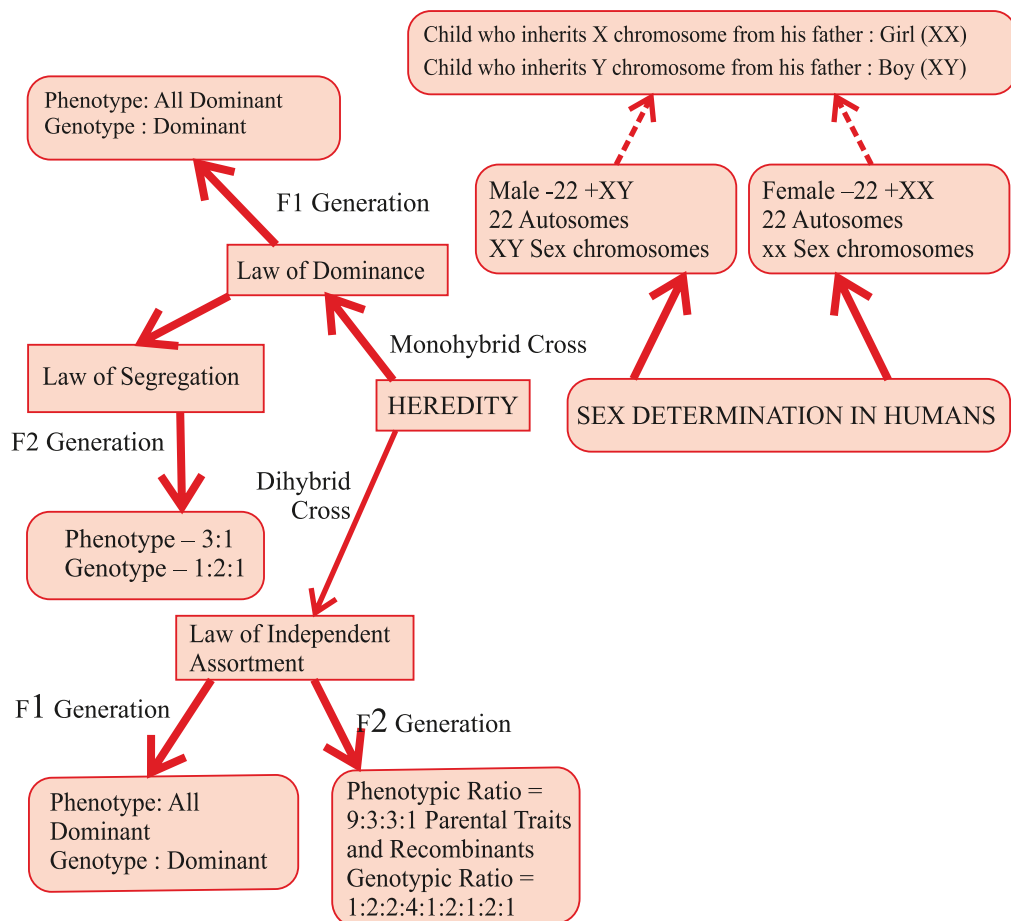
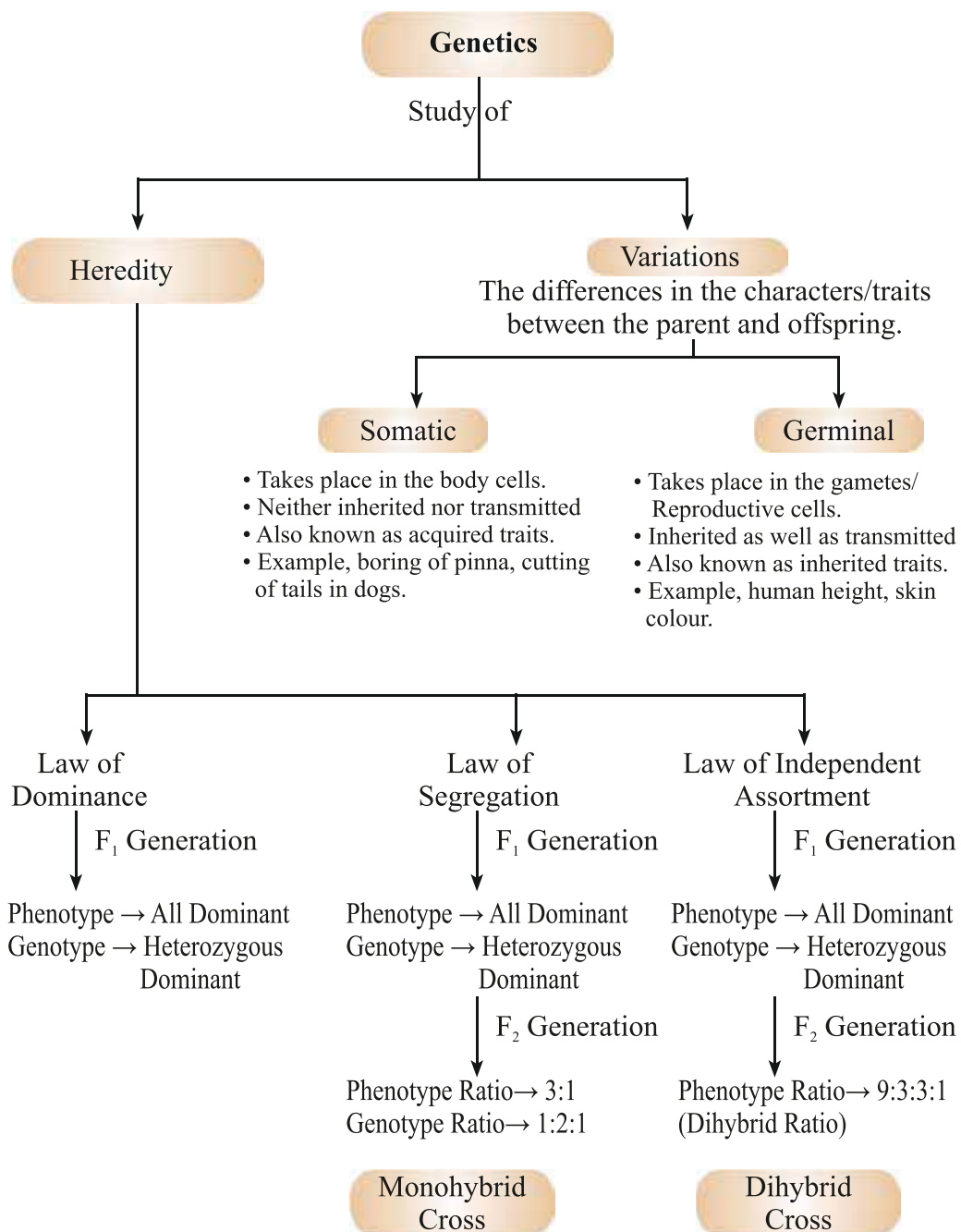




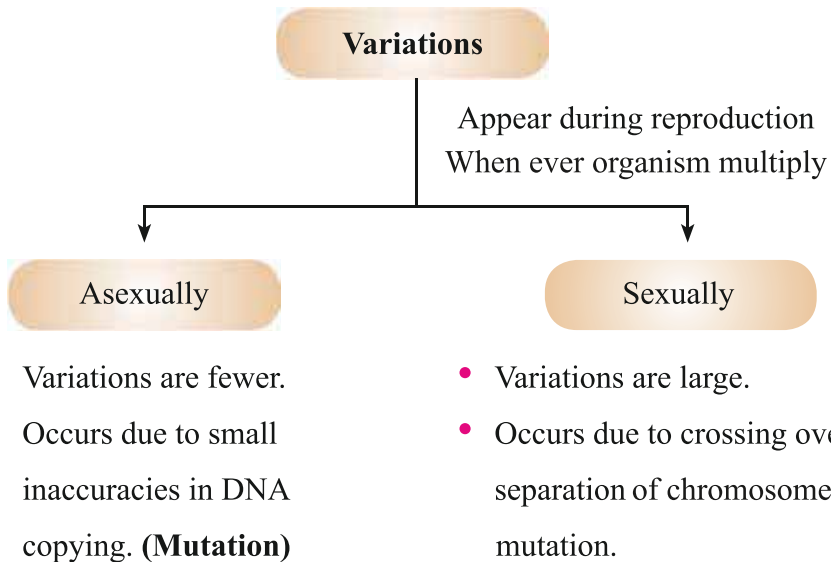
Chapter - 8

Heredity





Accumulation of Variation during Reproduction



Importance of Variation :

- (i) Depending upon the nature of variations different individuals would have different kinds of advantage.
Example, Thermostatic Bacteria that can withstand heat will survive better in a heat wave.
- (ii) Main advantage of variation to species is that it increases the chances of its survival in a changing environment.

Free ear lobes and **attached ear lobes** are two variants found in human populations.

Mendel and His Work on Inheritance

- **Gregor Johann Mendel (1822 & 1884)** : Started his experiments on plant breeding and hybridisation. He proposed the laws of inheritance in living organisms.
Mendel was known as **Father of Genetics**.
- **Plant selected by Mendel** : *Pisum sativum* (garden pea). Mendel used a number of contrasting characters for garden pea.

CHARACTER	DOMINANT TRAIT	RECESSIVE TRAIT
Seed shape	 Round	 Wrinkled
Seed colour	 Yellow	 Green
Flower colour	 Violet	 White
Pod shape	 Inflated/full	 Constricted
Pod Colour	 Green	 Yellow
Flower position	 Axial	 Terminal
Stem height	 Tall	 Dwarf

Mendel's **Experimental Material** : He chose Garden Pea (*Pisum sativum*) as his experiment material because of :

- (i) Availability of detectable contrasting traits of several characters.
 - (ii) Short life span of the plant.
 - (iii) Normally allows self-fertilisation but cross-fertilisation can also be carried out.
 - (iv) Large no. of seeds produced.
- **Mendel's Experiments** : Mendel conducted a series of experiments in which he crossed the pollinated plants to study one character (at a time).

Monohybrid Cross

Cross between two pea plants with one pair of contrasting characters is called a monohybrid cross.

Example : Cross between a tall and a dwarf plant (short).

TT	Both dominant alleles	Pure or homozygous condition
tt		
Tt	One dominant, one recessive allele	Hetrozygous condition – Hybrid

Phenotypic ratio → 3 : 1

Genotypic ratio → 1 : 2 : 1

Phenotype → Physical appearance [Tall or Short]

Genotype → Genetic make up [TT, Tt or tt]

MONOHYBRID CROSS

PARENT → Tall plant × Dwarf plant → PHENOTYPE
 ALLELIC PAIR → TT × tt → GENOTYPE
 OF GENES
 GAMETES → T × t
 F₁ GENERATION → Tt All tall plants
 (First filial generation)

SELF POLLINATION →
of F₁ GENERATION

GAMETES

F₂ GENERATION →

Gametes →

	T	t
T	TT tall	Tt tall
t	Tt tall	tt dwarf

Phenotypic ratio $\rightarrow$ 3 : 1 Tall : Dwarf

3 : 1

Genotypic ratio $\rightarrow 1 : 2 : 1$ $TT : Tt : tt$

$$1 : 2 : 1$$

Observations of Monohybrid Cross

- (i) All F₁ progeny were tall, no medium height plant. (Half way characteristic)
- (ii) F₂ progeny $\frac{1}{4}$ were short, $\frac{3}{4}$ were tall.
- (iii) Phenotypic ratio F₂ – 3 : 1 (3 tall : 1 short)

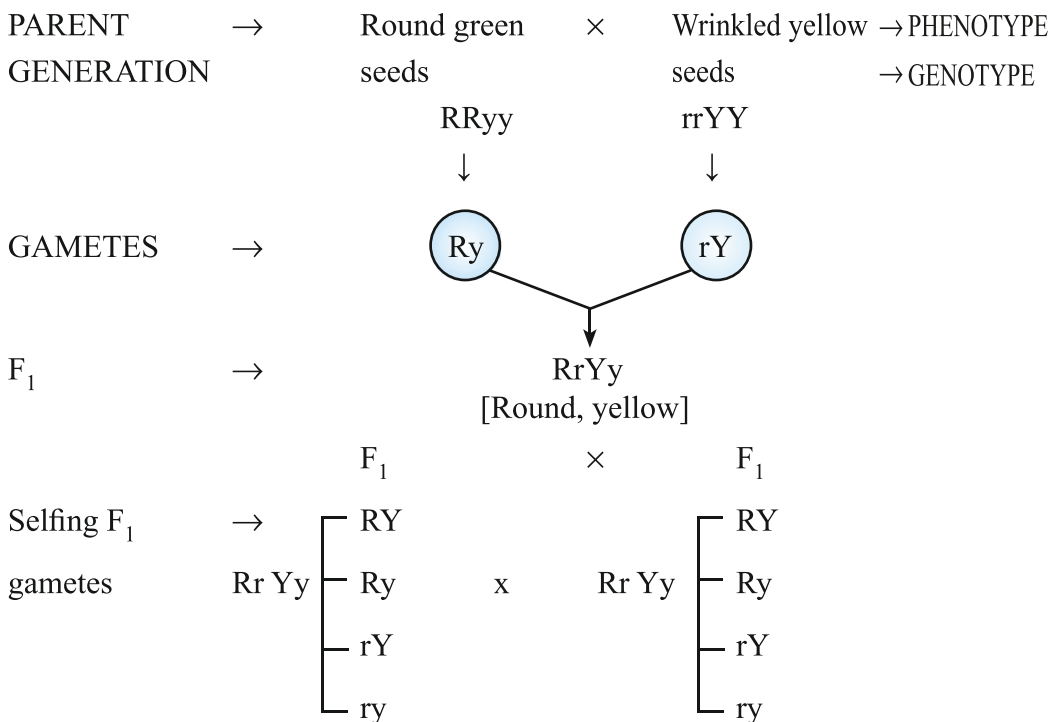
$$\text{Genotypic ratio F}_2 - 1 : 2 : 1 \left(\begin{array}{ccc} \text{TT} & : & \text{Tt} & : & \text{tt} \\ 1 & : & 2 & : & 1 \end{array} \right)$$

Conclusions

- 1. TT and Tt both are tall plants while tt is a short plant.
- 2. A single copy of T is enough to make the plant tall, while both copies have to be 't' for the plant to be short.
- 3. Characters/traits like 'T' are called dominant trait (because it express itself) and 't' are recessive trait (because it remains suppressed).

Dihybrid Cross

A cross between two plants having two pairs of contrasting characters is called dihybrid cross.



F₂ Generation →

	RY	Ry	rY	ry
RY	RRYY	RRYy	RrYY	RrYy
Ry	RRYy	RRyy	RrYy	Rryy
rY	RrYY	RrYy	rrYY	rrYy
ry	RrYy	Rryy	rrYy	rryy

Phenotypic Ratio/Dihybrid Ratio → 9:3:3:1

Round, yellow : 9

Round, green : 3

Wrinkled, yellow : 3

Wrinkled, green : 1

Observations

- When RRYy was crossed with rrYY in F₁ generation all were Rr Yy round and yellow seeds.
- Self pollination of F₁ plants gave parental phenotype and two mixtures (recombinants round yellow and wrinkled green) seeds plants in the ratio of 9 : 3 : 3 : 1.

$$\begin{array}{ccccccc}
 9 & : & 3 & : & 3 & : & 1 \\
 \left(\begin{array}{c} \text{Round} \\ \text{yellow} \end{array} \right) & & \left(\begin{array}{c} \text{Round} \\ \text{green} \end{array} \right) & & \left(\begin{array}{c} \text{Wrinkled} \\ \text{yellow} \end{array} \right) & & \left(\begin{array}{c} \text{wrinkled} \\ \text{green} \end{array} \right)
 \end{array}$$

Conclusions

- Round and yellow seeds are Dominant characters.
- Occurrence of new phenotype combinations show that genes for round and yellow seeds are inherited independently of each other.

Mendel's Law of Inheritance

Based on his hybridisation experiments, Mendel proposed the laws of inheritance.

1. Law of dominance - This law states that when two alternative forms of a trait or character (genes or alleles) are present in an organism, only one factor expresses itself in F₁ progeny and is called dominant while the other that remains masked is called recessive.

Characters are controlled by discrete units called factors. Factors occur in pairs.

2. Law of segregation or law of purity of gametes.

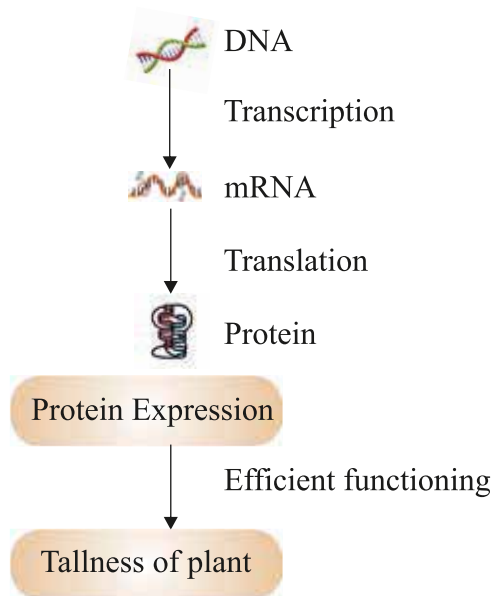
This law states that the factors or alleles of a pair segregate from each other during gamete formation such that a gamete receives only one of the factors. They do not show any blending but simply remain together.

Homozygous parent produces all gametes that are similar, heterozygous parent produces two types of gametes, each having one allele in equal proportion.

3. Law of independent assortment - This law states that the two factors of each character assort or separate out independent of the factors of other characters at the time of gamete formation and get randomly rearranged in the offsprings producing both parental and new combination of characters.

When two pairs of traits are combined in a hybrid, segregation of one pair of character is independent of the other pair of characters.

How do these traits get expressed



Genetic Control of Expression of Traits

SEX DETERMINATION

Determination of sex of an offspring.

FACTORS

Responsible for Sex Determination

Environmental

In some animals, the temperature at which the fertilized eggs are kept decides the gender.

E.g., in turtle

Genetic

In some animals like humans gender of individual is determined by a pair of chromosomes called sex chromosome.

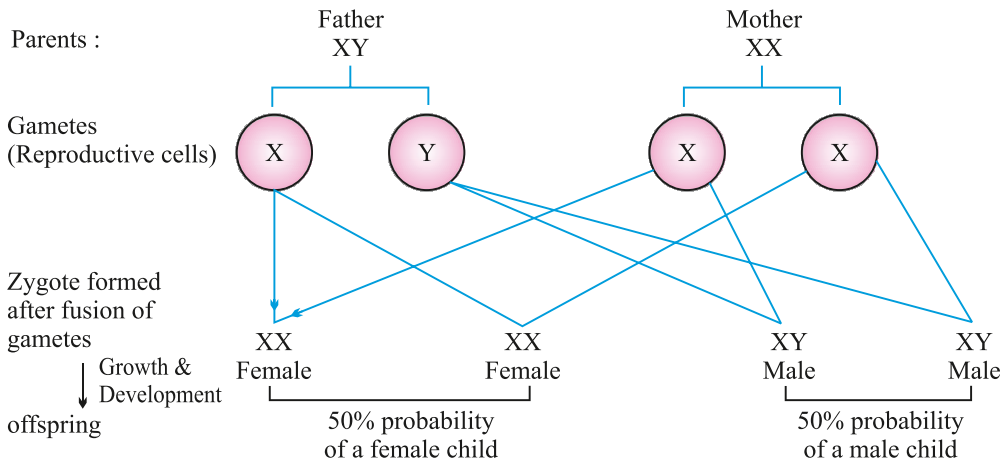
XX – Female

XY – Male

Sex Chromosomes : In human beings, there are 23 pairs of chromosome. Out of these 22 chromosomes pairs are called autosomes and the last pair of chromosome that help in deciding gender of that individual is called sex chromosome.

XX – Female SEX
XY – Male CHROMOSOMES

Sex determination in Human Beings



This shows that half the children will be boys and half will be girls. All children will inherit an X chromosome from their mother regardless whether they are boys or girls. Thus, sex of children will be determined by what they inherit from their father, and not from their mother. Fertilization is a chance factor i.e. which type of sperm will fuse with ovum is a matter of chance.

Blood Group Inheritance In Human Beings:-

There are four blood groups in human beings namely A, B, AB and O and their expression in human population is controlled by three alleles namely I^A , I^B and i [Multiple Allelism]. An individual has only two alleles out of three for blood group. Genotypes and Phenotypes for these 4 blood groups are as under-

PHENOTYPE/ Blood Group	PROBABLE GENOTYPE
A	$I^A I^A$; $I^A i$
B	$I^B I^B$; $I^B i$
AB	$I^A I^B$
O	ii

There Are 6 probable genotypes for 4 phenotypes.

