EXPERIMENT

AIM

Study Mendelian inheritance (Law of segregation) using seeds of different colour/sizes of any plant.

THEORY

Genetics is a branch of science which deals with the study of inheritance and variation of characters from parents to offspring. Gregor Johann Mendel, also known as the father of genetics, had conducted several hybridisation experiments on garden pea (Pisum sativum) for several years and proposed three different laws of inheritance in living organisms.

Mendel's Laws of Inheritance

The three laws of inheritance as proposed by Mendel are as follows:

Law of Dominance According to this law, out of two alleles present in heterozygous condition only one is able to express its effect in the individual and that is called dominant allele. The other allele which does not express itself is called recessive allele, e.g. T (representing tallness) is dominant over t (representing dwarfness) in a pea plant. Therefore, T is the dominant allele and t is the recessive allele. Law of Segregation Mendel hypothesised that allele pairs separate or segregate from each other at the time of gamete formation and the paired condition is restored by the random fusion of gametes during fertilization, i.e. egg cell and sperm cell. So, gametes are pure for a character. This is the reason it is also called as law of purity of gametes.

Law of Independent Assortment Mendel also found that each pair of alleles seggregate independent of the other pairs of alleles during gamete formation.

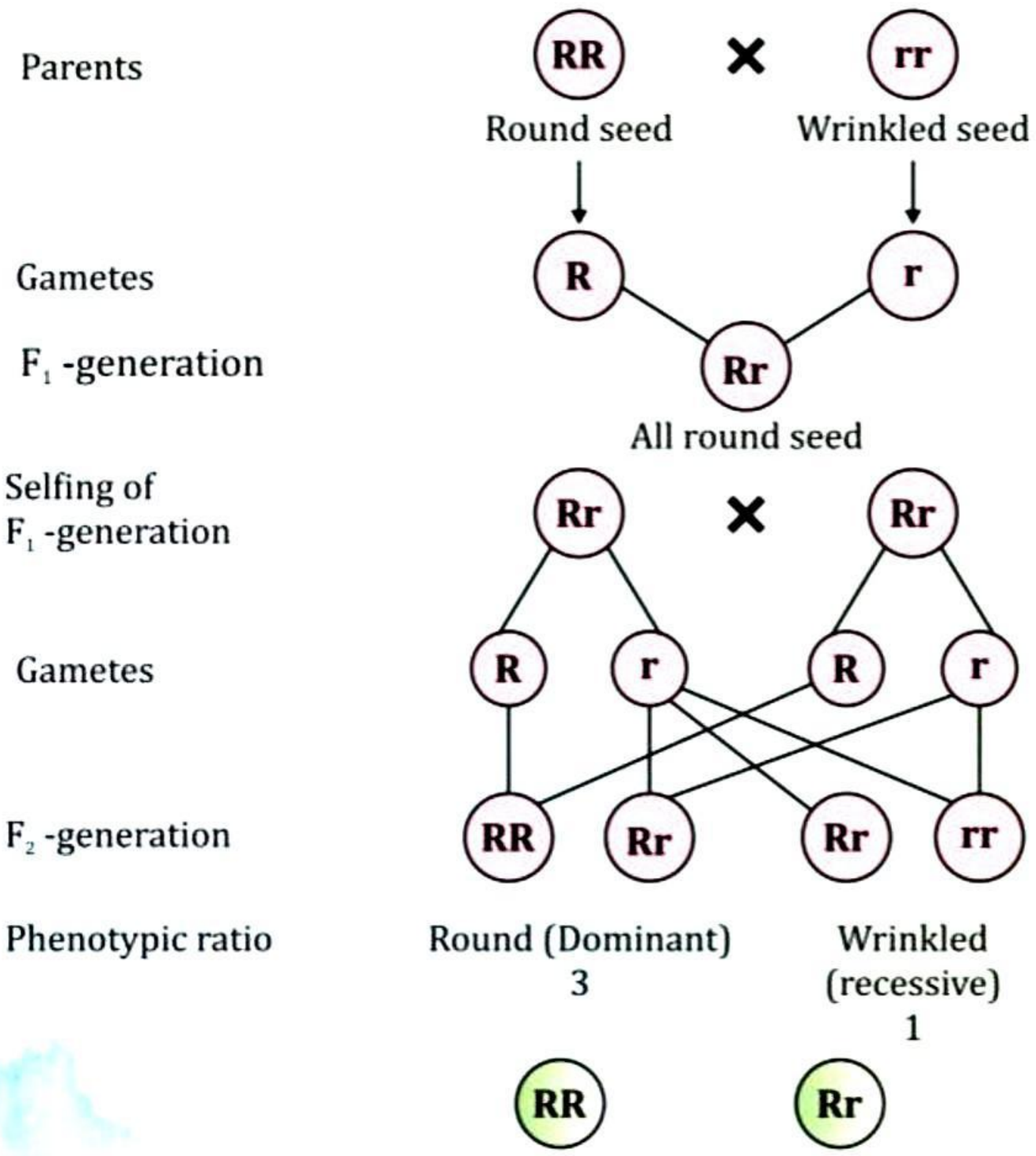
REQUIREMENTS

Pea seed sample, enamel tray, petridish, napkin, notebook, pencil/pen.

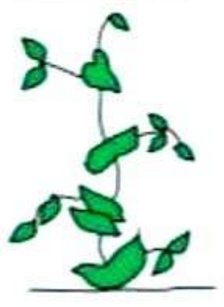
PROCEDURE

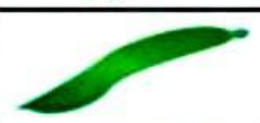
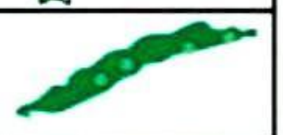
1. Coliect 100 pea seeds of different shapes and sizes and those varied in colour in an enamel tra:
2. Put 50 round seeds in one petridish and 50 wrinkled seeds in the other to represent male and female gametes respectively. Let the round seed be indicated by ' *R* ' and wrinkled seed by '.
3. Take a seed from each container and place them together (it represents fertilisation) on the napkin.
4. Just like the previous step, continue to pick seeds and arrange them in pairs. Thus, 50 pairs of seeds are obtained representing the 50 heterozygous F_1-progeny.
5. Note that all the F_1-individuals are represented by one round and one wrinkled seed.
6. Put 25 F_1-progeny in one petridish and the remaining 25 in another petridish (representing the males and females).
7. Stir the seeds of each petridish with a pencil for about 10 times taking care that no seed falls off.

8. To obtain the F_2-generation, one student would withdraw one seed from one beaker labelled male and one from the other beaker labelled female while keeping his/her eyes closed (to ensult randomness), and put them together in the stretched palm of the partner, who will put thent together on the napkin spread over the table. Continue this process till all the seeds are parred Thus, 50 offsprings of F_2 are obtained.
9. Note the genotype RR or Rr or ir of each pair and their possible phenotype.
10. Repeat the experiment (steps 1 to 9) for five more times with partners changing their roles. Pool all the data from the six repeats together.
11. Calculate the genotypic and phenotypic ratios of your pooled data.



Traits studied by Mendel

Characteristic studied	Dominant Charecter	Received character
Stem length	Long 	Short 

Flower Position	Axillary		Terminal 
Flower colour	Blue 		White 
Pod shape	Inflated 		Constricted 
Pod colour	Green 		Yellow 
Seed shape	Round 		Wrinkled 
Seed colour	Yellow 		Green 

OBSERVATION

Record the result in the following table:

Generation	Repeat No.	Total no. of individuals	Genotype(s) RR:Rr:rr	Phenotype(s) Round: Wrinkled
F_1	1.			
	2.			
	3.			
	4.			
	5.			
	6.			
		Total		
F_2	1.			
	2.			
	3.			
	4.			
	5.			
	6.			
		Total		

Phenotypic Ratio: in F_1.....

in F_2.....

Genotypic Ratio: in F_1.....

in F_2.....

PRECAUTION

Large sample of seeds (traits with shape and colour) should be collected to minimise the error.

The contrasting form of the trait should be observed carefully.

VIVA VOCE

Q1. Do you expect the same result in the terms of 3: 1 ratio in F_2 if you had started with smaller number of seeds (say 10 seeds)?

Ans. No, the same ratio of 3.1inF-generation will not be obtained in a smaller number of seeds or samples be the sample size is very small and there will be larger chances of errors in the experiment. To avoid the error. possibilities large sample size should be taken.

Q2. Who is known as the father of Genetics? Name the plant on which he/she performed his/her experiments.

Ans. Gregor Johann Mendel, an Austrian monk, is known as the father of Genetics. He performed his experiment on garden pea or Pisum sotivum.

Q3. What were the reasons to select the pea plant for formulating the laws of heredity by Mendel)

Ans. Mendel selected the pea plant for formulating the laws of heredity because:

(i) Pea plant has several (7) pairs of contrasting characters.

(ii) Pea plant has short life cycle.

(iii) These can be pollinated (self or cross) easily whenever required.

Q4. What is the difference between phenotype and genotype?

Ans. Phenotype is the visible expression or morphological appearance of an individual due to a particular genotye while genotype is the genetic constitution of an organism.

Q5. Allele is often used in genetics. What do you mean by this term?

Ans. A pair of genes that controls the two alternative expressions of the same characters and have the same locior sites in homologous chromosomes are called alleles.

Q6. Give the genotypic ratio obtained in the law of segregation.

Ans. The genotypic ratio obtained in the law of segregation in Mendel's law of inheritance is 1:2:1.

Q7. Explain the observation on which the law of segregation is based.

Ans. Law of segregation is based on the following observation:

(i) The alleles do not show any blending.

(ii) Both the characters are recovered as such in F_2-generation though one of these is not seen in the F_1 stoge

Q8. Hybrid term is used for which kind of individuals?

Ans. Hybrid is an individual obtained from the crossing of two individuals different in atleast one pair of controsting character.

Q9. The round seeds obtained from a pea plant were sown in the ground. After few days, it was noted that the new pea plant bore some wrinkked seeds as well, besides round seeds. What does this observation prove?

Ans. When round seed pea plant is sown, it also produces wrinkled seeds in its progeny because round seeds we hybrid and round shape of seed was dominant over wrinkled seed which gets segregated in F_2-generation.

EXPERIMENT 6-b

AIM

To verify the Mendel's law of independent assortment.

THEORY

According to the law of independent assortment, when two pairs of traits are combined in a hybrid. segregation of one pair of characters is independent of the other pair of characters at the time of gamete formation. Law of independent assortment involves random rearrangement of gene pairs in the offspring that shows up both parental and new combination of characters. The genes of two different traits assort independently to give a probability ratio equal to segregation probability ratio of one allele pair multiply by segregation probability ratio of other allele pair which becomes (3: 1) × (3: 1) = 9: 3: 3: 1.

REQUIREMENTS

Pea seeds, enamel tray, forcep, needle, hand lens, petridishes, notebook, pencil/pen.

PROCEDURE

1. Take 64 beads each of colours yellow, green, red and white in four separate beakers.
2. Place the beakers containing yellow and red beads on your left side and those containing green and white beads on your right side. Here, the beakers on left side represent plants bearing yellow seed and red flower (dominant characters *Y*, RR) and the beakers on the right side represent plants bearing green seeds and white flowers (recessive characters yy, rr).
3. Stir the beads in each beaker with a pencil/pen for about 5 minutes, taking care that no bead falls off the beaker. Each bead represents alleles in the male and female gametes.
4. Pick up one bead from each beaker and put them together (represents fertilisation) on the napkin spread on the table.
5. Repeat step number 4 till all the beads are utilised and 64 such 4-bead clusters are obtained. These clusters represent the F_1-generation. Ascertain their genotype and phenotype.
6. Let half of the 4-seed clusters, i.e. 32 clusters represent the male parents and the remaining half (32 clusters) as the female parents.
7. Take 4 beakers and label them as 1,2,3 and 4. Now, place the beads in each of the beakers in the following fashion:

   Beaker 1: 32 red beads + 32 white beads
   Beaker 2: 32 yellow beads + 32 green beads — female F_1

   Beaker 3: 32 red beads + 32 white beads
   Beaker 4: 32 yellow beads + 32 green beads — female F_2
8. Stir the beads in each beaker with a pencil/pen for about 5 minutes, taking care that no bead falls off the beaker.
9. Now, one of the students should close his/her eyes and pick one bead from each of beaker 1 (female)

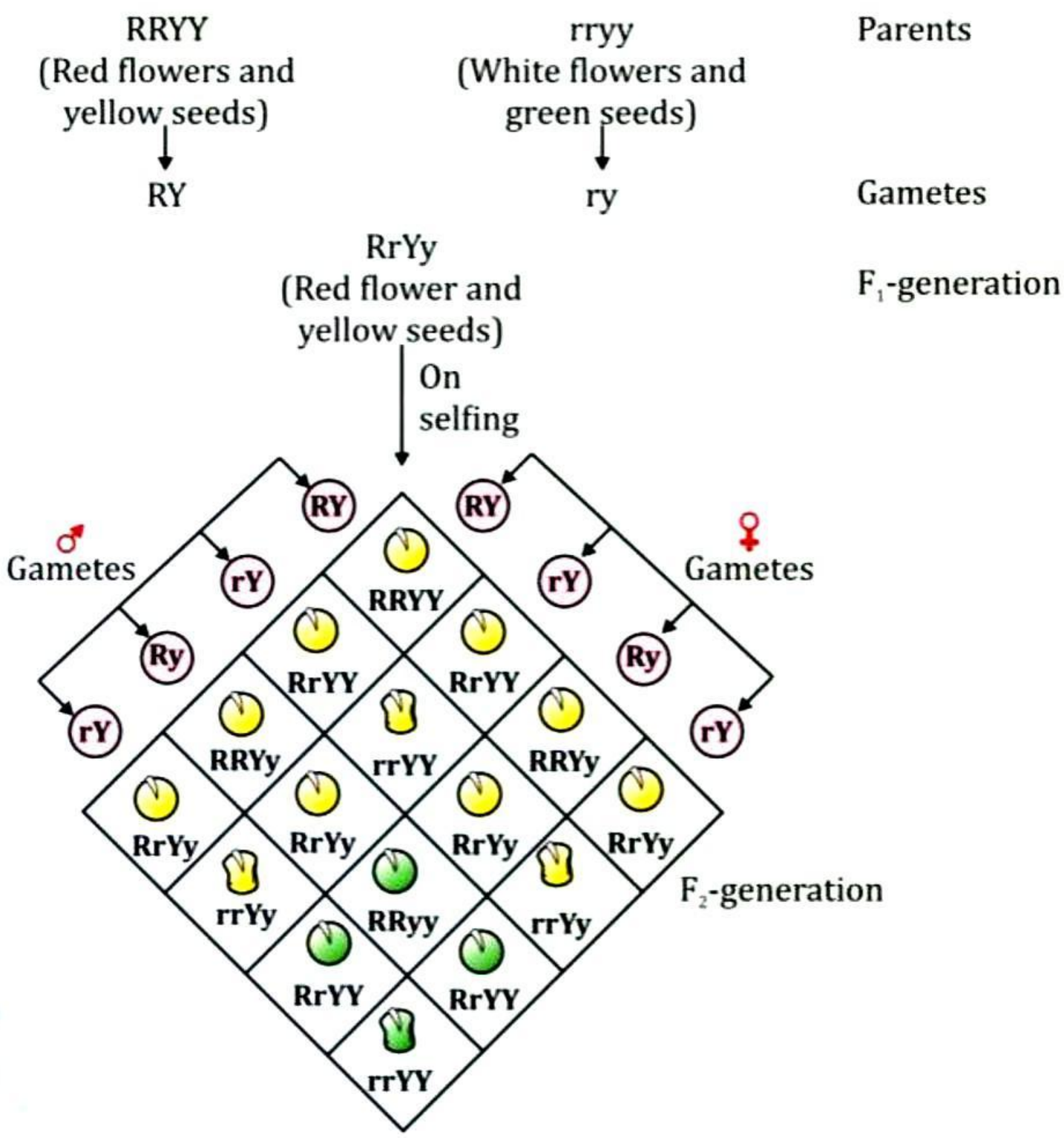
and beaker 3 (male) and put them into the palm of the partner student. Similarly pick a bead each from beaker 2 and beaker 4 .

10. The partner student would now keep all the four beads together (representing F_2 individual after fertilisation).

11. Repeat the steps 9 and 10 till all the beads are utilised. These will represent $64F_2$ individuals.

12. Determine the genotype and phenotype of each of the $64F_2$-individuals and write down the number of individuals of different genotypes and phenotypes in the tabular form, remembering that *Y* (yellow seed colour) is dominant over *y* (green seed) and *R* (red flower) is dominant over *r* (white flower).

13. Repeat the whole procedure(steps 1 to 12) six times and tabulate your results.



Phenotypic ratio = Red flowers and yellow seeds : Red flowers and green seeds : White flowers and yellow seeds: White flowers and green seeds = 9: 3: 3: 1

Genotypic ratio = 1: 2: 2: 4: 1: 2: 1: 2: 1

OBSERVATIONS

F_1-generation

1. Total number of individuals `_____
2. Phenotype(s) _____
3. Genotype(s) _____

Generation and repeat No.	Total No. of offsprings	Genotype				Phenotype			
		YYRR	YYrr	yyRR	yyrr	Yellow red	Yellow white	Green red	Green white
F_1									
1.									
2.									
3.									
4.									
5.									
6.									
Total									

Generation and repeat No.	Total No. of offsprings	Genotype				Phenotype			
		YYRR	YYrr	yyRR	yyrr	Yellow red	Yellow white	Green red	Green white
F_2									
1.									
2.									
3.									
4.									
5.									
6.									
Total									

F_2-generation

6. Total number of individuals _____

7. Phenotypes_____

8. Number of individuals in each phenotypic class.

Number	**Phenotype**
_____	_____
_____	_____
_____	_____
_____	_____

9. Phenotypic ratio

10. Genotypic ratio

11. Number of individuals of each genotypic class.

Number	**Genotype**
_____	_____
_____	_____
_____	_____
_____	_____

12. Genotypic ratio _____

PRECAUTIONS

1. Large sample of seeds (beads) should be collected.
2. Care should be taken while counting seeds or beads, so that any seed or bead should not be missed, repeated or confused.
3. The contrasting form of the trait should be observed carefully.

VIVA VOCE

Q1. How is independent assortment of alleles important from the point of view of variation?

Ans. Independent assortment means the random distribution of maternal and paternal genes to the gametes it gives an idea that how one pair of homologous chromosomes separates into gametes and does not affect the way of separation of other pair. It explains that each gamete may have different combination of chromosomes which forms the basis of variation.

Q2. Linked traits fail to assort independently. Explain.

Ans. The genes that are located physically apart on separate non-homologous chromosomes assort independenty The segregation of alleles into gametes is influenced by linkage in which genes are located physically close to each other on the same chromosome and are more likely to be inherited as a pair.

During the process of recombination or crossing over, it is not possible for two genes present close to each other on the same chromosome to act independent or non-linked, le. they can not be assorted independently.

Q3. On which observation Mendel's law of independent assortment is based?

Ans. The law of independent assortment is based on the observation of dihybrid crosses between plants differing in two traits.

Q4. Name the three scientists who rediscovered the Mendel's law of inheritance.

Ans. Hugo de Vries, Tschermark and Correns were three scientists who rediscovered the Mendel's law of inheritance

Q5. What is back cross and what is its advantage?

Ans. Crossing of F_1-hybrids with either of the parents (dominant or recessive) is called back cross. Back cross is done to incorporate superior characters of a plant into a cultivated variety having large number of other superior characters.

Q6. What is the importance of test cross in genetics?

Ans. The cross of unknown dominant genotype of F_1-generation with homozygous recessive parent is called test cross. It is done to know the genotype of F_1-generation.

Q7. How is test cross different from back cross?

Ans. Test cross is done between the F_1-generation and the recessive parent only. in back cross, F_1-generation con 6 s crossed with any of the parents.