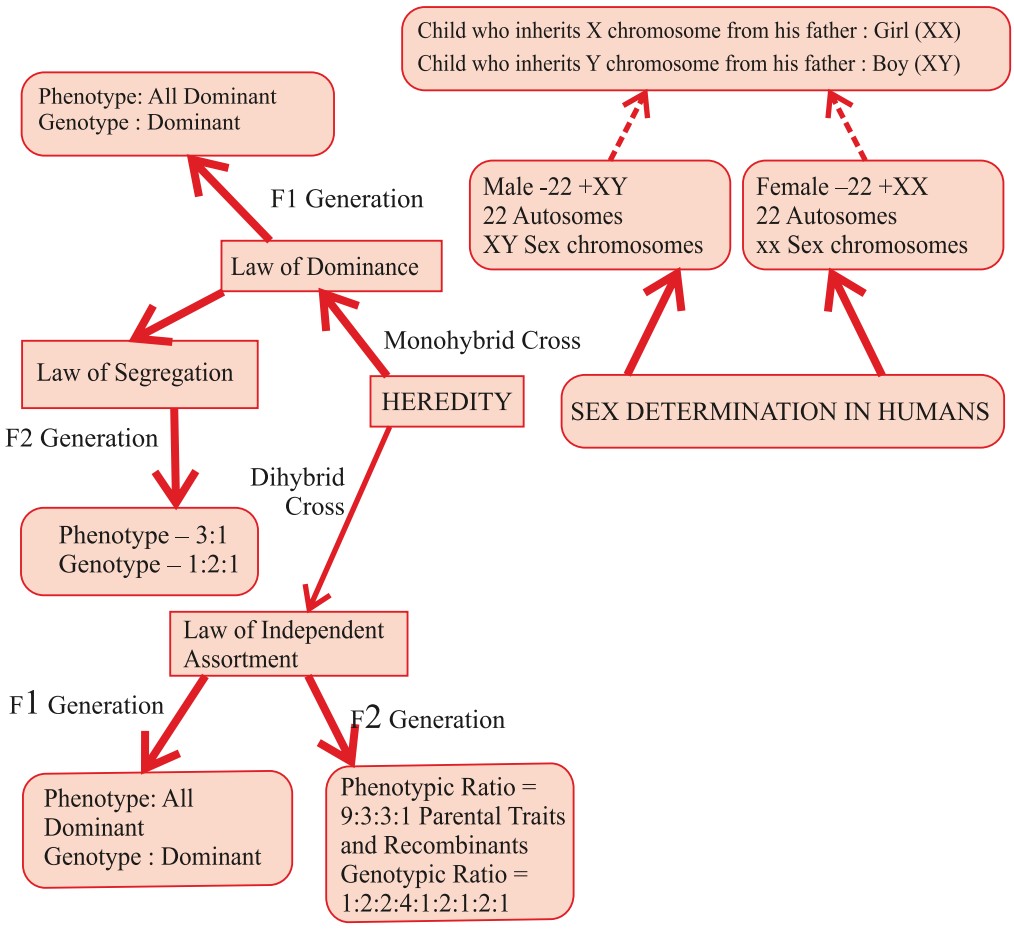
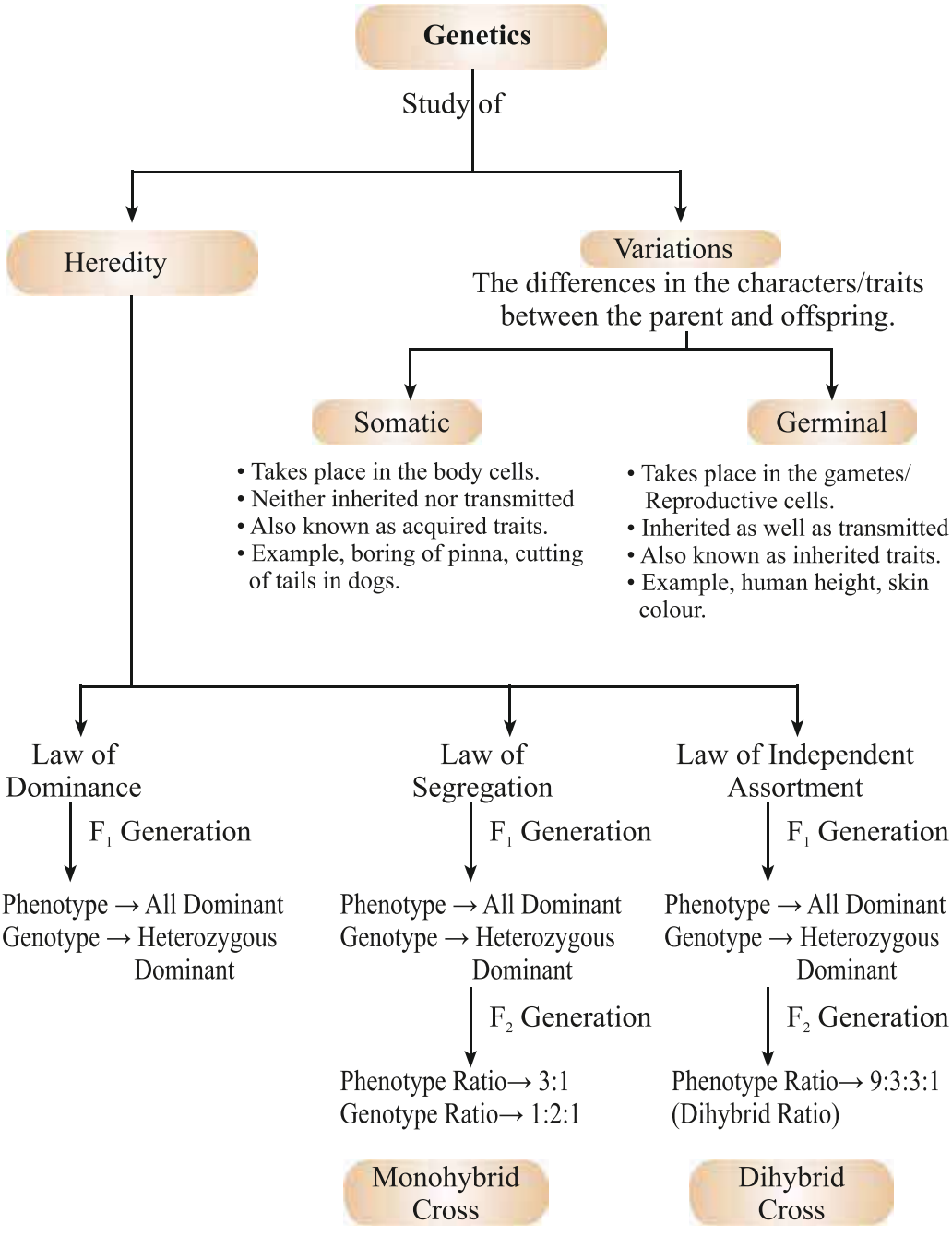
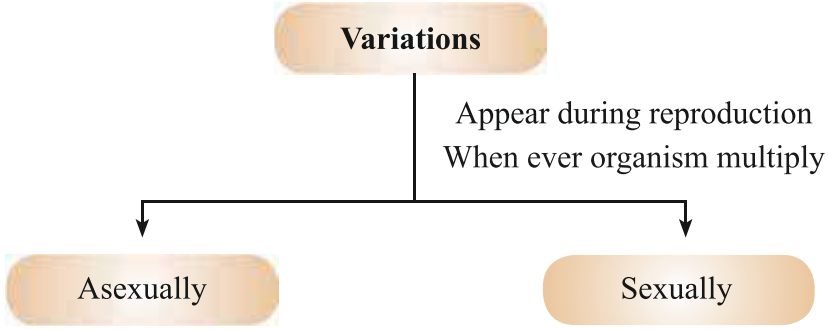
Chapter - 8

Heredity




Genetics
Study of
Heredity
Variations
The differences in the characters/traits between the parent and offspring.
Somatic
Germinal
• Takes place in the body cells.
• Neither inherited nor transmitted
• Also known as acquired traits.
• Example, boring of pinna, cutting of tails in dogs.
• Takes place in the gametes/ Reproductive cells.
• Inherited as well as transmitted
• Also known as inherited traits.
• Example, human height, skin colour.
Law of Dominance
Law of Segregation
Law of Independent Assortment
F1 Generation
F1 Generation
F1 Generation
Phenotype → All Dominant
Genotype → Heterozygous Dominant
Phenotype → All Dominant
Genotype → Heterozygous Dominant
Phenotype → All Dominant
Genotype → Heterozygous Dominant
F2 Generation
F2 Generation
Phenotype Ratio→ 3:1
Genotype Ratio→ 1:2:1
Phenotype Ratio→ 9:3:3:1
(Dihybrid Ratio)
Monohybrid Cross
Dihybrid Cross

Accumulation of Variation during Reproduction



- Variations are fewer.
- Occurs due to small inaccuracies in DNA copying. **(Mutation)**

- Variations are large.
- Occurs due to crossing over, separation of chromosomes, mutation.

Importance of Variation :

(i) Depending upon the nature of variations different individuals would have different kinds of advantage.

Example, Thermostatic Bacteria that can withstand heat will survive better in a heat wave.

(ii) Main advantage of variation to species is that it increases the chances of its survival in a changing environment.

Free ear lobes and **attached ear lobes** are two variants found in human populations.

Mendel and His Work on Inheritance

- **Gregor Johann Mendel (1822 & 1884) :** Started his experiments on plant breeding and hybridisation. He proposed the laws of inheritance in living organisms.

  Mendel was known as **Father of Genetics.**

- **Plant selected by Mendel :** *Pisum sativum* (garden pea). Mendel used a number of contrasting characters for garden pea.

CHARACTER	DOMINANT TRAIT	RECESSIVE TRAIT
Seed shape	 Round	 Wrinkled
Seed colour	 Yellow	 Green
Flower colour	 Violet	 White
Pod shape	 Inflated/full	 Constricted
Pod Colour	 Green	 Yellow
Flower position	 Axial	 Terminal
Stem height	 Tall	 Dwarf

Mendel's **Experimental Material :** He chose Garden Pea *(Pisum sativum)* as his experiment material because of :

(i) Availability of detectable contrasting traits of several characters.

(ii) Short life span of the plant.

(iii) Normally allows self-fertilisation but cross-fertilisation can also be carried out.

(iv) Large no. of seeds produced.

- **Mendel's Experiments :** Mendel conducted a series of experiments in which he crossed the pollinated plants to study one character (at a time).

Monohybrid Cross

Cross between two pea plants with one pair of contrasting characters is called a monohybrid cross.

Example : Cross between a tall and a dwarf plant (short).

TT, tt — Both dominant alleles / Both recessive alleles → Pure or homozygous condition

Tt — One dominant, one recessive allele → Hetrozygous condition – Hybrid

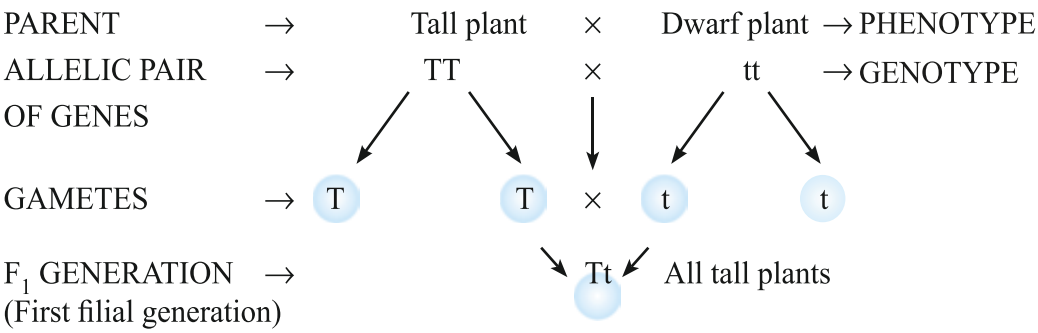
Phenotypic ratio → 3 : 1

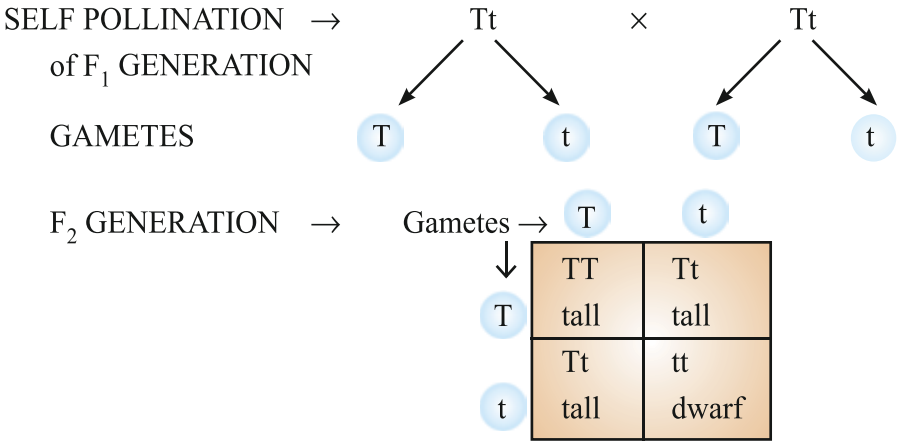
Genotypic ratio → 1 : 2 : 1

Phenotype → Physical appearance [Tall or Short]

Genotype → Genetic make up [TT, Tt or tt]

MONOHYBRID CROSS





Phenotypic ratio	→	3 : 1	Tall : Dwarf 3 : 1
Genotypic ratio	→	1 : 2 : 1	TT : Tt : tt 1 : 2 : 1

Observations of Monohybrid Cross

(i) All F1 progeny were tall, no medium height plant. (Half way characteristic)

(ii) F2 progeny ¼ were short, ¾ were tall.

(iii) Phenotypic ratio F2 – 3 : 1 (3 tall : 1 short)

Genotypic ratio F2 – 1 : 2 : 1 $\begin{pmatrix} TT & : & Tt & : & tt \\ 1 & : & 2 & : & 1 \end{pmatrix}$

Conclusions

1. TT and Tt both are tall plants while tt is a short plant.
2. A single copy of T is enough to make the plant tall, while both copies have to be 't' for the plant to be short.
3. Characters/traits like 'T' are called dominant trait (because it express itself) and 't' are recessive trait (because it remains suppressed).

Dihybrid Cross

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

PARENT GENERATION → Round green seeds × Wrinkled yellow seeds → PHENOTYPE → GENOTYPE

RRyy × rrYY

GAMETES → Ry, rY

F_1 → RrYy [Round, yellow]

F_1 × F_1

Selfing F_1 gametes → Rr Yy (RY, Ry, rY, ry) x Rr Yy (RY, Ry, rY, ry)

F_2 Genration $\rightarrow$

	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/Dihybrid Ratio $\rightarrow$ 9:3:3:1

Round, yellow : 9

Round, green : 3

Wrinkled, yellow : 3

Wrinkled, green : 1

Observations

(i) When RRyy was crossed with rrYY in F1 generation all were Rr Yy round and yellow seeds.

(ii) Self pollination of F1 plants gave parental phenotype and two mixtures (recombinants round yellow and wrinkled green) seeds plants in the ratio of 9 : 3 : 3 : 1.

9	:	3	:	3	:	1
(Round yellow)		(Round green)		(Wrinkled yellow)		(wrinkled green)

Conclusions

1. Round and yellow seeds are Dominant characters.

2. Occurrence of new phenotype combinations show that genes for round and yellow seeds are inherited independently of each other.

Mendel's Law of Inheritance

Based on his hybridisation experiments, mendel proposed the laws of inheritance.

1. Law of dominance - This law states that when two alternative forms of a trait or character (genes or alleles) are present in an organism, only one facter expresses itself in F, progeny and is called dominant while the other that remains masked is called recessive.

Characters are controlled by discrete units called factors. Factors occur in pairs.

2. Law of segregation or law of purity of gametes.

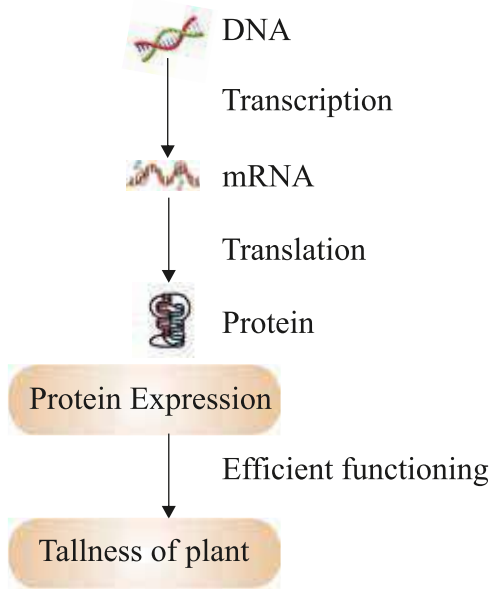
This law states that the factors or alleles of a pair segregate from each other during gamete formation such that a gamete recieves only one of the factors. They do not show any blending but simply remain together.

Homozygous parent produces all gametes that are similar, heterozygous parent produces two types of gametes, each having one allele in equal proportion.

3. Law of independent assortment - This law states that the two factors of each character assort or separate out independent of the factors of other characters at the time of gamete formation and get randomly rearranged in the offsprings producing both parental and new combination of characters.

When two pairs of traits are combined in a hybrid, segreration of one pair of character is independent of the other pair of characters.

How do these traits get expressed



SEX DETERMINATION

Determination of sex of an offspring.

FACTORS

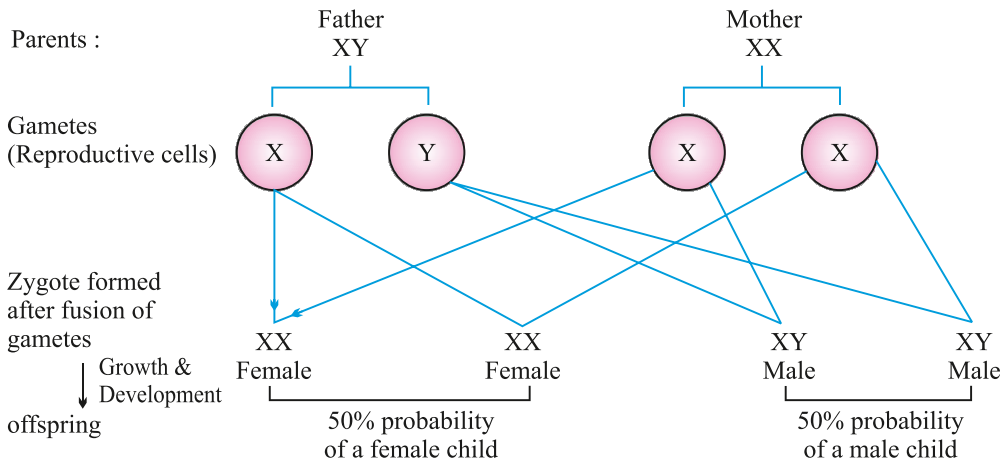
Responsible for Sex Determination

Environmental	**Genetic**
In some animals, the temperature at which the fertilized eggs are kept decides the gender. E.g., in turtle	In some animals like humans gender of individual is determined by a pair of chromosomes called sex chromosome. XX – Female XY – Male

Sex Chromosomes : In human beings, there are 23 pairs of chromosome. Out of these 22 chromosomes pairs are called autosomes and the last pair of chromosome that help in deciding gender of that individual is called sex chromosome.

XX – Female SEX
XY – Male CHROMOSOMES

Sex determination in Human Beings



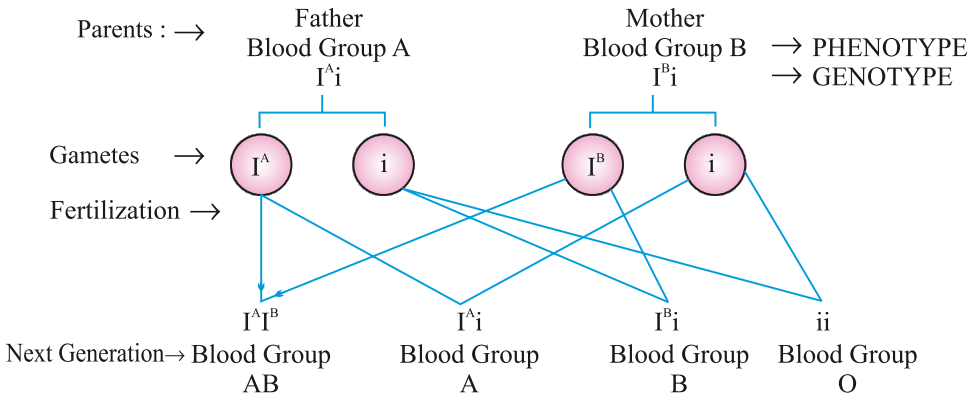
This shows that half the children will be boys and half will be girls. All children will inherit an X chromosome from their mother regardless whether they are boys or girls. Thus, sex of children will be determined by what they inherit from their father, and not from their mother. Fertilization is a chance factor i.e. which type of sperm will fuse with ovum is a matter of chance.

Blood Group Inheritance In Human Beings:-

There are four blood groups in human beings namely A, B, AB and O and their expression in human population is controlled by three alleles namely I^A, I^B and i [Multiple Allelism]. An individual has only two alleles out of three for blood group. Genotypes and Phenotypes for these 4 blood groups are as under-

PHENOTYPE/ Blood Group	PROBABLE GENOTYPE
A	$I^A I^A$; I^A i
B	$I^B I^B$; I^B i
AB	$I^A I^B$
O	ii

There Are 6 probable genotypes for 4 phenotypes.



QUESTIONS

VERY SHORT ANSWER TYPE QUESTIONS (1 Mark)

Multiple Choice Questions (M.C.Q.'s)

1. The organism on which Mendel performed his experiments (CBSE-2019)
   a) Gram b) Garden Pea c) Peanut d) Pigeon Pea
2. A cross between a tall plant (TT) and short pea plant (tt) resulted in progeny that were all tall plants because—
   a) Shortness is a dominant trait
   b) Tallness is a recessive trait
   c) Tallness is the dominant trait
   d) Height of pea plant is not governed by gene 'T' or 't'
3. A zygote has an X-chromosome from the father will develop into a
   a) Boy
   b) X-Chromosome does not determine the sex of child.
   c) Girl
   d) Either boy or girl
4. A normal cell of human body contains 23 pairs of chromosomes. The number of chromosomes in a sex cell (sperm or ovum) of a human being is most likely to be.
   a) 46 b) 23
   c) 21 d) 42
5. The visible charactertistics in an organism is known as
   a) Prototype b) Sterotype
   c) Phenotype d) Genotype
6. A cross between two individuals results in a ratio of 9 : 3 : 3 :1 for four possible phenotypes of progeny. This is an example of a :
   a) Dihybrid cross b) Monohybrid cross
   c) Test cross d) None of these

7. Of what chromosomes are made up of

a) DNA & Proteins b) DNA & RNA

c) DNA, RNA & proteins d) None of these

8. The number of pair of sex chromosome in zygote of human is:

a) One b) Two

c) Three d) Four

9. Which section of DNA provides information of one protein?

a) Nucleus b) Chromosome

c) Trait d) Gene

10. The maleness of a child is determined by

a) The 'X' chromosome in the zygote

b) The 'Y' chromosome in the zygote

c) Cytoplosm of germ cell determines the sex

d) Sex is determined by chance

Answer

1. (b)	2. (c)	3. (c)	4. (b)
5. (c)	6. (a)	7. (a)	8. (a)
9. (d)	10. (b)		

Read the assertion and reason carefully and then mark the correct option out of the option given below:

(a) Both (A) and (R) are true but (R) is correct explanation of the Assertion (A).

(b) Both (A) and (R) are true (R) is not correct explanation of the Assertion (A).

(c) (A) is true but (R) is false.

(d) (A) is false but (R) is true.

1. Assertions (A) : Mendel chose a pea plant for his experiments.

   Reason (R) : Pea in easy to grow and had distinctly easily detectable contrasting variants of features.

2. Assertion (A) : Variation is minimum in asexual reproduction.

   Reason (R) : All variations in a species have equal chance of survival.

3. Assertion (A) : Recessive trait can only be expressed in homozygous condition.

   Reason (R) : Dominant trait cannot be expressed in heterozygous condition.

Answer:

1. (a) 2. (c) 3.(c)

Very Short Answer Type Questions (1 Marks)

4. (1) Write the scientific name of garden pea and human being.
   (2) Where are genes located?
   (3) No two individuals are absolutely alike in a population. Why?
   (4) What are the chromosomes XY and XX known as?
5. Give Reasons :
   (1) Mendal chose pea plant for his experiments
   (2) Human beings who look different from each other in terms of size, colour and looks are said to belong to same species.

Short Answer Type Question

1. Variation is beneficial to the species but not necessarily for the individual. Give three reasons to justify it.
2. Distinguish between autosomes and sex chromosomes.
3. A cross is carried between pure bred tall plant and pure bred dwarf pea plant.

   (a) What is the phenotype of F_1 progeny and why

   (b) What is the phenotype of F_2 progeny when F_1 is selfed.

2 Marks

1. Explain sex determination.
2. What are genes? Where are they located?
3. What is meant by dominant genes and recessive genes? Give one example of each.
4. What are sex chromosomes?
5. How many sex chromosomes are there? Name them.
6. Write down the phenotypic ratio and genotypic ratio in monohybrid cross.

Long Answer Type of Questions (5 Marks)

1. Explain the mechanism of sex determination in human being.
2. (a) What are dominant and recessive traits?

   (b) Is it possible that a trait is inherited but may not be expressed in the next generation? Give a suitable example to justify this statement.