RAMA UNIVERSITY

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FACULTY OF AGRICULTURAL SCIENCES AND ALLIED INDUSTRIES

LAWS OF MENDEL

Mendel was borne in 1822 near Brunn (Czechoslovakia) in Austria, in the family of a poor farmer. Unable to continue his studies, due to poverty, he joined St. Augustinian Monastry at Brunn in 1843 and became a priest. He was sent to the University of Vienna, where he studied physics, maths and philosophy etc., Then he returned to Brunn in 1854 where he was appointed as a substitute science teacher and his peformance as a science teacher was excellent. In addition he worked as a priest in the local church. He lived in a house located within the premises of the church. He began to collect pea seeds for his experiments in 1857 from commercial seed growers all over the Europe. He conducted all his experiments within the kitchen garden of his house with the help of his own resources.

After 7 years, he presented his findings byne the Natural History Society of Brunn in 1865. This paper entitled " Experiments in plant hybridization" was presented in German language. Later Mendel studied on Honey bee, some other plants and climatology. He died in 1884 at an age of 62 years and long before the world understood and appreaciated his contributions to our understanding of life.

Sixteen years after his demise, three scientists working independently of each other de vries in Hollad, correns in Germany and Tschermak in Austria, arrived at the same conclusions as those of Mendel. After this rediscovery there was a spirit of interest in the Mendel's findings and the science of genetics was timely borne. Although the basic principles of genetics wre enuciated in 1865 itself, the new baby borne was kept in an incubator and forgotten for the next 35 years.

PEA as an experimental material

Pea offered several advantages as an experiment material.

i. In the pea varieties available commercially, several characters had two contrasting form which were easily distinguishable from each other.

Character	Dominant form	Recessive form
Seed shape	Round	Wrinkled
Seed coat colour	Grey	White
Cotyledon colour	Yellow	Green
Pod colour	Green	Yellow
Pod shaped	Full	Constricted
Position of flowers	Axial	Terminal

Length of stem	Tall	Dwarf

ii. The flower strcuture of pear ensured self pollination this was experimentally verified by Mendel. This greatly facilitated the production of F2 and F3 progeny as well as avoided contamination by foreign pollen.
iii. Pea flowers are relatively large. Therefore emasculation and pollination is quite easy, which allows easy artificial hybridization in pea.
iv. The duration of pea crop is of a single season. As a result, every year one generation of pea can be grown.
v. Pea seeds are large and present no problem in germination. Pea plants are relatively easy to grow and each plant occupies only a small space. This persists a large number of plants to be grown in a relatively small area.
(In addition, Mendel worked in Raj mash, *P. vulgaris*)

Reason for Mendel's success

i. Mendel studied the inheritance of only one pair of contrastiang chracters at a time. This allowed him to classify in F2, F2 progenies into two clear cut groups.
ii. He selected pea varieties that had clearly different gorms of one or more chracters.
iii. Mendel classified all the plants of a population on the basin of the contrasting chracters under study and kept an accurate record of the numbner of plants in each category.
iv. Mendel carried out his experiments with great care and elaborators. For e.g. He grew the pea varieties used as parents for two seasons to avoid mechanical mixtures and the verify homozygosity of varieties and stability of the character difference.
v. His knowledge of maths was a definite asset on interpretation of his findings.
e.g. He was able accept the ratios ranging from 2.82:1 to 3.15:1 over all estimation of 3:1 and not separate ratio.

vi. Mendel was able to formulate appropriate hypothesis on the basis of explanation he offered for his experimental findings. Further, he proceeded to test these hypothesis experimentally to prove the correctness of his explanations.

MENDEL WAS UNDOUBTEDLY LUCKY

i. Seven characters selected by Mendel showed qualitative inheritance.
ii. Each characters is governed by a single dominant gene.
iii. Of the 7 characters, the gene for 2 character were located in one chromosome. While 3 other were in another chromosome. But out the these,

only 2 were close enough to distort di hybrid ratio of 9:3:3:1. Luckily Mendel did not study this character pair.

REASONS FOR NEGLECT OF MENDEL'S FINDINGS

i. Mendel used mathematical principles of probability to explain a biological phenomena. This was something new and not radily acceptable to biologist.
ii. He studied constrasting pairs of characters exhibiting discontinueous variation, which is unimportant in evolution.
iii. In this studies, only the parental forms appeared, no new forms (variation) were recovered.
iv. The pheneomenon of fertilization, behaviour of chromosomes during cell division wre not known at the time, when Mendel presented his findings.
v. Mendel failed to demonstrate his conclusion in other species.

LAWS OF MENDEL

Mendel selected 22 distinct varieties of pea *Pisum sativum* for hybridization. Each of these varieties differed from the other with respect of one or more characters. Mendel crossed varieties differing for one pair of contrasting characters. A cross between tow parents differing for a single character is termed as 'Monohybrid ratio'. While those between parents differing for two and three characters are known as dihybrid and tri hybrid crosses respectively. The progeny obtained by crossing are known as 'hybrid' or F1 generation (F1= first filial or progeny generation).

Mendel crossed a variety of pea having rounds seeds with a variety having wrinkled seeds.

Round x Wrinkled

RR rr

↓

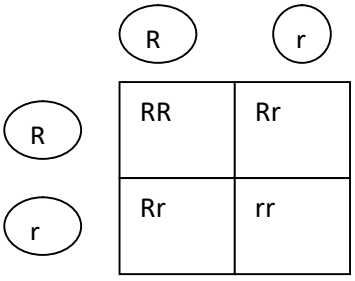
(First filial) F1 Rr : Round

↓

F2 3 Round : 1 Wrinkled

RR: Rr, Rr : rr

Round Wrinkled



In F1, all the offspring were uniform and resembled one of the parents so closely that the characters of the other escaped observation completely. Those parental chracters which aappeard in F1 were termed dominant, and those parental characters which entirely disappeared in F1 were termed 'Recessive'.

GENE

Hypothetical unit of inheritance located at (Johannsen) a fixed position (i.e. Locu) on a chromosome. (Factor - (Bateson) determines a character.

ALLELE:

Alternative form of a gene. Mendel recognised the presence of constant differentiating characters. These contrasting chracters are attributed to the presence of allelomorphus, situated at the same locus of homologus chromosomes.

GENE SYMBOLS

Dominant gene is represented by capital letter and its recessive allele by the corresponding small letter.

Homozygote (Bateson)

As organism derived from the union of gametes of similar genetic constitution e.g. RR, rr

Heterozygote (Bateson)

An organism derived from the union of gamets of dissimilar genetic constitution e.g Rr.

Phenotype (Johnnsen)

It is the external appearance of an organism. It is the result of the interaction between genotype and environment.

Gentoype

The entire genetic constitution of an organism e.g. TT - Genotype

Character - Phenotype.

MENDELS FIRST LAW (LAW OF SEGREGATION)

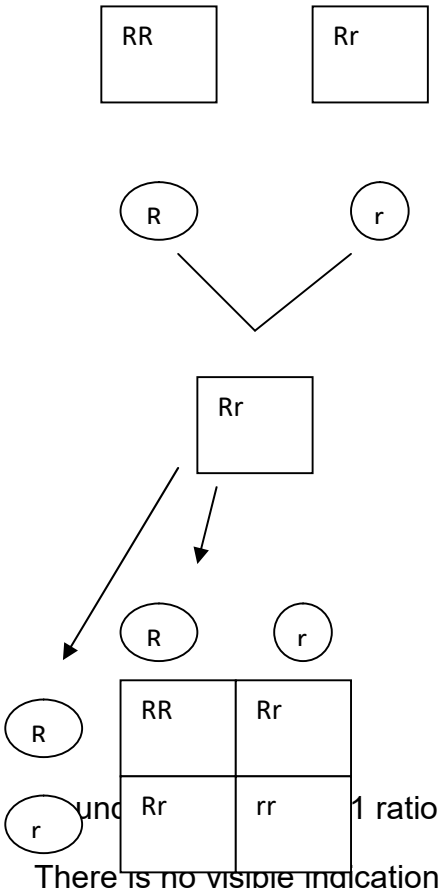
When a pair of contrastiang characters are brought together in a hybrid, the factors responsible for the character donto belnd or contaminate each other in the hybrid, but when gametes are formed they segregate and pass into different gametes in a difinite proportion.

In fertilization, the gametes combine at random (i.e they unite freely in all possible combinations). The F2 consists of 4 combinations viz., RR, Rr, rR, rr in equal numbers.

RR have only gene for round

Rr, rR have gene for round and wrinkle

Rr have only wrinkeld gene.



1 ratio

There is no visible indication of the presence of allele 'r' in the F1, the allele R and r do not linked or fuse with each other while they are together in F1. The alleles R and r do not also contaminate or affect each other.

Monohybrid

A cross between parents differing in a single gene. An individual heterozygous for one pair of alleles.

Purity of gametes

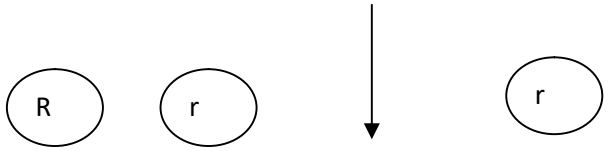
The most important principle of Mendel's Law of segregation is that, even hybrid individuals produce gametes which are always pure. Hybrid individuals (heterozygous) with refererred to one pair of allells produce two kinds of gametes. It is pure and has either dominant allele or recessive allelle but never both. The twokinds of gametes are formed by hybrid in approximately equal numbers, has been shown in several species.

Backcross and testcross

Backcross in a cross between hybrid and any one of the parents, whereas testcross is a cross between hybrid and a recessive homozygote.

F1 Test cross Back cross

Rr x rr Rr x RR or rr



Rr : rr

Round : Wrinkled

1 : 1

Reciprocal crosses

It is a second cross involving the same characters as the first but with the sexes of the parents interchanged.

Whichever way the cross is made, the results will be the same, in case nuclear genes determine the characters. However, when heriditory factors, in the cytoplasm also interact with nuclear genes, receiprocal differences have been observed. In representing crosses, it is conventional to write the female parent first and the male parent second.

Xenia

Effect of pollen on the embryo and endosperm. E.g. in maize, colourless seeded plant is dusted with purple seeded plant pollen, shows the purple seed in the cob.

Purple is dominant over colourless.

Incomplete dominance

Dominance is incomplete and the hybrids resemble neither parent exactly but are more or less intermediate between the two.

e.g. Fowl BB - Black F1 - Bb blue

Bb - While F2 - 1:2:1

bb - Blue 1 Black 2 Blue 1 white

eg. Meiabilis jalapa

RR - Red

Rr - Rose

Rr - White 1 : 2 : 1 in F2

Co-dominance

Heterozygote express the phenotype of both the parents mingled together, as neither of allels exhibit either the dominant or recessive expression. Such a condition whre both alleles dominant and recessive are capable of expression equally in heterozygote condition called 'Co-dominance'.

e.g. Cattle coaf coat colour

WW - Red hair

Ww - Roan (Red hair + White hairs)

ww - Whire hair F1 - Roan

F1 - 1:2:1

e.g. Blood group 'MN' - aggluination test based on antigen antibody relationship.

	Phenotype			Reaction to antiserum	'M'	'N'
L^M	L^M	-	M		+	-
L^N	L^N	-	N		-	+
L^M	L^N	-	M^N		+	+

Co dominance is also referred to as "Mosaic dominance' Mosaic expression of both.

LAW OF INDEPENDENT ASSORTMENT (Law of inheritance)

Law: The segregation is one pair of allelles is independent of the segregation in any other pair of allels.

When an individual forms gametes, the member of a pair of alleles always segregate frome ach other but the members of different pair of alleles assort independent of each other.

Dihybrid ratio

RR yy - Round, yellow seeded

Rr yy - Wrinkled and greed seeded

RR	yy	x	rryy	R-Y	9	Round yellow
		↓		R-yy	3	Round green
F1		RrYy		rr-Y	3	Wrinkled yellow
		↓		rr-yy	1	Wrinkled green
F2		9:3:3:1				

Test cross

F1 Rr Yy x rr yy (recessive)

1:1:1:1

Dihybrid

A cross between parents differing in two genes, an individual heterozygous for two pairs of alleles.

Poly hybrid

An individual heterozygours for several genes.