Chapter - 35
Mendel's Laws of Inheritance

It is we all know that mango tree is produced by germination of seeds of mango tree and puppies are produced by dogs neither children of any other animal. Humans give birth to human. This tendency of offspring in which they acquire features or characters of their parents is called **Heredity**. The science which is concerned with study of heredity and variation among parents and their offspring is known as **Genetics**. Genetics also provides answer of such type of questions that why the two offspring of same parents are seemed to be different. Why some persons have black coloured skin and some persons have light coloured skin; in other words why the variation is found in organisms of same kind.

Whenever a baby is born in any family then relatives match the eyes, nose, shape- colour, and colour of hairs with mother, father, siblings, grandparents, maternal grandparents, siblings. Generation wise transfer of genes from parents is the main reason of such type of similarities and variations.

The science of genetics was started in 1900 AD when Mendel's laws were rediscovered. The word genetics was first of all used by **William Bateson** in 1905. It is a Greek word which means 'to become or to grow'. **Heredity** and variations are studied under this science.

Our intention for heredity refers those traits or characters which are continuously transmitted from one generation to another generation or from parents to offspring. These characters are fixed for any particular animal. Genetical variations are developed through sexual reproduction and mutations in organisms. These variations are inherited in offspring from parents. Similarly environmental variations are those which are caused by environment hence these are not transmitted from parents to the offsprings. Genetics is established with Mendel's work, so here we will study his biography and work in brief. By the significance of Mendel's work he was considered as **Father of Genetics**.

Mendel's life history –

Modern genetics is originated as a result of Gregor John Mendel's (1822 – 1884) contribution. He is also known as 'Father of Genetics'. He was born on 22nd July 1822 in Moravia named village (which is now in Czechoslovakia) in a family of poor farmer. He completed his two years course in 1842 in philosophy and started to work in 1843 as a priest in a church in Bruno city of Austria, which is now known as Bruno city of Czechoslovakia. Here he was honored with degree of Gregor. After this Mendel went to Vienna in 1851 where he studied Mathematics and Natural History in Vienna University for three years. This study proved very helpful in his coming researches on Genetics. In 1854 to 1864 he returned to Bruno city and worked there as a teacher in Modern school. During his teaching period about 8 years from 1857 to 1865 he conducted important experiments on the garden pea plant in the garden of church. On the basis of these experiments he proposed the concept of units of

inheritance. According to him such units are inherited in equal number from each parent which are responsible for appearance of ordinary and special characters of progeny (fig. 35.1).

Fig. 35.1 Mendel and his pea

From 8th February to 8th March 1865, he presented his result before the Brunn Society of Natural History which he obtained from his experiments conducted on 30,000 pea plants and in 1866 he published his research work as **"Experiments in Plant Hybridization"**titeled research paper in annual magazine of the society. Their original research paper was published in German language entitled with "Versucheuber Pflanzenhybriden". On the basis of results of Mendel's experiments, law of heredity were framed which are known as Mendelism. This research work was neglected for about 34 years but in 1900, **Hugo De Vries** of **Holand, Karl Correns** of **Germany** and **Eric Von Tschermark** of **Austria** observed the same results like Mendel from their separate experiments by which forgotten works of Mendel retained validity.

Selection of pea plant for study by Mendel -

Due to following reasons Mendel selected garden pea (*Pissum sativum*) for his experiments on heredity –

(1) It can be easily grown in garden or in any flowering pot.

(2) The life – span of this plant is very short and it completes its life cycle in one year. Hence its many generations can be studied easily in short time.

(3) Its flowers are bisexual and they have self-pollination by which the purity of characters is maintained for many generations.

(4) Cross pollination can also be achieved in it.

(5) Many contrasting characters are found in pea plants.

Selection of characters

Among 34 contrasting characters found in pea plant Mendel selected 7 pairs of contrasting characters for his study. These characters were following –

S.No.	Character	Recessive	Dominant
1	Height of plant	Dwarf	Tall
2	Position of flower	Terminal	Axillary
3	Shape of pod	Constricted	Inflated
4	Colour of pod	Yellow	Green
5	Shape of seed	Wrinkled	Round
6	Colour of seed coat	White	Grey
7	Colour of cotyledon	Green	Yellow

Some writers consider a character of colour of flowers white and purple instead of colour of seed coat.

After studying these seven pairs of characters Mendel found that these characters were genetically pure. Pure character means such remains unchanged in generation to generation. It means if we grow tall plants then they will remain tall in next generation too.

Crossing Technique of Mendel

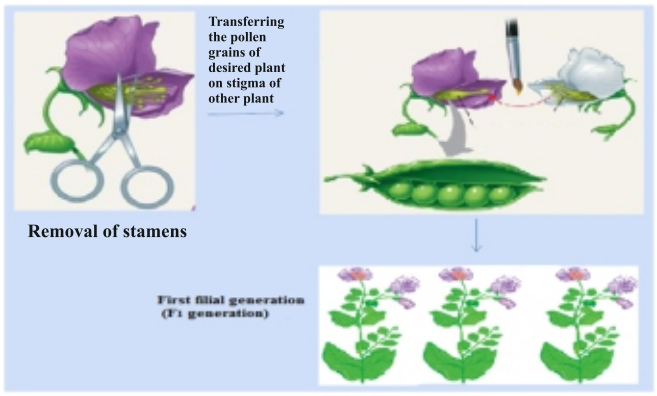


Fig. 35.2 Crossing technique of Mendel

(1) Pea is a self-pollinated plant because its flower structure is of such type that its pollen grains fall on stigma of same flower and thus self-pollination/ autogamy occurs. To prevent the autogamy Mendel removed the stamens by opening flower bud before maturation of stigma. This process is known as emasculation.

(2) He used to put pollen grains of flower of such plants on stigma of that castrated flower which was used to be as other parent.

(3) Bags were tied over these artificially fertilized flowers to prevent fertilization by insects or other plants.

(4) Different contrasting characters related to stem, flowers, pods and seeds were studied in these plants develop from such obtained seeds.

If he wanted to study the second hybrid generation after crossing then these flowers were self-pollinated through ordinary process.

The plants used for experiment are called parental generation which is represented by P (Parent). The first generation obtained from parent plants is called first filial generation which is represented by F_1. The plants obtained from self-fertilization of **First filial generation** (F_1) are known as second filial generation which is represented by F_2. They observed after their origin. He counted the number or plants of contrasting characters and formulated theoretical explanation with the help of these observed data. The theoretical explanation of the results from these experiments is now known as **Mendel's laws of Inheritance.**

Mendel used the term **Factor** in his experiments. These factors are now known as **Genes**. By above mentioned crossing method, Mendel did following experiments taking under consideration of one or more characters among the seven pairs of contrasting characters and propounded the laws of genetics.

1. Monohybrid Cross
2. Di-hybrid Cross
3. Poly hybrid Cross

1. Monohybrid Cross

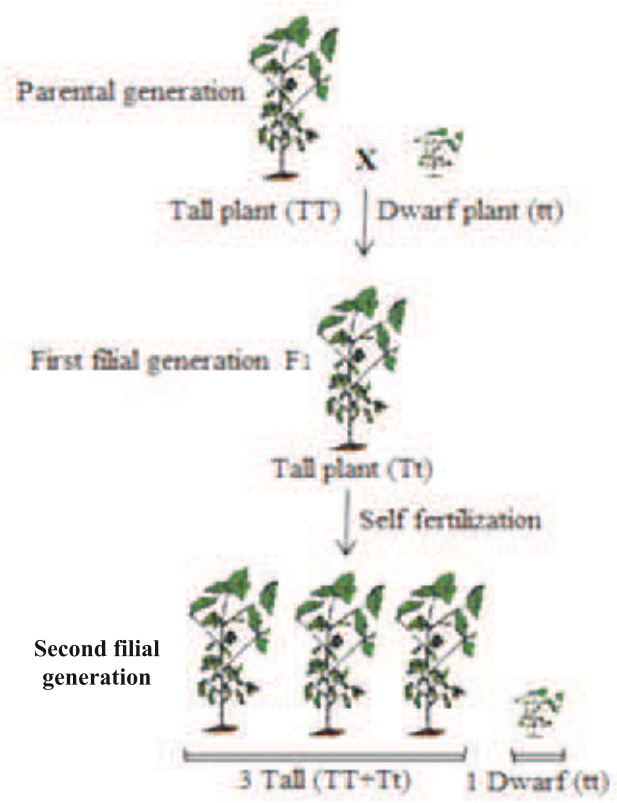


Fig. 35.3 Monohybrid cross

By growing seeds got from this cross, all tall plants were obtained in F_1generation. Mendel observed in this cross that all plants obtained in F_1 generation were like their tall parents, none of them was dwarf. Such type of results was observed by crossing the other contrasting characters. It is concluded from these experiments that only one of

the two contrasting characters could be expressed in F_1 generation and other character could not be expressed.

After this the seeds obtained by self-fertilization among plants of F_1 generation he called them F_2 generation. In F_2 generation tall and dwarf both type of plants were obtained in 3:1 ratio. This 3:1 ratio is known as **monohybrid phenotypic ratio** (Fig. 35.3). Seeds of dwarf plants from these were grown again and self-fertilized, dwarf plants are obtained and by growing again the seeds of tall plants and selfing them tall and dwarf plants were again observed in 3:1 ratio. By observing their genotype ratio then it is 1:2:1 (1 TT: 2 Tt: 1tt) means genes in tall plants are homozygous TT and heterozygous Tt whereas in dwarf plants only homozygous tt genes are present.

In this way monohybrid cross has phenotype ratio 3:1 and genotype ratio 1:2:1

Mendel's experiments can be explained as follows –

The character of length in pea plant is controlled by a pair of factors or alleles (Tallness and dwarfness). These **factors** are called **genes** at present. One factor of this pair is from father (paternal) and second factor from mother (maternal) which comes together after fertilization. The factor which expresses its factor in F_1 generation called **Dominant factor** and that factor which is not able to express itself is called **Recessive factor.**

2. Di – Hybrid cross –

When a cross between two pairs of factors or alleles is done then it is called Di-hybrid cross. Mendel crossed pea plant having two pairs of contrasting characters like yellow and round (YYRR) homozygous seed plants and green and wrinkled (yyrr) homozygous seed plants By crossing these plants all plants of yellow and round seeds (YyRr) were developed in F_1 generation (First filial generation). In the pea plant yellow seed colour is dominant over green colour and round seed shape is dominant over wrinkled. When the seeds developed from plants of F_1 generation were grown again and self-fertilized, four types of plants are obtained in F_2 generation whose **phenotype ratio 9:3:3:1** was obtained (Fig. 35.4).

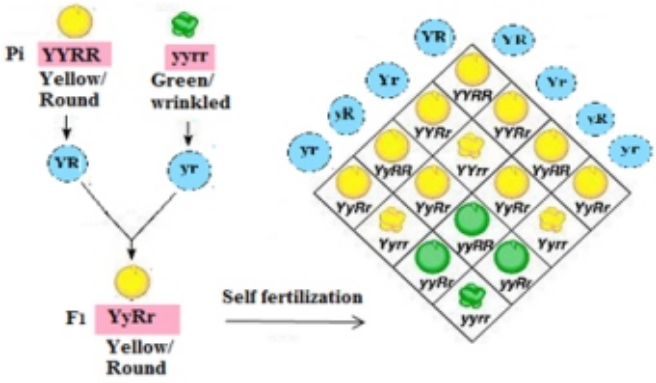


Fig. 35.4 Di-Hybrid cross

In 9/16 both dominant character or – yellow and round seeds

In 3/16 one dominant and one recessive – yellow and wrinkled seeds

In 3/16 one recessive and one dominant - green and round seeds

In 1/16 both recessive - green and wrinkled seeds

The genotype ratio of F_2 generation comes 1:2:2:4:1:2:1:2:1.

On the basis of this experiment, Mendel propounded the "Law of Independent Assortment"

Mendel's laws of inheritance –

The results obtained from his experiments, Mendel propounded the important law of inheritance which is called Mendel's laws of inheritance. These are as follow-

(I) Law of Dominance - From monohybrid cross experimented by Mendel on pea, the plants of only one type of characters were developed in F_1 generation. If tall plant is crossed with dwarf plant, only tall plants are observed. It means the character of tallness does not allow the character of dwarfness to express in pea plant. Hence the character of tallness was called **dominant** character and the character of dwarfness was called recessive character. The result of this experiment was called the **Law of Dominance** by Mendel. This law is very

important for organisms. In human, the genes of retarded I.Q., diabetes, colour blindness, heredity diseaseses are recessive. In the presence of dominant genes these cannot express themselves hence the human remains normal.

(ii) Law of Purity of gametes or Law of segregation – On the basis of results obtained from his monohybrid cross experiments Mendel propounded the **Law of Purity of gametes** or **Law of segregation.**

In monohybrid cross experiments a similar, hybrid tall plants are obtained in F_1 generation while after self-pollination in F_2 generation tall and dwarf plants, similar to parent plants are obtained. In F_1 generation the factors for tallness and dwarfness remain together but they do not mix with each other means one does not affect by second. These factors segregate or become separated and form 75% tall plants and 25% dwarf plants in F_2 generation. In this way the gametes retain their purity it is called the **Law of purity of gametes** and at the time of gamete formation both alleles (Tt) get separated or segregate from each other reaches in separate gametes and recessive character, dwarfness be also appeared in F_2 generation. Hence in this way the segregation or separation of dominant and recessive factors in gametes is known as Mendel's **Law of segregation.**

Significance of law of segregation –

- Gene hypothesis is proved by this law.
- Gene is a unit of inheritance which transmits the characters or traits from one generation to other.
- Each character is controlled by gene in organisms.
- Each gene has two alleles which control single pair of contrasting characters.
- The alleles of a gene remain together but do not mix with each other.
- Alleles become separated from each other during gametes formation and transfer to separate gametes.

(iii) **Law of Independent Assortment** – This law is applicable on dihybrid or high level of crossings. It is not applicable on monohybrid cross. In di-hybrid and higher cross experiments conducted by Mendel, when a cross is conducted between two or more than two contrasting characters then dominant characters are observed in F_1 generation but when seeds of these plants are grown and self-pollination is conducted in them then these appear in offspring independently without affecting each other. It means the inheritance of one character does not affect the presence of other character. This is called the **Law of Independent Assortment**.

According to this law, member of each pair of alleles not only segregate but alleles of different characters behave independently with each other. It means the genes of more than one contrasting characters carry characters independently from one generation to other without affecting each other.

Mendel crossed pure yellow and round seed (YYRR) plants with green and wrinkled seed (yyrr) plants and observed that in F_1 generation yellow and round seed (YyRr) plants were obtained. After self-fertilization among plants of F_1 generationfollowing four types of plants obtained in following ratio.

Yellow and round seeds	=	9
Yellow and wrinkled seeds	=	3
Green and round seeds	=	3
Green and wrinkled seeds	=	1

It is clear from the above experiment that beside the parental combination of yellow and round seed and green and wrinkled seed plants, two new combinations of yellow and wrinkled seed and green and round seed plants are also observed. It means these factors or alleles assort independently in the formation of gametes without affecting each other. This is called **Mendel's law of Independent Assortment.**

Significance of Mendel's Laws –

With the help of his experiments Mendel discarded all the laws and principles given by earlier scientists, because most of them were only fictional and they had not any scientific base. In the beginning Mendel's work had no recognition but

after 34 years of his death in 1900, when **Hugo de Vries** scientist of Holland, **Karl Correns** of Germany and **Eric Von Tschemark** of Austria presented the results similar to Mendel then Mendel's work was recognized. After the work conducted by him, the scientists doing further research work got new direction. On the basis of this, the new experiments and discoveries in genetics were achieved.

For this extra ordinary contribution in the field of genetics, Mendel regarded as the **Farther of Genetics.**

On the basis of experiments of Mendel, the scientists identified dominant and recessive characters in different organisms through crossing process. With the help of crossing methods, the good characters or traits found in different varieties are brought together in one variety. By using Mendel's laws disease resistant, capability to maintain in adverse conditions, much large and beautiful flowers or fruits and high productive crops are developed. Similarly the breeds of cow, buffalo, goat and hen can also be improved. The capacity to produce more milk and more reproducing power has been developed in these breeds. Some hereditary diseases or defective traits are present in many animals these can also be rectified on gene level with the help of Mendel's law.

New combinations and their frequency developed in hybrid offspring can be determind early by these laws.

Reasons of Mendel's success

1. Mendel included clearly visible 07 contrasting characters in his experiments and studied the **inheritance of single character at a time**. The factors or genes controlling these seven contrasting characters are located on seven different chromosomes by which Mendel was lucky enough to escape from process of linkage.
2. Mendel used the plants of only completely pure character (homozygous).
3. Mendel conducted his experiments up to F_2 and F_3 generation only and he kept the record of results of his experiments systematically.

Back cross and Test cross

Back cross – If crossing of plants or animals developed from F_1 generation of monohybrid cross with one of its parents then this cross is known as back cross.

Test cross – When any plant of F_1 generation or any unknown homozygous genotype plant or animal is crossed with homozygous (pure) recessive parents then it is known as test cross. It is known by this cross that this unknown plant or animal is homozygous or heterozygous.

- **Factor –** It is a unit or factor responsible for inheritance and expression of a particular character. Now this factor is known as gene.
- **Gene -** It is a special segment of DNA molecule that determines the inheritance and expression of a particular trait or character.
- **Alleles or Allelomorphs –** Alleles are two or more alternative form of any factor or gene. For example in pea plant, there may be two alternative forms of the gene that determines the shape of seed – Round (R) and wrinkled ®. Both genes for round and wrinkled seeds are alleles of each other. Similarly there are three alleles or forms of the gene that control the blood group in humans. These are I_A, I_B and I_O (I= Immuno haemoglobin gene). Alleles are located at same location in homologous chromosomes.
- **Trait –** It is expressed character, Example colour of flower, shape of seed etc.
- **Dominant character –** One of the two alternative forms of a character which expresses itself in F_1 generation of a heterozygous organism is called dominant character (Dominant allele) and this event is known as dominance. Example-in a Tt organism T expresses tallness or length itself and t (dwarfness) can not expresses hence T is dominant gene and tallness is dominant character.
- **Recessive character –** In two allomorphic forms of a character which is not expressed in

F_1hybrid that is called recessive character, recessive character is expressed in homozygous condition (e.g. tt) only.

- **Genotype –** Genetic structure of an individual which male or female receives from his/her parents through inheritance are called genotype. Example – The genotype of pure rounded seed of parent pea plant is RR.
- **Phenotype –** The external expression of one or more characters of any individual is known as phenotype. Example- Round or wrinkled character of seeds is phenotype.
- **Homozygous –** An individual that has same kind of alleles for any character is called homozygous for that character. Example – The plant with RR alleles is homozygous for the shape of seed.
- **Heterozygous –** The unequal condition of both alleles for any character in an organism is called heterozygous for any character. Example- The plant with Rr alleles is heterozygous for the shape of seed.
- **Parent generations –** The mother and father that take part in first crossing, represent parent generation (P_1)
- **F_1 generation –** The first generation developed from crossing between two parents (P_1) is called F_1 generation or first filial generation.
- **F_2 generation –** The generation developed after self-pollination or autogamy among F_1 generation is called second filial generation or F_2 generation.
- **Monohybrid Cross –** Such type of cross in which one pair of character is taken then it is called monohybrid cross and F_1generation is called hybrid. From self-pollination in F_1 generation the phenotypic ratio 3:1 (Dominant: recessive) is obtained in F_2 generation.
- **Di-hybrid Cross –** When to study the two pairs of contrasting characters parent is crossed then it is called di-hybrid cross. The phenotype ratio obtained in F_2 generation from di-hybrid cross is known as di-hybrid phenotype ratio (Example – 9 : 3 : 3 : 1 is in Mendelian cross).
- **Hybridization–** The cross (Fertilization) between parent organisms of different species is called hybridization.
- **Test cross –** The cross between F_1generation and one of the parent having homozygous recessive character is called test cross. If F_2 generation is heterozygous then the ratio of 1:1 is observed resulting test cross.
- **Reciprocal cross –** In this type of cross the sex of mother-father (parents) are reversed means if in first cross the father is dwarf and mother is tall then mother will be taken dwarf and father will be taken tall in reciprocal cross.

Deviation from Mendel's laws-

Incomplete dominance

Among the seven pairs of contrasting characters taken for experiment by Mendel, one character or trait was dominant and other was recessive. Therefore only dominant character is appeared in F_1 generation. But later on, in the experiments conducted by various scientists, these characters did not appear in such type.

The law of dominance is not effective in 4'O clock plant (*Mirabilis jalapa*) and snapdragon (*Antirrhinum*). In this case when homozygous red flower plant (RR) is crossed with other homozygous white flower plant then in F_1 generation an intermediate character red and white is observed. The flowers of all plants are pink in F_1 generation. When F_1 plants are self-fertilized then phenotype and genotype both ratio RR (Red): Rr (Pink): rr (White) 1:2:1 is observed.

Parent	RR X rr
Gamete	R, R X r, r
F_1	Rr Pink
F_2	1 Red : 2 Pink : 1 White
	(RR) : (Rr) : (rr)

Co-dominance

Both dominant and recessive factors present in

one pair of alleles are equally contributed to express in F_1 generation. This process is known as co-dominate.

The skin colour in cattle is red (RR) and white (rr). By crossing among them the roan Rr colour of skin in cattle is developed in F_1 generation. The roan colour develops due to expression of characters of both factors. If cattle of F_1 generation are crossed with each other than the ratio of red, roan and white cattle 1:2:1 (RR : Rr : rr) is obtained in F_2 generation. Hence Mendelian ratio is not followed in co-dominance too (Fig 35.5).

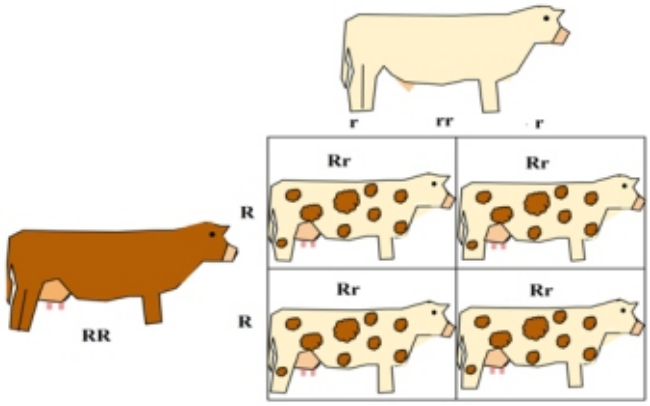


Fig. 35.3 Co-dominance

Multiple alleles –

Generally there are two forms of a gene i.e. tall or dwarf red or white, brown eyes or blue eyes etc. There genes (alleles) are of only two types. But most of genes have more than two alleles. These are called multiple alleles. One example of itis inheritance of blood group in human.

The four blood groups of human are determined by a single gene. This gene has three alleles I_A, I_B and I_O. Alleles I_A and I_B of group are both dominant so blood group AB with both alleles I_A and I_B because both groups are co-dominant. When gene I_O is homozygous then blood group is O. The gene type and phenotype are given in following table 35.1.

Table 35.1 Genotype and phenotype of Human blood Group

Genotype	Blood group
I_AI_A or $I_A I_O$	A
I_BI_B or $I_B I_O$	B
$I_A I_B$	AB
I_OI_O	O

Lethal Genes

Some genes also affect the viability of organisms controlling with their external characters. A French scientist L. Cuenot in 1905 presented the results of inheritance of body colour in rats which were not in favor of Mendel's law of segregation. He observed that yellow fur coat in rats is due to presence of gene (Y). It is dominant over brown colour (y). When yellow coloured rats are crossed with each otherthen yellow and brown coloured rats are obtained in 2:1 ratio. The brown coloured rats obtained from this cross were homozygous but yellow rats were heterozygous like preexisting. It means yellow rats could not be survive in homozygous state YY and along with yellow colour Y gene also affects the vitality in rats and it is responsible for death. Therefore along with yellow colour of body rat is also died in homozygous state of Y gene so yellow homozygous rat never visible.

Such type of genes (YY) is called lethal genes and this phenomenon is known as lethality. Some lethal genes are deadly in homozygous state only and are called recessive lethal genes. Dominant lethal may be mortal in heterozygous state too.

Pleiotropy-

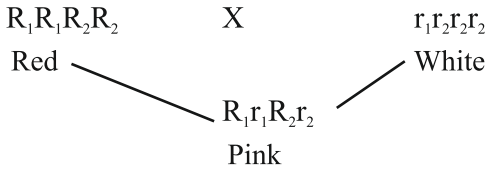
Generally one gene may affect one function at cellular level. Means one gene is determined for one action. But some genes reflect its effect on more than one characters then this effect is known as pleiotropy. Means one gene determines more than one function. So such type of genes which determine more than one characters or traits those are known as pleiotropic gene. One gene may have many alleles

and many genotypes. One gene may control many genotypes. For example the recessive gene for white colour of eyes in Drosophila when present in homozygous state affects many other characters i.e. shape of wings, shape of abdomen. Hence vestigial wings and coiled abdomen are found in white eyed drosophila.

Another important example of pleiotropy is found in inheritance of hereditary disease sickle-cell anaemia. This disease is caused by a recessive gene. By the presence of this gene abnormal haemoglobin is formed. All those Red Blood corpuscles which have this type of abnormal haemoglobin by deforming their shape becomes like sickle. Due to this the person suffers from successive loss of blood. The person, who has this gene in homozygous state, dies in early childhood due to anaemia. But some blood cells are normal and some are sickle shaped in heterozygous state. These heterozygous persons are carrier of that disease and suffer from common anaemia. A beneficial condition for the patients of this disease is this that in areas like Africa continent where malaria is very common disease, such persons usually do not suffer from it, because the malaria parasite does not get their nutrition properly from sickle shaped red blood corpuscles. Hence parasite dies. In progeny of carrier of this diseased heterozygous male and female human one fourth progeny are normal, half progeny are carrier and one fourth progeny are likely to suffer from this disease.

Polygenes –

When one trait (shape or character) is controlled by one gene then it is called monogenic inheritance. Many traits (shape or character) are controlled by many various types of genes. For example the skin colour in human and grain colour in wheat is due to combined effect of many genes. None of them are effective alone. There polygenes affecting a particular trait/ character are found in different chromosomes. These all genes contribute equally and collectively to reveal the total effect. Three or four genes contribute in the formation of skin pigmentation in human. Hence there are indistinguishable changes in colour between blackness and fairness in skin. Such type of inheritance controlled by polygenes is called quantitative inheritance or polygenic inheritance (Fig. 35.6).



	R_1R_2	R_1r_2	r_1R_2	r_1r_2
R_1R_2	$R_1R_1R_2R_2$ Red	$R_1R_1R_2r_2$ Dark Pink	$R_1r_1R_2R_2$ Dark Pink	$R_1r_1R_2r_2$ Pink
R_1r_2	$R_1R_1R_2r_2$ Dark Pink	$R_1R_1r_2r_2$ Pink	$R_1r_1R_2r_2$ Pink	$R_1r_1r_2r_2$ Light pink
r_1R_2	$R_1r_1R_2R_2$ Dark Pink	$R_1r_1R_2r_2$ Pink	$r_1r_1R_2R_2$ Pink	$r_1r_1R_2r_2$ Light pink
r_1r_2	$R_1r_1R_2r_2$ Pink	$R_1r_1r_2r_2$ Light pink	$r_1r_1R_2r_2$ Light pink	$r_1r_1r_2r_2$ White

1 Red : 4 Dark pink : 6 Pink : 4 Light Pink : 1 White

Chromosome and sex determination-

In some diploid organisms, a particular chromosome plays an important role in sex determination. Such types of chromosomes are called sex chromosomes and remaining chromosomes are called autosomes.

Sex – determination in Human –

When sex chromosomes are morphologically dissimilar (XY) in an organism as in case of male human, then that is called heterogametic. In such situation, two types of gametes are formed in males (one has X chromosome and other has Y chromosome). By the presence of only one type of sex chromosomes (XX) in female human she will form one type (22+X) of gametes (Homogametic). Human has 23pair means 46 chromosomes. Male human has 44 autosomes and two sex chromosomes XY (44+XY) while female human has 44 autosomes and two sex chromosomes XX (44+XX). When human ovum fertilizes with Y containing sperm then male baby is developed and with X containing sperm then female baby will develop. To be born baby will be male or female is only a matter of

chance. No one parent can be blamed for the sex of offspring.

Important Points

1. Genetics is a branch of biology which is related to transmission and expression of inheritable information.
2. The meaning of heredity refers to those characters or traits which are transferred from parent generation to filial generation.
3. Genes are located on chromosomes. That place on chromosome where genes are located is known as locus.
4. Many alternative forms of a gene are called alleles. These are present on corresponding loci of homologous chromosomes.
5. The factor which expresses its character in offspring is called dominant factor and that one which is unable to express its characters is called recessive factor.
6. For study of inheritance, Mendel crossed between a pair of alleles contrasting characters. It is called monohybrid cross.
7. When crossed between two pairs of factors or alleles contrasting characters then it is called dihybrid cross.
8. **F_1 generation-** The generation developed as a cross between two parents is called first filial generation or F_1 generation.
9. **F_2 generation** – The generation developed by crossing between F_1 generations is called second filial generation or F_2 generation.

Practice Questions

Multiple Choice Questions-

1. The main reason for success of Mendel was that he –
   (a) Selected pea plant
   (b) Selected one character in one time in his crossing
   (c) Kept generation records
   (d) All of above.
2. The Law of independent assortment is proved that
   (a) All offspring of F_1 generation is tall
   (b) By appearance of tall and dwarf plant in 3:1 ratio
   (c) By appearance of smooth and wrinkled seeded plants in F_2 generation.
   (d) By appearance of tall and dwarf plants in F_2 generation
3. The phenotype ratio of monohybrid cross in F_2 generation is –
   (a) 9:3:3:1 (b) 3:1
   (c) 1:1 (d) 2:1
4. The offspring produced by crossing of red and white are pink. It has proven to be of which type of gene is R?
   (a) Hybrid
   (b) Recessive
   (c) In complete dominance
   (d) Mutant
5. The genotype effect seen in human blood group AB, which is called?
   (a) Dominant- recessive
   (b) In complete dominance
   (c) Co-dominance
   (d) Complementary
6. What is the genotype ratio in lethal gene?
   (a) 1:2:1 (b) 3:1
   (c) 2:1 (d) 9:3:3:1

Very short Answer Questions-

1. Who is called father of Genetics and why?
2. Mention phenotype ratio of monohybrid and di-hybrid crosses in F_2 generation.
3. What are polygenic characters?
4. Where and in which institute did Mendel read research paper of his experiments?
5. The original research paper of Mendel was published in which language and what was its title?

6. Mention the name of scientists who rediscovered Mendel's works.

Short Answer Questions-

1. Mention difference between followings –
   (i) Homozygous and Heterozygous
   (ii) Dominant and Recessive traits
   (iii) Genotype and phenotype
   (iv)Monohybrid and dihybrid cross
2. Define –
   (I) Allele
   (ii) Co-dominance
   (iii) Polygene
   (iv) Lethal Gene
3. Mention the reasons of Mendel's success.
4. Describe with example the incomplete dominance
5. Why Mendel is selected pea for his experiments? Explain.

Essay Type Questions-

1. Which genetical characters of inheritance were studied by Mendel in his experiments? Explain.
2. Explain different Mendel's laws in detail
3. Explain the deviation of Mendel's Laws.

Answer Key-

1. (d) 2. (c) 3. (b)
4. (c) 5. (c) 6. (c)