Heredity and Evolution

Heredity : A recognisable feature of a human being (or any other organism) like height, complexion, shape of hair, colour of eyes and shape of nose and chin, etc., is called 'character' or 'trait'.

. The transmission of characters (or traits) from the parents to their offspring is called heredity. In most simple terms, heredity means continuity of features from one generation to the next.

. The hereditary information is present in the sex cells (or gametes) of the parents. Thus, gametes constitute the link between one generation and the next, and pass on the paternal (father's) and maternal (mother's) characters or traits to the offspring.

Variations : The offspring are never a true copy of their parents. In fact, no two individuals are exactly alike and the members of any one species differ from one another in some characters (or traits) or the other. These differences are known as variations, i.e., the differences in the characters (or traits) among the individuals of a species is called variation.

Accumulation of variations : Variations appear during reproduction whether asexual or sexual

. Minor variations may arise during asexual reproduction due to small inaccuracies in DNA copying.

. Sexual reproduction generates even greater diversity. This is so because sexual reproduction involves two parents (father and mother) and every offspring receives some characters of father and some of mother. Different offspring receive different combinations of characters of their parents and show distinct variations among themselves as well as from their parents.

During sexual reproduction variations arise due to –

Chance separation of chromosomes during gamete formation (gametogenesis)

Chance coming together of chromosomes during fertilisation

Mutations, i.e., alterations in the genetic material

Crossing over during meiosis

. The significance of a variation shows up only if it continues to be inherited by the offspring for several generations.

. The great advantage of variation to a species is that it increases the chances of its survival in a changing environment.

Gene as unit of heredity: Chromosome is a thread-like structure in the nucleus of a cell and is formed of DNA which carries the genes.

. Genes for controlling the same characteristic of an organism can be of two types : dominant or recessive. The gene which decides the appearance of an

organism even in the presence of an alternative gene is known as a **dominant gene** and the dominant gene is represented by a capital letter. The gene which can decide the appearance of an organism only in the presence of another identical gene is called as **recessive gene**. The corresponding recessive gene is represented by the corresponding small letter. Genotype is the description of genes present in an organism.

Mendel's experiments : Mendel selected garden pea (Pisum sativum) for series of hybridisation experiments because it has some special features.

Special features of garden pea plant are:

It is easy to grow.

Garden pea plant has distinct, easily detectable contrasting variants of features.

Mendel, in fact, noted seven pairs of such contrasting characters in garden pea plant.

The plant has bisexual flowers wherein artificial cross fertilisation could be easily achieved.

It has a short life cycle and, therefore, it is possible to study number of generations in less time.

Each pea plant produces many seeds in one generation.

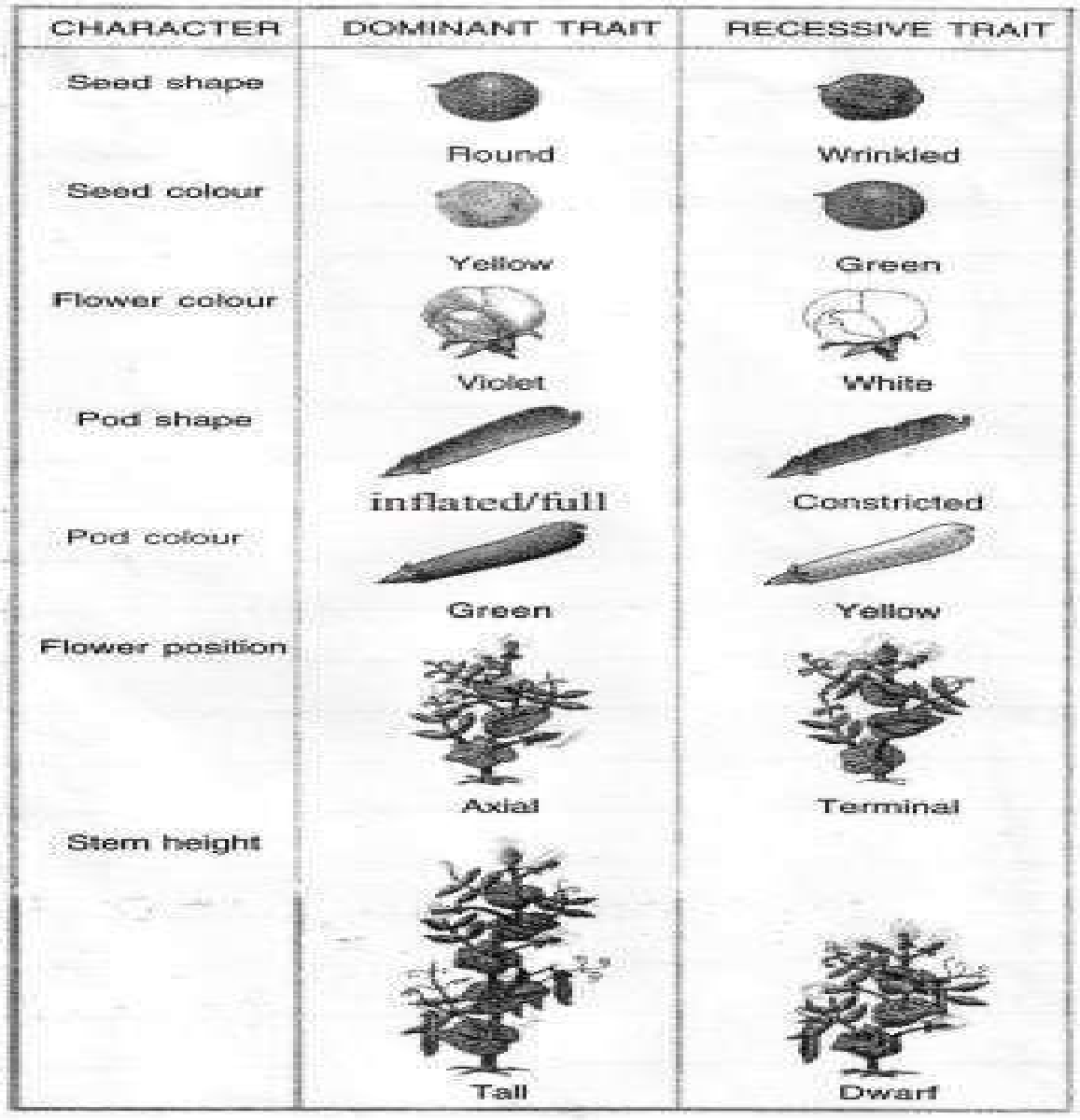
The characters which always appear in two opposing conditions are called contrasting characters.

PLANTS SELECTED BY MENDEL

Pisum sativum (garden pea). Mendel used a number of 7 contrasting characters for garden peas

(TABLE OF CONTRASTING CHARACTERS. SEVEN PARTS)		
CHARACTER	**DOMINANT TRAIT**	**RECESSIVE TRAIT**
Flower colour	Violet	White
Flower position	Axial	Terminal
Seed colour	Yellow	Green
Seed shape	Round	Wrinkled
Pod shape	Inflated	Constricted
Pod colour	Green	Yellow
Height of plant	Tall	Dwarf/Short

Seven pairs of contrasting characters in Garden Pea.

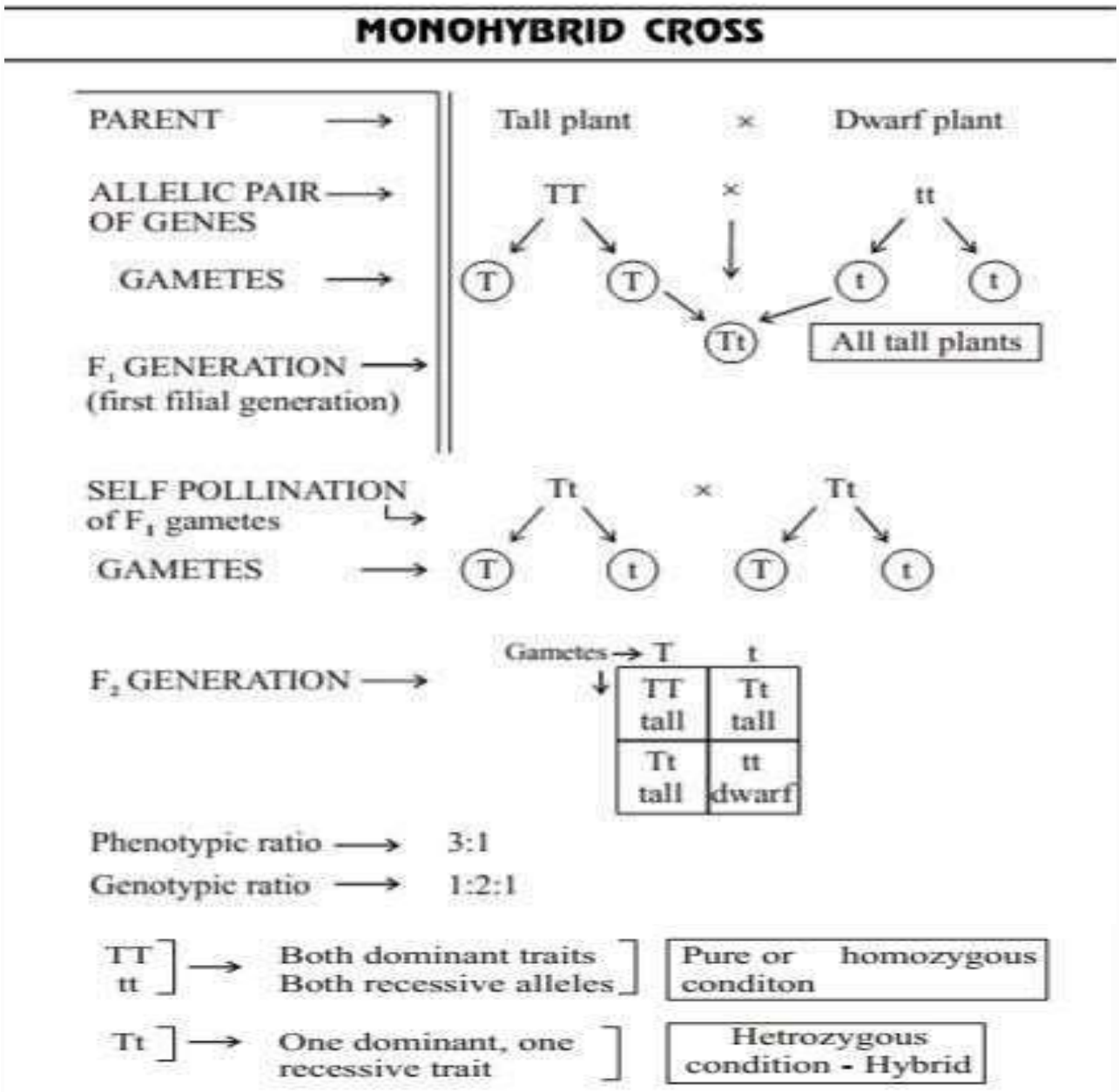


Mendel's Experiments

Mendel conducted a series of experiments in which he crossed the

pollinated plants to study one character (at a time)

- A Cross between two pea plants with one pair of contrasting characters is called a monohybrid cross.
- Cross between a tall and a draft plant (short).



Phenotype ® Physical appearance [Tall or Short]

Genotype ® Physical appearance [Tall or short]

Observations of Monohybrid Cross

1. All F1 progeny were tall (no medium height plant (half way characteristic)
2. F2 progeny ¼ were short, 3/4 were tall
3. Phenotypic ratio F2 – 3 : 1 (3 tall : 1 short)

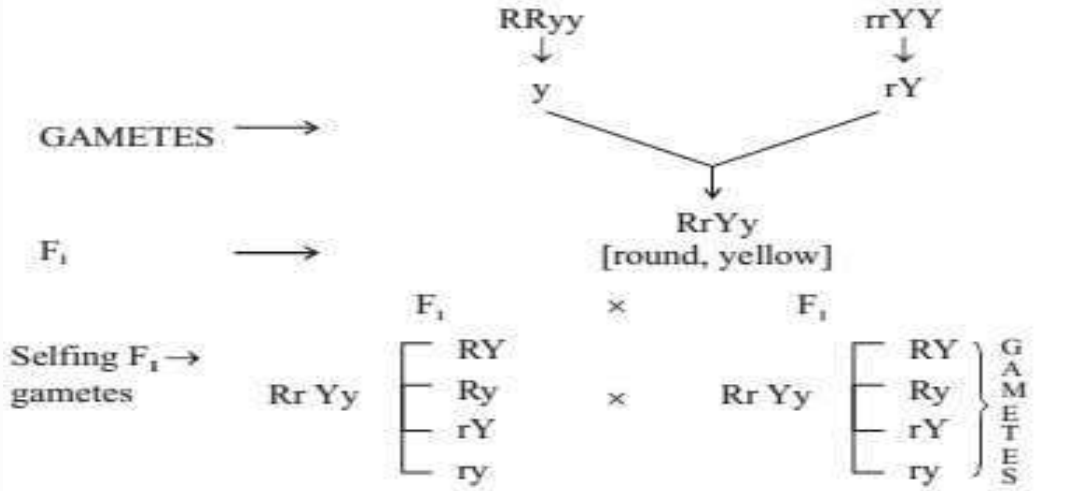
$$\begin{pmatrix} TT : Tt : tt \\ 1 : 2 : 1 \end{pmatrix}$$

Genotypic ratio F2 – 1:2:1

Dihybrid Cross

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

Parent Generation	→	Round Green seeds	×	Wrinkled Yellow seeds



F1 gametes →

♂ →	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

Round, yellow: 9
Round, green: 3
Wrinkled, yellow: 3
Wrinkled, green: 1

“

Observations

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

Conclusions

1. Round and yellow seeds are **DOMINANT** characters
2. The occurrence of new phenotypic combinations shows that genes for round and yellow seeds are inherited independently of each other.

From these observations, Mendel put forward the rules of inheritance

Mendel's law of dominance states that

When parents with pure, contrasting traits form of trait appears in the next generation . The hybrid off springs will exhibit only the dominant trait in the phenotype.” Law of dominance is known as the first law of inheritance.

Law of Segregation

Every individual possesses a pair of alle from the alleles. A gamete formation, a gamete receives only dominant or recessive in a particular gen

Law of Independent Assortment

Alleles of different characters separate during gamete formation. In the above true were independently from those of seed colour.

SEX DETERMINATION

Determination of the sex of an offspring.