Gene interaction

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Introduction

- **Defination**- The phenomenon of two or more genes affecting the expression of each other in various ways in the development of a single character of an organism is known as gene interaction

- Most of the characters of living organisms are controlled/ influenced/ governed by a collaboration of several different genes.

- Mendel and other workers assumed that characters are governed by single genes but later it was discovered that many characters are governed by two or more genes.

- Such genes affect the development of concerned characters in various ways; this lead to the modification of the typical dihybrid ratio (9:3:3:1) or trihybrid (27:9:9:9:3:3:3:1).

Cont…

- In gene interaction, expression of one gene depends on expression (presence or absence) of another gene.

Types of Gene Interactions

- Gene interactions can be classified as

a) **Allelic/ non epistatic gene interaction/ -** This type of interaction gives the classical ratio of 3:1 or 9:3:3:1

b) **Non-allelic/ epistatic gene interaction-** In this type of gene interaction genes located on same or different chromosome interact with each other for their expression

Discovery of non allelic gene interaction has been made after Mendel and can be best understood by studying phenotypic trait of gene

Epistatic and Hypostatic gene

❑ Epistatic gene

When a gene or locus which suppress or mask the phenotypic expression of another gene at another locus such gene is know as epistatic gene.

Epistatic is Greek term and meaning is standing up

❑ Hypostatic gene

The gene or locus which was suppressed by a epistatic gene was called hypostatic gene

Classification of epistatic gene interaction

- Epistatic gene interaction Gene is classified as follow on the basis manner by which concerned genes influence the expression of each other

1. Supplementary gene action (9:3:4)
2. Complementary gene action (9:7)
3. Inhibitory gene action (13:3)
4. Duplicate gene interaction (15:1)
5. Masking gene action (12:3:1)
6. Polymeric gene action (9:6:1)

1. Supplementary gene action (9:3:4)

- In supplementary gene interaction, the dominant allele of one of two gene governing a character produces phenotypic effect
- However dominant allele of the other gene does not produce a phenotypic effect on its own.
- But when it is present with dominant allele of the first gene it modifies the phenotypic effect produced by that gene.
- For example development of agouty (gray) coat color in mice.

Dominant allele- C produces Coloured phenotype while dominant allele A produces no phenotype (albino) but when **dominant allele A present with C it produces agouti (grey) phenotype**

Parents	CCaa Coloured			ccAA Albino
Gamete	Ca	×		cA
F_1		CcAa		
	Selfing of F_1	Agouti		
Gametes	CA	Ca	cA	ca
CA	CCAA Agouti	CCAa Agouti	CcAA Agouti	CcAa Agouti
Ca	CCAa Agouti	CCaa Coloured	CcAa Agouti	Ccaa Coloured
cA	CcAA Agouti	CcAa Agouti	ccAA Albino	ccAa Albino
ca	CcAa Agouti	Ccaa Coloured	ccAa Albino	ccaa Albino

F_2 Generation

Phenotypic ratio- 9 Agouti : 3 coloured : 4 Albino

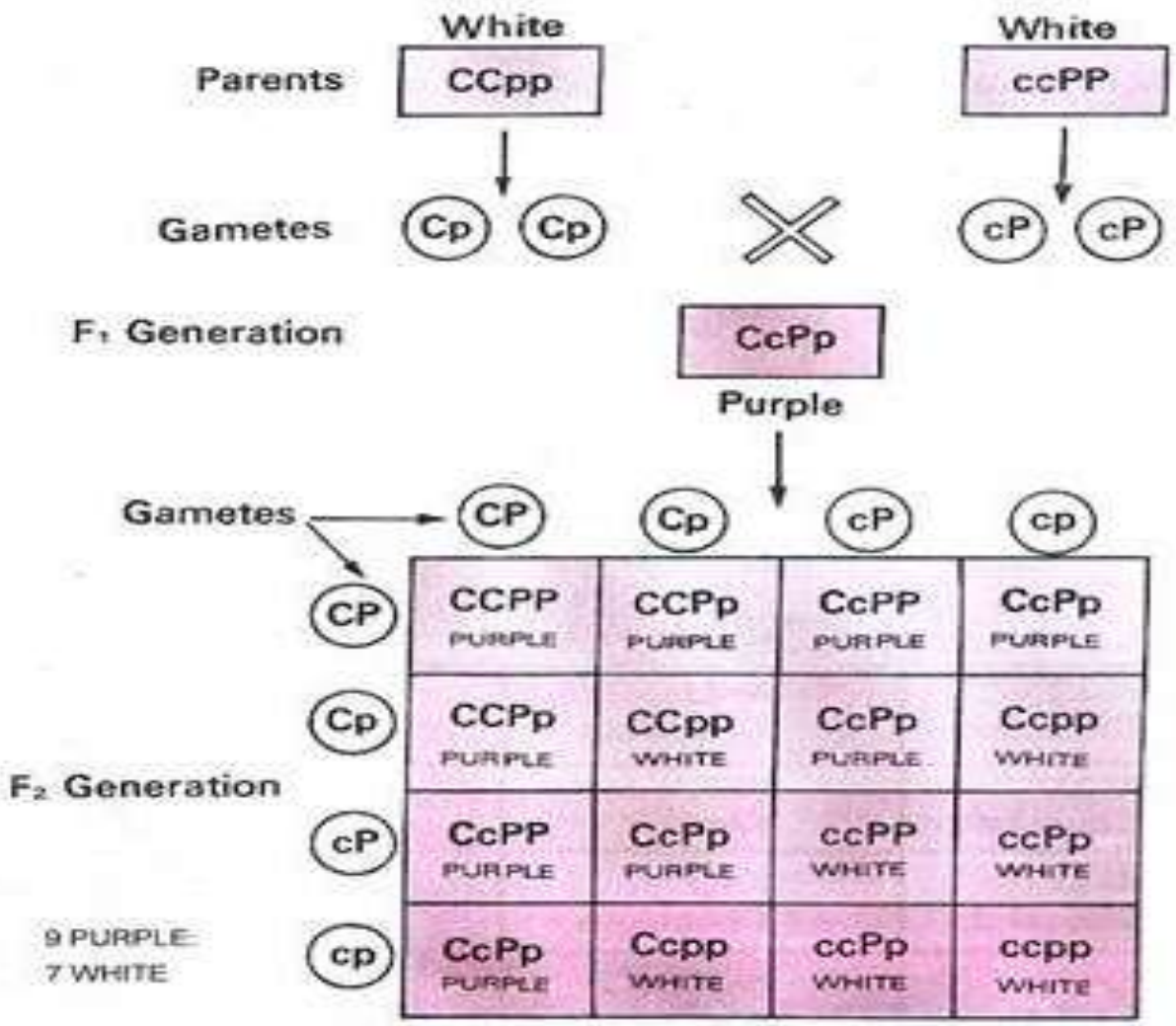
2. Complementary gene interaction

- If both gene loci have homozygous alleles and both of them produce identical phenotypes the F2 ratio become 9:7 instead 9:3:3:1

- In such case, the genotype aaBB, aaBb, Aabb, aabb produce one phenotype.

- Both dominant alleles when present together each other are called complementary genes and produce a different phenotype.

In sweet pea Presence of genes CC, cc, PP and pp in homozygous condition produces no color (white) because expression of chromogen doesn't occur in homozygous condition while expression of chromogen occurs when these two genes present in heterozygous condition



3. Inhibitory gene action

- When dominant allele of one gene locus (B) in homozygous (BB) and heterozygous (Bb) condition produce the same phenotype the F_2 ratio becomes 13:3 instead of 9:3:3:1

- While homozygous recessive (bb) condition produces different phenotype.

- Homozygous recessive (bb) condition inhibits phenotypic expression of other genes so know as inhibitory gene action

Gene B when present in homozygous recessive condition that is bb it inhibits the action of other gene and other gene produces no phenotype

13/16 = White

3/16 = coloured

White leg horn × White plymouth Rock

AABB ↓ aabb

AaBb × AaBb

White White

AB = 9 white

Ab = 3 coloured

aB = 3 white

ab = 1 white

13 : 3

White : Coloured

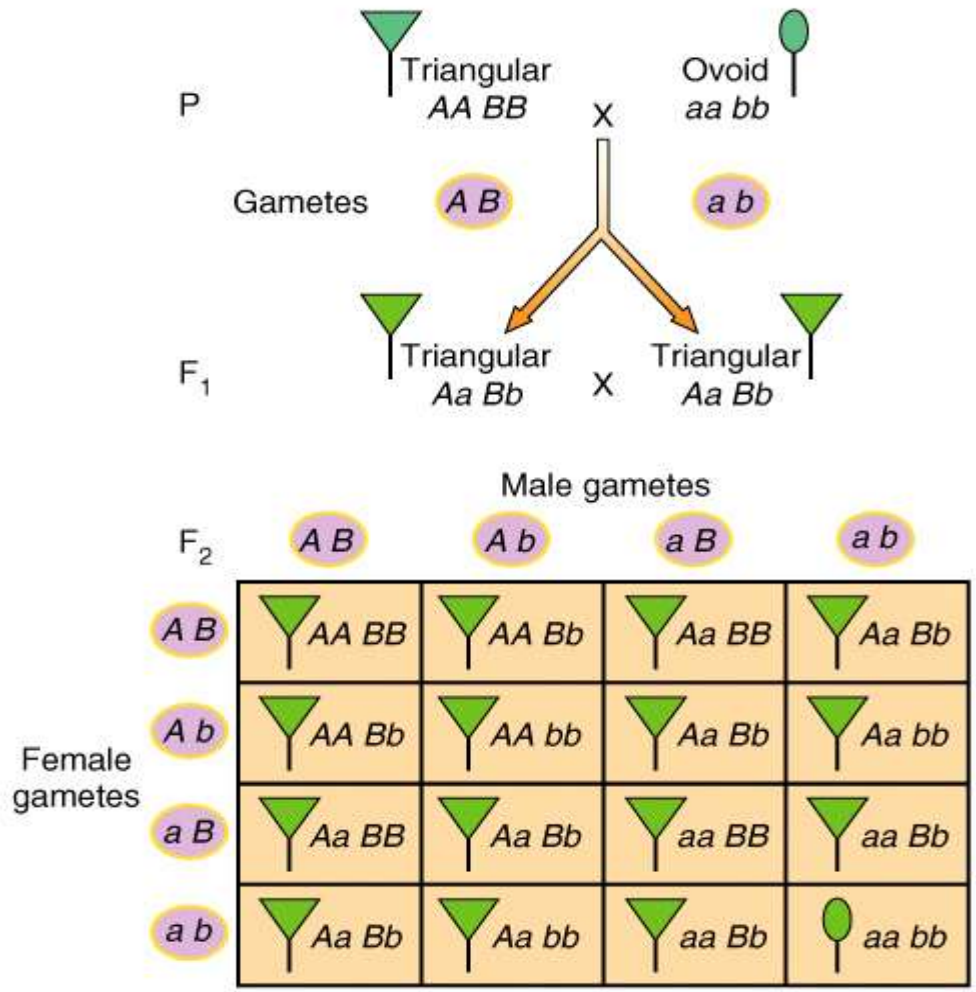
	AB	Ab	aB	ab
AB	AABB White	AABb White	AaBB White	AaBb White
Ab	AABb White	AAbb* Coloured	AaBb White	Aabb* Coloured
aB	AaBB White	AaBb White	aaBB White	aaBb White
ab	AaBb White	Aabb* Coloured	aaBb White	aabb White

4. Duplicate gene interaction

- When dominant allele of both gene loci produce the same phenotype without cumulative effect
- In that case the ratio becomes 15:1 instead of 9:3:3:1
- Duplicate gene interaction occurs in shepherds purse plant.

In shepherds purse plant seed capsule occurs in two shapes i.e. triangular and ovoid shapes.

Ovoid shape seed capsule occurs when both genes are present in homozygous recessive condition



(b) Summary: 15/16 triangular, 1/16 ovoid

6. Masking gene action (12:3:1)

- When out of two genes, the dominant allele (e.g., A) of one gene masked the activity of allele of another gene (e.g., B)
- Then A gene locus is said to be epistatic to the B gene locus
- Dominant allele A express itself only in the presence of either B or b so such type of epistatic is know as *dominant epistatic*
- The allele of hypostatic locus express only when the allele of epistatic locus present in homozygous recessive condition

PARENT GENERATION: BROWN DOG bbli X WHITE DOG BB li

GAMETES: bi, bi | Bi, Bi

F_1 GENERATION: ALL WHITE Bbli

GAMETES: Bi, bi, Bi, bi

SELF CROSSED

F_2 GENERATION

GAMETES				
	WHITE BBII	WHITE BbII	WHITE BBli	WHITE Bbli
Bl	WHITE Bbli	WHITE bbil	WHITE Bbll	WHITE bbli
bi	WHITE BBli	WHITE Bbli	BLACK BBli	BLACK Bbil
Bl	WHITE Bbli	WHITE bbli	BLACK Bbii	BROWN bbil
bl				

F_2 GENERATION: WHITE : BLACK : BROWN

12 : 3 : 1

7. Polymeric gene action (9:6:1)

Sphere shape × Sphere shape
AAbb aaBB
AaBb × AaBb
Disc shape ↓ disc shape

AB = 9 Disc shape
Ab = 3 = Sphere shape
aB = 3 = Sphere shape
ab = 1 = Long shape
= 9 : 6 : 1
Disc Sphere Long

	AB	Ab	aB	ab
AB	AABB Disc	AABb Disc	AaBB Disc	AaBb Disc
Ab	AABb Disc	AAbb Sphere	AaBb Disc	Aabb Sphere
AB	AaBB Disc	AaBb Disc	aaBB Sphere	aaBb Sphere
ab	AaBb Disc	Aabb Sphere	aaBb Sphere	aabb Long

P_1	DEAF-MUTE	X	DEAF-MUTE
GENERATION	aaBB		AAbb
GAMETES	aB		Ab
F_1		Normal	
GENERATION		Aa Bb	

♀ \ ♂	AB	Ab	aB	ab
AB	AA BB Normal	AABb Normal	AaBB Normal	AaBb Normal
Ab	AABb Normal	AAbb DEAF-MUTE 1	AaBb Normal	Aabb DEAF-MUTE 2
aB	AaBB Normal	AaBb Normal	aaBB DEAF-MUTE 3	aaBb DEAF-MUTE 4
ab	AaBb Normal	Aabb DEAF-MUTE 5	aaBb DEAF-MUTE 6	aa bb DEAF-MUTE 7

F_1F_2 GENERATION {Normal : 9, Deaf - Mute : 7}

Deaf - Mute in Man

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Epistasis (2)

F_2

eggs

sperm ♂ \ ♀	AB	Ab	aB	ab
AB	AABB	AABb	AaBB	AaBb
Ab	AABb	AAbb	AaBb	Aabb
aB	AaBB	AaBb	aaBB	aaBb
ab	AaBb	Aabb	aaBb	aabb

offspring

Key:
A = purple flower
B = purple flower
a = white flower
b = white flower

Phenotypic Ratio 9 purple : 7 white