

Principles of Inheritance and Variation

- ❖ Genetics deals with inheritance and variation of characters from parents to offsprings.
- ❖ **Inheritance** is the process by which characters are passed on from parent to progeny.
- ❖ **Variation** is the degree by which progeny differ from their parents and is caused due to sexual reproduction.
- ❖ Gregor Mendel conducted hybridisation experiments on **garden peas** for seven years (1856-1863) and proposed the laws of inheritance.
- ❖ Mendel selected **14-true breeding** pea plant varieties as pairs which were similar except for one character with contrasting traits.
- ❖ The characters studied by Mendel were stem height, flower colour and position, pod shape and colour, seed shape and colour.
- ❖ **Law of dominance** explains the expression of only one parental character in F_1 of monohybrid cross. It also explains the proportion of 3 : 1 obtained at the F_2 .
- ❖ Monohybrid cross is a cross between two organisms which is made to study the inheritance of a single pair of alleles of character.
- ❖ Monohybrid phenotypic ratio is 3:1 and genotypic ratio is 1:2:1.
- ❖ Dihybrid cross is a cross between two organisms which is made to study the inheritance of two pairs of alleles belonging to two different genes.
- ❖ Dihybrid phenotypic ratio is 9:3:3:1 and genotypic ratio is 1:2:1:2:4:2:1:2:1.
- ❖ **Law of segregation explains**, the factors or alleles of a pair segregate from each other such that gametes receive only one of the two factors. **Law of independent assortment** explains when two pairs of traits are combined in a hybrid, segregation of one pair of characters is independent of the other pair of characters.
- ❖ If F_1 did not resemble either of the parents and was in between the two this type of interaction is called as **incomplete dominance**, e.g., dog flower (Snapdragon or *Antirrhinum sp.*).
- ❖ The genotypic and phenotypic ratio of incomplete dominance is 1:2:1.
- ❖ Genes are units of inheritance. They contain information required to express a particular trait an organism.
- ❖ British geneticist R.C Punnett developed a graphical representation call Punnett square to calculate **possibility of all possible genotypes** of offsprings in a genetic cross.
- ❖ The alleles which do not show dominance-recessive relationship and are able to express themselves independently and equally when present together. This type of allele interaction is called **codominance**.
- ❖ ABO blood group in human being is controlled by Gene-*I*, having three alleles I^A , I^B and i . I^A and I^B produce slightly different form of sugar, while i does not produce any sugar.
- ❖ I^A and I^B are completely dominant over i , but when I^A and I^B are present together, they express their own sugars, because of co-dominance hence RBC have both sugars.
- ❖ There are **6 genotypes** and **4 phenotypes** in human ABO blood types.
- ❖ ABO blood grouping is a very good example of multiple allelism in which **more than two** alleles govern the **same** character.
- ❖ **Pleiotropy** is a condition in which a single gene can exhibit multiple phenotypic expression. It is the effect of a gene on metabolic pathways which contribute towards different phenotypes, e.g., Phenylketonuria.
- ❖ **Walter Sutton** and **Theodore Boveri** noted that the behaviour of chromosomes was parallel to behaviour of genes and they used chromosome movement to explain Mendel's Laws.
- ❖ Sutton united the knowledge of chromosomal segregation with Mendelian principles and proposed chromosomal theory of inheritance.
- ❖ Linkage is the phenomenon of genes staying together during inheritance without any separation due to their being present on the same chromosome.
- ❖ Morgan proved and defined linkage on the basis of his breeding experiments in *Drosophila melanogaster*.

- ❖ Morgan's student Alfred Sturtevant used **frequency of recombination** between genes on same chromosome as a measure of distance between genes and mapped their position on chromosomes.
- ❖ If traits are controlled by three or more genes then the traits are called as polygenic traits. It also takes into account influence of environment.
 - ✦ The phenotype reflects the contribution of each allele, i.e., the effect of each allele is additive, e.g. Human Skin Colour
- ❖ **Types of sex-determination.**
 - XO-Type = Male heterogamete
e.g. = Grasshopper
 - XY-Type = Male heterogamete
e.g. = *Drosophila*, Man
 - ZW-Type = Female heterogamete
e.g. = Birds
- ❖ In Humans, genetic make-up of sperm determines sex of the child and in each pregnancy, there is always 50% probability of a male or female child.
- ❖ In honey bees, sex-determination is haplo-diploid type in which unfertilised egg develops as male (**drone**) i.e. **haploid** and Queen and worker bees (females) are **diploid**.
- ❖ Mutation is caused due to alteration in chromosomes which result in abnormalities or aberrations. Chromosomal aberrations are commonly observed in cancer cells.
- ❖ **Mutagens are** Chemical and physical factors that induce mutations, e.g. UV radiations, X-rays etc.
- ❖ Pedigree analysis is a study of family history about inheritance of a particular trait or disease.
- ❖ A few chromosomal aberrations are colour-blindness, Haemophilia, Thalassemia, Sickle Cell anaemia and phenylketonuria.
- ❖ A few disorders are Down's syndrome, klinefelter's syndrome, Turner's syndrome