copy of the allele per cell and hence produce inadequate enzyme to synthesize enough red pigment as compared to a homozygote. Consequently, heterozygotes are pink.

Codominance: condition in which both alleles are equally expressed in the phenotype of the heterozygote. The heterozygote simultaneously expresses the phenotypes of both types of homozygotes

E.g. coat colour of short horn cattle

Both alleles of a gene code for functional products. Both products appear in the phenotype of the heterozygote. In the example, the heterozygote has a roan coat that consists of a mixture of red and white hairs.

**for incomplete dominance, the heterozygote phenotype is intermediate between the two homozygote phenotype, while for codominance, the heterozygote phenotype is not intermediate, but equal expression of both parental traits

Lethal Genes: cause death, frequently at an early developmental stage

Multiple Alleles: three or more alleles controlling a characteristic in a population e.g. ABO blood group in humans

Dihybrid Inheritance: Inheritances of two pairs of contrasting characters at the same time in each dihybrid cross

Monohybrid Crosses	**Genotypic Ratio**	**Phenotypic Ratio**
DD x dd	All Dd	All heterozygous dominant
Dd x Dd	**1**DD : **2**Dd : **1**dd	**3:1**
Dd x dd (Test cross)	**2**Dd : **2**dd	**1:1**
C^DC^d x C^DC^d	**1**C^DC^D : **2**C^DC^d : **1**C^dC^d	**1:2:1**
Lethal Genes	**2**Dd : **1**dd	**2:1** (1/4 of offspring dies)
Dihybrid Crosses	**Genotypic Ratio**	**Phenotypic Ratio**
AABB x aabb	All AaBb	All heterozygous dominant
AaBb x AaBb	**9**A_B_ : **3**A_bb : **3**aaB_ : **1**aabb	**9:3:3:1**
AaBb x aabb (Test cross)	**4**A_B_ : **4**A_bb : **4** aaB_ : **4**aabb	**1:1:1:1**

Sex Chromosomes

- the 23rd pair of **XY** chromosomes
- **Sex Linkage:** the carrying of genes on the sex chromosomes
- X chromosome contains many loci that are required in both sexes, whereas the Y chromosome contains only a few genes
- Genes located on the X chromosome are known as **sex-linked genes** because they **follow the transmission pattern of the X chromosome**
- E.g. haemophilia, red-green colour blindness and Duchenne muscular dystrophy in humans, and white eye colour in Drosophila

Effect of Environment on Phenotype

- Degree of expression of genes may be influenced by the environment in which the organism develops

Effect of Temperature: Coat colour in Himalayan rabbits

- All Himalayan rabbits are homozygous for the C^h allele of the gene coding for a heat-sensitive form of an enzyme, tyrosinase, which is needed for melanin production
- Tyrosinase is active then the air temperature is below 33^{o}C, thus there is growth of black fur
- The fur-producing cells will not produce the melanin pigment when exposed to higher temperatures, thus hair of the rabbits appear light/white
- Heat from environment prevents the development of black fur

Effect of soil acidity on Hydrangea Macrophylla

- Hydrangea may have different flower colours, despite carrying the same alleles
- The soil acidity in which the plants grow affects the plants' ability to take up aluminium
- In acidic soils (pH 5.5 or lower), aluminium assumes a form that is easily absorbed by plant roots, and thus flowers are predominantly blue
- In alkaline soils (pH 6.5 or higher), aluminium is unavailable and flower colour is pink purple
- Sometimes a single plant has both blue and pink flowers due to varying soil condition around the plant

Gene interactions: the idea that two or more genes influence one particular character

- Various gene products function in a metabolic pathway that contributes to development of one particular phenotype
- Two independently assorting genes may interact to influence a single character
- Biochemical basis of comb shape in chickens: different combinations of alleles from the two genes result in different phenotypes of a single character, presumably due to the interaction of their gene products, each of which contributes to the comb shape at the biochemical or cellular level

Epistasis: when the expression of an allele of one gene **suppresses/inhibits** the expression of alleles of a **different gene** at a **different locus**; suppressed gene is termed the **hypostatic** gene

*Dominant/recessive/duplicate recessive epistasis