– 7th poush, Wednesday.

Mendelian Genetics.

Symbols and terminology

The basic terms used in the genetic inheritence are described below:

1. Gene:- A gene is the shortest segment of DNA. A gene is also called the basic unit of heredity. Genes are arranged on chromosomes.

2. Genome: It is the total genetic content of an organism.

3. Allele or allelomorph: An allele is one of a particular form of gene. Allele is the short form of allelomorph. It is an alternate form of the same gene in which one is parental and another is maternal. For example, T and t are two allelomorphs of the gene for height of the plant.

4. Locus: The point on a chromosome where an allele is located is called locus. (loci = plural)

5. Homozygous: A diploid individual carrying two identical (similar) alleles is known as homozygous. It is pure or traits. The upper TT and tt are two identical alleles for tallness and dwarfness respectively.

6. Heterozygous: A diploid individual carrying two different alleles is known as heterozygous or hybrid.

7. Dominant allele: Out of two alleles, the one that is capable of expressing itself by hiding or suppressing its contrasting allele is known as dominant allele.

8. Recessive allele: Out of the two alleles, the one which is being suppressed by its alternative allele is called the recessive allele. Recessive allele doesn't express itself when present with the dominant allele (in heterozygous form).

9. Genotype: A genotype is the genetic expression of an organism. It is the genetic constitution of an organism. For plant height, TT, Tt and tt are different genotype.

10. Phenotype: It is the physical or the observable expression of an organism.

11. Character: It refers to a general feature of an organism such as eye colour, plant height etc.

12. Parental generation: The plants used as parents in a cross are said to represent parental generation designated by 'P'.

13. Hybrid: It is the product of a cross in between the two dissimilar parents having contrasting characters.

14. Monohybrid cross: A cross between the two parents that differ in one pair of alternating (contrasting) characters is called monohybrid cross.

15. Dihybrid cross: A cross between the two parents that differ in two pairs of alternating characters is called dihybrid cross. For example, seed shape and seed colour (round yellow versus wrinkled green).

16. Filial (F) generation: The progeny obtained as a result of crossing between parts is a hybrid progeny and is called filial generation. It is represented by F_1 and F_2.

17. Purline: It is the variety (line) which may be homozygous or heterozygous in condition. It is the parental lines. It is called the true breeding varieties.

18. Backcross: A cross that involves crossing of a F_1 hybrid with one of its parents (P_1 or P_2) is known as Back cross.

19. Test cross: In this cross, the individual of an unknown genotype is crossed with homozygous recessive parents. This cross is made in order to determine the genotype of the unknown individual.

20. Pedigree: The history of the descent of a person or family.

21- Reciprocal cross : It is the cross of the same genotype where gametes from the parental generation are reversed. In experiments of "A" is used as the female parent and "B" as the male parent in one experiment and in other experiment "A" and "B" are used opposite of 1st experiment. The purpose of reciprocal cross is to find out whether both parents are making equal contribution or not.

22. Punnett square: It is a checker board or graphic method to study all possible result of various crosses. It was devised by a geneticist R.C Punnett (1906). Punnett square is helpful to understand various probability of combinations as well as to find their probability of occurance in a generation.

Biography of Gergor John Mendel

Gergor John Mendel was born in 1822 at Moravia a small village in Czech Republic. Due to the poor family status he could not continue his higher studies. After returning to the Monastry he continued to work of hybridization and spent his life making crosses in betn the plants. He studied various characters of plants and performed various experiments on a common pea plant (Pisum sativum). With his experiments on the garden pea plant which explain the process of inheritance of characters. He published his result in "The Annual Proceeding of Natural History Society" a local natural history society. Mendel's law were discovered simultaneously by Dutch biologist Hugode vries, a german botanist carl correns and an Austrian botanist Erich von Tschermark. After the rediscovery, Mendel's law were widely accepted and Mendel, on this basis, was called "Father of Genetics"

1. Pea plant posses many varieties, with well defined characters Mendel chose among these varieties from seven different 'unit characters' to follow inheritance.
2. The flowers of pea plants are bisexual. The stomens and the pistils (sex organs) are completely enclosed within a corolla (petals) and hence the flower are normally self pollinated.
3. Pea flowers could easily be cross pollinated or crossed (hybridized) by the hand which is done by removing the stomens before the pistil of the flower matured and then dusting the stigma of the pistil with the pollens from another desired pea plant, so it can be easily crossed.
4. It can easily be cultivated and it relatively required a small space to grow each plant.
5. Pea plants have a very short lifespan and thus many generations can be formed in only a single growing season.
6. The hybrids of the pea plant are perfectly fertile.

Mandel was lucky that the pea plant didn't show any incomplete dominance.

Mendel's experiment.

Mendel's studied the inheritance of seven different morphologically traits on pea plants. These traits are:-

Traits	Dominant	Recessive
Seed shaped	Round	wrinkled.
Seed colour	yellow	Green
pod shape	Inflated	constricted
Pod colour	Green	Yellow
flower colour	purple	white.

flower location	Axial	Terminal
plant size	Tall	short (dwarf).

Mendel's monohybrid cross:

A cross between the two pure (homozygous) parents plants differing in only one pair of contrasting characters is called monohybrid cross. It involves the cross with a single pair of contrasting characters. Here a cross is made between tall plant (TT) and dwarf plant (tt).

In this experiment, he removed pollen grain from the anther of the tall plants and transffered them to the stigma of the dwarf plant. these plants were tall and he called them as the hybrized plants and he called it as first hybrid generation (Filia) 1 or (F_1) and offspring were called filial 1st or F_1 progeny.

T = Tall allele (dominant) t - dwarf allele (recessive)

Genotype of parents TT × tt

Meiosis

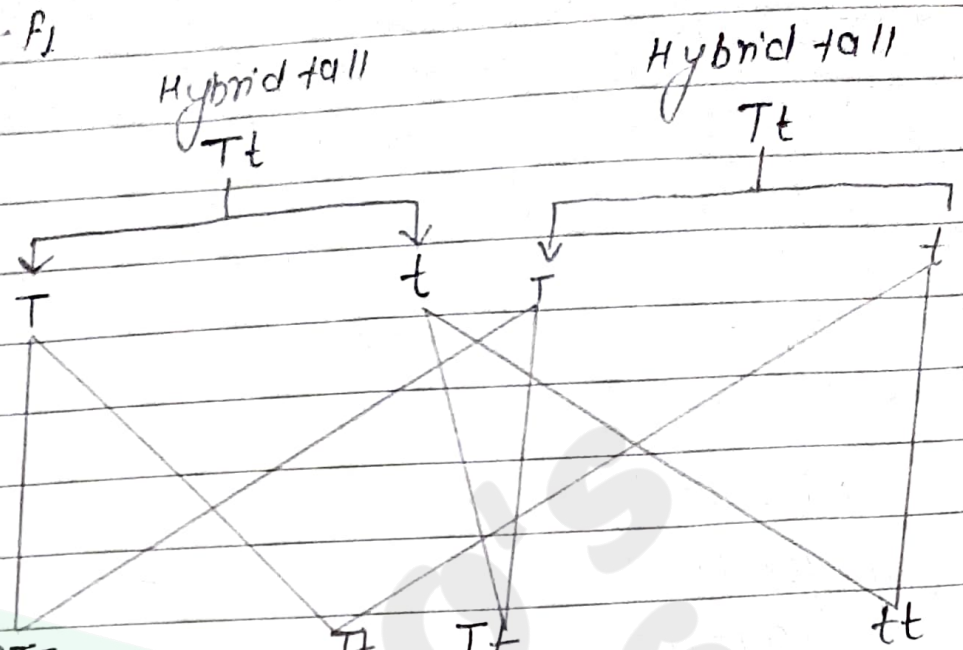
Gametes T T t t

Random fertilization

Genotype:	Tt	Tt	Tt	Tt
phenotype	Tall	Tall	Tall	Tall

(All plants are tall in F_1 generation).

On self pollination of F_1



TT = Homozygous dominat or pure tall.

Tt and Tt = Heterozygous or hybrid tall.

tt = Homozygous recessive or pure dwarf.

Mendel continued his experiment with self pollination of F_1 progeny plants. Surprisily, he observed that one out of four plant were dwarf and other were tall. There phenotype ratio was 3:1 however, the genotype ratio was 1:2:1. He called them second hybrid generation were called filial or F_2 progeny.

Parental (P) Phenotypes:	Homozygous tall and round seed	Homozygous dwarf and wrinkled seed
Genotype:	TTRR	ttrr
Meiosis	↓	↓
Gamete	TR	tr

Offspring (F_1)
Genotypes — TtRr
Phenotypes — Heterozygous tall and round

F_1 parents — TtRr × TtRr

Gametes — TR, Tr, tR, tr (for each parent)

♂ \ ♀	TR	Tr	tR	tr
TR	TTRR Tall Round	TTRr Tall Round	TtRR Tall Round	TtRr Tall Round
Tr	TTRr Tall Round	TTrr Tall wrinkled	TtRr Tall Round	Ttrr Tall wrinkled
tR	TtRR Tall Round	TtRr Tall Round	ttRR Dwarf Round	ttRr Dwarf Round
tr	TtRr Tall Round	Ttrr Tall wrinkled	ttRr Dwarf Round	ttrr Dwarf wrinkled.

Genotype
TTRR=1
TTRr=2
TtRR=2
TtRr=4
TTrr=1
Ttrr=2
ttRR=1
ttRr=2
ttrr=1

Phenotype: Tall round — Tall wrinkled — wrinkled Round — wrinkled dwarf

Phenotype ratio: 9 : 3 : 3 : 1
Genotype ratio: 1:2:2:4:1:2:1:2:1.

Mendel's dihybrid cross:

Across between two pure (homozygous) parental stock differing in two pairs of contrasting characters is called dehybrid cross. In such cross, crossed between tall-round ~~dihybrid cross. In su~~ seed (TTRR) and dwarf-wrinkled (ttrr) was made just like in mono hybrid cross. In F_1 generation, the outcome was the seeds that were tall-round (TtRr) plant which indicated that the tall and round traits are dominant while the dwarf and wrinkled shaped were recessive trait.

The self-pollination of the obtained plants from F_1 progeny resulted in four varying combinations of seeds in the subsequent generation, the filial or F_2 generation. The outcome and the dehybrid cross ratio were tall round, dwarf round, dwarf-wrinkled, tall wrinkled and the phenotype ratio was 9:3:3:1. However the genotypic ratio was 1:2:1:2:4:2:1:2:1

Genotypes of F_2	Number of genotype	Total phenotypic probability no of each kind of phenotype.

(*) Mendel's law of inheritance

On the basis of above monohybrid and dihybrid crosses, Mendel's postulated three laws which are now called Mendel's law of inheritance.

(a) principal of dominance

In hybrid, the plants are heterozygous. In heterozygous plants, single trait is controlled by two contrasting alleles. Out of these alleles, only one express its character and supress the other. The one, which is expressed is called dominant and the other is called recessive.

In F_1 generation all plants are heterozygous tall (Tt) although they have received the factor of both tallness and dwarfness but since the tallness is dominate so it is expressed whereas dwarfness is not expressed and it becomes recessive.

The principal states that "one factor in a heterozygous pair may mask the expression of the other.

(b) Law of segregation (First law of inheritance)

The first law states that "two constrating allele factors of a character which remain together in a heterozygote individual do not get mixed up but keep there identity distinct, seprate or segratate at the time of gamete formation, so that a gamete gets only one out of two alleles". this is known as the law of segregation or law of purity of gametes.

In other word, the hybrid (heterozygote) of f_1 generation being dominant and ~~receive~~ recessive type and these factors, remain together without blending or mixing with eachother these alleles segregate or separate at the time of gamete formation carrying only one factor either dominant or recessive. It is called law of purity of gametes.

(c) Law of independent assortment (second law of inheritance).

This law states that the factors (genes) of different characters located in different pair of chromosomes are independent of one another during gamete formation (meiosis). when two pairs of independent alleles enter into combination in the F_2, they show independent dominant effects. In the formation of a gametes, the law of segregation operates but the factors assort themselves independently or random or freely.

Mendel formulated this law from the results of dihybrid cross. when a pea plant of two different characters with tall and round cotyledons (TTRR) is crossed in F_1 generation, all the plant have round ~~round all four types of gametes~~ seed with tall plant and genotype TtRr. F_1 plant produce all four types of gametes TR, Tr, tR, tr and the T and R and t and r are free to assort themselves at random. Thus, there are 4 phenotypes and 9 genotypes in F_2 generation.

The F_1 hybrid produce four kinds of gametes TR, Tr, tR, tr in equal number. There are chance of 16 possible combination among the gametes.

Of these, tall round and dwarf wrinkled green seeds are in the parental combinations whereas two new combinations are obtained as tall wrinkled and dwarf round (hence called recombinations) The ratio of F_2 generation is 9:3:3:1 and is termed as dihybrid ratio this experiment shows that each pair of alleles strictly segregates and is independent of each other which demonstrates the Independent assortment or law of free recombination. The apperance of the recombinations in F_2 generation of dihybrid cross proves this law

The plants show 4 types characters in the ratio of 9:3:3:1.

- Tall plant and round seeds - 9/16.
- Dwarf plant and round seeds - 3/16.
- Tall plants and wrinkled seeds - 3/16.
- Dwarf plants and wrinkled seeds - 2/16.

Importance of Mendelism.

Mendel's law are of great use in solving the problems of genetics. Some of these are mentioned below:

1. Dominant and recessive characters can be found out.
2. Crosses can be made to produce of hybrid with desired characters.
3. Agriculturally useful plant can be improved.
4. Pure but recessive characters can be used whenever required.
5. The genotypes and phenotypes likely to be produced in the next generation can be predicted even before the cross can be made.
6. New varieties of plants can be created.

* Eye colour of Drosophila (fruit fly):-

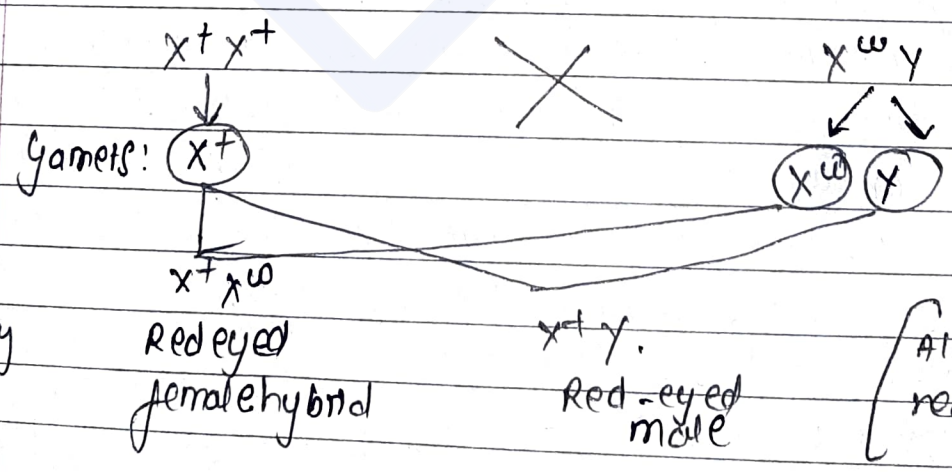
The first person to explain the sex inheritance in the fruit fly (Drosophila Melanogaster) was an American biologist Thomas Hunt Morgan. The Drosophila has XX and XY sex chromosome in female and Male respectively.

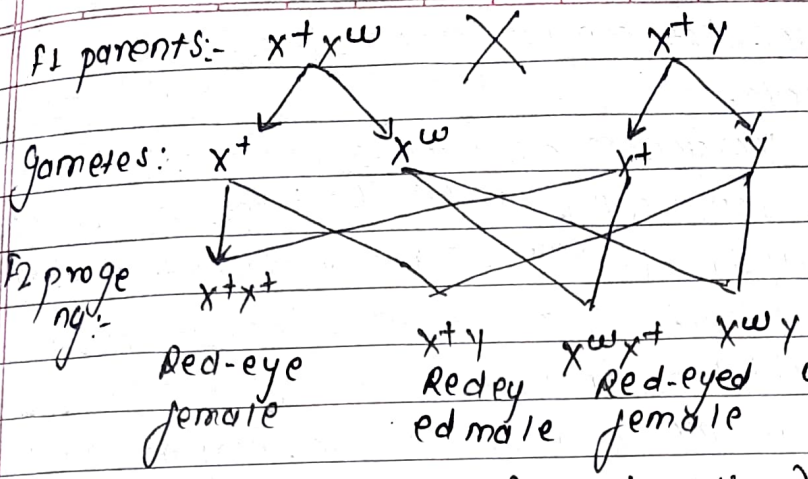
1. The ~~no~~ normal eye colour of the fruit fly is red.
2. White eye colour was the mutant form.

Cross :-I :- A cross betn red-eyed female and white-eyed male Drosophila.

Red eyed female: X^+X^+

White eyed :- X^wY





when a homozygous (pure breeding) red-eyed female (X^+X^+) was crossed with the white-eye male fly (X^wY) all the fly in f_1 generation were found to be red-eyed. It is because of red eye colour is domenant over white eye colour.

Further, when the f_1 gred-eyed male (X^+Y) and red eyed female (X^+X^w) fruitflies were allow to interbreed (self-breed) in f_2 generation both the fruits of red-eyed and white eyed appeared in the ratio of 3:1.

Morgan found new rumpning results as given below (In f_2 generation)

→ All f_2 females were red-eyed.
→ Half of f_2 females were red-eyed.
→ Half of the f_2 males were white eyed.
→ The ratio of red-eyed to white eye is 3:1.

* Cross-II :- A cross between heterozygous red-eyed female and white eyed male.

Morgan made a cross between heterozygous f_1 red-eyed female fly. (x^+x^w) obtained from cross-I. with a white eyed male (x^wy). It is similar to a test cross where f_1 offsprings are crossed with homozygous recessive parents. He obtained in F_2 generation, the red and white eyed females as well as males in equal portion. (one red-eyed female and white-eyed female, one white-eyed male and one red-eyed male) this test cross indicates that white colour is not restricted to male sex was also present in the recessive form in the females.

Parents :- F_1 red eyed female — white eyed male

Genotype :- x^+x^w — x^wy

Gametes :- x^+ x^w — x^w y

Punetts square :-

	x^+	x^w
x^w	x^+x^w	x^wx^w
y	x^+y	x^wy

x^+x^w → Red-eyed female
x^wx^w → white-eyed female
x^+y → Red-eyed male
x^wy → white-eyed male.

As a result, in f_2 generation he obtained.
25% red-eyed female
25% white-eyed female
25% red-eyed male
25% white eyed male.