SAVITRIBAI PHULE PUNE UNIVERSITY , PUNE

T.Y.B.Sc. Botany

(Sem-III)

SUBJECT

Genetics and Evolution(Paper-III)

PowerPoint Presentation

Topic-Interaction of gene

Presented by
Prof. V.B.Yelmame
M. Sc. B.Ed

Adv.M.N.D. College Rajur

Epistatic genetic interaction

1)Masking gene (12:3:1)or Dominant epistasis

When out of two genes, the dominant allele (e.g.. A) of one gene masked the activity of alleles of another gene (e.g. B) and expressed itself phenotypically, then A gene locus is said to be epistatic to the B gene locus. Because, the dominant allele A can express itself only in the presence of either B or b alleles, therefore, such type of epistasis is termed as **dominant epistasis**. The alleles of gene B will be able to express themselves phenotypically only when gene locus A may contain two recessive alleles (aa). Thus, the genotype AA BB or Aa Bb and AA bb or Aa bb produce the same phenotype whereas the genotype aa BB or aa Bb and aa bb produce two additional phenotypes. The dominant epistasis modify the classical ratio of 9:3:3:1 into 12:3:1 ratio.

Example

Dominant epistasis in dogs. Among dogs, the colours of coats depend upon the action of two genes. One gene locus has a dominant epistatic inhibitor allele (I) of coat colour pigment . The allele I prevents the expression of colour allele at another independently assorting, Hypostatic gene locus (B or b) and produces white coat colour. The alleles of hypostatic gene locus (BB, Bb, or bb) express only when two recessive alleles (ii) occur on the epistatic locus, i.e., ii BB or ii Bb produces black and ii bb produces brown individuals. When two such white coat colour dogs are crossed, in F_1 the white, black and brown coat colours appear in 12:3:1 ratio as shown in below.

Parent White (Male) X White (Female)

IiBb IiBb

Gametes IB Ib iB ib IB Ib iB ib

F_1 Generation

♀ \ ♂	IB	Ib	iB	ib
IB	IIBB White	IIBb White	IiBB White	IiBb White
Ib	IIBb White	Iibb White	IiBb White	Iibb White
iB	IiBB White	IiBb White	iiBB Black	iiBb Black
ib	IiBb White	Iibb White	iiBb Black	iibb Brown

F1 Phenotypic ratio: 12:3:1

12 White : 3 Black : 1 Brown

Epistatic genetic interaction

2) Supplementary Gene or Recessive Epistasis or 9:3:4 ratio

A gene or gene pair that mask or prevent the expression of another is said to be epistatic to it. This phenomenon of masking one gene by the another is known as Epistasis.

This is exhibited by the inheritance of coat color in mice. The color of typical wild mouse is called agouti(Grey). Some mice are black in color and homozygous for a recessive gene causing the productions of black color. These animals also carry7 for albinism, which produce white color(No pigment), when present in homozygous condition. The for albins(aa) is not an allele of the gene for black and agouti.

Agouti(Grey)= BB

Black= bb

Albino= aa

It appear that the dominant allele of albino(AA) produce an enzyme which is necessary for the formations of the pigment and in the absence of this gene color is not produce. Thus a cross between black mice with agouti one, may be produce an albino in the F_1 as shown in figure.

Parents Agouti Mouse X Black Mouse

BBAa bbAa

BA Ba bA ba

In the F1 all offspring are not agouti color, and in the individual coandition, the expression of gene B is suppressed. Thus the gene for albinism is epistatic to the gene for black and agouti. Beacause these gene cannot be expressed themselves when gene for albinism is presents in homozygous condition. Since gene for albinism is recessive and pair must be present to be effect this is called recessive Epistasis.

For example- If we crossed homozygous agouti male having two dominant allele for albinism(BBAA), with albino female(bbaa), all the offspring in F1 are agouti. When F1 are crossed among themselves F2 consist of agouti, black and albino in particular ratio 9:3:4. This is also due to the fact that all animal having gene for albinism in Homozygous condition (aa) are albinos, Exhibiting recessive epistasis.

Parent Agouti Male X Albino Female

BBAA bbaa

F1 Generation BbAa (All Agouti)

Gametes BA , Ba , bA , ba

♀ \ ♂	BA	Ba	bA	ba
BA	BBAA Agouti	BBAa Agouti	BbAA Agouti	BbAa Agouti
Ba	BBAa Agouti	BBaa Albino	BbAa Agouti	Bbaa Albino
bA	BbAA Agouti	BbAa Agouti	bbAA Black	bbAa Black
ba	BbAa Agouti	Bbaa Albino	bbAa Black	bbaa Albino

9 : 3 : 4

Agouti Black Albino

Epistatic genetic interaction

3) Inhibitory Genes (13:3)

In this type of epistasis, a dominant allele at one locus can mask the expression of both (dominant and recessive) alleles at second locus. This is also known as inhibitory gene interaction. An example of this type of gene interaction is found for anthocyanin pigmentation in rice. The green colour of plants is governed by the gene I which is dominant over purple colour. The purple colour is controlled by a dominant gene P. when a cross was made between green (IIpp) and (iiPP) colour plants, the F_1 was green. Selfing of F_1 plants produced green and purple plants in 13:3 ratio in F_2

Parents: Green X Purple

IIpp iiPP

Gametes Ip iP

F_1 Hybrid IiPp (Green)

Gametes(F1) IP , Ip , iP , ip

♀ \ ♂	IP	Ip	iP	ip
IP	IIPP Green	IIPp Green	IiPP Green	IiPp Green
Ip	IIPp Green	IIpp Green	IiPp Green	Iipp Green
iP	IiPP Green	IiPp Green	iiPP Purple	iiPp Purple
ip	IiPp Green	Iipp Green	iiPp Purple	iipp Green

13 Green : 3 Purple

Epistatic genetic interaction

4) Lethal Genes (2:1)

Lethal genes are mutant genes and result in the death of the individual which carries them. Death the individual occurs either in the prenatal or postnatal period prior to sexual maturity A **fully** (completely) dominant lethal allele kills both in homozygous and heterozygous states. Individuals with a **dominant lethal allele** die before they can leave progeny. Therefore, the mutant dominant lethal removed from the population in the same generation in which it arose. **Recessive lethal genes** ill only when they are in a homozygous state and they may be of two kinds : 1. one which has no obvious phenotype effect in heterozygotes and 2 one which exhibits a distinctive phenotype when heterozygous

The **completely lethal genes** usually cause death of the zygote, later in the embryonic development or even after birth or hatching. Complete lethality, thus, is the case where no individuals of a certain genotype attain the age of reproduction. However in many cases lethal genes become operative at the time the individuals become sexually mature. Such lethal genes which handicap but do not destroy their possessor are called **subvital**, **sublethal** or **semilethal genes**. The lethal alleles modify the 3:1 phenotypic ratio into 2:1.

Examples of Lethal Alleles

Lethal alleles in plants. In plants, recessive lethal alleles are known which produce albinism, where absence of chlorophyll is lethal (fatal) to them.

For example

In maize (Zea mays) the amount of chlorophyll is controlled by a recessive allele (g) which, exhibits a lethal effect in homozygous (gg) and in heterozygous condition (Gg) has phenotype similar to homozygous condition for dominant gene GG. It modifies 3: 1 phenotypic ratio into 2:1.

F1 heterozygote	Green	X	Green
	Gg		Gg
Gametes	G g		G g

F2 Generation

♀ \ ♂	G	g
G	GG Green	Gg Green
g	Gg Green	gg White(Lethal)

1 Green(GG)

2 Green(Gg)

1 : 2 or 2 : 1

Inheritance of sickle cell anemia

The multiple effect of a single gene is called pleiotropy and the gene is called pleiotropic gene i.e. single gene controls two or more different traits.

Pleiotropic genes may not have equal influence on all the traits they control. It may cause a very evident expression of its specific trait (major effect) and a less evident expression of its other trait (secondary effect). Pleiotropy is the converse of polygenic inheritance in which two or more genes have an additive effect on single phenotype.

e.g. Sickle cell anaemia.

Sickle cell anaemia is an autosomal hereditary disease found among certain African tribes. The disease is caused due to recessive gene Hb^S in homozygous condition and is **lethal**. Normal healthy gene is Hb^A. The heterozygotes. i.e. carriers Hb^AHb^S develops mild anaemia in which the RBCs become sickle shaped or half moon shaped in oxygen deficiency. Thus, the gene for sickle cell anaemia is lethal in homozygous condition and produces sickle cell trait in heterozygous condition. i.e. two different expressions are produced by a single gene and thus this is an example of pleiotropy.

Hb^AHb^A -----Nonmal person.

Hb^AHb^S ------Sickle cell carrier

Hb^SHb^S-------Sickle cell anemia (Lethal-person dies)

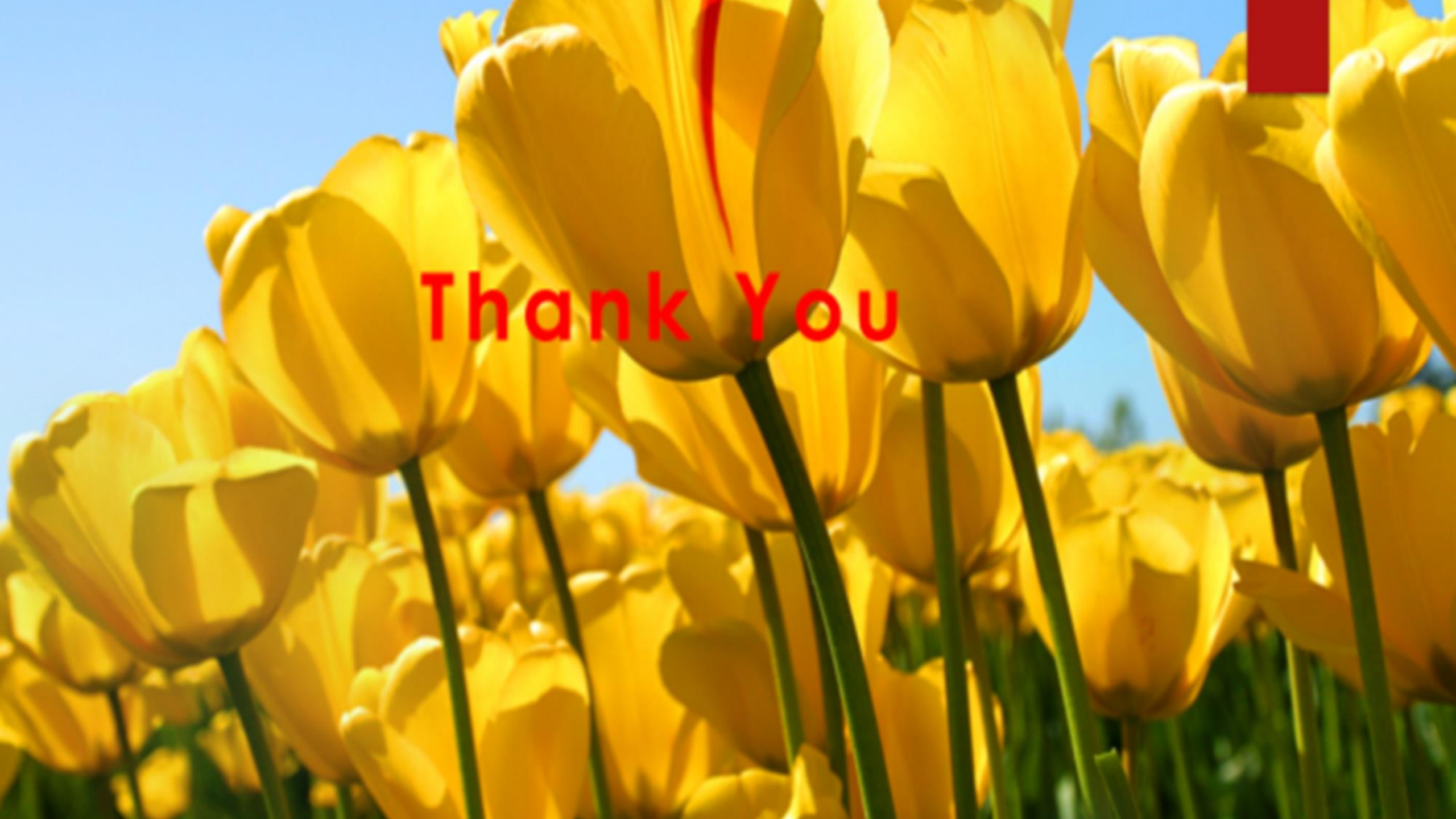
	Sickle cell		Sickle cell
Phenotype	Carrier	X	Carrier
Genotype	Hb^AHb^S	X	Hb^AHb^S
Gametes	Hb^A Hb^S		Hb^A Hb^S

A marriage between two sickle cell carriers produces 1 normal, 2 sickle cell carriers, and 1 sickle cell anaemic children in 1:2:1 ratio but as the name anaemic die the ratio of carriers and normal is 2:1.

Therefore the marriages between two sickle cell carriers should be avoided.

Checker Board

♀ \ ♂	Hb^A	Hb^S
Hb^A	Hb^AHb^A Normal	Hb^AHb^S Carrier
Hb^S	Hb^AHb^S Carrier	Hb^SHb^S Sickle cell anaemic


Thank You