Gene interactions

- A single character can be governed by two or more genes. They are called ***non - allelic*** or ***intergenic*** genetic interactions.

- The independent genes (non-homologous) located on the same or on different chromosomes interact with one another for the expression of a single phenotypic trait of an organism.

1. Epistasis

- Epistasis involves ***inter-genic suppression*** or the masking effect which one gene locus has upon the expression of another.

- Thus, epistasis refers to variation resulting from the *interaction of alleles at different loci.*

- A gene or locus which suppressed or masked the action of a gene at another locus was termed ***suppressor*** or ***epistatic*** gene.
- The gene or locus which was suppressed by an epistatic gene was called ***hypostatic gene.***
- Body colour in many tropical fish is controlled by epistatic interactions between or among two or more loci.

- Body colour in the Siamese fighting fish is an example of a set of phenotypes that is controlled by the epistatic interaction among four genes.
- Scale pattern in common carp is the most important phenotype controlled by epistasis

Dominant and recessive Epistasis

Dominant Epistasis

- Dominant epistasis occurs when a dominant allele at one locus (the epistatic locus) produces a particular phenotype, regardless of the genotype at the second locus.

- The second gene can express its phenotype only when the epistatic locus is homozygous recessive.

Phenotypes controlled by the different types of epistatic interaction of two genes in fish

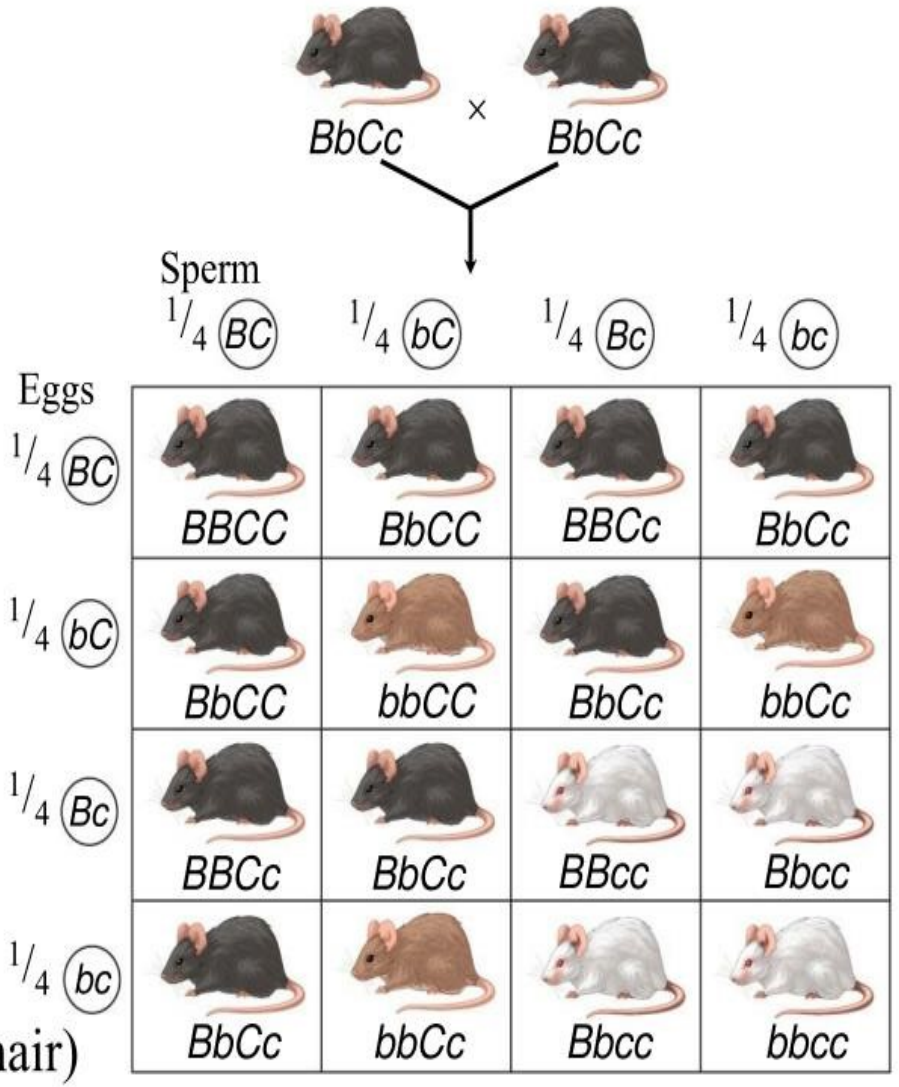
Species	**Phenotype**	**Type of epistasis**	**F_2 phenotypic ratio**
Common carp	Scale pattern	Dominant epistasis	12:3:1
Chinook salmon	Flesh colour	Duplicate recessive gene interaction	9:7
Gold Fish	Albinism	Dominant epistasis	12:3:1
Mexican cave characins	Eye colour	Recessive epistasis	9:3:4
Sumatran tiger barb	Trunk striping	Duplicate genes with cumulative effects	9:6:1

Recessive epistasis

- Recessive epistasis occurs when the recessive alleles of one gene locus (aa - the epistasis locus) suppress the phenotypic expression of the alleles of another gene (BB, Bb or bb alleles). This type of epistasis is called recessive epistasis

9:3:4 = Recessive Epistasis

- e.g., coat color in mice
- The gene B encodes for the pigment, but gene C encodes for transporting that pigment into hair follicles.



9 B_C_ = black (pigment + hair)
3 B_cc = white (pigment, not in hair)
3 bbC_ = brown (No pigment)
1 bbcc = white (No pigment, not in hair)

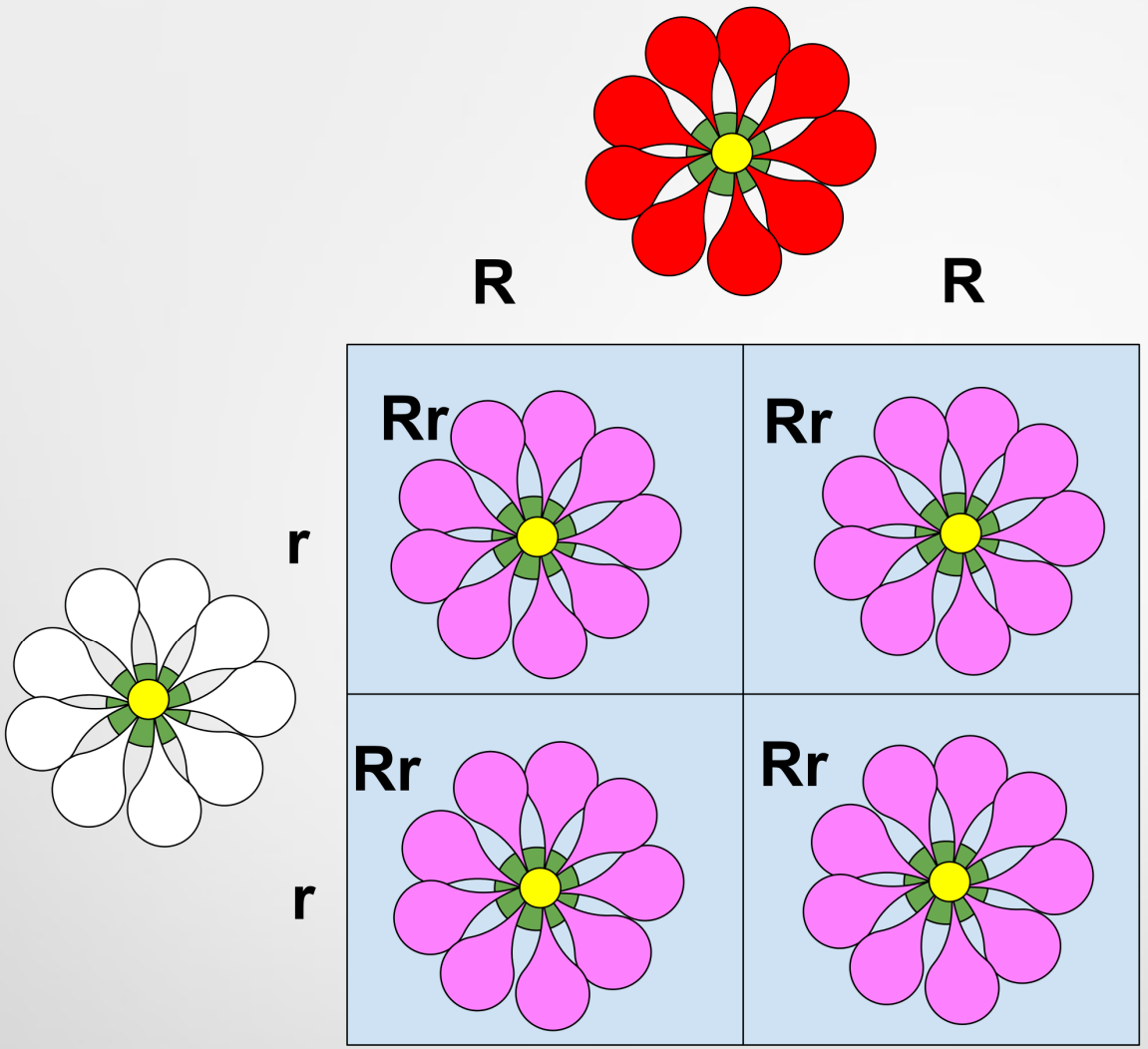
2. Pleiotropism

- The phenomenon of multiple effect (multiple phenotypic expression) of a single gene is called *pleiotropism*.
- One gene has got its own effect on different parts or different characteristics of one and the same organism.

Examples for pleiotropism in fishes

- L, D, B and G colour genes in common carp have many pleiotropic effects. For example, Blue (bb) and gold (gg) common carp have lowered growth rate as a pleiotropic effect.
- The S allele in *T. aurea* produces *saddle back* in the heterozygous state (S+).
- The a allele in channel catfish produces *albinism* in the homozygous state (aa).

- **Dominance gene action** :Complete dominant gene action occurs when the dominant allele is so strong that it produces its phenotype, regardless of the genotype.
- **Incomplete dominant gene action:**A second type of dominance occurs when the dominant allele is incompletely dominant, i.e., the dominant allele always produces its phenotype, but it is unable to completely suppress the recessive allele in the heterozygous state


R
R
r
r
Rr
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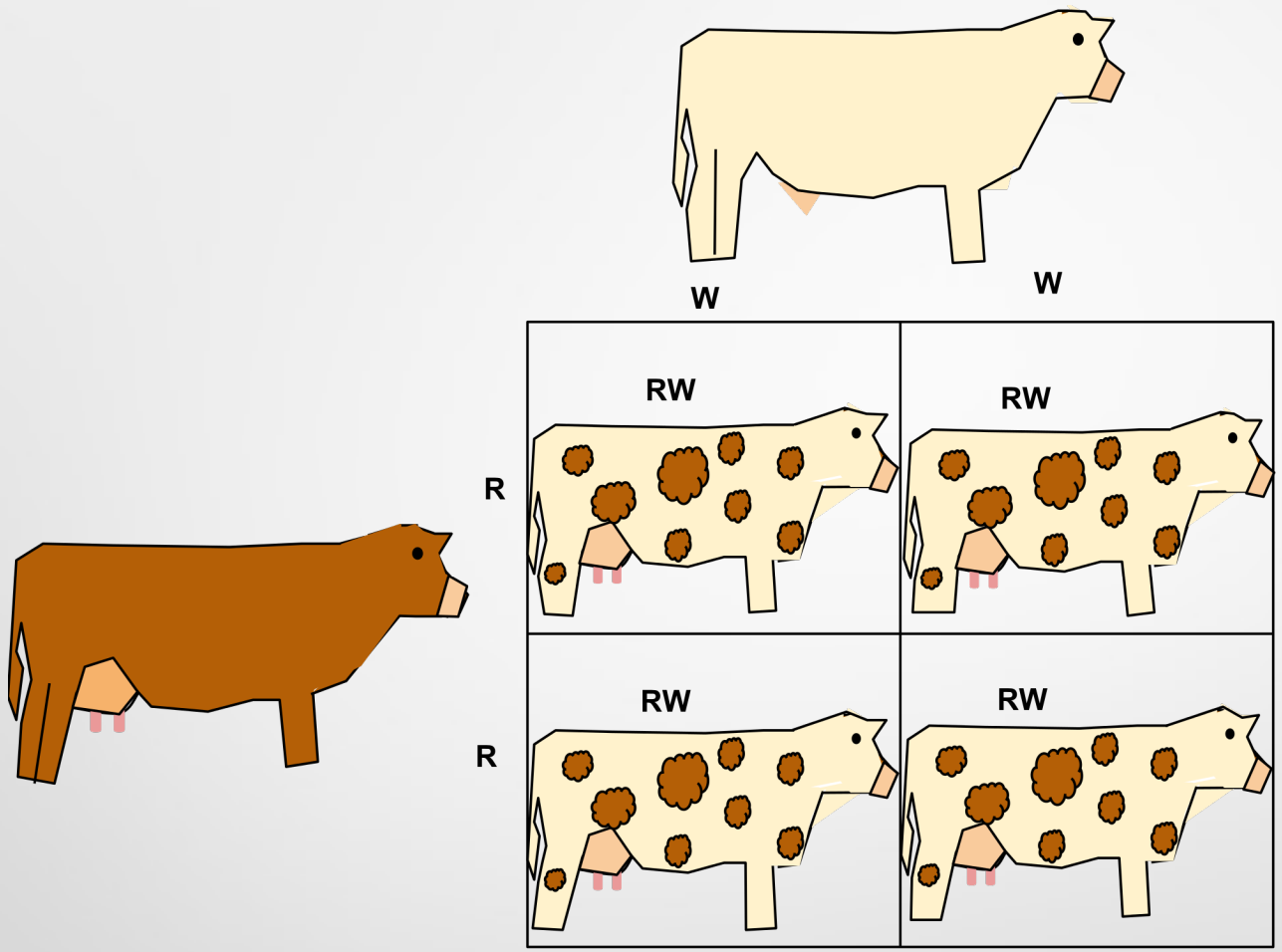
Rr
Rr

Codominant alleles

- The two alleles at a locus are co-dominant that is, both contribute equally to the phenotypic character of the heterozygote.
- This inheritance pattern is difficult to distinguish from the partial dominance of a single allele.


W
W
R
R
RW
RW
RW
RW

Additive gene action

- When the mode of gene action is additive, neither allele is dominant, and each allele always produces its phenotype in a undirectional step-wise manner.

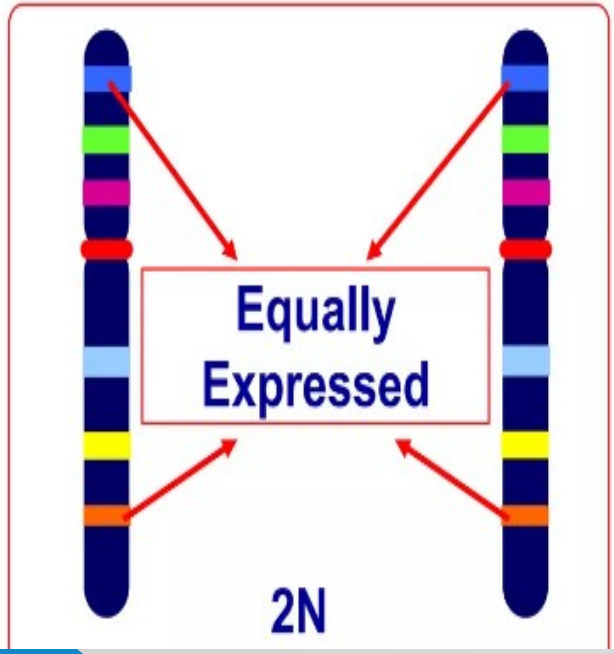
- This means the heterozygous phenotype is intermediate between the two homozygous phenotypes.

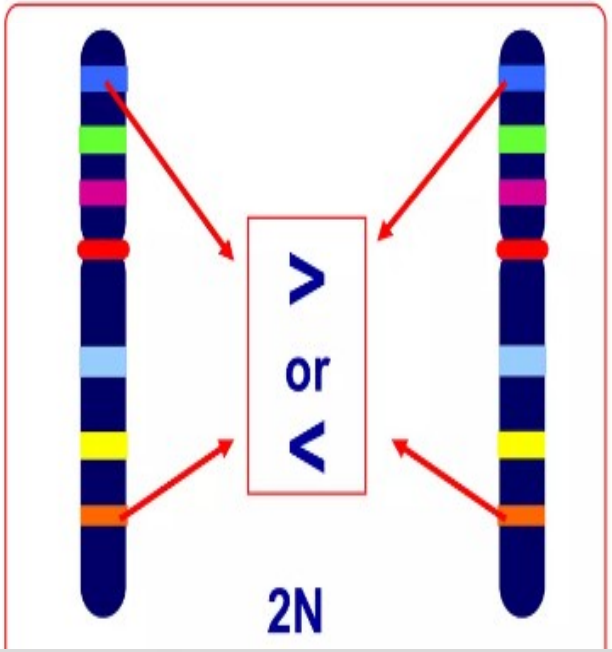
Additive Gene

Each allele contributes equally to the production of the phenotype

Non-Additive Gene

One allele (dominant allele) is expressed more strongly than the other allele (recessive allele)





Lethal genes

- A gene whose phenotypic effect is sufficiently drastic to kill the bearer is called lethal gene.
- Death from different lethal genes may occur at any time from fertilization of the egg to advanced age
- Lethal genes may be dominant, incompletely dominant or recessive.

Dominant lethal genes

- Dominant lethal gene in common carp. Lethal genes N (reduction of scales) and L (lighter pigmentation) kill the carriers in the homozygous state

- The S gene in *Tilapia* in another example of a dominant lethal gene.

Genotype	Phenotype
SS	death
S+	saddleback (abnormal dorsal fin)
++	normal

Recessive lethal genes

- In guppy, *Poecilia reticulata*, when two Y-chromosomes are combined in a male, homozygotes with respect to genes

  ma (maculatus), ar (Armatus) and pa (Pauper) turn out to be non-viable.

Sex-linked lethal gene

- The X and Y chromosome of medaka. *Oryzias latipes* contain one “pigment” locus *R* with three alleles.
- Normal fishes living in nature contain *R* gene in the sex chromosomes X and Y.
- Genetic analysis has shown that Y^R Y^R males obtained in crossing are practically non-viable and the lethal ratio 2:1 has been reported

Complementary genes or duplicate recessive genes

- If both gene loci have homozygous recessive alleles and both of them produce identical phenotypes, the F_2 ratio 9:3:3:1 would become 9:7.
- Both dominant alleles when present together (AA BB, Aa BB, AA Bb, Aa Bb) and complement to each other and are called complementary genes and produce different phenotype.
- This 9:7 ratio is observed in ‘Pearl” Nile tilapia.
- Two loci A and B are involved. Each locus has two alleles

Thank you