MODULE 16

AIM

The aim of this module is to provide students with an introduction to Gene interaction (Non-allelic).

CONTENTS AND OBJECTIVES

- Mechanism of Gene interaction
- Epistasis
  - ✓ Dominant Epistasis
  - ✓ Recessive Epistasis
  - ✓ Duplicate Recessive Epistasis
  - ✓ Duplicate Dominant Epistasis

GENE INTERACTION

- When two or more genes (non-allelic) influence the outcome of a single trait, it is known as gene interaction.
- On the basis of his experiments, Mendel proposed that genes function independently of each other.
- However, there are many traits which are governed by the complex contributions of different genes.

Mechanism of Gene Interaction

- A lot of processes that occur in a cell are the direct result of various sets of reactions linked together in a pathway.
- Each reaction in the pathway is controlled by a different enzyme and each enzyme is the product of a different gene.
- If any of the enzymes is defective, the final product of the pathway cannot be manufactured properly and this will result in a mutant phenotype which, in turn, modifies the Mendelian phenotypic ratios.
- There are various ways in which genes at different loci can interact with each other. Eg- Epistasis, complementation, etc.

EPISTASIS

- Epistasis is a Greek word which means “standing over”.
- It refers to the interaction between two genes (or two loci) in which the phenotypic effect of one locus depends on the genotype at the second locus.
- Thus, the gene
    - Which has a masking effect on another gene- **epistatic gene**
    - the one whose expression gets masked - **hypostatic gene**.
- There is a fine difference between epistasis and dominance. In epitasis, the interaction occurs between different genes (non-alleles), whereas the dominant effect is shown by an allele on another allele at the same loci (same gene).

- In epistasis, less than four types of phenotypes appear in F2 generation.

1. Dominant Epistasis

- This phenomenon occurs when one dominant allele (A) of a gene masks the expression of either allele (B or b) of the second gene.
- This condition is called dominant epistasis because the dominant allele (A) produces a certain phenotype regardless of the allelic condition of the other locus.
- Therefore, A is said to be epistatic to B.
- Example- **Fruit Colour in Squash**

  Gene pair A: White dominant over colour

  Gene pair B: Yellow dominant to green

  Phenotypic ratio- **12:3:1**

  12 White- AABB (1), AABb (2), AaBB (2), AaBa (4), AAbb (1), Aabb (2)

  3 Yellow – aaBB (1), aaBb (2)

  1 Green- aabb (1)

Epistatic Alleles	Hypostatic Alleles	Phenotypic Expression
aa	bb	Green
aa	BB, Bb	Yellow
AA, Aa	BB, Bb, bb	White

2. Recessive Epistasis

Recessive allele (aa) of one gene locus expresses itself phenotypically by making the expression of another gene locus (BB, Bb or bb).

This happens mainly because A can produce a phenotypic effect independently in dominant state, but the second gene B cannot produce a phenotypic effect independently. As a result, the expression of alleles at B locus is masked by recessive genotype aa.

aa is epistatic to B and b

Example- Mouse coat colour

Gene pair A: Colour dominant over albino

Gene pair B- Agouti colour dominant over black

Phenotypic ratio- **9:3:1**

9 agaouti- AABB (1), AABb (2), AaBB (2), AaBb (4)

3 black- AAbb (1), Aabb (2)

4 albino- aaBB (1), aaBb (2), aabb (1)

Epistatic Alleles	Hypostatic Alleles	Phenotypic Expression
aa	BB, Bb, bb	Albino
AA, Aa	BB, Bb	Agouti
AA, Aa	bb	Black

Duplicate Recessive Epistasis

In this case both the dominant alleles are necessary to produce the correct phenotype.

One homozygous recessive allele at either allelic pair would result in the mutant phenotype.

Thus, aa is epistatic to B, b; bb is epistatic to A, a

Example- Sweet pea flower colour

Gene pair A- Purple dominant over white

Gene pair B- Colour dominant over white

Phenotypic ratio- 9:7

9 Purple- AABB (1), AABb (2), AaBB (2), AaBb (4)

7 White- AAbb (1), Aabb (2), aaBB (1), aaBb (2), aabb (1)

Epistatic Alleles	Hypostatic Alleles	Phenotypic Expression
Aa, AA, aa	bb	No colour production
aa	BB, Bb, bb	No Colour Production
AA, Aa	BB, Bb	Purple

Duplicate Dominant

The dominant alleles of both the loci produce the same phenotype without the cumulative effect.

At least one dominant allele is necessary for the phenotypic effect. In the absence of dominant alleles, recessive phenotype will be expressed.

Thus, A is epistatic to to B, b; B is epistatic to A, a

Example- Seed capsules of shepherd's purse

Gene pair A- Triangular shape dominant to ovoid

Gene pair B- Triangular shape dominant to ovoid

Phenotypic ratio- 15:1

15 triangular- AABB (1), AABb (2), AaBB (2), AaBb (4), AAbb (1), Aabb (2), aaBB (1), aaBb (2)

1 ovoid- aabb (1)

Epistatic Alleles	Hypostatic Alleles	Phenotypic Expression
aa	bb	Ovoid
aa	BB, Bb	Triangular
AA, Aa	BB, Bb, bb	Triangular