BIOLOGY

HEREDITY AND EVOLUTION

Concepts Covered

- Heredity
- Variation
- Importance of variation
- Monohybrid cross
- Dihybrid cross
- Mendel's laws

Introduction

Reproduction gives rise to new individuals that may be similar or may be different.
Heredity refers to the passing of characteristics from one generation to the next. The study of the mode of transmission of traits from parents to their offspring is called genetics.
Here in this chapter, we will learn about the mechanism by which variations are created, and the rules of heredity determining the pattern of inheritance.

Variation

The differences in characteristics between individuals of the same species are called variations.
The two main causes of variation are:

1. Mutation
2. Genetic recombination in sexual reproduction.

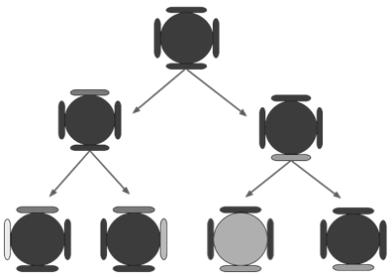
A mutation is a change in the DNA sequence. These variations in gene sequences can sometimes be advantageous to an organism. Most mutations that result in genetic variation produce traits that confer neither an advantage nor a disadvantage.

Sexual reproduction promotes genetic variation by producing different gene combinations.

Some variation is passed on from parents to offspring, via genes during reproduction. This is inherited variation.

Accumulation of Variation during Reproduction

We know that reproduction results in variation from one generation to the next. The variation produced in the organisms during the successive generation gets accumulated over a long period in an organism. After several generations, these variations come up in the organisms and the organisms start showing up different characteristics and hence leading to the appearance of new species.
The main advantage of variation in a species is that it increases the chance of its survival in a changing environment. The organisms which show positive variation survives. Those who do not show variations get extinct.



Variation in Asexual Reproduction

In an asexual mode of reproduction, only one parent is involved in the process. The genetic materials are transferred from a single parent. As a result, the frequency of variation is highly reduced among offspring. Only little alterations can be noticed due to faults in the DNA copying machinery. Budding and fragmentation are the best examples of asexual reproduction.

Variation in Sexual Reproduction

In a sexual mode of reproduction gametes from two separate people are fused. As two separate people are involved, variation takes place at a higher frequency. As two people are involved, DNA becomes jumbled up, resulting in the greatest amount of variants in their kids, who look different from their parents. This accumulated variety in children is handed down from generation to generation, ensuring that an organism's genetic continuity is maintained. These variations can be observed from one generation to the next. The offsprings of human beings, cows, and horses are a good example of variation through sexual reproduction.

Importance of variation

1) Variation helps in the selection of the most desirable attributes and assists organisms in a variety of physical attributes.
2) It assists organisms to evolve with time to be best suited under environmental circumstances.
3) Changes allow species to distinguish from one another. It also allows us to determine if they reproduce sexually or asexually.
4) Due to variation, hybrids can be created. For example, broccoli is a hybrid of cauliflower.
5) Variations result in the base of healthy genes being passed down from generation to generation.

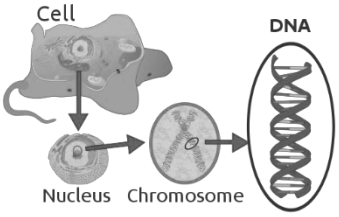
Heredity

The offspring reproduced by organisms is similar to its parents in many respect. This similarity in the organism is due to the transmission of traits from one generation to the next. This transmission of traits from one generation to the next is called heredity.

(1) Why accumulation of variation during reproduction is essential? Discuss.
(2) Differentiate between asexual and sexual modes of reproduction.
(3) Write a short description of Variation in Asexual Reproduction.
(4) Discuss for example, how variation leads to the formation of new species?
(5) How is variation important for survival? Explain with examples.
(6) What is the importance of variation during reproduction?
(7) What are the steps that lead to variations during reproduction?
(8) Why variation during reproduction is needed?

Humans share about 90% of genetic material with mice and 98% with chimpanzees.

Some important terms



1. Chromosomes are long thread-like structures present in the nucleus of a cell that contains hereditary information about the cell in the form of genes.

2. DNA is a chemical in the chromosome which carries the traits in a coded form.

3. Gene is the part of a chromosome that controls a specific biological function.

4. Contrasting characters: A pair of visible characters such as tall and dwarf, white and violet flowers, round and wrinkled seeds, green and yellow seeds, etc.

5. Dominant trait: The character which expresses itself in an (F1) generation is a dominant trait. Example: Tallness is a dominant character in pea plants.

6. Recessive trait: The character which does not express itself but is present in a generation is a recessive trait. Ex. dwarfism in the pea plant.

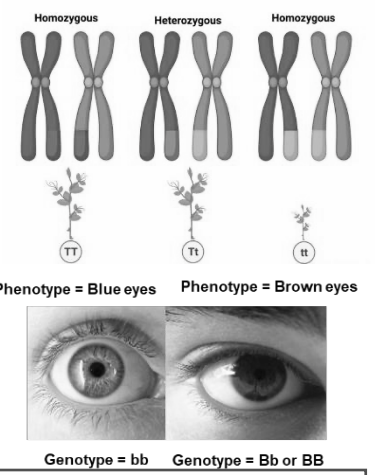
7. Allele: An allele refers to one of the two or more alternative forms of a gene.

8. Homozygous: A condition in which both the genes of the same type are present for example; an organism has both the genes for tallness expressed as TT and genes for dwarfness written as tt.

9. Heterozygous: A condition in which both the genes are of different types for example; an organism has genes Tt which means it has a gene for tallness and the other for dwarfness only tall character is expressed.

10. Genotype: It is the genetic makeup of an individual for example; a pure tall plant is expressed as TT and a hybrid tall as Tt.

11. Phenotype: It is the external appearance of the organism for example; a plant having Tt composition will appear tall although it has a gene for dwarfness.

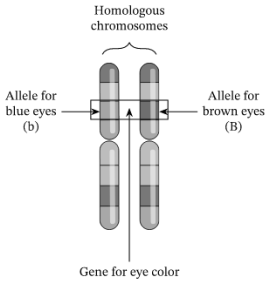


Extended Learning

Almost all the cells in our body have DNA, the exception being red blood cells. However, all red blood cells start with DNA – they simply destroy their nucleus once it is no longer needed as part of the maturation process.

Difference Between Allele and Trait

A piece of DNA that contains information to determine a particular character is called a Gene. A single gene may consist of alternative forms known as alleles. Each allele consists of slight differences in its nucleotide sequence. The expression of different alleles produces slightly different characteristics in the individuals within a population. These different characteristics of a gene that are produced by its alleles are collectively known as a variation. The main difference between allele and trait is that an allele is an alternative form of a particular gene whereas a trait is a character that is determined by the allele.



Rules for the inheritance of the traits

The rules of inheritance come from the fact that both the parents contribute equally to the development of the traits in the offspring.
Gregor John Mendel was a pioneer who used his science and mathematics knowledge to frame these laws of inheritance.


Gregor John Mendel

Gregor John Mendel was the first to give scientific explanation regarding the mode of transmission of characters and formulate the basic laws of heredity. Hence, he is rightly called the 'father of genetics'.

Extended Learning

Darwin, Lamarck and Acquired Traits

Lamarck initially hypothesized that the acquired traits can be passed on from parents to offspring's making the organism more suitable to the environment. Darwin, later on, removed this hypothesis from his publication – Theory of Evolution, once he had enough evidence to prove that the acquired traits are not passed on from one generation to another.
E.g. an offspring born to a bodybuilder need not necessarily have extremely large muscles. This is because the muscles were acquired by the bodybuilder during his lifetime.

Acquired Traits

An acquired trait is the character developed in an individual as a result of environmental influence. These traits are not coded by the DNA of a living organism and therefore cannot be passed on to future generations.

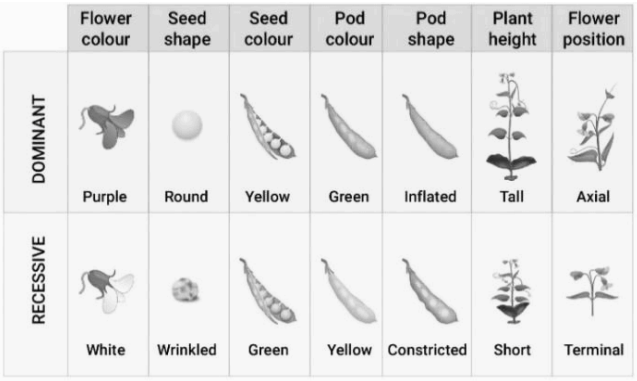
Inherited Traits

These are the traits that are inherited from the parents to the offspring. Hair, skin, eye colour, body type, height, and susceptibility to certain diseases are some of the examples of inherited traits in humans. The inherited traits of an individual are determined by their genes. A single cell in a human body contains 25,000 to 35,000 genes. These genes carry the traits inherited by an individual from his parents.

Gregor Mendel explained the concept of inherited traits in his experiments with the pea plant. He depicted that the traits that are visible in the phenotype are called the dominant traits, while the traits that are not visible are known as the recessive traits.

Mendel's Experiment

Mendel started his experiment on the Pisum sativum (Pea plant). He used several contrasting characters for the pea plant.



Why did Mendel choose pea plants for his experiments?

The reason for the selection of pea plants for the genetic experiments are:

1. Easy to grow in the garden.
2. The flowers of pea plants are hermaphrodite, i.e. flowers have bisexual characteristics.
3. Easy to obtain pure breed plants through self-fertilization
4. The generation time of pea plants is less.
5. They have excellent disease resistance and have an optimal rate of survival.
6. He conducted the first monohybrid and then dihybrid crosses.

Mendel conducted a series of experiments in which he crossed the pollinated plants to study one character (at a time).

Extended Learning

Mendel's findings were rejected during his time and it was several decades after his death that he was credited for his revolutionary discovery.

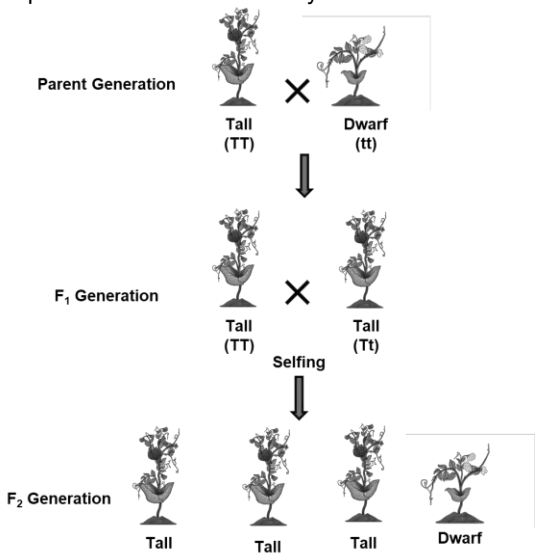
Experiments:

1. Monohybrid Cross

A cross between two types of plants of the same species considering only the transmission of one character is called a monohybrid cross.

For example, a cross between tall pea plants and dwarf pea plants that is considering only the height of the parents is a monohybrid cross.

Representation of the monohybrid cross: character in focus is the height.



	T	t
T	TT	Tt
t	Tt	tt

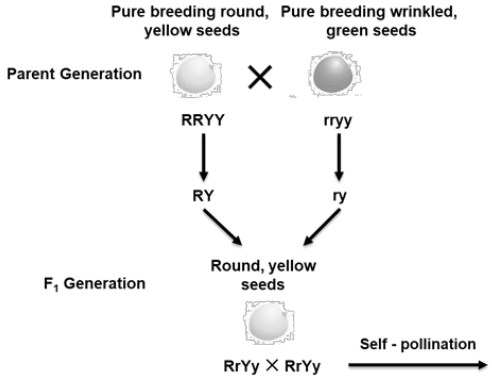
Punnett square

Observations of Monohybrid Cross

- All F_1 progeny were tall (no medium height plant (halfway characteristic)
- F_2 progeny 1/4 were short, 3/4 were tall.
- Phenotypic ratio F_2 – 3:1 (3 tall: 1 short)
- Genotypic ratio - 1:2:1 (TT:Tt:Tt:tt)

2. Dihybrid Cross

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



Punnett square

	RY	rY	Ry	ry
RY	RRYY	RrYY	RRYy	RrYy
ry	RrYY	rrYY	RrYy	rrYy
Ry	RRYy	RrYy	RRyy	Rryy
ry	RrYy	rrYy	Rryy	rryy

Observations of Dihybrid Cross

When RRyy was crossed with rrYY in the F_1 generation all were Rr Yy (round and yellow) seeds. 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.

Phenotypic Ratio

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

Laws of Mendel

Mendel proposed three laws:

1. Law of Dominance
2. Law of Segregation
3. Law of independent assortment

Law of Dominance: The law of dominance states that recessive traits are always dominated or masked by dominant traits. For example, when pea plants with round seeds (RR) are crossed with plants with wrinkled seeds (rr), all seeds in the F_1 generation were found to be round (Rr).

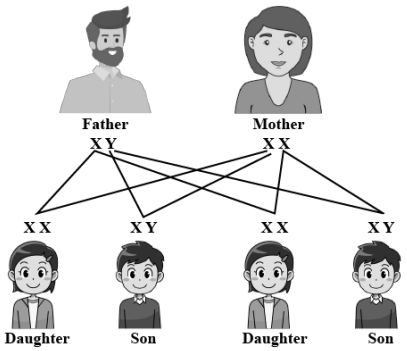
Law of Segregation: The law of segregation during the formation of gamete, states that each gene separates from each other so that each gamete carries only one allele for each gene.

Law of Independent Assortment: The law of independent assortment states that the alleles of different genes are inherited independently from each other within the organisms that reproduce sexually.

How these traits do gets expressed?

The proteins in the cell are made up of information coded in the cellular DNA. A segment of this DNA provides information for one protein and is called a gene for that protein. These genes influence traits. As per the Mendelian law, both parents equally support the contribution of genes, and thus the child has a combination of a set of genes from both parents. Gene sets are present as separate independent portions called chromosomes and not a single long thread of DNA.

Therefore, each cell will have two copies of the chromosomal set, one from each parent. When germ cells combine, they will re-establish a normal number of chromosomes to ensure the stability of DNA in species.



Sex Determination

Sex determination is the process by which the sex of a person is determined.

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

XX – female

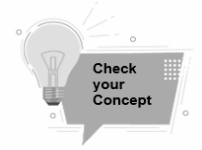
XY – male

When the male gametes with the X chromosome fuse with the female egg then the child will be female. Similarly, when the male gamete with the Y chromosome fuses with the female egg then the child will be male.

The Bombay blood group is a rare blood group, phenotypes of this group lacking H antigen on the red cell membrane and have anti-H in the serum. It fails to express any A, B or H antigen on their red cells or other tissues.

Extended Learning:

Marriage between close cousins is similar to inbreeding. The recessive traits (from genetic defects) present in such families become homozygous and cause incurable diseases.



(1) Name the plant which was selected by Mendel for his experiments why he selected these plants?

(2) Which of the following traits are recessive in pea plant? Dwarfness, violet flower, wrinkled seed.

(3) In humans, the gene for black hair colour is B and gene for brown hair colour is b. What will be the hair colour of person having the genetic constitution?
(a) BB (b) bb (c) Bb

(4) Give the pair of contrasting traits of the following characters in pea plant and mention which is dominant and recessive
(i) Yellow seed, (ii) Round seed.

(5) How did Mendel explain that it is possible that a trait is inherited but not expressed in an organism?

(6) What is a sex chromosome?

What is hemophilia?

Hemophilia is an inherited bleeding disorder. With this condition, the blood does not clot as it should, which can result in spontaneous bleeding and bruising after surgery or other injuries.

Causes of hemophilia

According to the Centers for Disease Control and Prevention (CDC), hemophilia is a sex-linked recessive condition. Hemophilia is typically an inherited disorder, which means that a person is born with the condition.

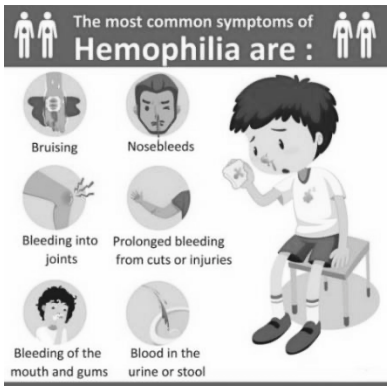
Hemophilia tends to occur in males. The reason for this has to do with inherited genes.

Males inherit one X chromosome from the female parent and one Y chromosome from the male parent. Females have two X chromosomes, inheriting one from each parent.

The genetic change that causes hemophilia is recessive in the X chromosome. Males have one copy of the genes in the X chromosome, and females have two copies.

As a result, males have a 50% chance of developing hemophilia if their biological mother is a carrier of the gene. If they inherit the affected X chromosome, they have hemophilia.

Females can also inherit hemophilia. However, this is rare. For females to inherit hemophilia, the affected gene is in both X chromosomes, or the affected gene is in one X chromosome, and inactive or missing in the other. Females with one altered gene can be carriers and pass the condition to any children they may have.



Symptoms of hemophilia

- Bruising Hematomas, which is when there is bleeding into the muscle or soft tissues
- Bleeding from the mouth and gums
- Bleeding after a circumcision
- Blood in the stool
- Blood in the urine
- Nosebleeds that are frequent and difficult to stop
- Bleeding after vaccinations or other injections
- Bleeding into the joints

In severe cases of hemophilia, a person may experience spontaneous bleeding, often in the muscles or joints. This can lead to pain and swelling. Without treatment, it can result in arthritis in the affected joints. Doctors can often diagnose severe cases when the person is an infant.

Blood Transfusion

The method to transfer blood from one person to another's circulatory system is called a blood transfusion.

Blood transfusion is required:

- In case of an accident and excess bleeding.
- A severe shortage of blood in the body.
- During surgery.
- Low platelet count in the blood.
- Patient of hemophilia.
- Patient of sickle cell anemia.

Process of Blood Transfusion: It is divided into two parts:

(A) Blood Collection:

- Thorough health checkup of the donor.
- Blood is collected in a sterilized anticoagulant-containing pouch with the help of a cannula.
- The collected blood is stored at a low temperature.
- Blood is checked for any infection; like hepatitis, HIV, etc., and is also checked for ABO grouping and Rh factor.

(B) Blood Transfusion

- Donor's blood is matched with recipients' blood for ABO grouping and Rh factor.
- Stored blood is taken out of the refrigerator about 30 minutes before the actual transfusion.
- Blood is transfused intravenously and the process takes about 4 hours.
- The recipient is continuously monitored for any untoward reaction.

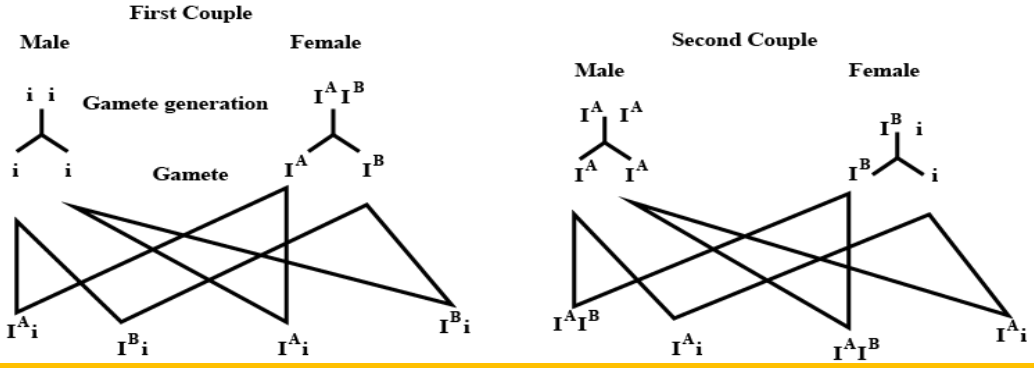
Significance of Blood Group Heredity

The following table shows the genotype of different blood groups:

Blood Group	Genotype
A	I^AI^A or I^Ai
B	I^BI^B or I^Bi
AB	I^AI^B
O	Ii

A Blood group in the child obeys Mendel's laws of inheritance.

Inheritance of blood groups has many uses, like in settling disputes related to the parentage of a child, in blood transfusion, in treating hemophilia patients, etc.



Solved Examples

(1) **Give the basic features of the mechanism of inheritance.**

Answer:
- Characteristics are controlled by genes.
- Each gene controls one character.
- There may be two or more forms of a gene.
- One form may be dominant over the other.
- Genes are present on chromosomes.
- An individual has two forms of gene whether similar or dissimilar.
- The two forms separate from each other at the time of gamete formation.
- The two forms are brought together in the zygote.

(2) **How is the equal genetic contribution of male and female parents ensured in the progeny?**

Answer: During sexual reproduction, a female gamete or egg cell fuses with a male gamete or sperm cell which are haploid to form a zygote. A zygote is a diploid that contains 23 chromosomes from the mother and 23 from the father. In this way, an equal genetic contribution of male and female parents is ensured in the progeny.

(3) **What is meant by characteristics?**

Answer: It is the detail of appearance or behavior; in other words, a particular form or a particular function.
Example: Four limbs of human beings is a characteristic and that plants can perform photosynthesis is also a characteristic.

(4) **Why do offspring differ from parents in certain characteristics?**

Answer: It is due to biparental percentage. The genes on chromosomes that pass over to the next generation are partly derived from both the parents (mother and father). During fertilization of an egg by the sperm, a new combination of chromosomes enters the zygote, due to which certain variations occur in the offspring. Thus, brothers and sisters show variations in their complexion habits and behavior.

(5) **What is DNA copying? State its importance.**

Answer: A process where a DNA molecule produces two similar copies of itself in a reproducing cell is called DNA copying.
Its importance is:
- It makes the transmission of characters from parents to the next generation possible.
- It causes variation in the population.

(6) **"We cannot pass on to our progeny the experiences and qualifications earned during our lifetime." Justify the statement by giving reason and examples.**

Answer: We acquire knowledge and skills in our life such as learning dance, music, physical fitness, etc. But these skills cannot be passed to our progenies because:
Such characters or experiences acquired during one's lifetime do not bring any change in the DNA of the germ cell.
Only germ cells are responsible for passing on the characters from the parents to the progeny. These traits can be passed to the next generation when the changes are in the DNA of the germ cell.

(7) **List the two types of reproduction. Which one of the two is responsible for bringing in more variations in its progeny and how?**

Answer: The two types of reproduction are sexual reproduction and asexual reproduction. Sexual reproduction is responsible for bringing in more variations because of the process of DNA copying which may result in some errors in it. Also, it involves the fusion of male and female gametes from two different parents.

(8) **In one of his experiments with pea plants Mendel observed that when a pure tall pea plant is crossed with a pure dwarf pea plant, in the first generation, F, only tall plants appear.**
(A) What happens to the traits of the dwarf plants in this case?
(B) When the F, generation plants were self-fertilized, he observed that in the plants of the second generation, F, both tall plants and dwarf plants were present. Why did it happen? Explain briefly.

Answer: (A) The dwarf traits of the plants are not expressed in the presence of the dominant tall trait.
(B) In the F, generation, both the tall and dwarf traits are present in the ratio of 3: 1. This showed that the traits for tallness and dwarfness are present in the F, generation, but the dwarfness, being the recessive trait does not express itself in the presence of tallness, the dominant trait.

(9) **Mention the total number of chromosomes along with the sex chromosomes that are present in a human female and a human male. Explain how in sexually producing organisms the number of chromosomes in the progeny remains the same as that of the parents.**

Answer: The human male has 22 pairs of chromosomes along with the XY sex chromosome. The human female has 22 pairs of chromosomes along with XX sex chromosomes.
The original number of chromosomes (the amount of DNA) becomes half during gamete formation. When the gametes fuse, the original number of chromosomes (the amount of DNA) is restored in the progeny.

(10) **How did Mendel's experiments show that different traits are inherited independently? Explain.**

Answer: Mendel conducted a dihybrid cross and observed that though he started with two types of parents, he obtained four types of individuals in F2. The appearance of new recombination in F2, generations along with parental type characters show that traits are inherited independently of each other.

Exercise

OBJECTIVE TYPE QUESTIONS

(1) Mendel selected garden peas as his experimental material because
(i) Pea plants possess several well-defined contrasting characters.
(ii) Pea plants contain unisexual flowers.
(iii) Pea plants have perfect bisexual flowers.
(iv) These are annual plants.
(A) (i) & (iv) (B) (i) & (ii)
(C) (i) & (iii) (D) (i), (iii) & (iv)

(2) Match the traits studied by Mendel in column I with their related recessive traits in column II and select the correct option from the codes given below.
(A) (a) – (i), (b) – (iii), (c) – (iv), (d) – (vi)
(B) (a) – (i), (b) – (vi), (c) – (iv), (d) – (ii)
(C) (a) – (v), (b) – (iii), (c) – (ii), (d) – (vi)
(D) (a) – (v), (b) – (vi), (c) – (ii), (d) – (iii)

Column I	Column II
(a) Flower position	(i) Axillary
(b) Pod colour	(ii) White
(c) Flower colour	(iii) Yellow
(d) Seed colour	(iv)Violet
	(v)Terminal
	(vi) Green

(3) Two tall plants with heterozygous alleles as shown below are crossed.
Tt X Tt (T = Tall, t = Dwarf)
Predict the phenotypic ratio of the F1 generation from the following:
(A) 3 tall: 1 dwarf (B) 2 tall: 2 dwarfs
(C) 1 tall: 3 dwarf (D) 4 tall: 0 dwarf

(4) In the pea plants, the factors round yellow seeds (RRYY) are dominant over wrinkled green seeds (rryy). Keeping this in mind, identify the seed that has the genotype round and green.
(A) Rryy (B) rrYy
(C) RrYy (D) RRYy

(5) Which of the following crosses and resultant phenotypic ratios are mismatched?
Cross Phenotypic Ratio
(A) Tt x Tt -- 3: 1 (B) Tt x Tt --2: 1
(C) Ttyy x Ttyy -- 1: 1: 1: 1 (D) Ttyy x Tyyy -- 9: 3: 3: 1

(6) In tomatoes, round fruit (R) is dominant over oblong fruit (r) what is the genotype of a round-fruited plant that resulted from a test cross?
(A) RR (B) Rr
(C) Rr (D)Rr Or Rr

(7) The ratio of 1: 1: 1: 1 is obtained from a cross between the parents:
(A) RRYY x rryy (B) RrYy x rryy
(C) rrYy x rrYy (D) RRYy x rrYy

(8) In F2 the phenotypic ratio of dihybrid cross is:
(A) 1: 1 :1: 1 (B) 3: 1
(C) 9: 3: 3: 1 (D) 9: 3: 4

(9) Which type of gametes are produced by RrYy?
(A) RY, Ry, rY, ry (B) RY, RY, RY, RY
(C) ry, ry, ry, ry, (D) RY, RY, rY, rY

(10) A blue Andalusian fowl is a product of mating a black fowl with white fowl. A cross of blue fowl with another blue fowl results in:
(A) 1 black: 2 white: 1 blue (B) 1 black: 2 blue: 1 white
(C) 2 black: 1 white: 1 blue (D) None of these

(11) In a plant, red fruit (R) is dominant over yellow fruit (r) and tallness (T) is dominant over shortness (t). if a plant with RRTt genotype is crossed with a plant that a rrtt:
(A) 25 % Will Be Tall with Red Fruit (B) 50% Will Be Tall with Red Fruit
(C) 75% Will Be Tall with Red Fruit (D) All the Offspring Will Be Tall with Red Fruit

(12) When a heterozygous red (dominant) flower is crossed with a white flower, the progeny would be:
(A) 350 Red: 350 White (B) 450 Red: 250 White
(C) 380 Red: 320 White (D) None of these

(13) In which process the variation is maximum?
(A) Asexual Reproduction (B) Sexual Reproduction
(C) Environmental changes (D) All of these

(14) The genetic constitution of an organism is called its
(A) Phenotype (B) Variation
(C) DNA (D) Genotype

(15) In a monohybrid cross between two heterozygous individuals, the percentage of pure homozygous individuals obtained in the F1 generation is
(A) 25% (B) 50%
(C) 75% (D) 100%

(16) Ruby crossed a tall pea plant with white flowers and a dwarf plant with violet flowers. She performed a_____.
(A) Test cross (B) Dihybrid cross
(C) Natural selection (D) Monohybrid cross

(17) The genotype for the height of an organism is Tt. What conclusion may be drawn from this?
(A) The allele for height has at least two different genes.
(B) There are at least two different alleles for the gene for height.
(C) There are two different genes for height, each having a single allele.
(D) There is one allele for height with two different forms.

(18) Pure breeding pea plants with green pods are crossed with pure breeding pea plants with yellow pods. All the F1 generation plants have green pods. Plants from the F1 generation are allowed to be interbred. What color of pods will be observed in F2 generation plants?
(A) All green (B) All yellow
(C) 1 green: 1 yellow (D) 3 green: 1 yellow

(19) Humans inherit the colour of their eyes from their parents. The brown-eyed couple has three blue-eyed children. Which of the following statements gives the correct explanation of this situation?
(i) Each parent has an allele for brown eyes and an allele for blue eyes.
(ii) The allele for blue eyes is recessive.
(iii) The probability that their next child will have blue eyes is 0.75.
(iv) The probability that their next child will have brown eyes is 0.5.
(A) (i) and (ii) only (B) (i) and (iii) only
(C) (ii) and (iv) only (D) (iii) and (iv) only

(20) A Mendelian experiment consists of breeding tall pea plants bearing violet flowers with short pea plants bearing white flowers. The progeny all bore violet flowers, but almost half of them were short. This suggests that the genetic make-up of the tall parent cod depicted as
(A) TTWW (B) TTww
(C) TtWW (D) TtWw

Answer Key

OBJECTIVE TYPE QUESTIONS

(1)	D	**(11)**	B
(2)	B	**(12)**	A
(3)	D	**(13)**	B
(4)	A	**(14)**	D
(5)	B	**(15)**	B
(6)	B	**(16)**	B
(7)	B	**(17)**	B
(8)	C	**(18)**	D
(9)	A	**(19)**	A
(10)	B	**(20)**	D