Chapter 4

Heredity and Evolution

- The transmission of characters from parent to their offsprings is known as **heredity**.
- **Variation** is the difference in the characters or traits among the individuals of a species.
- The study of heredity and variations is known as **genetics**.
- **Factor** is a particulate entity that functions as a unit of inheritance passing from generation to generation and controlling expression of a character, generally alongwith another factor of the same character.
- **Alleles** are various forms of a gene which occur at the same particular position or gene locus over the chromosome. In higher plants and animals, there are two alleles of a gene called allelomorphs or allelomorphic pair that may express the same trait or different traits of a character, *e.g*., TT, T*t, tt*.
- **Homozygous** is an individual having identical alleles of a gene, *e.g*., TT, *tt*.
- **Heterozygous** is an individual having both the contrasting alleles of a character is called hybrid or heterozygous individual, *e.g.* T*t*.
- Dominant gene trait is an expressed characteristic trait within an organism.
- Recessive gene trait is an unexpressed characteristic within an organism through the gene for it is present.
- Paired condition of chromosomes is known as **diploid**.
- Unpaired condition of chromosomes is known as **haploid**.
- Genes are made up of chemical called as DNA which have the ability to duplicate themselves.
- DNA (Deoxyribo Nucleic Acid) is the genetic material in all organisms.

Mendel's laws of inheritance

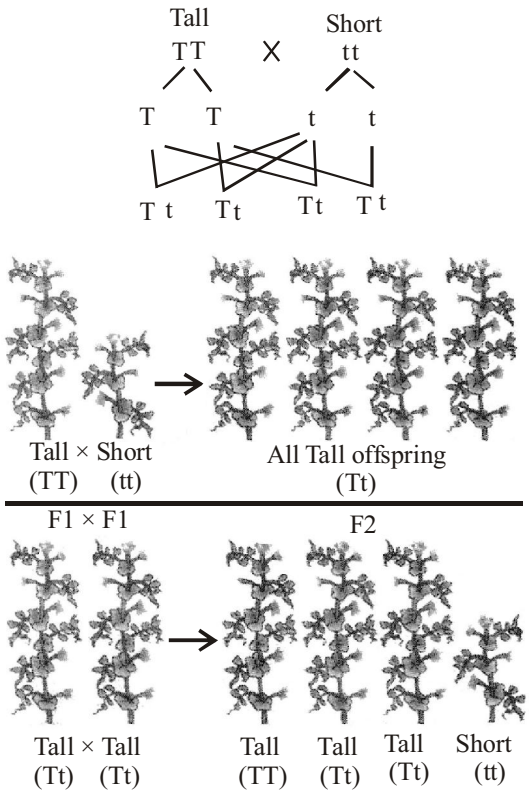
The first study of inheritance was done by **Gregor Mendel** on garden pea (*Pisum sativum*). He used a number of contrasting characters like round / wrinkled seeds, tall/ short plants, white/ violet flowers and so on.

(i) Law of Dominance : Out of a pair of allelomorphic characters one is dominant (expressed) and the other is recessive/ unexpressed. The benefit of this law is that recessive (harmful) characters not expressed in hybrid and can exist for several generations.

(ii) Law of Segregation : The factors for each character segregate during gametogenesis. As a result, each gamete receives only one factor for each character and hence is always pure.

(iii) Law of Independent Assortment : The two factors of each trait assort at random and independent of the factors of other trait at the time of meiosis and get randomly as well as independently arranged in the offspring.

- **Genotype** is the composition of genes present in an organism and the characteristic which is visible in an organism is called its **phenotype**.
- When two parents cross (or breed) to produce progeny (or offsprings), then their progeny is called **F_1-generation (First Filial Generation)** and when the first generation progeny cross among themselves to produce second progeny, then this progeny is called **F_2-generation Second Filial Generation.**



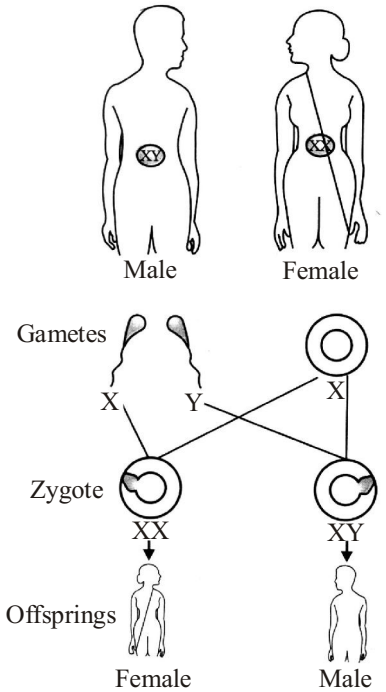
Inheritance of traits over two generations

- **Monohybrid Cross and Dihybrid Cross**
- When **tall pea plants** are crossed with **short pea plants** then in **F_1 generation** only tall plants were obtained.
- F_2 progeny of F_1 tall plants are not all tall but one quarter of them are short indicating that both tallness and shortness traits were inherited in F_1 but only tallness trait was expressed due to dominance. Both the traits appear in the ratio of 3 : 1 (three tall and one dwarf). It is called **monohybrid ratio**.
- In dihybrid cross two pairs of contrasting characters were considered. Tall plant with round seeds were crossed with short plant with wrinkled seeds. In F_1 tall plants with round

seeds were obtained. On selfing these F_1 plants F_2 showed tall plants with round seeds, short plant with wrinkled seeds and same new combinations (tall plant with wrinkled seeds and short plant with round seeds) were also obtained in the ratio of 9 : 3 : 3 : 1. It is called **dihybrid ratio**.

- The tall/short trait and round wrinkled traits are independently inherited.
- The expression of a particular trait is controlled by gene.
- Plants have hormones that can trigger growth, *e.g.* Plant height can depend on the amount of a particular hormone. The amount of that hormone will depend on the efficiency of the process of making it.
- The characteristics or traits of parents are transmitted to their progeny through genes present on their chromosomes during the process of sexual reproduction.
- **Sex Determination**

  Sex determination is a biological system that determines the development of sexual characters in an organism.
- Different organisms use different strategies to determine the sex of new born.
- In some animals, the temperature at which fertilised eggs are kept determines whether the animals developing in the eggs will be male or female.
- In **snails**, individuals can change sex, indicating that sex is not genetically determined.
- In **human beings** the sex of an individual is genetically determined.
- All human chromosomes are not paired. 22 pairs are called **autosomes**. Women have a perfect pair of sex chromosomes XX. But men have a mismatched pair XY.
- Given figure shows all children will inherit an X chromosome from their mother. The sex of children will be determined by what they inherit from their father.
- A child who inherits an X chromosome from father will be a girl and one who inherits a Y chromosome will be a boy.



Sex determination in human beings

- **Evolution**

  It is the sequence of gradual changes which take place in the primitive organisms over millions of years in which new species are produced.
- **The evidences of evolution are :**
  (i) **Homologous organs :** The organs which have same fundamental structure but different functions are called **homologous organs**. The examples are forelimb of frog, lizard, pigeon, mole, bat and humans have the same basic structural plan.
  (ii) **Analogous organs :** The organs which have similar functions but are different in their structural detail and origin are **analogous organs**. *E.g.* wings of insect and wings of bird. The organ which are present in reduced form and do not perform any function in the body but correspond to the fully developed functional organs of related animals called **vestigial organs** *E.g.* Muscles which are responsible for movement of ear are found in man but have lost their power to move the ear.
  (iii) **Fossils :** Fossils are the remains of the past and the study of fossils is known as **paleontology**.
- **Theories of Evolution**

  Jean Baptiste Lamarck gave the first theory of evolution.

  Darwin's Theory of Evolution

  Charles Robert Darwin (1809-1882) explained the evolutionary principle in his famous book "**The origin of species**". The theory proposed by him is popularly known as theory of **natural selection**.
- The main features of the theory of natural selection are as follows:
  (i) **Over production:** All organisms possess enormous fertility. They multiply in geometric ratio, *e.g.* plants produce thousands of seeds, insects lay hundreds of eggs, etc.
  (ii) **Limited food and space:** Despite of rapid multiplication of all types of species, food and space and other resources remain limited. They are not liable to increase.
  (iii) **Struggle for Existence:** It is the struggle between the individuals of the same or different species because their requirements like food, shelter, breeding places, etc are similar.
  (iv) **Variations:** Except the identical twins, no two individuals are similar and their requirements are also not exactly the same. It means there are differences among the individuals. These differences are called variations.
  (v) **Natural Selection or Survival of the Fittest:** The organisms which are provided with favourable variations would survive, because they are the fittest to face their surroundings while the unfit are destroyed. Originally it was an idea of **Herbert Spencer** (1820–1903) who used the phrase "**the survival of the fittest**" for the first time.
- Natural selection is the process of evolution of a species whereby characteristics which help individual organisms to survive and reproduce are passed on to their offsprings and those characteristics which do not help are not passed on.

Acquired trait : A trait (characteristics) of an organism which is 'not inherited' but develops in response to the environment is called an acquired trait *e.g.* muscular body of an athlete, learning of music.

Inherited trait : A characteristic of an organism which is caused by a change in its genes is called an inherited trait. *e.g.* fused and free ear lobes.

- **Speciation**
  The process by which new species develop from the existing species is known as speciation.
- **The important factors which could lead to the rise (or formation) of a new species are the following :**
  (i) **Geographical isolation** of a population caused by various types of barriers (such as mountain ranges, rivers and sea). The geographical isolation leads to reproductive isolation due to which there is no flow of genes between separated groups of population.
  (ii) **Genetic drift** caused by drastic changes in the frequencies of particular genes is by chance alone.
  (iii) **Variations** caused in individuals due to natural selection.

  Speciation is of two types, **Allopatric speciation** is formation of new species from populations occurring in different and mutually exclusive areas of distribution. **Sympatric speciation** is development of new species from a segment of population in the same area due to some intrinsic factors like mutations.

Evolution and Classification

(i) We can classify the organisms by studying their evolutionary relationships.
(ii) This can be done by identifying hierarchies of characteristics between them.
(iii) Characteristics are details of appearance or behaviour of an organism.
(iv) The more characteristics two species will have in common, the more closely they are related and have a common ancestor.

- **Evolutions are of three types :-**
  (i) Convergent Evolution
  (ii) Divergent Evolution, and
  (iii) Parallel Evolution.
- **Fossils**
  (i) The remains of dead plants or animals that lived in the remote past are known as **fossils**.
  (ii) Various kinds of fossils are : -
  Ammonite, Trilobite and Dinosaur.
  (iii) The age of fossils can be detected. The most appropriate method is by detecting the ratios of different isotopes of the same element in the fossil material.

Evolution by stages

(i) Evolution of complex organs have taken place bit-by-bit over generations. *e.g.* eye, feathers of birds have evolved because of survival advantage of intermediate stages.
(ii) Man had cultivated wild cabbage as a food plant and generated different vegetables like kohlrabi, kale, cauliflower, broccoli, red cabbage from it through artificial selection.
(iii) Thus changes in DNA during reproduction are the main cause of evolution.

Human Evolution

(i) All human beings belong to single speceis *Homo sapiens*, although there were many races of humans.
(ii) They have originated in Africa, some ancestors left Africa and migrated to West Asia, Central Asia, Eurasia, South Asia, East Asia, Indonesia, Australia, America, while others stayed there.
(iii) Excavating, time-dating, studying fossils and determining DNA Sequences have been used for studying human evolution.

Exercise 1

DIRECTIONS : This section contains multiple choice questions. Each question has 4 choices (1), (2), (3) and (4) out of which only one is correct.

1. Selection of variants by environmental factors
   (1) forms the basis of evolutionary processes
   (2) forms the basis of reproduction
   (3) cause inheritance of traits
   (4) have different kind of advantages
2. The rules of heredity determine the process by which _____ and _____ are reliably inherited.
   (1) shape and size
   (2) traits and characteristics
   (3) Both (1) and (2)
   (4) Neither (1) nor (2)
3. Plants having similar genotypes produced by plant breeding are called
   (1) clone (2) haploid
   (3) autopolyploid (4) genome
4. Mendel's law of segregation is based on separation of alleles during
   (1) gametes formation (2) seed formation
   (3) pollination (4) embryonic development
5. Disease resistant varieties can be produced by
   (1) crossing a plant with wild variety
   (2) treating with colchicine
   (3) crossing with hormones
   (4) treating with low temperature
6. According to Mendel's laws of inheritance
   (1) traits in human beings are related to the fact that both the parents have contributed practically amount of genetic material to the child.
   (2) each trait will be influenced by both maternal and paternal DNA.
   (3) for each trait there will be two versions in each child.
   (4) all these three statements describe the law of inheritance.

7. _____ is a section of cellular DNA that provides information for one protein.
   (1) Progeny (2) Traits
   (3) Gene (4) Hormone
8. A pure tall plant can be differentiated from a hybrid tall plant
   (1) by measuring length of plant
   (2) by spraying gibberellins
   (3) if all plants are tall after self-pollination
   (4) if all plants are dwarf after self-pollination
9. In animals sex determination is due to
   (1) X-chromosome (2) Y-chromosome
   (3) A-chromosome (4) B-chromosome
10. The famous book "Origin of species" was written by Charles Darwin in
   (1) 1809 (2) 1859
   (3) 1885 (4) 1871
11. In a Mendelian experiment tall plants bearing violet flowers were bred with short pea plants bearing white flowers. The progeny all bore violet flowers but almost half of them were short. The genetic make-up of the tall parent would have been
   (1) TtWw (2) TtWW
   (3) TTww (4) TTWW
12. A gene has two separate independent pieces, each called chromosome. Each cell will have two copies of each chromosome
   (1) one each from the male and female parents
   (2) both from the male parent
   (3) both from the female parent
   (4) both different from those of the parents
13. The term evolution in biology means that
   (1) fossils are old
   (2) life began in sea
   (3) living things constantly change
   (4) life began on land
14. Homolgous structures have
   (1) similar origin but disimilar functions
   (2) dissimilar origin but similar functions
   (3) dissimilar origin but dissimilar functions
   (4) dissimilar origin but dissimilar structures
15. The idea of "Survival of fittest" was given by
   (1) Darwin (2) Herbert Spencer
   (3) Mendel (4) Lamarck
16. Choose the odd one out
   (1) Colour variation takes place during reproduction only
   (2) Sexually reproducing individuals have two copies of genes for the same trait.
   (3) If the copies are not identical, the trait that gets expressed is called the dominant trait.
   (4) The trait that does not get expressed is called the recessive trait.
17. In human beings, the sex of the child depends on whether
   (1) The paternal chromosome is X (for girls) or Y (for boys)
   (2) The paternal chromosome is Y (for girls) or X (for boys)
   (3) The maternal chromosome is X (for girls) or Y (for boys)
   (4) The maternal chromosome is Y (for girls) or X (for boys)
18. Which one is not a vestigial organ in man ?
   (1) Vermiform appendix
   (2) Plica seminuralis
   (3) Ear muscles
   (4) Epiglottis
19. When an organ is used it will develop and if it is not used, it weakens to become vestigial. Who could have said this theory ?
   (1) Darwin (2) Hugo de-Vries
   (3) Lamarck (4) Mendel
20. An experiment to prove that organic compounds were the basis of life, was performed by
   (1) Oparin (2) Miller
   (3) Melvin (4) Fox
21. There is a tendency of variation during reproduction because of
   (1) errors in DNA copying
   (2) sexual reproduction
   (3) Both (1) or (2)
   (4) Neither (1) nor (2)
22. Evolution takes place because of
   (1) natural Selection resulting in adaptation to fit environment better.
   (2) genetic Drift providing diversity without adaptation.
   (3) both natural selection and genetic drift.
   (4) experiences of daily life.
23. According to the Neo-Darwinian theory which of the following is responsible for the origin of new species ?
   (1) Mutations
   (2) Useful variations
   (3) Mutations together with natural selection
   (4) Hybrdization
24. Nucleoprotein gave most probably the first sign of
   (1) life (2) amino acid
   (3) soil (4) sugar
25. Origin of life is due to
   (1) spontaneous generation
   (2) will to God
   (3) effect of sun rays on mud
   (4) None of the above
26. The changes in non-reproductive tissues
   (1) cannot be passed on to the DNA of the germ cells
   (2) cannot direct evolution
   (3) are the acquired traits
   (4) All of these
27. Variation combined with geographical isolation result in
   (1) speciation (2) dominant traits
   (3) recessive traits (4) None of these
28. If a round, green seeded pea plant (RR yy) is crossed with wrinkled, yellow seeded pea plant, (rr YY) the seeds produced in F_1 generation are
   (1) round and yellow
   (2) round and green
   (3) wrinkled and green
   (4) wrinkled and yellow

29. In human males all the chromosomes are paired perfectly except one. This/these unpaired chromosomes is/are
(i) large chromosome
(ii) small chromosome
(iii) Y-chromosome
(iv) X-chromosome
(1) (i) and (ii) (2) (iii) only
(3) (iii) and (iv) (4) (ii) and (iv)

30. New species may be formed if
(i) DNA undergoes significant changes in germ cells
(ii) chromosome number changes in the gamete
(iii) there is no change in the genetic material
(iv) mating does not take place
(1) (i) and (ii) (2) (i) and (iii)
(3) (ii), (iii) and (iv) (4) (i), (ii) and (iii)

31. Characteristics
(1) decide more fundamental differences among organisms.
(2) are details of appearance - particular form.
(3) are details of behaviour - particular function.
(4) are details of particular form or function that decide more fundamental differences than less basic differences.

32. Classification of species is done on the basis of
(1) cell design - nucleated or non-nucleated
(2) unicellular or multi-cellular.
(3) specialisation of cell types and tissues - Autotrophs or heterotrophs.
(4) some other factors also in addition to these.

33. Two pea plants one with round green seeds (RRyy) and another with wrinkled yellow (rrYY) seeds produce F_1 progeny that have round, yellow (RrYy) seeds. When F_1 plants are selfed, the F_2 progeny will have new combination of characters. Choose the new combination from the following
(i) Round, yellow (ii) Round, green
(iii) Wrinkled, yellow (iv) Wrinkled, green
(1) (i) and (ii) (2) (i) and (iv)
(3) (ii) and (iii) (4) (i), (i) and (iii)

34. Select the statements that describe characteristics of genes
(i) Genes are specific sequence of bases in a DNA molecule.
(ii) A gene does not code for proteins
(iii) In individuals of a given species, a specific gene is located on a particular chromosome.
(iv) Each chromosome has only one gene.
(1) (i) and (ii) (2) (i) and (iii)
(3) (i) and (iv) (4) (ii) and (iv)

35. In peas, a pure tall plant (TT) is crossed with a short plant (tt). The ratio of pure tall plants to short plants in F_2 is
(1) 1 : 3 (2) 3 : 1
(3) 1 : 1 (4) 2 : 1

36. Evolutionary relationships can be followed by
(1) similar homologous characteristics indicate common origins even in apparently different species.
(2) similar analogous characteristics may not have common origins
(3) Both (1) and (2)
(4) None of these

37. Age of a fossil can be estimated by
(1) how closer to earth surface the fossil was found
(2) detecting the ratio of different isotopes of the same element in the fossil
(3) comparing DNA of different species
(4) All of these

38. Some dinosaurs had feathers although they could not fly but birds have feathers that help them to fly. In the context of evolution this means that
(1) reptiles have evolved from birds.
(2) there is no evolutionary connection between reptiles and birds.
(3) feathers are homologous structures in both the organisms.
(4) birds have evolved from reptiles.

39. Genetics is the study of
(1) inheritance (2) cell structure
(3) only plants (4) only animals

40. If two parents have the genotypes AA × aa, the probability of having an aa genotype in the F_1 generation is
(1) 25 percent (2) 50 percent
(3) 75 percent (4) None of the above

41. A heterozygous red-eyed female Drosophila mated with a white-eyed male would produce
(1) red-eyed females and white-eyed males in the F_1
(2) white-eyed females and red-eyed males in the F_1
(3) half red and half white-eyed females and all white eyed males in the F_1
(4) half red and half white-eyed females as well as males in the F_1

42. Complex organs may have evolved because of
(1) survival advantage of even the intermediate stages
(2) human intervention
(3) environmental changes
(4) competition among the same species

43. Newly generated species
(1) eliminate the existing species
(2) will have more complex body designs than the older ones
(3) are formed because of natural selection and genetic drift
(4) Both (2) and (3)

44. Which of the following would stop evolution by natural selection from occurring?
(1) If humans became extinct because of a disease epidemic.
(2) If a thermonuclear war killed most living organisms and changed the environment drastically.
(3) If ozone depletion led to increased ultraviolet radiation, which caused many new mutations.
(4) If all individuals in a population were genetically identical, and there was no genetic recombination, sexual reproduction, or mutation.

45. Which of the following rediscovered the Mendel's work?
(1) Correns (2) Hugo de-Vries
(3) Tschermark (4) all of the above

46. From heredity point of view which marriage is not suitable ?
(1) Man Rh (–) and Woman Rh (+)
(2) Both Rh (+)
(3) Both Rh (–)
(4) Man Rh (+) and Woman Rh (–)

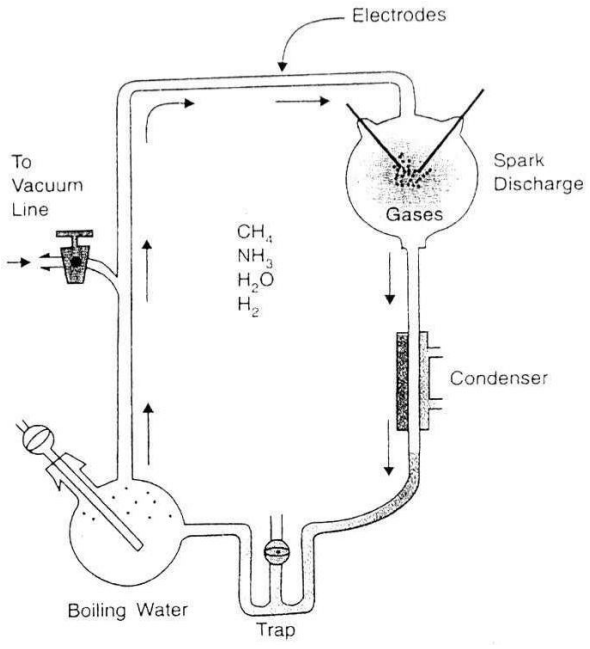
47. Palaentology is the study of
(1) fossils (2) bones
(3) birds (4) embryo

48. The generation of diversity and the shaping of diversity by environmental selection are
(1) evolution (2) diversity
(3) heredity (4) All of these

49. Study of evolution of human beings indicates that
(1) all humans belong to a single species that evolved in Africa and spread across the world in stages.
(2) the difference in colour, size and looks is the result of environmental changes
(3) Both (1) and (2)
(4) None of these

50. New species may be formed if
(i) DNA undergoes significant changes in germ cells
(ii) chromosome number changes in the gamete
(iii) there is no change in the genetic material
(iv) mating does not take place
(1) (i) and (ii) (2) (i) and (iii)
(3) (ii), (iii) and (iv) (4) (i), (ii) and (iii)

51.



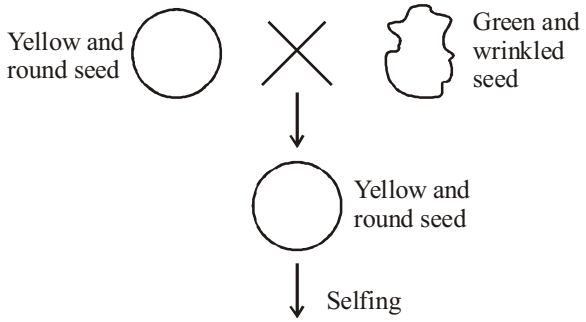
The figure represents :
(1) Experiment to create different gases
(2) Simple fractionation process
(3) Experiment to demonstrate chemical evolution of life
(4) Haldane's reaction

52. Which one of the following has four limbs with similar basic structure as the mammals?
(1) Birds (2) Reptiles
(3) Amphibians (4) All the three

53. Birds and bats have wings, but they do not have common origin because
(1) wings of bats are skin-fold stretched mainly between elongated fingers, but the wings of birds are a feathery covering all along the arm.
(2) structure and components of their wings are very different.
(3) they look similar because they have a common use.
(4) All of these.

54. Which one of the following does not describe formation of fossils?
(1) Extinct species must have existed at some stage.
(2) Bodies of organisms will decompose and be lost after their death.
(3) Some part of the environment does not let the body or a part of it to decompose completely.
(4) An impression of the body parts may be left on the immediate surroundings for ever.

55.



Total number of seeds were 556.
Yellow round = a, Yellow wrinkled = b, Green round = c, Green wrinkled = d
Choose the correct option :
(1) a = 32, b = 108, c = 101, d = 315
(2) a = 108, b = 315, c = 32, d = 101
(3) a = 315, b = 101, c = 108, d = 32
(4) Can't say

56. A mendelian experiment consisted of crossing tall pea plants bearing red flowers, with short pea plants, bearing white flowers. All plants of F_1 generation consists of tall with red flowers. Then the genetic make up of the tall parents can be defined as :
(1) TTWW (2) TTww
(3) TtWW (4) TtWw

57. Simplest life forms inhabiting adverse habitats are
(1) humans (2) bacteria
(3) plants (4) vultures

58. A change that is useful for one property
(1) can become useful later for quite a different function.
(2) can be used for performing the same function.
(3) can perform some other function also without abandoning the original use.
(4) All of these

Exercise 2

Matching Based MCQ

DIRECTIONS (Qs. 1 to 7) : Match Column-I with Column-II and select the correct answer using the codes given below the columns.

1.

Column I	Column II
(A) BB × bb	(p) 100% Bb
(B) Bb × Bb	(q) 25% BB,50%Bb,25%bb
(C) BB × BB	(r) 100% BB
(D) b× bb	(s) 100% bb

(1) (A) → (q); (B) → (p); (C) → (r); (D) → (s)
(2) (A) → (p); (B) → (q); (C) → (r); (D) → (s)
(3) (A) → (p); (B) → (q); (C) → (s); (D) → (r)
(4) (A) → (p); (B) → (s); (C) → (q); (D) → (r)

2.

Column I	Column II
(A) Fossils	(p) Comparing similarities and differences between amino acid sequences in two organisms.
(B) Embryology	(q) Comparing and constrasting cell structures found within an organism.
(C) Cytology	(r) Comparisons of the early development stages of an organism.
(D) DNA evidence	(s) The remains of decreased organisms that are studied.

(1) (A) → (s); (B) → (r); (C) → (q); (D) → (p)
(2) (A) → (r); (B) → (s); (C) → (q); (D) → (p)
(3) (A) → (r); (B) → (s); (C) → (p); (D) → (q)
(4) (A) → (r); (B) → (p); (C) → (s); (D) → (q)

3.

Column I	Column II
(A) Erect ape man	(p) 5-Bromouracil
(B) *Homo sapiens* fossils	(q) Java man
(C) Base analogous	(r) Cromagnon man
(D) Lamarck	(s) Theory of inheritance of acquired character.

(1) (A) → (r); (B) → (q); (C) → (s); (D) → (p)
(2) (A) → (q); (B) → (r); (C) → (s); (D) → (p)
(3) (A) → (q); (B) → (r); (C) → (p); (D) → (s)
(4) (A) → (q); (B) → (p); (C) → (r); (D) → (s)

4.

Column I	Column II
(A) Allopatric speciation	(p) Swan neck experiment
(B) Bar eye character in *Drosophila*	(q) Finches to darwin
(C) Louis Pasteur	(r) 3 : 1
(D) Monohybrid ratio	(s) Duplication in X-chromosome

(1) (A) → (s); (B) → (q); (C) → (p); (D) → (r)
(2) (A) → (q); (B) → (s); (C) → (r); (D) → (p)
(3) (A) → (q); (B) → (p); (C) → (s); (D) → (r)
(4) (A) → (q); (B) → (s); (C) → (p); (D) → (r)

5.

Column I	Column II
(A) Genetic changes	(p) Darwin
(B) Independent inheritance	(q) 9 : 3 : 3 : 1
(C) Natural selection	(r) DNA copying
(D) Dihybrid ratio	(s) Mendel

(1) (A) → (r); (B) → (s); (C) → (p); (D) → (q)
(2) (A) → (s); (B) → (r); (C) → (p); (D) → (q)
(3) (A) → (s); (B) → (r); (C) → (q); (D) → (p)
(4) (A) → (r); (B) → (p); (C) → (s); (D) → (q)

6.

Column I	Column II
(A) Male human beings	(p) Homologous organs
(B) Wing of a bat and a wing of a bird	(q) Fossil
(C) Remnant of ancient animals	(r) XY
(D) Arm of a man and wing of a bird	(s) Analogous organ

(1) (A) → (s); (B) → (r); (C) → (q); (D) → (p)
(2) (A) → (r); (B) → (s); (C) → (q); (D) → (p)
(3) (A) → (r); (B) → (s); (C) → (p); (D) → (q)
(4) (A) → (r); (B) → (p); (C) → (s); (D) → (q)

7.

Column I	Column II
(A) *Planaria*	(p) Molecular Biology
(B) DNA	(q) 1953
(C) Miller and Urey	(r) Natural selection
(D) Darwin	(s) Rudimentary eyes

(1) (A) → (p); (B) → (s); (C) → (r); (D) → (q)
(2) (A) → (s); (B) → (p); (C) → (r); (D) → (q)
(3) (A) → (s); (B) → (p); (C) → (q); (D) → (r)
(4) (A) → (s); (B) → (q); (C) → (p); (D) → (r)

Statement Based MCQ

8. Consider the following statements :
(a) Life can originate on earth from pre-existing life only.
(b) The atmosphere of the primitive earth was reducing.
Which of these statement(s) is/are correct ?
(1) (a) only (2) (b) only
(3) Both (a) and (b) (4) Neither (a) nor (b)

9. Consider the following statements :
(a) At present time evolution is not possible.
(b) There was plenty of oxygen present in atmosphere of primitive earth.
Which of these statement(s) is/are correct ?
(1) (a) only (2) (b) only
(3) Both (a) and (b) (4) Neither (a) nor (b)

10. Consider the following statements:
(a) Variations arising during the process of reproduction cannot be inherited.
(b) Changes in the non-reproductive tissues caused by environmental factors are inheritable.
Which of these statement(s) is/are correct ?
(1) (a) only (2) (b) only
(3) Both (a) and (b) (4) Neither (a) nor (b)

11. Consider the following statements :
    (a) Sex is determined by different factors in various species.
    (b) Exchange of genetic material takes place in asexual reproduction.
    Which of these statement(s) is/are correct ?
    (1) (a) only (2) (b) only
    (3) Both (a) and (b) (4) Neither (a) nor (b)
12. Consider the following statements :
    (a) A cross between a true tall and pure dwarf pea plant resulted in production of all tall plants because tallness is the dominant trait.
    (b) The more characteristics two species will have in common, the more closely they are related.
    Which of these statement(s) is/are correct ?
    (1) (a) only (2) (b) only
    (3) Both (a) and (b) (4) Neither (a) nor (b)
13. Consider the following statements :
    (a) Reduction in weight of an organism due to nutrition is genetically controlled.
    (b) New species may be formed if DNA undergoes significant changes germ cells or chromosome number changes in the gametes.
    Which of these statement(s) is/are correct ?
    (1) (a) only (2) (b) only
    (3) Both (a) and (b) (4) Neither (a) nor (b)
14. Consider the following statements :
    (a) Both the parents contribute DNA equally to the offspring.
    (b) Sex of the child is determined by the type of ovum provided by the mother.
    Which of these statement(s) is/are correct ?
    (1) (a) only (2) (b) only
    (3) Both (a) and (b) (4) Neither (a) nor (b)
15. Consider the following statements :
    (a) A recessive trait can also be common as blood group O.
    (b) Charles Darwin discovered the law of independent assortment.
    Which of these statement(s) is/are correct ?
    (1) (a) only (2) (b) only
    (3) Both (a) and (b) (4) Neither (a) nor (b)

Passage Based MCQ

DIRECTIONS (Qs. 16 to 22) : Read the passage(s) given below and answer the questions that follow.

PASSAGE - 1

The theory of natural selection was put forth by Charles Darwin in his book 'On the Origin of Species by means of Natural Selection', co-authored by Alfred Russel Wallace. According to Darwin, nature has its own ways of selecting the best from the available species for continuation of life. The mechanism of natural selection works as follows:

Individuals of a species produce more offspring than necessary to replace themselves. This results in competition and struggle for existence among the individuals. Within the species itself there is variation that results in minor differences between the individuals.

Thus in the struggle for existence only the ones with the variations best adapted to their environment survive. In this manner nature ensures survival of the fittest.

16. The book 'On the Origin of Species by means of Natural Selection' was published in the year
    (1) 1859 (2) 1860
    (3) 1861 (4) 1862
17. Darwin formulated theory of natural selection in the year
    (1) 1858 (2) 1859
    (3) 1860 (4) 1861
18. Darwin's theory is also known as
    (1) Theory of Natural Selection
    (2) Mutation Theory
    (3) Theory of Inheritance of Acquired Characters
    (4) None of these
19. Which animal is the slowest breeder in the animal kingdom?
    (1) Elephant (2) Rat
    (3) Lion (4) Tiger

PASSAGE - 2

Adaptations are favourable, heritable variations or changes that enable an organism to increase its chances of survival. Such variations are the result of genetic recombination or mutations. Adaptations can be either permanent (*i.e.*, heritable from generation to generation) or temporary (*i.e.*, within an organism's life span. It can again be a short term or long-term adaptation). Short-term adaptations are temporary in nature and appear in response to a particular condition, season or stage of the life-cycle. For example, when skin is exposed to sunlight for a considerable period of time, it starts turning black in colour. It is due to the formation and accumulation of melanin pigment. It protects the body tissues from harmful radiation. Long- term adaptations are permanent changes that have occurred over many generations, in response to some significant changes in the environment. These adaptations have now become genetic characteristics of the species. For example, in the course of human evolution, forelimbs have become free from the task of locomotion and have opposable digits. This adaptive feature has enabled man to use his forelimbs for various activities like holding, examining or throwing an object, making and using of tools and so on.

20. 'Descent with modification' is the central theme of
    (1) recapitulation (2) genetics
    (3) evolution (4) biogenesis
21. The ultimate source of variation is
    (1) natural selection
    (2) mutation
    (3) sexual reproduction
    (4) None of these
22. Adaptations can
    (1) permanent (2) temporary
    (3) Both (1) and (2) (4) Neither (1) nor (2)

Assertion Reason Based MCQ

DIRECTIONS (Qs. 23 to 28) : Following questions consist of two statements, one labelled as the **'Assertion'** and the other as **'Reason'**. You are to examine these two statements carefully and select the answer to these items using the code given below.

Code :

(1) Both A and R are individually true and R is the correct explanation of A:
(2) Both A and R are individually true but R is not the correct explanation of A.
(3) A is true but R is false
(4) A is false but R is true.

23. **Assertion :** Chromosomes are known as hereditary vehicles.
Reason : The chromosomes are capable of self-reproduction and maintaining morphological and physiological properties through successive generations.

24. **Assertion :** Ear muscles of external ear in man are poorly developed.
Reason : These muscles are useful which move external ear freely to detect sound efficiently.

25. **Assertion :** Although living organism always arise from other living organism, life should certainly have had a beginning.
Reason : The study of the conditions and the mechanisms involved in the creation of most primitive living structures on earth is actually the problem of origin of life.

26. **Assertion :** The establishment of reproductive isolations in an event of biological significance.
Reason : In the absence of reproductive isolation species can merge back into single population.

27. **Assertion:** We have lost all the direct evidence of origin of life.
Reason : The persons responsible for protecting evidences were not skilled.

28. **Assertion :** Among the primates, chimpanzee is the closest relative of the present day humans.
Reason : The banding pattern in the autosome numbers 3 and 6 of man and chimpanzee is remarkably similar.

Correct Definition Based MCQ

29. Allele is
(1) an alternative form of a gene that is located at a specific position on a specific chromosome.
(2) a form of a gene that is located on a chromosome.
(3) an alternative form of a gene that is not located on a specific position on a specific chromosome.
(4) a form of gene that is located on different positions on a chromosome.

30. Heredity is
(1) transmission of genetic characters from parents to offspring or one generation to the next.
(2) transmission of sexual characters from one generation to the next.
(3) transmission of morphological characters from one generation to the next.
(4) transmission of physical characters from one generation to the next.

31. Sex determination is
(1) a system that determines the development of physical characters in an organism.
(2) a system that determines the development of feeding habits in an organism.
(3) a biological system that determines the development of sexual characters in an organism.
(4) a biological system that determines the development of morphological characters in an organism.

32. Evolution is
(1) a rapid development of more complex species from pre-existing simpler forms.
(2) a gradual development of more complex species from pre-existing simpler forms.
(3) a rapid development of simpler species from pre-existing complex forms.
(4) a gradual development of more simpler species from pre-existing complex forms.

Feature Based MCQ

33. On the basis of following features identify correct option.
(I) They have a similar function.
(II) They occur in unrelated organisms.
(III) They show convergent evolution.
(1) Analogous organs (2) Homologous organs
(3) Vestigial organs (4) Heterologous organs

34. On the basis of following features identify correct option.
(I) It is able to express its effect even in the presence of recessive factor.
(II) It produces an effective or complete protein for expressing its effect.
(1) Recessive factor (2) Heterozygous factor
(3) Homozygous factor (4) Dominant factor

35. On the basis of following features identify correct option.
(I) It is conducted by nature on a vast scale all over the world.
(II) Traits selected for evolution are beneficial to the species.
(III) Results are achieved over a long period of time.
(1) Artificial selection (2) Natural selection
(3) Man-made selection (4) Random selection

36. On the basis of following features identify correct option.
(I) New species are formed in isolated small peripheral populations that are prevented from exchanging genes with the main population.
(II) Genetic drift plays an important role here.
(1) Allopatric speciation (2) Parapatric speciation
(3) Peripatric speciation (4) Sympatric speciation

Hints & SOLUTIONS

Exercise 1

1. **(1)** Variants by environmental factors like temperature form the basis of evolutionary processes.

2. **(2)** Reproductive processes generate individuals of similar design so, the rules of heredity determine the process by which traits and characteristics are reliably inherited.

3. **(1)** **4.** **(1)** **5.** **(1)**

6. **(4)** Mendel proposed the laws of inheritance based on experiments conducted on pea plants.

7. **(3)** Gene is a section of cellular DNA that provides information for one protein.

8. **(3)** **9.** **(2)** **10.** **(2)**

11. **(2)** Genetic make up of the progeny is decided on the basis of the dominant and recessive traits of the parents. The genetic make-up of the tall parent would have been TtWW.

12. **(1)** A gene has two separate independent chromosome. Each cell will have two copies of each chromosome one each from the male and female parents.

13. **(3)** **14.** **(1)** **15.** **(1)**

16. (1) Colour variation can take place due to environment as well.

17. (1) In human beings, males have XY chromosomes and females have XX chromosomes.

18. **(4)** **19.** **(3)** **20.** **(2)**

21. (4) There are possibilities of errors in DNA copying due to sexual reproduction causing variations.

22. **(3)** **23.** **(3)** **24.** **(1)** **25.** **(4)**

26. **(4)** The changes in non-reproductive tissues are the acquired traits and these cannot be passed on to the DNA of the germ cells.

27. **(1)** Speciation takes place on the basis of variation combined with geographical isolation.

28. **(1)** **29.** **(3)** **30.** **(1)**

31. **(4)** Characteristics are details of appearance or behaviour.

32. **(4)** Classification of species is done on the basis of cell design, specialisation of cell types and tissues and evolutionary relationship.

33. **(2)** **34.** **(2)** **35.** **(3)**

36. **(3)** Similar homologous characteristics indicate common origins even in apparently different species whereas similar analogous characteristics may not have common origins.

37. **(4)** Age of a fossil can be estimated by guessing how closer it was to earth surface when found, by isotope dating or by comparing DNA of different species.

38. **(4)** **39.** **(1)** **40.** **(4)** **41.** **(4)**

42. **(1)** Complex organ may have evolved because it had survival advantage at intermediate stages.

43. **(4)** Because of natural selection and genetic drift, newly generated species are found to have more complex designs, though original species might not have vanished completely.

44. **(4)** **45.** **(4)** **46.** **(4)** **47.** **(1)**

48. **(1)** Evolution can be described as generation and shaping of diversity by environmental selection.

49. **(3)** Study of evolution of human beings indicates that all humans originated from a single species that evolved in Africa. Spreading across the world in stages with wide variations in environment and climate made the difference in colour, size and looks.

50. **(1)** **51.** **(3)**

52. **(4)** Basic structure of four limbs of birds, reptiles or amphibians is similar to that of the mammals.

53. **(4)** Structure and components of wings are different, but look similar for their common function.

54. **(1)** Extinct species must have existed at some stage describe evolution.

55. **(3)** **56.** **(1)**

57. **(2)** Bacteria have survived adverse habitats.

58. **(1)** Becoming useful later for quite a different function than abandoning is a welcome change.

Exercise 2

1. **(2)** **2.** **(1)** **3.** **(3)** **4.** **(4)**

5. **(1)** **6.** **(2)** **7.** **(3)** **8.** **(3)**

9. **(4)** Evolution is the unfolding of nature where in newer types of organisms develop from the pre-existing ones through modification. Modifications occur due to accumulation of variations. At the time of formation of earth lighter elements present on the surface were in their atomic state, viz, H, C, N and O.

10. **(4)** Variations develop during reproduction due to errors in DNA copying or mutations, chance separation of chromosomes during gametogenesis, crossing over and chance pairing of chromosomes. and can be inherited. Acquired traits are those variations which an individual develops during its life time due to effect of environmental factors, use and disuse of organs and conscious efforts. These traits ae non-inheritable.

11. **(1)** Exchange of genetic material takes place in sexual reproduction by involving male and female parents.

12. **(3)** **13.** **(2)**

14. **(1)** Sex of the child is determined by inheritance of X or Y chromosomes from males.

15. **(1)** Mendel gave the law of independent assortment and Charles Darwin gave the theory of Natural selection.

16. **(1)** **17.** **(1)** **18.** **(1)** **19.** **(1)** **20.** **(3)**

21. **(2)** Every mutation or change in trait is caused by change in nucleotide sequence of DNA representing a gene.

22. **(3)** Adaptations can be either permanent (*i.e.* heritable from generation to generation) or temporary (*i.e*., within an organism's life span).

23. **(1)**

24. **(3)** Ear muscles of external ear in man are poorly developed. These muscles are useless which move external ear freely and these muscles are called vestigial organs.

25. **(1)** **26.** **(1)**

27. **(3)** We have lost all the direct evidence of origin of life because evolution does not proceed continuously in a particular direction. Continuation of old species also depends upon the environment.

28. **(1)** The banding pattern seen on stained chromosomes from humans and chimpanzee show striking similarities which indicates that they have evolutionary relationships (cytogenetic evidence).

29. **(1)** **30.** **(1)** **31.** **(3)** **32.** **(2)** **33.** **(1)**

34. **(4)** **35.** **(2)** **36.** **(3)**