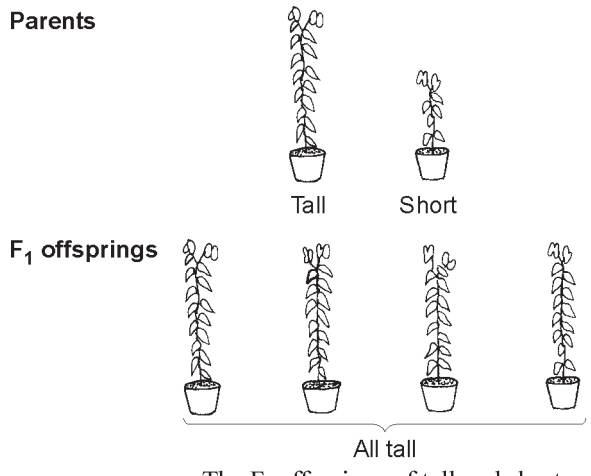
9 HEREDITY AND EVOLUTION

CONCEPTS

1. The similarities between parents and their offspring are accounted for by 'heredity', and the dissimilarities by 'variation'.
2. Both heredity and variation are accounted for when we study 'genetics'.
3. Asexual reproduction tends to produce 'clones', i.e., organisms which are genetically identical.
4. Chances of variations are higher in organisms showing sexual reproduction.
5. Inheritance from the previous generation provides a common basic body design, as well as subtle changes in it, for the next generation.
6. Depending on the nature of variations, different individuals would have different kinds of advantages, like bacteria that can withstand heat will survive better in a heat wave.
7. The rules of heredity determine the process by which traits and characteristics are reliably inherited.
8. The differences or dissimilarities between parents and children as individuals of a species are called variations.
9. **Hereditary variations** refer to the differences which are inherited by the progeny from their parents.
10. The inheritance of such heritable variations is determined by the genetic constitution of an individual.
11. Examples of inheritable variations are blood type, skin colour, hair colour, height, etc.
12. **Environmental variations** are caused due to differences in light, water, soil, nutrients and other factors of environment.
13. Causes of variation are — (i) reshuffling of genes during meiosis, (ii) errors in DNA copying, (iii) environment.
14. Gregor Johann Mendel is considered the 'father of genetics'. Mendel attributed contrasting 'factors' coming from the parents and their random combinations, as the cause of 'variation'.
15. Mendel's 'factors' were termed 'genes' by Johannsen.
16. It was observed that the paired condition of the 'factors' is present in the diploid state. But when haploid gametes are formed, the factors 'segregate'. Since chromosomes are paired in its diploid state but separate during gametic meiosis, it is fair enough to judge that the 'factors' are placed on the 'chromosomes'.

    Today it is known that 'genes' are parts of a chromosome molecules.
17. Chromosomes are made up of DNA. DNA molecule consists of two polynucleotide strands forming a double helix. DNA is the genetic material throughout the living world except in a few viruses where RNA serves as the genetic material (e.g., HIV).
18. Chromosomes in each of the 22 pairs are similar in size and shape in both man and woman. The chromosomes of the 23rd pair in man are different from the 23rd pair in woman. These are the sex chromosomes. The larger chromosomes are called the X-chromosomes, the smaller chromosome is called the Y-chromosome.

19. Mendel represented the inheritance of characters as follows :



The F_1 offsprings of tall and short parents are all tall.

F_1 parents produce a mixture of tall and short F_2 offsprings

20. Mendel's Dihybrid Cross

P RRyy × rrYY

Round and Yellow — Wrinkled and Green

↓

RrYy F_1 generation

(Selfing)

↓

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

F_2 Generation

Phenotypic Ratio = 9 : 3 : 3 : 1

21. Mendel selected varieties that differed with respect to seven traits with easily distinguishable contrasting forms, i.e., he selected fourteen varieties as shown in the table given below :

S.No.	Character	Alternate Forms	
		Dominant	Recessive
1.	Stem height	Tall	Dwarf
2.	Flower colour	Purple	White
3.	Seed colour	Yellow	Green
4.	Seed shape	Round	Wrinkled
5.	Pod colour	Green	Yellow
6.	Pod shape	Inflated	Constricted
7.	Flower position	Axillary	Terminal

22. Eukaryotic chromosomes have basic proteins mixed with DNA and are usually more complex in structure than prokaryotic chromosomes. A gene is the functional unit of DNA that serves as hereditary unit.

23. Each human nucleus has 23 pairs of chromosomes out of which 22 are same in male and female and are known as 'autosomes'. The 23rd pair is different in male and female and are known as 'sex chromosomes'. Females have 'XX' sex chromosomes and males have sex chromosomes 'XY'.

24. Evolution is a set of changes brought about by the forces of nature selection on the variation within a population, so that resultant organisms are better adapted to their surroundings.

25. Evidences of evolution can be summarised as follows :

A. Paleontological or fossil evidence

Fossils are the remains or impressions of organisms of the past. *Archaeopteryx* is a fossil that had both reptilian and avian features, proving that birds have evolved from the reptiles.

B. Morphological and anatomical evidences

(i) **Homologous organs :** Organs which are similar in structure and origin but different in function and appearance are called homologous organs, e.g., forearm of man, wing of a bat, flipper of a seal, etc.

(ii) **Analogous organs :** Organs which are similar in appearance and function but different in structure and origin are known as 'analogous organs', e.g., wings of a bird and the wings of a butterfly.

26. The most accepted theory of evolution comes from Charles Darwin, whose theory is known as 'Origin of Species by Natural Selection'. Its tenets are as follows :

(a) Organisms have a far higher capacity to reproduce that can be sustained by nature, thereby creating 'competition' or 'struggle for existence'.

(b) Offspring vary from one another and from the parents.

(c) Those with 'favourable variations' are fit for the 'Struggle for Existence'.

(d) The favourable variations are accumulated over a long time period creating a new species. The weak point of Darwinism is that it could not explain how variations arise.

27. The latest theory of evolution is the 'synthetic theory of evolution' which is a mixture of genetic variation and natural selection.

28. Certain fossils show features which are intermediate between two groups. Such fossils form the **connecting links** and clearly demonstate stages during the evolutionary process.

29. A very well known example of an extinct animal is **dinosaur** that existed long ago in large numbers.

I. SUMMATIVE ASSESSMENT

NCERT QUESTIONS WITH THEIR ANSWERS

SECTION A : IN-TEXT QUESTIONS

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1. If a trait A exists in 10% of a population of an asexually reproducing species and a trait B exists in 60% of the same species, which trait is likely to have arisen earlier?

Ans. In asexual reproduction, offspring is produced from single parents. There may be small inaccuracies in DNA copying which can develop new traits. They will be in smaller proportion than the traits already present. Therefore, trait B which exists in 60% of population must have arisen earlier than trait A which occurs in 10% of the population.

2. How does creation of variations in a species promote survival?

Ans. The variations generated in offspring do not have equal chances to survive and get inherited in the next generation. The inheritance of such characteristics or variations depends on a number of environment factors as well as on the nature of variation. Same variations are pre-adaptations which can be beneficial under certain environmental condition. For example, in a heat wave most of the bacteria will die but a few having pre-adaptation or variation to tolerate heat wave, will survive and multiply.

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1. How do Mendel's experiments show that traits may be dominant or recessive?

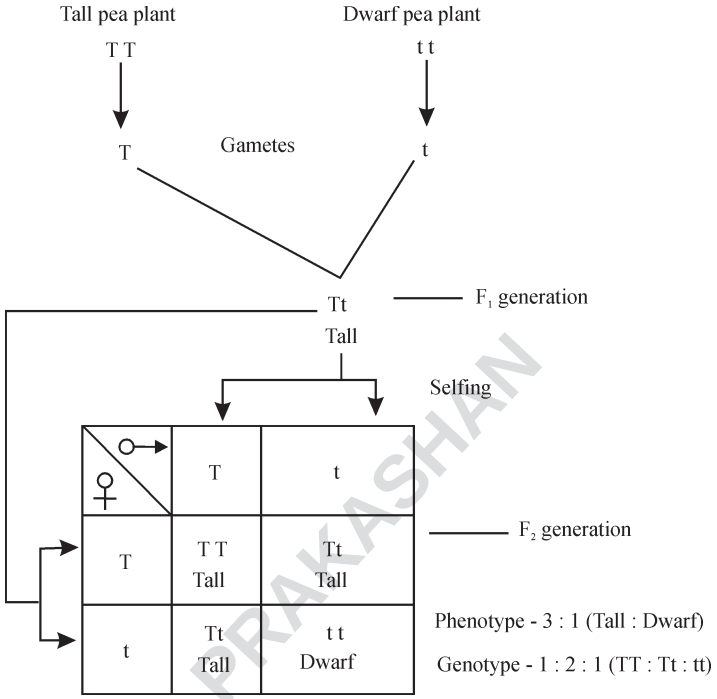
OR

Illustrate Mendel's experiment to show that traits may be dominant or recessive by taking tall/short plants as a character in garden pea. **[2011 (T-II)]**

Ans. Mendel took pea plants with contrasting characters some with short and some with tall stem. He produced the progeny of first generation (F_1) from them. All the plants were tall in F_1 generation, there was no intermediate characteristic. Mendel used the progeny of F_1 as parent plants and produced the progeny of F_2 generation to test whether the tallness of F_1 progeny was same as their parents. He noticed that the progeny of F_2 generation were not all tall. One fourth of progeny were short. This characteristic of shortness proves that both the

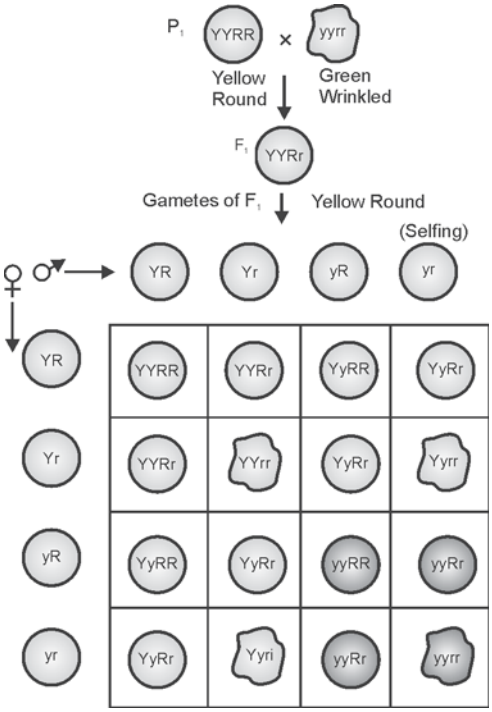
characteristics (tallness and shortness) were inherited From the parents to F_1 progeny. In F_1 progeny only tallness character was expressed. However, the second-generation progeny (F_2 progeny) expressed both the characters in a particular ratio i.e. 3 : 1 phenotypically and 1 : 2 : 1 genotypically.

In a cross trait (T) which expresses itself in the hybrid (Tt) is called **dominant.** In such hybrid only T is sufficient to express its trait i.e. tallness. While the trait which does not express itself in the hybrid is called **recessive** trait. In such a trait both the copies should be tt.



2. How do Mendel's experiments show that traits are inherited independently? **[2011 (T-II)]**

Ans. Mendel crossed a variety of pea with round, yellow seeds with another variety having wrinkled green seeds, the F_1 progeny showed only round yellow seeds. After self-fertilisation of F_1 plants, the F_2 progeny obtained, showed four different types of plants having seeds in a ratio 9 (round, yellow) : 3 (round, green) : 3 (wrinkled, yellow) : 1 (wrinkled, green). This is called a **dihybrid ratio (9 : 3 : 3 : 1)**



3. A man with blood group A marries a woman with blood group O and their daughter has blood O. Is this information enough to tell you which of the traits - blood group A or O - is dominant? Why or why not?

Ans. No, this information is not enough to tell that which of the traits is dominant. As you know a recessive trait appears only when the two alleles are similar. Therefore, there can be two possibilities.

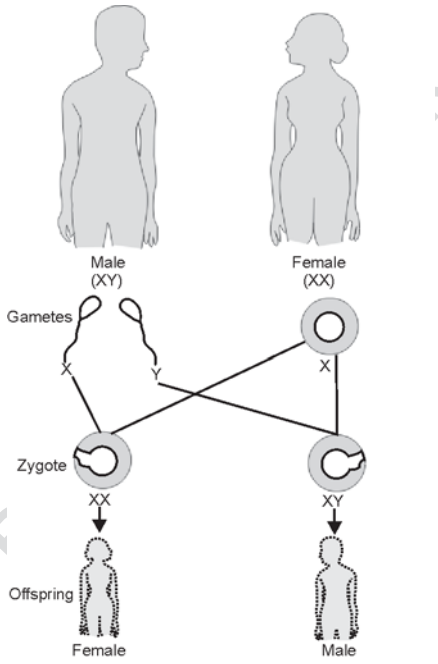
- Blood group O is dominant and blood group A is recessive. In this case father should have both alleles of A (I^AI^A) and mother can be homozygous or heterozygous (I^OI^O or I^OI^A) for allele of O. The daughter will have one dominent allele of O (I^AI^O).

- Blood group A is dominant and blood group O is recessive. In this case mother and daughter should have both alleles of O ($I^{\circ}I^{\circ}$) and father may be homozygous or heterozygous ($I^{A}I^{A}$, $I^{A}I^{\circ}$) for allele A.

  As both the possibilities can occur, the given information is unable to tell whether the allele for blood group A or O is dominant.

4. How is the sex of the child determined in human beings?

Ans. It is assumed that half the children of a couple will be girls and half will be boys. All children of the couple will inherit similar chromosomes (22 + X) from the mother but the sex of the children will depend on the chromosomes they inherit from the father. If a child inherits (22 + X) chromosomes from the father that will be a girl but when a child will inhert (22 + Y) chromosomes from the father that will be a boy. Therefore, the sex of a child is determined by the inheritance of X or Y chromosome from the father.



Sex determination in human beings

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1. What are the different ways in which individuals with a particular trait may increase in a population?

Ans. The different ways in which individuals with a particular trait may increase in a population are following :

- **Food availability** – Individuals with a particular trait may have extra abundance of food in their environment. They will naturally increase in number.
- **Genetic drift** – Individuals with a particular trait may increase in a population due to genetic drift. In it, there is a seasonal or accidental decline in population. The survivors have certain combination of traits which increase in number with increase in population.

- **Natural selection** – The particular trait which has survival value is picked up by natural selection. It increases in population through differential reproduction.

2. Why are traits acquired during the life time of an individual not inherited? **(Imp.)**

OR

Why traits such as intelligence and knowledge cannot be passed on to the next generation?

Ans. Acquired traits develop due to the effects of environmental factors, use and disuse of organs and special (conscious) efforts. These are somatic variations and remain restricted to somatic cells. They are destroyed with the death of the individual and cannot pass to the progeny.

3. Why are the small number of surviving tigers a cause of worry from the point of view of genetics?

Ans. The small number of surviving tigers is always at a risk of degeneration and extinction. Due to the small population, there would be excessive inbreeding that brings about inbreeding depression or degeneration. There are fewer recombinations and variations in a small population which are essential for vigour of the species.

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1. What factors could lead to the rise of a new species?

Ans. Following factors could lead to the rise of a new species :

a. **Physical barrier** – Absence of gene flow amongst sub-populations due to the presence of physical barriers lead to the rise of a new species.

b. **Spatial Isolation** – Sub-populations at the two ends of a long range seldom interbreed. They undergo changes in structures, timing and season of breeding resulting in formation of new species.

c. **Gene Mutation** – A large mutation can make some members reproductively isolated from the rest. It leads to the rise of a new species.

d. **Genetic drift** – It is the random change in the frequency of alleles in a population over successive generations due to error during DNA copying in the gametes. It leads to the rise of a new species.

2. Will geographical isolation be a major factor in the speciation of a self pollinating plant species? Why or why not? **(Imp.)**

Ans. No, geographical isolation will not be a major factor in the speciation of a self pollinating plant species because there is already no gene flow among members of the species.

3. Will geographical isolation be a major factor in the speciation of an organism that reproduces asexually? Why or why not?

Ans. No, geographical isolation will not be a major factor in the speciation of an organism that reproduces asexually because there is no recombination of genes in it. Therefore, variations originating in them do not get diluted but spread to all the subsequent generations.

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1. Give an example of characteristics being used to determine how close two species are in evolutionary terms.

Ans. The presence or absence of fundamental characteristics and correlated characters determine the closeness of species. Two species of sponges are closely related as they possess cellular level of organisation. Human beings are close to chimpanzee because they possess similar

mammalian and primate characters. Nowadays closeness of the species is determined by DNA matching.

2. Can the wings of a butterfly and the wings of a bat be considered homologous? Why or why not?

Ans. No, the wings of a butterfly and the wings of a bat are not homologous organs because the wings of a bat are skin fold between the elongated fingers, while the wings of a butterfly are the extension of integument. They are analogous organs.

3. What are fossils? What do they tell us about the process of evolution?

Ans. Fossils are the remains or traces and impressions of any organism that lived in the geological past. Fossils provide a direct evidence of evolution and are called written documents of evolution. They directly indicate the presence of different types of organisms in different ages. The path of evolution is known by arranging the fossils in a proper sequence agewise. The early fossils are the simple organisms. Later on different complex forms arose, flourished and died down. They are replaced by newer forms.

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1 Why are human beings who look so different from each other in terms of size, colour and look are said to belong to the same species?

OR

How different races of human beings belong to the same species? **[2011 (T-II)]**

Ans. Human beings are different in size, colour and look because these characteristics are based on preponderance of specific alleles and their interactions with environment. They are said to belong to the same species because they have a common gene pool and they can marry amongst themselves and can produce fertile offspring.

2. In evolutionary terms, can we say which among bacteria, spider, fish and chimpanzee have a better body design? Why or why not?

Ans. Chimpanzees have a better body design out of the four (bacteria, spider, fish and chimpanzee) because a better body design is the one which has more complexity, more elaboration and more controls which gives the organism a better competitive edge over others.

SECTION B : QUESTIONS AT THE END OF THE CHAPTER

1. A Mendelian experiment consisted 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 can be depicted as

(a) TTWW (b) TTww (c) TtWW (d) TtWw

Ans. (c)

2. Example of homologous organs is

(a) our arm and a dog's foreleg (b) our teeth and an elephant's tusks

(c) potato and runners of grass (d) all of these

Ans. (d)

3. In evolutionary terms, we have more in common with

(a) a Chinese school-boy. (b) a chimpanzee (c) a spider (d) a bacterium

Ans. (a)

4. A study found that children with light-coloured eyes are likely to have parents with light-coloured eyes. On this basis, can we say anything about whether the light eye colour trait is dominant or recessive? Why or why not?

Ans. We cannot say with certainty whether the light coloured eyes is a dominant or a recessive character. Since both the parents and children have light coloured eyes, it should be a recessive trait.

5. How are the areas of study – evolution and classification interlinked?

Ans. The living organisms are classified on the basis of similarities and differences amongst them. More similar characteristics indicate their evolution from a common ancestor. Similarly, more differences indicate their different adaptations and divergence from a common ancestor.

6. Explain the terms analogous and homologous organs with examples.

Ans. **Analogous organs** : — The organs which look alike and perform same functions but are quite different in basic structure and embryonic origin in different species are called analogous organs. For example, the wings of a bat and the wings of a bird are analogous organs. Though the basic design of these wings are completely different, they look similar because they have a common function.

Homologous organs : — The organs which are similar in basic structure and embryonic origin but perform different functions in different species are called homologous organs. For example, the forelimbs of a human, a bird, a lizard and a frog show similarity in basic structure.

7. Outline a project which aims to find the dominant coat colour in dogs.

Ans. We can organise a survey to find the dominant coat colour in dogs. It can be performed as follows :

(i) Observe a dog population in your locality. Note down the different colours of dogs and number of dogs of each colour. Then find the percentage of each colour of dogs.

(ii) Observe the pups where same coat colour is present in both parents and offspring.

(iii) Find the colour of F_1 generation of these dogs.

(iv) Allow the dogs for test cross i.e. allow cross between F_1 dogs and the one having the other recessive colour.

8. Explain the importance of fossils in deciding evolutionary relationships.

OR

(a) What are fossils?

(b) Explain the importance of fossils in evolutionary relationship. **[2011 (T-II), 2009]**

Ans. Fossils are the remains or traces and impressions of any organism that lived in the geological past. Fossils provide a direct evidence of evolution and are called written documents of evolution. A few such fossils are as follows : –

(i) *Trilobite*, a palaeozoic arthropode

(ii) *Ammonite*, a spirally coiled shelled mollusc

(iii) *Rajasaurus*, a dinosaur.

There are some other fossils which give a strong evidence of a common ancestor as well as evolution. Fossils indicate the path of evolution of different groups. They indicate the phylogeny of some organisms. Some fossils have characteristics intermediate between two groups indicating the evolution of one group from another.

9. What evidences do we have for the origin of life from inanimate matter?

Ans. Stanley Miller and Harold Urey in 1953, assembled an apparatus and maintained the atmospheric conditions similar to those that existed on early earth over water. The temperature was maintained just below 100°C and sparks were passed through the mixture of gases to stimulate lightning. At the end of the experiment after a week, they found that 15% of the carbon (from methane) was converted to simple carbon compounds including amino acids which forms protein molecules. It clearly proved that organic compounds of life developed from inanimated matter.

10. Explain how sexual reproduction gives rise to more viable variations than asexual reproduction. How does this affect the evolution of those organisms that reproduce sexually?

Ans. The offspring produced as a result of sexual reproduction show more variations while the individuals produced asexually are often quite similar to their parents. Though no offspring can be the exact copy of its parents, very minor differences are observed in asexually produced offspring. Variations arise during sexual reproduction due to —

(i) Chance separation of homologous chromosomes during gametogenesis.

(ii) Crossing over between homologous chromosomes.

(iii) Mutations occur during DNA replication, etc.

(iv) The variations are quite viable. Change in DNA due to replication are fewer. Most of them are harmful. They may have some negative impact on evolution except when the changing environment finds them useful.

11. How is the equal genetic contribution of male and female parents ensured in the progeny?

Ans. The genetic material of diploid organisms consists of two sets of chromosomes. The gametes are haploid and consist of single set of chromosomes. Sexual reproduction involves the fusion of male and female gametes. Each gamete brings one set of chromosomes hence diploid chromosome complement is restored. As a result diploid organism consists of 50% chromosomes from male parent and 50% chromosomes from female parent. So both the parents contribute equal amount of genetic material to the offspring.

12. Only variations that confer an advantage to an individual organism will survive in a population. Do you agree with this statement? Why or why not?

Ans. The variations generated in offspring do not have equal chances to survive and get inherited in the next generation. The inheritance of such characteristics or variations depends on a number of environmental factors as well as on the nature of variations. For example, a marine-water fish cannot survive in freshwater, a bacterium can survive even in extremely hot places and most of the amphibians hibernate during winter to survive. The disadvantageous variations which are either lethal or extremely harmful are eliminated.

ADDITIONAL QUESTIONS
(As Per CCE Pattern)

A. Very Short Answer Questions [1 Mark]

Previous Years' Questions

1. State one advantage of variation of a species. **[2009]**

Ans. The variation of a species increases the chance of its survival in a changing environment.

2. What is the effect of DNA copying which is not perfectly accurate on the reproduction process? **[2008]**

Ans. DNA copies generated will be similar but it will not necessarily be identical to the original.

Other Important Questions

1. Define the term 'speciation'.

Ans. Speciation is the formation of new species from pre-existing species. Speciation depends on distribution of population, mutation, micro-evolution and macro-evolution.

2. What is a factor?

Ans. The carriers of hereditary information were called factors by Mendel.

3. What decides that humans give rise to humans? **(Imp.)**

Ans. It is the heredity that decides that humans give rise to humans.

4. What are hereditary characteristics?

Ans. The characteristics which can be passed from parents to the children are called hereditary characteristics.

5. Are the variations created by sexual reproduction heritable or non-heritable? **(Imp.)**

Ans. The variations created in sexual reproduction are heritable.

6. What are the components of a chromosome? **(Imp.)**

Ans. Two chromatids attached at a centromere, together form a chromosome.

7. What is a retrovirus?

Ans. A virus that has RNA as its genetic material is known as a retrovirus, e.g., AIDS virus.

8. What is a sex chromosome?

Ans. A chromosome that helps in determining the sex of an individual is known as a sex chromosome.

9. How many chromosomes are there in a human ovum?

Ans. 23 chromosomes.

10. Who coined the term 'factor'? **(Imp.)**

Ans. The term 'factor' was coined by Mendel.

11. Give the monohybrid ratio.

Ans. Monohybrid ratio = 3 : 1.

12. Write the dihybrid ratio.

Ans. Dihybrid ratio = 9 : 3 : 3 : 1.

13. Define 'recessive characteristic'.

Ans. Any characteristic present in the parental generation that does not appear in F_1 generation but reappear in F_2 generation is known as recessive character.

14. What is the basis of sex determination in most plants and animals? **(Imp.)**

Ans. In most plants and animals genetic basis of sex determination is gamete (chromosome).

15. Name the most accepted theory of evolution.

Ans. Synthetic theory of evolution.

16. Define the term 'evolution'.

Ans. Evolution can be defined as the gradual unfolding of the organisms from pre-existing organisms through change since the beginning of life.

17. Whose theory influenced Darwin? What did Darwin fail to explain? **(Imp.)**

Ans. The theory of Malthus inspired Darwin. Darwin failed to explain how variations arise.

B. Short Answer Questions – I [2 Marks]

Previous Years' Questions

1. (a) Write full form of DNA.
(b) Why are variations essential for the species? **[2011 (T-II)]**

Ans. (a) DNA — Deoxyribo Nucleic Acid

(b) The variation of a species increases the chance of its survival in a changing environment.

2. In tobacco plant, the male gametes have 24 chromosomes. State the number of chromosomes in (i) egg nucleus, (ii) zygote (iii) endosperm and (iv) leaf cell. **[2011 (T-II)]**

Ans. (i) The number of chromosomes in egg nucleus - 24
(ii) " " " zygote = 48
(iii) " " " endosperm = 72
(iv) " " " leaf cell = 48

3. What are fossils? What do they tell about the process of evolution? **[2008]**

Ans. The preserved traces or impressions of the body parts of living organisms are called fossils. Since fossils reveal evolutionary relationships among different organisms, they are the proof of organic evolution.

4. What do you understand by the term heredity? **[2008]**

Ans. The transmission of recognisable traits or characters like height, complexion, eye-colour, shape of nose, shape of chin, etc. from the parents to their offspring is called heredity.

5. What constitutes the link between one generation and the next? **[2008]**

Ans. The hereditary information is transferred from parents to offspring through the gametes. So, gametes constitute the link between one generation and the next and pass on the paternal and maternal characters to the offspring.

6. "The sex of the children is determined by the what they inherit from their father and not from the mother." Justify. **[2008]**

Ans. The children inhert similar chromosomes (22 + X) from the mother but the sex of the children will depend on the chromosome they inherit from the father. If a child inherits (22 + X)

chromosomes from the father that will be a girl but when a child inherits (22 + Y) chromosomes from the father that will be a boy. Therefore, the sex of a child is determined by the inheritance of X or Y chromosome from the father.

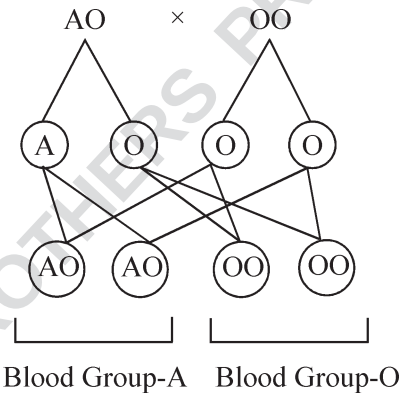
7. Explain the terms analogous and homologous organs with one example of each. **[2008]**

Ans. **Analogous organs : —** The organs which look alike and perform same functions but are quite different in basic structure and embryonic origin in different species are called analogous organs. For example, the wing of a bat and the wing of a bird are analogous organs. Though the basic design of these wings are completely different, they look similar because they have a common function.

Homologous organs : — The organs which are similar in basic structure and embryonic origin but perform different functions in different species are called homologous organs. For example, the forelimbs of a human, a birds, a lizard and a frog show similarity in basic structures.

8. A man with blood group A marries a woman with blood group O and their daughter has blood group O. Is this information enough to tell you which of the traits – blood group A or O – is dominant? Why? **[2008]**

Ans. Yes, the given information is enough. Blood group O is dominant. It is because the F_1 progeny, i.e. daughter has blood group O which is dominant over blood group A.



9. Define variation in relation to a species. Why is variation beneficial to the species? **[2008]**

Ans. The differences among the individuals of a plant or animal of a species are called variations. All the variations in a species do not equally survive in the environment where they are found. Depending on the nature of variation, different individuals have different types of advantages. For example – bacteria can survive in very high temperature also.

10. Describe briefly four ways in which individuals with a particular trait may increase in a population. **[2008]**

Ans. The individuals with a particular trait may increase in a population in the following ways–

(i) **Sufficient Food :-** By obtaining more food the individuals can increase in growth and reproduction.

(ii) **Differential Reproduction** :- It gives an advantage to the individuals to survive and reproduce.

(iii) **Variations :** The useful variations help the individuals to adopt the environmental condition.

(iv) **Genetic Drift :-** The random change in the frequency of alleles in a population over successive generations due to error during DNA copying on the gametes.

11. 'Variations that confer an advantage to an individual organism only will survive in a population.' Justify. **[2008]**

Ans. Useful variations give advantage to individuals in obtaining more food, reproduction, adaptation to environmental changes and higher success in the struggle for existence. They give benefit in survival and increasing the population. Differential reproduction increases the useful variations in the populations. Other individuals with harmful variations will be destroyed. For example, some bacteria have ability to tolerate high temperature. But other non-resistant bacteria will be killed.

Other Important Questions

1. What are acquired characteristics? **(Imp.)**

Ans. Characteristics which people acquire during their lives, like knowledge and skills are called acquired characteristics. Development of muscles in an athlete is an acquired characteristic.

2. What is variation?

Ans. Variation is the difference or dissimilarity between parents and children as individuals of a species. It can be defined as the occurrence of difference among the individuals of a species.

3. Why is variation less common in asexually reproducing organisms?

Ans. Asexual reproduction tends to preserve the similarities among all the individuals belonging to a given line of descent. Therefore, asexually reproducing organisms show more hereditary features.

4. Clarify the term heredity and variation. **(Imp.)**

Ans. Heredity means continuity of features from one generation to another whereas variation is the occurrence of differences among the individuals.

5. Define variation in relation to a species. Why is variation beneficial to the species? **(Imp.)**

Ans. The differences or dissimilarities between the parents and the children as individuals of the same species are called variations.

Variation is beneficial to the species as

(i) they enable the organisms to adapt themselves in the changing environment.

(ii) variations form the basis of heredity.

(iii) they form raw materials for evolution and development of new species.

6. What are autosomes?

Ans. In females two copies of an unpaired chromosome are present along with paired chromosomes. These are known as sex chromosomes. The rest of the chromosomes are known as autosomes.

7. What is the reason that a male is called 'heterogametic'? **(Imp.)**

Ans. A male is called heterogametic because he forms two different types of gametes. One containing 'X' chromosome and the other containing 'Y' chromosome.

8. What was the basic study material of Mendel? How did he bring in the term 'factor'?

Ans. The basic study material of Mendel were the contrasting characters in various generations of garden pea. He said that these characters are controlled by units known as factors.

9. How many chromosomes are there in the human
(a) Ovum (b) Liver cell

Ans. (a) Ovum — 23 chromosomes; (b) Liver cell — 46 chromosomes.

10. How did the Mendelian 'factors' acquire a change in the terminology? Who changed it?

Ans. The carriers of hereditary information were called 'factors' by Mendel. Johanssen later called these factors genes.

11. Why can the wings of a bird and the wings of a bat not be considered analogous? **(Imp.)**

Ans. Wings of a bird and a bat are modified forelimbs and hence, show structural similarity. Hence, they cannot be considered as analogous structures.

12. What is palaeontology? What is its importance? **(Imp.)**

Ans. Palaeontology is a branch of biology that deals with the study of fossils. It provides a direct evidence of evolution and is called a written document of evolution.

C. Short Answer Questions – II [3 Marks]

Previous Years' Questions

1. The genotype of green stemmed tomato plants is denoted as GG and that of purple stemmed tomato plants is denoted as gg. When these two are crossed with each other :
(a) What colour of stem would you expect in the F_1 progeny?
(b) Give the percentage of purple stemmed plants if F_1 plants are self pollinated.
(c) In what ratio would you find the genotypes GG and gg in the progeny?
Draw flow chart in support of your answer. **[2011 (T-II)]**

Ans. (a) Green stemmed tomato plant — Purple stemmed tomato plant

(GG) — (gg)

↓ — ↓

G (gamete) — g (gamete)

Gg — F_1 generation

(Green stemmed tomato plant)

In F_1 generation, all the plants would be green stemmed.

(b) If F_1 plants are self pollinated

Gg ↓

♀ \ ♂	G	g
G	GG green stemmed	Gg Green stemmed
g	Gg Green stemmed	gg Purple stemmed

Gg →

25% purple stemmed plants

(c) We would find the genotypes GG and gg in 1 : 1 ratio.

2. (a) Name the plant used by Mendel to carry out his experiments.

(b) Study the following cross and answer the questions that follow :

Parents	Green and Round seed	×	Yellow and Wrinkled seed
F_1 Generation	All Green and Round seeds		
F_2 Generation	Green and Round (9)		Green and Wrinkled (3)
	Yellow and Round (3)		Yellow and Wrinkled (1)

(i) List the dominant and recessive characters.

(ii) Are the characters linked or independent? **[2011 (T-II)]**

Ans. (a) Garden Pea (*Pisum sativum*)

(b) (i) Dominant characters are Green and Round seeds.
Recessive characters are yellow and wrinkled seeds.

(ii) The characters are independent.

3. Acquired characters are not inherited. Justify the statement with an example. The wings of bat and the wings of insects are considered analogous organs. Why? **[2011 (T-II)]**

Ans. The acquired changes during a lifetime are not inherited by the progeny. It can be understood with the help of some examples such as —

If a group of mice having tail will breed, their progeny will also have the same type of tail but if the tail of all the mice is removed by surgery in each generation, no tailless mouse will be produced even after a few generations. It is because the removal of tail is a physical change which could not make a change in the gene responsible for the presence of tail in mice.

The wings of birds and the wings of insects are considered as analogous organs because they have different structures but perform the same function.

4. How has the method of artificial selection by humans helped in the evolution of different vegetables? Explain in brief giving an example. **[2011 (T-II)]**

Ans. Humans have developed different varieties of vegetables from a single wild cabbage by artificial selection some of these are as follows —

(i) Some farmers have wanted to select very short distances between the leaves and developed the present day **cabbage.**

(ii) Some farmers selected immature green flowers and developed the **broccoli.**

(iii) Some have selected the sterile flowers and developed the **cauliflowers.**

(iv) Some farmers selected the swollen part of the wild cabbage and developed the **kohlrabi.**

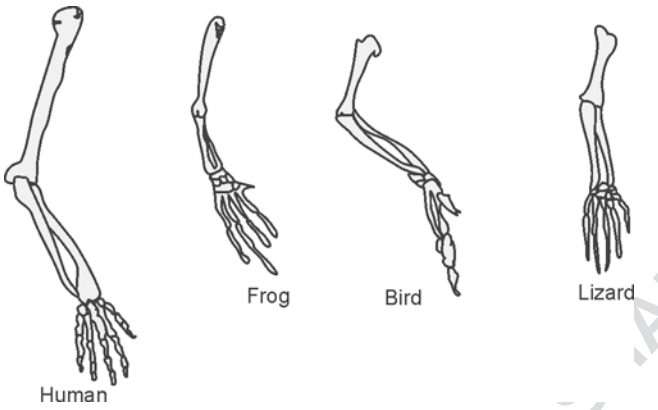
(v) Some of them have selected the larger leaves and developed **Kale.**

So all these vegetables are descended from a common ancestor.

5. (a) Write two factors which could lead to the rise of a new species.

(b) (i) What is the scientific term of the organs shown below?

(ii) How do these organs provide evidence in support of evolution? **[2011 (T-II)]**



Ans. (a) Following factors could lead to the rise of a new species :

(i) **Physical barrier :** Absence of gene flow amongst sub-populations due to the presence of physical barriers lead to the rise of a new species.

(ii) **Gene Mutation :** A large mutation can make same members reproductively isolated from the rest. It leads to the rise of a new species.

(b) (i) The organs shown above are homologous organs.

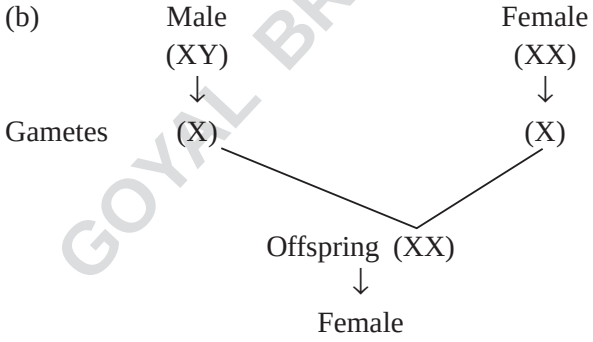
(ii) These organs are similar in basic structure and embryonic origin but perform different functions in different species.

6. (a) Name the type of sex chromosome present in human male and human female.

(b) With the help of a flow chart determine genetically in human beings the sex of the offspring if a sperm carrying X-chromosome fertilizes the egg? **[2011 (T-II)]**

Ans. (a) The type of sex chromosome present in human male and female is known as allosome.

(b)



If a sperm carrying X-chromosome fertilizes the egg, the offspring would be girl.

7. In pea plant round seed is dominant over the wrinkled. If a cross is carried between these two plants, give answer to the following questions.

(a) Mention the genes for the traits of parents.

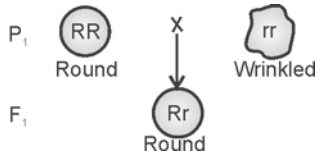
(b) State the trait of F_1 hybrids.

(c) Write the ratio of F_2 progeny obtained from this cross. What is the name of the cross? **[2011 (T-II)]**

Ans. (a) The pea plant with round seeds — (RR)

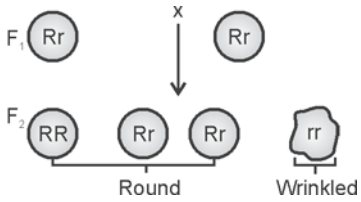
The pea plant with wrinkled seeds — (rr)

(b)



The trait of F_1 hybrids is round (Rr)

(c)



Phenotypic ratio of F_2 progeny = 3 : 1

Genotypic ratio of F_2 progeny = 1 : 2 : 1

The cross is monohybrid because in it only one pair of character is taken into consideration.

8. Guinea pig having black colour when crossed with guinea pig having same colour produced 100 offsprings out of which 75 were black and 25 were white. Now find out.

(a) What is the possible genotype of the guinea pig?

(b) Which trait is dominant and which trait is recessive?

(c) What is this cross called as and what is the ratio of F_2 progeny obtained from these cross? **[2011 (T-II)]**

Ans. (a) The possible genotype of the guinea pig is Bb.

(b) Black colour is dominant and white colour is recessive.

(c) This cross is called monohybrid cross.

Phenotypic ratio of F_2 progeny is 3 : 1

Genotypic ratio of F_2 progeny is 1 : 2 : 1

9. Give appropriate terms for the following :

(a) The trait which can express itself in next generation.

(b) The trait an organism have due to inheritance.

(c) Origin of a new species from pre-existing one. **[2011 (T-II)]**

Ans. (a) Inherited trait (b) Inherited trait (c) Speciation

10. If a pure tall pea plant is crossed with a pure dwarf plant, then in the first generation only tall plants appear.

(a) What happens to the traits of the dwarf plant?

(b) In the second generation, the dwarf trait reappears. Why? **[2011 (T-II)]**

Ans. (a) According to law of dominance, ''when a pair of contrasting characters are present together, only one is able to express itself in the F_1 generation while others remain suppressed''. Dwarf trait is recessive trait which does not express itself in the hybrid (First generation).

(b) Both the characteristics (tall and dwarf) were inherited from the parents to F_1 progeny. In F_1 progeny only tallness character was expressed. However, the second generation progeny (F_2 progeny) expressed both characters in a particular ratio i.e. 3 : 1 (three tall and 1 dwarf).

11. Distinguish between analogous organs and homologous organs. Identify the analogous and homologous organs amongst the following : Wings of an insect, wings of a bat, forelimbs of frog, forelimbs of human. **[2009, 2011 (T-II)]**

Ans.

Analogous organs	Homologous organs
These organs are look alike and perform same functions but are quite different in basic structure and embryonic origin in different species.	These organs are similar in basic structure and embryonic origin but perform different functions in different species.

Analogous organs — Wings of an insect and wings of a bat

Homologous organs — Forelimbs of frog and forelimbs of human.

Other Important Questions

1. What do you mean by environmental variations?

Ans. An individual grows in a particular environment which influences the external appearance and characteristics of that individual. Such characteristics are called environmental variations. Differences in light, water, soil, nutrients and other factors in the environment are responsible for causing such variations.

2. Why are environmental variations non-heritable? **(Imp.)**

Ans. Environmental variations result in change in external appearance of an individual which depend on several environmental factors like light, water, temperature, etc. These variations are temporary and are not passed on from one generation to the next generation. Thus, they are called non-heritables.

3. What are the factors causing variation? **(Imp.)**

Ans. Every organism has its own distinctive characteristics, differing from others. There are basically three ways in which variations develop in organisms. These are as follows :

(i) Reshuffing of genes during meiosis (sexual reproduction).

(ii) Errors in DNA copying.

(iii) Environment.

4. What is the importance of variation?

Ans. (i) Variations enable the organisms to adapt themselves in changing environment.

(ii) Variations form the basis of heredity.

(iii) Variations form raw materials for evolution and development of new species.

5. Define the following terms : **(Imp.)**

(i) Genetics, (ii) Sex chromosome, (iii) Gene

Ans. (i) **Genetics :** Genetics is a branch of biology that deals with the study of heredity and variation.

(ii) **Sex chromosome :** Sex chromosomes are the chromosomes associated with sex determination.

(iii) **Gene :** Gene is a segment of DNA that is responsible for a variation or change in a character.

6. Show a monohybrid cross made by Mendel. **(Imp.)**

Ans.

Monohybrid Cross

Tall (Pea Plant) × Short (Pea Plant)

↓

F_1 generation Tall Plants

↓ **Selfing**

F_2 generation Tall Plants : Short Plant

(3) (1)

7. Mendel crossed the round and green seeded pea plants with the wrinkled and yellow seeded pea plants. Give the phenotypic ratio of F_2 generation. **(Imp.)**

Ans.

P_1 Rryy × rrYY

Round and Green — Wrinkled and Yellow

↓

F_1 RrYy (Round and Yellow)

↓ (Selfing)

F_2

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 = 9 : 3 : 3 : 1

8. List the contrasting characters which were taken for experiments by Mendel. **(Imp.)**

Ans. Mendel selected varieties that differed with respect to seven traits with easily distinguishable contrasting forms, i.e., he selected fourteen varieties as shown in the table given below :

S.No.	Character	Alternate Forms	
		Dominant	Recessive
1.	Stem height	Tall	Dwarf
2.	Flower colour	Purple	White
3.	Seed colour	Yellow	Green
4.	Seed shape	Round	Wrinkled
5.	Pod colour	Green	Yellow
6.	Pod shape	Inflated	Constricted
7.	Flower position	Axillary	Terminal

9. How was it established that genes are located on the chromosomes? **(Imp.)**

Ans. In all the organisms, the number of chromosomes is fewer than the number of characteristic features, which are many. If 'genes' are responsible for a characteristic feature, they have to be certainly many more than the number of chromosomes. For example, in human beings, the total number of chromosomes is 23 pairs, but the total number of characters (genes) have been estimated to be between 30,000 to 40,000. This suggests that genes are located on the chromosomes.

10. Suggest three similarities between Mendel's 'factors' and 'chromosomes'.

Ans. Similarities between Mendel's factors and chromosomes are as follows :

(1) Both Mendel's factors as well as chromosomes are present in pairs.

(2) Both segregate during meiotic cell division to form gametes in which they remain unpaired.

(3) After fertilisation the paired feature is again restored in the zygote which develops into an offspring.

11. Justify logically that many genes are present on one chromosome.

Ans. In all organisms the number of chromosomes is fewer than the number of characteristic features which are many. If 'genes' are responsible for characteristic features, they have to be certainly many more than the number of chromosomes.

12. Clarify the terms 'haploid' and 'diploid'. What is the relation between the two terms? **(Imp.)**

Ans. The paired condition of chromosomes is known as diploid whereas a set of unpaired chromosomes is said to be haploid.

During gamete formation, the diploid chromosomes segregate and haploid conditions achieved. After fertilisation, the diploid condition is again restored.

13. Explain the law of segregation by taking an example.

Ans. **Law of segregation :** Paired factors responsible for a character segregate into gametes and are recombined at the time of fertilisation.

When a yellow seeded and green seeded plants are crossed, the F_1 progeny are all yellow seeded. It indicates that yellow colour is dominant over green seed colour. When F_1 plants are selfed we get yellow and green seeded plants in the ratio of 3 :1.

D. Long Answer Questions [5 Marks]

Previous Years' Questions

1. (i) What are chromosomes? Where are they seated?

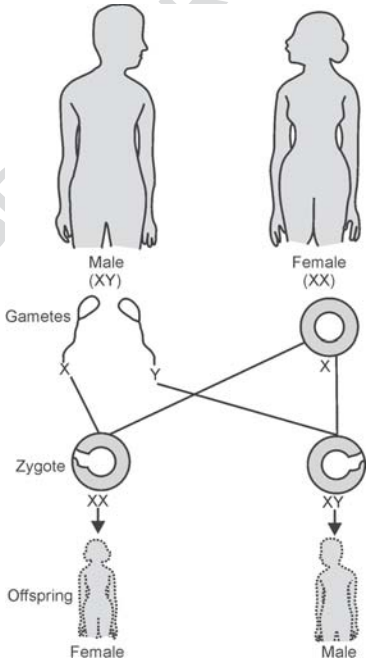
(ii) What is a sex chromosome?

(iii) Explain the mechanism of sex determination in human beings. **[2008, 2011 (T-II)]**

Ans. (i) **Chromosomes :** Chromosomes are the thread like structures found in the nucleus of a cell (plant and animal). These are composed of chromatin and carry the genes from one generation to the next generation.

(ii) A chromosome that helps in determining the sex of an individual is known as a sex chromosome.

(iii) **The mechanism of sex determination in human beings :** It is assumed that half the children of a couple will be girls and half will be boys. All children of the couple will inherit similar chromosomes (22 + X) from the mother but the sex of the children will depend on the chromosome they inherit from the father. If a child inherits 22 + X chromosomes from the father that will be a girl but when a child will inherit 22 + Y chromosomes from the father that will be a boy. Therefore, the sex of a child is determined by the inheritance of X or Y chromosome from the father.



2. Distinguish between acquired and inherited traits giving one example of each. Why are the traits acquired during lifetime of an individual not inherited? **[2009]**

Ans. Differences between Acquired and Inherited Traits :

Acquired Traits	Inherited Traits
• These are somatic variations.	• These are genetic variations.
• Acquired traits develop due to the effects of environmental factors, use and disuse of organs and special (conscious) efforts.	• Inherited traits develop due to reshuffling of genetic material and mutations.
• These traits develop throughout the lifetime of an individual and die with the death of that individual.	• These traits are transferred (inherited) by the parents to their offspring. These do not die but are passed on to the next generation.
• Example—Learning of dance, music, etc, and muscular body of a wrestler.	• Example—Attached or free earlobe and curly hair.

Acquired Traits : Acquired characters are those variations or changes which an individual develops during its lifetime due to some special efforts, use or disuse of organs and due to some environmental factors. They are not controlled by genes.

The acquired changes during lifetime do not inherit to the progeny. It can be understood with the help of some examples, such as —

If a group of mice having tail will breed, their progeny will also have the same type of tail. But if the tail of all the mice is removed by surgery in each generation, no tailless mouse will be produced even after a few generations. It is because the removal of tail is a physical change which could not make a change in the gene responsible for the presence of tail in mice.

3. Human beings who look so different from each other in terms of colour, size and looks are said to belong to the same species. Why? Justify your answer. **[2009]**

Ans. There is a great diversity of human forms all over the planet (Earth). Earlier black, brown, yellow and white races were thought to be descendants of different species. But after a number of evidences it is known that all human races belong to a single ancestral species of *Homo sapiens sapiens.* The skin colour of different species developed due to the environmental conditions of that particular area. All the species of human beings have their origin in Africa. Thousands of years ago our ancestors left Africa while some stayed on. The migrants slowly spread across the earth, from Africa to Australia, America, Indonesia, etc. They travelled down from Africa to West Asia, then to Central Asia, Eurasia, South Asia, East Asia and so on. They went forwards and backwards separating from each other. They had come into being as an accident of evolution and live their lives the best.

Other Important Questions

1. Write about the relation between heredity and variation in asexual reproduction as well as sexual reproduction. **(Imp.)**

Ans. (i) In asexual reproduction organisms raised are the exact copies of their parents.

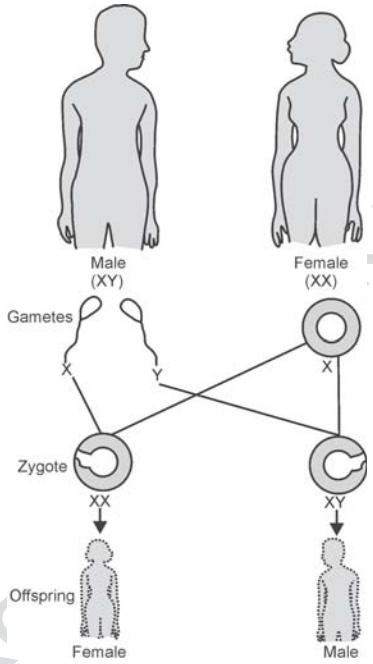
(ii) They tend to preserve the similarities among all the individuals belonging to a given line of descent.

(iii) They exhibit very little variation due to some environmental factors or mutations which are due to sudden changes in genes. Out of these two factors, only mutations are heritable.

In case of sexual reproduction, the offspring show variations from their parents due to crossing over and exchange of gene segments. These variations are heritable.

2. Explain the sex determination mechanism in human beings. Give relevant pictures also.

Ans. In human beings 23 pairs of chromosomes are found. Out of these 22 pairs are autosomes and one pair is sex chromosome. In man, the 23rd pair consists of X and Y chromosome whereas in woman X and X chromosomes are present. When a male gamete carrying X chromosome fertilises a female gamete, the offspring produced will be a female. When male gamete carrying Y chromosome fertilizes a female gamete the zygote develops into a male.



II. FORMATIVE ASSESSMENT

A. Quiz

1. There are some common hereditary chracteristics in humans. The teacher can ask the dominant and recessive character of the same trait :

Character studied	Dominant	Recessive
1. Eye colour	.....	.....
2. Hair	.....	.....
3. Eyebrows	.....	.....
4. Tongue	.....	.....
5. Hand	.....	.....
6. Earlobe	.....	.....
7. Lips	.....	.....
8. Colour vision	.....	.....

Ans.

Character studied	Dominant	Recessive
1. Eye colour	Brown	Blue
2. Hair	Curly	Straight
3. Eyebrows	Bushy	Thin
4. Tongue	Rolling	Non–rolling
5. Hand	Right-handedness	Left–handedness
6. Earlobe	Free	Attached
7. Lips	Thick	Thin
8. Colour vision	Normal	Colour blind

2. The teacher can ask students to find out the resultant progeny of the given crosses from the table—

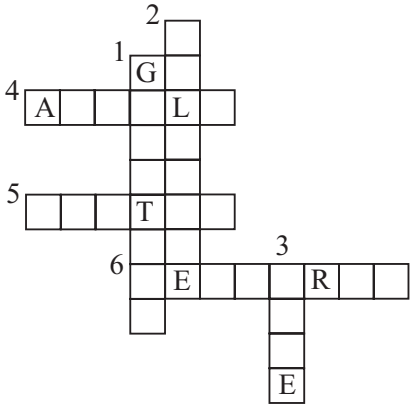
Cross	Progeny
(a) RR YY × RR YY Round–Yellow, Round–Yellow	.....
(b) Rr Yy × Rr Yy Round–Yellow, Round – Yellow	.....
(c) rr yy × rr yy Wrinkled–Green, Wrinkled–Green	.....
(d) RR YY × rr yy Round–Yellow, Wrinkled–Green	.....

Ans.

Cross	Progeny
(a) RR YY × RR YY Round–Yellow, Round–Yellow	(a) All Round–Yellow
(b) Rr Yy × Rr Yy Round–Yellow, Round–Yellow	(b) Round–Yellow, Round–Green, Wrinkled–Yellow, Wrinkled–Green
(c) rr yy × rr yy Wrinkled–Green, Wrinkled–Green	(c) All Wrinkled–Green
(d) RR YY × rr yy Round–Yellow, Wrinkled–Green	(d) All Round–Yellow

B. Puzzles

1. Find out the 6 terms used in genetics from the given puzzle by going down and across—



Down

1. The genetic constitution of an organism.
2. The chromosomes responsible for determining sex.
3. Basic unit of inheritance.

Across

4. Alternative form of a gene.
5. The term given by Mendel to the unit which controls inheritance of characters.

6. Ancestral record of an organism.

Ans. 1. Genotype 2. Allosome 3. Gene 4. Allele 5. Factor 6. Pedigree

2. Search 5 different varieties of wild cabbage plant (*Brassica oleracea)* from the given chart by going horizontally, vertically or diagonally—

1. . .....
2. . .....
3. . .....
4. . .....
5. . .....

C	K	K	J	I	X	Z	Y	S	N	O
C	A	B	B	A	G	E	T	L	L	I
P	L	U	M	M	U	J	E	N	B	P
L	E	Y	L	P	N	S	B	A	M	J
Z	I	K	N	I	S	A	R	F	I	L
S	P	U	T	U	F	L	E	G	H	K
B	A	N	R	A	H	L	Y	N	Y	U
D	Z	B	R	O	C	C	O	L	I	L
Y	L	N	K	L	M	C	D	W	R	Z
P	K	S	T	R	J	N	P	Y	E	K
K	J	P	S	R	Y	Z	N	O	P	R

Ans. 1. Cabbage 2. Kohlrabi 3. Cauliflower 4. Broccoli 5. Kale

C. Seminar

Topic— 'Evidences of Evolution'.

(Hints– The students can include the following points in seminar and can show the related pictures with the help of slide and animations)

(i) Features of fossils like *Archaeopteryx*, horse, dinosaurs, etc.
(ii) Features of eye of *Planaria*, octopus, fish, bird and humans.
(iii) Vestigial organs.
(iv) Homologous organs.
(v) Analogous organs, etc.

D. Group Activity

The teacher can divide the class into four groups. Ask each group to go into a classroom and observe the earlobe i.e., free or attached in the students of that class and note down in the given table :

S.No	Name of Students	Earlobe free/attached
1.	.....	.....
2.	.....	.....
3.	.....	.....
4.	.....	.....
5.	.....	.....
6.	.....	.....
7.	.....	.....

E. Debate

1. In humans, male not female is responsible for determination of sex of the baby.

2. Evolution is a continous process.

F. Group Discussion

1. Artificial selection

2. Modern theory of origin of life

3. Causes of variation