allele of one gene masks the effects of either allele of the second gene, it is termed as dominant epistasis. When the dominant allele at one locus, for e.g, the A allele produces a certain phenotype regardless of the allelic condition of the other locus, then the A locus is said to be epistatic to the B locus. Furthermore, since the dominant allele A is able to express itself in the presence of either B or b, this is a case of dominant epistasis. Only when the genotype of the individual is homozygous recessive at the epistatic locus (aa) then the alleles of the hypostatic locus (B or b) be expressed. Thus, the genotypes A-B- and A-bb produced the same phenotype, whereas aaB- and aabb produced two additional phenotypes. The classical 9:3:3:1 ratio becomes modified into a 12 : 3 : 1 ratio.

Purple		Red
AAbb	x	aaBB
↓		↓
Ab		aB

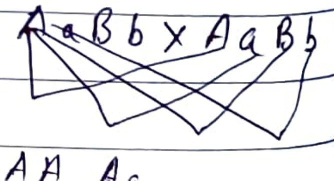
aaBB => red
aaBb => red

(AabB)
Purple



Selfing : AaBb x AaBb

AB, Ab, aB, ab



Date :

♀ \ ♂	AB	Ab	aB	ab
AB	AABB Purple AB	AABb AB Purple	AaBB AB Purple	AaBb AB Purple
Ab	AAbB AB Purple	AAbb Ab Purple	AabB AB Purple	Aabb Ab Purple
aB	aABB AB Purple	aABb AB Purple	aaBB aB Red	aaBb aB Red
ab	aAbB Purple AB	aAbB Purple Ab	aabB Red aB	aabb white ab

Purple = 12
Red = 3
White = 1

Phenotypic ratio = 12 : 3 : 1

(2) Recessive epistasis

In the case of recessive epistasis, in a pair of non-allelic genes, one produces its phenotypic effect independently in a dominant state, but another cannot produce a phenotypic effect independently. However, the later can produce its effect when they are together in dominant state. For eg: A and B are two non-allelic genes and A can produce a phenotypic effect independently in dominant state, but second gene B cannot produce a phenotypic effect independently. In this case, the recessive genotype aa suppresses the expression of alleles at the B locus.

Page :
Date :

But, in the presence of dominant allele at the A locus, the alleles of the B locus express. Thus, the genotype A - B - and A - bb produce two additional phenotypes. The 9:3:3:1 ratio becomes a ratio

Red		White
AAbb	x	aaBB
↓		↓
Ab		aB

AaBb
(Purple

Aabb } Red
Aabb }

A < B, b
a < B, b

Selfing - AaBb x AaBb
AB, Ab, aB, ab

♀/♂	AB	Ab	aB	ab
AB	AABB Purple (AB)	AABb P (AB)	AaBB P (AB)	AaBb P (AB)
Ab	AAbB P (AB)	AAbb (Ab) red	AabB (AB) P	Aabb (Ab) R
aB	aABB (AB) P	aABb (AB) P	aaBB (aB) W	aaBb (aB) W
ab	aAbB (AB) P	aAbb (Ab) R	aabB (aB) W	aabb (ab) white

Purple - 9
Red - 3
White - 4

Phenotypic ratio : 9 : 3 : 4

Duplicate Recessive Epistasis :

If two non-allelic genes are involved in a specific pathway and functional products from both are required for expression, then one homozygous recessive allele at either allelic pair would result in the mutant phenotype. In such case, the genotype aaBB, aaBb, AAbb and aabb produce one phenotype and genotype AABB, AaBB, AABb, AaBb produce another phenotype (9:7). Because both dominant alleles complement each other for the correct phenotype, these non-allelic genes are called complementary genes. Hence this interaction is also termed as complementary gene interacti

Duplicate Dominant Interaction :

If the alleles of both gene loci produce the same phenotype without cumulative effect, 9:3:3:1 ratio is modified into 15:1 ratio. Duplicate gene interaction allows dominant alleles of either duplicate gene to produce the white type phenotype. On the organisms with homozygous recessive of both genes have a mutant phenotype.

Mechanism by which wheat kernel color is determined is an example of duplicate gene action. In Wheat, Kernel color is dependent upon a biochemical reaction that converts a colorless precursor substance into a colored product, and this reaction can be

Page :
Date :

performed with the product of either gene A or gene B. Thus, having either an A allele or a B allele produces color in the kernel, but a lack of either allele will produce a white kernel that is devoid of color.

So, if two plants with genotype AaBb are crossed with each other, the genotype AABB, AABb, AaBB, AaBb, AAbb, Aabb, aaBB, and aaBb produced the color phenotype and the genotype aabb produce no colour. In this cross, whenever a dominant allele is present at either locus, the biochemical conversion occurs, and a coloured kernel results. Thus, only the double homozygous recessive genotype produces a phenotype with no colour and the resulting phenotypic ratio of colour to non-colour is 15 : 1.

Dominant and Recessive Interaction :

Dominant and Recessive Interaction is similar to dominant epistasis but occurs when a dominant allele of one gene completely suppresses the phenotypic expression of alleles of another gene. This type of epistasis is sometimes called dominant suppression, because the deviation formed 9:3:3:1 is caused by a single allele that produces a dominant phenotyp[e]. For e.g: In *Primula* plant, the pigment malvidi[n] creates blue colour flowers. Synthesis of malvidin is controlled by gene A, yet production of

Camlin

This pigment can be suppressed by non-allelic gene B. In this case, the B gene is dominant to the A gene, so plants with the genotype AaBb will not produce malvidin because of the presence of the B gene. So, if two plants with genotype AaBb are crossed with each other the genotype AABB, AABb, AaBB, AaBb, aaBB, aaBb and aabb produced the white colour and the genotype AAbb and Aabb produce blue colour. In this case, the presence of the B gene suppresses the production of malvidin.