MENDEL'S LAWS

Based on Mendel's experimental results certain principles are framed which are called Mendel's laws. They are as follows :

1. Law of dominance.
2. Law of segregation
3. Law of independent assortment.

1. LAW OF DOMINANCE

Each organism is formed of a bundle of characters and each character is controlled by a pair of factors or genes (T or t). Each factor of the paired factors (Tt) is responsible for the expression of a particular variety (tall or dwarf) of a character (height). Those characters which appears in F_1 generation and prevent or mask the effect of the factor for other character, is designated dominant while the character which does not appear is called recessive. Tallness is due to a dominant factor (T) and dwarfness is due to a recessive factor (t). In a hybrid, if a dominant factor is present, the recessive factor does not produce any obvious effect. For example, if T is present the t cannot produce its effect and the plant will always tall. A recessive factor (t) freely expresses itself in the absence of its dominant allele (T). This law is based on the monohybrid experiment.

Dominant & recessive characters in pea plant selected by Mendel

No.	Characters	Alternatives	
		Dominant	Recessive
1.	Length of the stem	Tall	Dwarf
2.	Position of the flower	Axial	Terminal
3.	Colour of the pod	Green	Yellow
4.	Shape of the pod	Inflated	Constricted
5.	Shape of the seed	Round	Wrinkled
6.	Colour of the seed coat	Coloured	White
7.	Colour of the cotyledon	Yellow	Green

TYPES OF DOMINANCE

When Mendel crossed a true breeding tall plant with a true breeding dwarf plant, the progeny became all tall. Mendel called such traits for tallness of plants as dominant and such traits for dwarfness of plants as recessive. This is known as complete dominance. Many other characters show such property. But the dominance is never assured. There are different kinds and degrees of dominance. They may be classified

as follows :

(A) Incomplete or partial dominance

When the hybrid resembles one parent much closely than the other but may not resemble it exactly. Often the F_1 products are clearly intermediate between two parents. A simple example of this is the inheritance of petal colour in Snapdragons. When pure-bred white and pure-bred red flowered plants are crossed, the F_1 generation has pink instead of white or red petal (Fig 1.4).

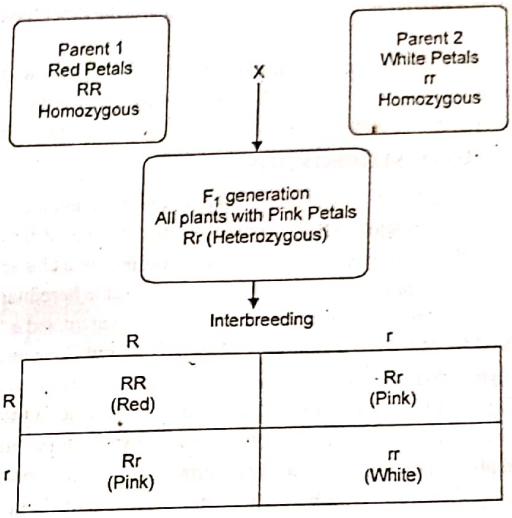


Fig. 1.4. Showing incomplete dominance.

(B) Delayed dominance

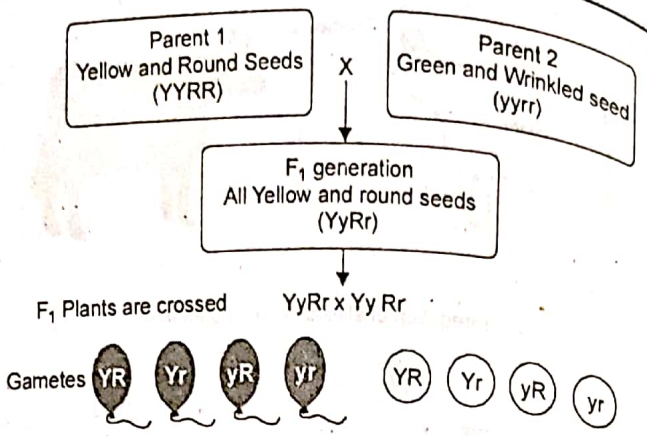
A character which is truly dominant but shows delayed expression. For example dark-haired individuals do not acquire their definitive hair colour until adulthood.

(C) Reversal of dominance

A recessive character may become dominant. In snail, *Helix* the colour of red shell is dominant over the colour of yellow shell. Sometimes an exception occurs and during crosses snails with yellow shells dominate over the red shells.

(D) Conditioned dominance

Morgan described a case in *Drosophila* fly where an abnormally banded abdomen becomes expressive when the flies are provided with



Gametes	YR	Yr	yR	yr
YR	YYRR Yellow Round	YYRr Yellow Round	YyRR Yellow Round	YyRr Yellow Round
Yr	YYRr Yellow Round	YYrr Yellow Wrinkled	YyRr Yellow Round	Yyrr Yellow Wrinkled
yR	YyRR Yellow Round	YyRr Yellow Round	yyRR Green Round	yyRr Green Round
yr	YyRr Yellow Round	Yyrr Yellow Wrinkled	yyRr Green Round	yyrr Green Wrinkled

F_2 Phenotypic Ratio : 9 : 3 : 3 : 1

Yellow Round 9 : Yellow Wrinkled 3 : Green Round 3 : Green Wrinkled 1

Fig. 1.6. Results of Mendel's Dihybrid experiment.

DIHYBRID BACK CROSS

The F_1 dihybrid yellow round (Yy Rr) is crossed with the recessive parent green wrinkled (yyrr). The F_1 dihybrid produces four types of gametes, namely (YR) (Yr) (yR) (yr) and the recessive parent produces only one type of gamete (yr). The four types of gametes of the F_1 hybrid are fused with the single type of gametes of the recessive parent at random. The resulting individuals will be yellow round (YyRr), yellow wrinkled (Yyrr), green round (yyRr) and green wrinkled (yyrr). The four types of plants occur in equal number in the ratio 1:1:1:1.

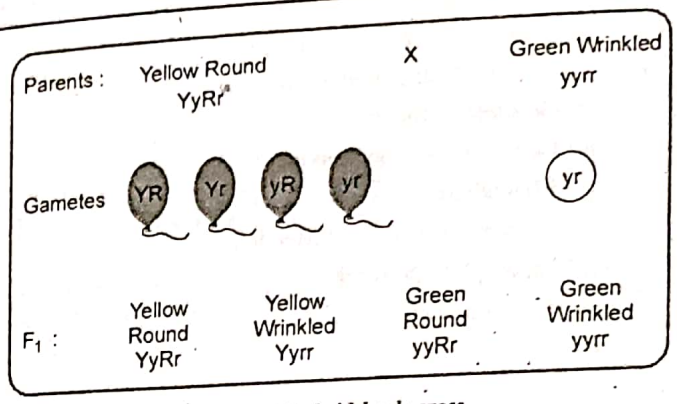


Fig. 1.7. Dihybrid back cross.

SUMMARY OF THE DISCOVERIES AND THEORY OF MENDEL RELATING TO HEREDITY

1. Hereditary factors (genes) are carried by gametes. Any individual, therefore, receives factors from both parents. This is known as principle of unit character.
2. Such factors exist in opposite or contrasted pair of characters known as allele or allelomorph *e.g.*, tall or dwarf plants, round and wrinkled seed in pea etc.
3. One character may be dominant and other recessive, the dominant show itself in a hybrid and the recessive remain masked. This is known as the law of dominance.
4. Only one of a pair of contrasted characters can be carried in a single gametes. This is Mendel's Law of segregation.
5. When two gametes combine to form a zygote, each one of a pair of contrasted characters may combine, by pure chance, with either of another pair. This is Mendel's Law of independent assortment.

QUESTIONS

Q. 1. Define heredity and variation. Describe the various theories of heredity.

Q. 2. Describe in detail the Mendel's dihybrid cross giving suitable examples. Why Mendel has chosen pea plants in his experiments?

Q. 3. Discuss the Mendel's law of dominance.

fresh and moist food. When food becomes dry and there is less moisture, the bands in the abdomen disappear. This is a type of dominance conditioned upon environmental factors.

(E) Co-dominance

When dominant and recessive alleles lack their dominant and recessive relationships and both express themselves independently, it is known as co-dominance. In this case the dominant character is not mixed with the recessive character. For example, there are two pure varieties in short-horned cattles, one have red and the other have white fur coat.

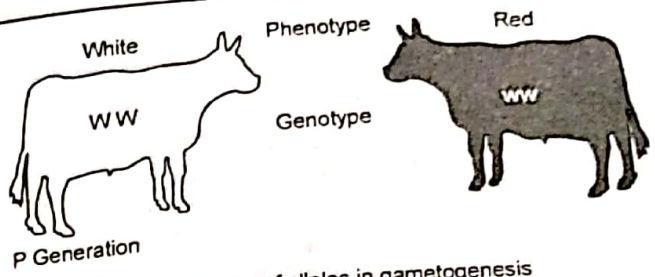
A cross between two varieties (Red WW x white ww) leads to the formation of a new variety (Ww) with redish grey colour or roan colour coat. The roan coat contains both red and white hairs (Fig 1.5).

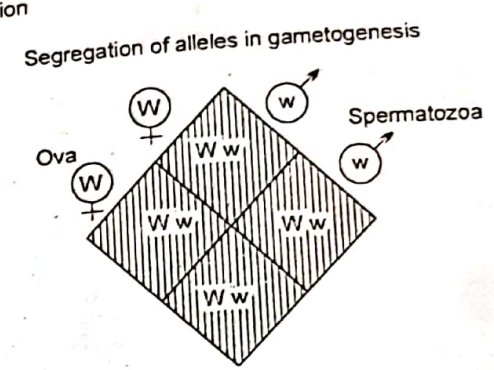
2. LAW OF SEGREGATION

An organism is the result of the union of the female and male gametes in fertilization. These gametes contain the hereditary factors which is transmitted. If an organism is true breeding for a character (Tall or Dwarf) the gametes of the parents contain the same hereditary factor (TT or tt) the hybrid receives a 'T' factor from one parent and a 't' factor from the other. Among the offspring of the true hybrid Tt again appears. The Tt hybrid does not form gametes in which T or t are mixed but produces gametes containing either T or t factor. So, it is concluded that – there are factors which affect development and these factors retain their individuality from generation to generation without being contaminated when they are present in hybrid. The factor become sorted out from one another when the gametes are formed.

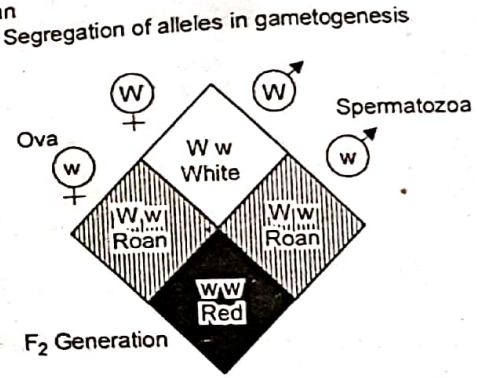
3. LAW OF INDEPENDENT ASSORTMENT (DIHYBRID CROSS)

This law is based on dihybrid experiment performed by Mendel. According to this law, the genes for each pair of character separate independently from those of other characters during gamete formation. In order to find out how different characters behave in relation to each other from generation to generation, Mendel made a cross between pea plant with yellow and round seed and one with green and wrinkled seeds. Such a cross involving two different character, *i.e.*, cotyledon-colour (yellow and green) and seed shape (round and wrinkled), separable in inheritance is called a dihybrid cross.





F_1 Generation
100% Roan



F_2 Generation

Fig. 1.5. An example of co-dominance.

RESULTS OF MENDEL'S EXPERIMENT

In F_1 generation, all plant and yellow and round seeds because yellow colour is dominant over the green and round seed is dominant over wrinkled. F_1 plants were crossed among themselves. The types of plants obtained were, yellow and round, green and round, yellow and wrinkled and green and wrinkled in the ratio of 9 : 3 : 3 : 1 respectively (Fig. 1.6).