Heredity and evolution

Structure of DNA, Gene, How Do Traits Get Expressed & Sex Determination

- **Germinal variation:** This variation affects the germ cells of an organism and is consequently inheritable. It is received by the individual from the parents and is transmitted to the next generation.
- **Significance of Variation:**
  - Variation enables the organisms to adapt themselves to the changing environment.
  - It forms raw material for evolution.
  - It enables the organisms to face the struggle for existence in a better way.
  - It helps men in improving the races of useful animals and plants.
  - It is the basis of heredity.
  - It also leads to the existence of new traits.

- **Gene:** It is a hereditary unit which carries character from one generation to another generation.
- **Allele:** Term allele refers to each of the members of a genetic pair or alternate trait of a gene pair.
- **Homozygous traits:** They have similar alleles for specific trait (TT or tt). They produce only one type of gametes.
- **Heterozygous traits:** They have dissimilar alleles for a specific trait (Tt). They produce two types of gametes.
- **Dominant trait:** The trait which appears in F1 generation is called as dominant trait. It is denoted by capital letter. e.g. TT (tall).
- **Recessive trait:** The traits which does not appear in F1 generation is called as recessive trait. It is denoted by small letter. e.g. tt (dwarf)
- **Genotype:** It is the genetic representation of a trait. e.g. TT or Tt for a tall plant.
- **Phenotype:** It is the expression(physical appearance) of a trait e.g. Tall pea plant. It can be noted by direct observation of an individual.
- **Monohybrid cross:** It involves the study of inheritance of one pair of contrasting characters. e.g. nheritance of tall and dwarf characters.
- **Dihybrid cross:** It is the study of inheritance of two pairs of contrasting characters.
- **Trihybrid cross:** It is the study of inheritance of three pairs of contrasting characters.

- **Back cross:** The cross between F1 generation with any of the parents is known as back cross.
- **Test cross:** The cross between F1 generation and the recessive parent is called as test cross.
- **Emasculation:** The removal of anther from a flower for the cross pollination

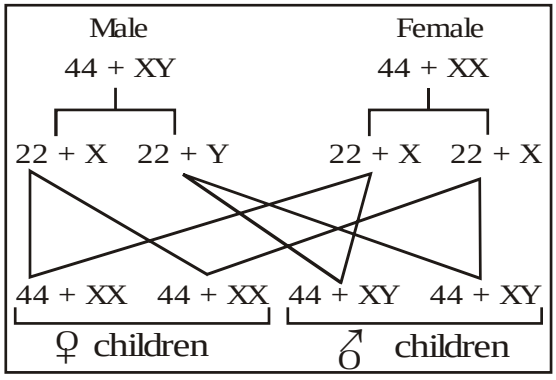
Traits :- Various forms of a character are called **traits.**

S. No.	Character	Dominant	Recessive
1.	Length of Plant	Tall	Dwarf
2.	Flower position	Axial	Terminal
3.	Shape of pod	Inflated	Constricted
4.	Colour of pod	Green	Yellow
5.	Shape of seed	Round	Wrinkled
6.	Colour of cotyledon	Yellow	Green
7.	Colour of flower	Violet	White

❖ SEX DETERMINATION

How is the sex of new born individual determined ? In human beings, the sex of the individual is largely genetically determined. In other words, the genes inherited from our parents have assumed that similar gene sets are inherited from both parents. If that is the case, how can genetic inheritance determine sex ?

All human beings these are 23 pairs of chromosomes are present out of these 23 pairs, are autosomes (similar in males and females) and 1 pair is called sex chromosome (different in males and females). In males sex chromosome are XY and in females sex chromosome are XX.



DEOXYRIBONUCLEIC ACID (DNA)

The expanded form of DNA is deoxyribonucleic acid. It was first isolated by the scientist **Frederick Meisher** from the nucleus of the pus cells in 1869. He named it as **'nuclein'** or nucleic acid because of its acidic nature. Later, it was experimentally proved by the scientists **Griffith (1928), Avery, McLeod and McCarty (1944)** that DNA is the carrier of the genetic information from generation to generation. It transmits the hereditary characters in a coded language from parents to the off springs (i.e., from one generation to another).

DNA is a macromolecule or polymer. It is made of very large number of 'nucleotide' units and hence is termed **polynucleotide**.

Each nucleotide unit in a DNA molecule is made up of three components

1.Deoxyribose sugar *:-* It is a pentose sugar.

2.Nitrogenous base *:-* Each nucleotide unit has a nitrogen containing base. In a DNA molecule, nitrogenous bases are of two types :

(a) **Purines:-** The purines in a DNA molecule are — **Adenine (A)** and **Guanine (G).**

(b) **Pyrimidines:-** The pyrimidines in a DNA molecule are — **Cytosine (C)** and **Thymine (T).**

❖ **Phosphate group:-** The phosphate group contains one phosphorus atom and four specifically linked oxygen atoms. Thus, there are four types of nucleotides in a DNA molecule depending upon the kind of nitrogenous base present in **each** nucleotide.

❖ **Double Helical Model of DNA**

J. D. Watson and **F.H.C. Crick** proposed the double helical model **of DNA** in **1953.** They were awarded the **Nobel Prize** for this discovery in **1962.** The important features of the double helical model are

(i) DNA molecule is made up of two **long polynucleotide strands** forming a **double helical structure (double helix)** just like a spiral staircase. Each helical turn of the DNA molecule is **3·4 nm** in length in which **ten nucleotide** base pairs are present.

(ii) **Deoxyribose sugar and phosphate molecules** are joined alternately to form the backbone of each polynucleotide strand. The **nitrogenous base** of each nucleotide is attached to the sugar molecule and projected towards the interior of the double helix.

(iii) In the interior of double helix, the nitrogenous bases of two polynucleotide strands form a pair with the help of hydrogen bonds. **Adenine (A)** always pairs with **thymine (T) and guanine (G) always** pairs with **cytosine (C).**

Thus, the two polynucleotide strands of the DNA molecule are joined by hydrogen bonds between specific nitrogenous bases. **Such a specific pairing of the bases of the opposite strands of the DNA molecule is called complementary pairing. Adenine (A) and thymine (T) are complementary to each other. Similarly, guanine (G) and cytosine (C) are complementary to each other.** The hydrogen bonding between the specific nitrogenous bases keeps the two strands to hold together. Therefore, all the base pairs remain stacked between the two strands.

❖ **Genes :**

Mendel was the first scientist to visualise a gene as a unit of inheritance in 1866. He called it factor. The word 'gene' was, however, introduced by Johannsen in 1909. It was then considered as the unit of inheritance. Genes are nothing but segments of DNA on a chromosome occupying specific position. For example, 30,000-40,000 genes are present on 46 human chromosomes.

Chemically, each gene has a specific sequence of nucleotides which determines its functional property. Gene is a segment of DNA molecule which has coded information to form a particular protein in the cell. This protein can function either as a structural protein or as a function protein (enzyme).

❖ **Acquired and Inherited Traits Introduction**

Acquired traits are the ones that a person develops during his lifetime. These are not passed from one generation to another. On the other hand, inherited traits are present in a person since the time of his birth and are passed on from one generation to another.

❖ **Acquired Traits:** An acquired trait is the character developed in an individual as a result of environmental influence. These traits are not coded by the DNA of a living organism and therefore cannot be passed on to future generations.

❖ **Inherited Traits:** These are the traits that are inherited from the parents to the off spring. Hair, skin eye colour, body type, height, and susceptibility to certain diseases are some of the examples of inherited traits in humans. The inherited traits of an individual are determined by their genes.

- A single cell in the human body contains 25,000 to 35,000 genes. These genes carry the traits inherited by an individual from his parents.
- Gregor Mendel explained the concept of inherited traits in his experiments with the pea plant. He depicted that the traits that are visible in the phenotype are called the dominant traits, while the traits that are not visible are known as the recessive traits.

❖ Blood Group System

Karl Landsteiner, an Austrian scientist discovered the ABO blood group system in the year 1900. In his experiments, he mixed different blood types and noted that the plasma from certain blood type produced agglutinates or formed clusters which were caused by the absence of molecules on red blood cells and resulting in antibodies to defeat that molecule. He then made a note of the agglutination and divided the blood types into 4 different groups. For the discovery of ABO blood group, he was awarded the Nobel Prize. The blood grouping system is pivotal in blood transfusion. Our immune system recognizes another blood type as foreign and attacks it if introduced in the body causing a **transfusion reaction**. Any inappropriate match with the Rh and ABO blood types, causes the most serious and life-threatening transfusion reactions. Therefore, before blood transfusion, it is suggested to have a blood group checked.

❖ ABO blood Group system

The basis of ABO grouping is of two antigens- Antigen A and Antigen B. The ABO grouping system is classified into four types based on the presence or absence of antigens on the red blood cells surface and plasma antibodies.

- **Group A** – contains antigen A and antibody B.
- **Group B** –contains antigen B and antibody A.
- **Group AB** –contains both A and B antigen and no antibodies (neither A nor B).
- **Group O** – contains neither A nor B antigen and both antibodies A and B.

➢ The ABO group system is important during blood donation or blood transfusion as mismatching of blood group can lead to clumping of red blood cells with various disorders. It is important for the blood cells to match while transfusing i.e. donor-recipient compatibility is necessary. For example, a person of blood group A can receive blood either from group A or O as there are no antibodies for A and O in blood group A.