9 Heredity and Evolution

The concept of heredity encompasses two seemingly paradoxical observations about organisms. Like in this photo the sum of all biological processes by which particular characteristics of the tigress are evolved and then transmitted to her offsprings (cubs) through the process of inheritance.

Topic Notes

- *Accumulation of Variation during Reproduction*
- *Heredity*
- *Evolution*
- *Speciation*
- *Evolution and Classification*

ACCUMULATION OF VARIATION DURING REPRODUCTION

Heredity can be defined as resemblances among individuals related by descent or the transmission of traits from parents to the offsprings. It means continuity of features from one generation to the next. Variation is defined as the occurrence of differences in the characters (or traits) among the individuals. In a number of sexually reproducing animals, including human beings, quite distinct variations are visible among different individuals. The long term accumulation of variations may lead to gradual changes in the form or functions of organisms and may even lead to the formation of a new species over time. This process is known as evolution.

In case an organism reproduces by asexual reproduction, one organism gives rise to two individuals which are similar in body design, but having subtle differences. These will in turn give rise to two individuals in the next generation. In this way, the four individuals formed will be different from each other.

If sexual reproduction is involved, greater diversity will be generated in the offsprings as compared to asexual reproduction where only minor differences would be generated due to small inaccuracies in DNA copying. Depending on the nature of variations, different individuals would have different kinds of advantages. Selection of variants by environmental factors forms the basis for evolutionary processes.

Example 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 population, which trait is likely to have arisen earlier?** **[NCERT]**

Ans. Trait B is likely to have arisen earlier as the trait B exists in 60 % of population as compared to trait A which exists in 10% of the population. Organisms with trait B reproduced and replicated the trait for a longer period as compared to trait A.

TOPIC 2

HEREDITY

Genetics is the branch of biology which studies heredity and variation. Inheritance is the transmission of genetically controlled traits from one generation to the next.

Inherited Traits

The traits or characteristics that are transmitted from one generation to the next are controlled by genes. A gene is a segment of DNA which is responsible for the synthesis of proteins that contains a specific character of the organism. An example is the free earlobes and attached earlobes found in human population.

Mendel's Contributions

Gregor Mendel was the first scientist to make a systematic study of patterns of inheritance which involved the transfer of characteristics from parents to progeny (offsprings). He is known as the Father of Genetics.

Mendel's Experiment

Mendel used a number of contrasting visible characters of garden peas – round/wrinkled seeds, tall/short plants, white/violet flowers and so on. He took pea plants with different characteristics – a tall plant and a short plant, produced progeny from them, and calculated the percentages of tall or short progeny. Mendel chose pea plants for studying inheritance because pea plants had a number of distinct differences which were easy to tell apart.

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

(2) Short life span of the plant.

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

(4) Large number of seeds produced.

Monohybrid inheritance:

(1) It concerns the inheritance of a single plant characteristic such as plant height or colour of flowers.

(2) Mendel first crossed pure-bred tall pea plants with pure-bred dwarf pea plants and found that there were no halfway characteristics or 'medium-height' plants in this first generation, or F1 progeny. All plants were tall.

(3) Mendel then crossed the tall pea plants of the first generation by self pollination and found that

tall plants are not all tall. Instead, one quarter of them were short.

(4) Both the tallness and shortness traits were inherited in the F1 plants, but only the tallness trait was expressed.

(5) Two copies of the trait are inherited in each sexually reproducing organism. These two may be identical, or may be different, depending on the parentage.

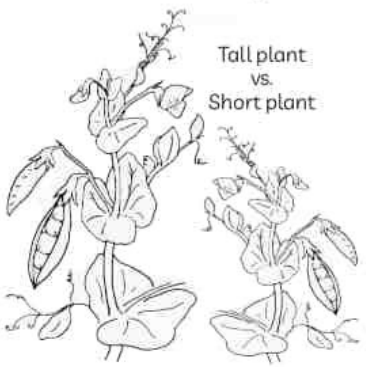
(6) Out of a total 1064 pea plants of F2 generation, Mendel found that there were 787 tall pea plants and 277 dwarf pea plants. The ratio of tall plants to dwarf plants comes to be approximately 3 : 1. The ratio 3 : 1 is known as the monohybrid ratio.

e.g., The genotypic ratio of F2 progeny is TT : Tt : tt = 1 : 2 : 1.

Example 2. **Case Based:**

Let us study further about the genotype and phenotype of pea plants in the F_1 and F_2 generations.

[NCERT Activity 9.2]



Traits that Mendel observed:

(A) Mendel used a number of contrasting visible characters of garden pea for his experiments. Select the incorrect pairs of contrasting characters:

(I) Pink / white flower colour

(II) Round/Wrinkled pea shape

(III) Green / White pod colour

(IV) Tall/Dwarf plant size

(a) Both (I) and (II)

(b) Both (I) and (III)

(c) Both (II) and (III)

(d) Both (III) and (IV)

(B) The table below gives the phenotypic ratio of Tall : Short pea plants in the F_1 and F_2 generation.

	F_1 Generation	F_2 Generation
(a)	3 : 1	1 : 3
(b)	4 : 0	1 : 3
(c)	4 : 0	3 : 1
(d)	3 : 1	3 : 1

(C) What will be the genotypic ratio of F_2 generation in the above cross?

(D) What experiment can you conduct to verify that the F_2 generation did in fact have a 1:2:1 ratio of TT, Tt and tt traits?

(E) Assertion (A) : When pure tall pea plants are crossed with pure short pea plants, the percentage of short pea plants in the first filial generation is 50%.

Reason (R) : All plants in the first filial generation will be tall as tallness is dominant.

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

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

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

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

Ans. **(A)** *(b) Both (I) and (III)*

Explanation: Mendel used the seven pairs of contrasting characters of pea plants for his experiments which are as follows:

(1) Pea shape: Round or Wrinkled.

(2) Pea color: Green or Yellow.

(3) Pod shape: Constricted or Inflated.

(4) Pod color: Green or Yellow.

(5) Flower color: Purple or White.

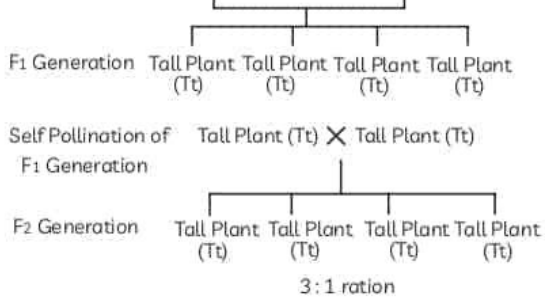
(6) Plant size: Tall or Dwarf.

(7) Position of flowers: Axial or Terminal.

(B) *(c) F_1 Generation: 4 : 0; F_2 Generation: 3 : 1*

Explanation: When a pure tall pea plant (TT) is crossed with a pure short pea plant (tt), all plants in the F1 generation will be tall (Tt).

When these tall plants of F_1 generation are crossed, 75 % of plants will be tall and 25 % will be short.



(C) The genotypic ratio of F_2 generation in the above cross will be TT : Tt : tt = 1 : 2 : 1 as all pea plants obtained in the F1 generation were tall having genotype Tt, the genotype ratio in the F2 generation will be TT : Tt : tt = 1 : 2 : 1, as can be seen from the above diagram.

(D) Let us cross a tall pea plant (obtained in F1 generation) with a short pea plant.Genotype of the tall parent will be Tt and that of short parent tt. We will observe that 50 % progenies were tall and 50 % were short, which means that the genotype of the tall plant was Tt (and not TT). Its gametes would be T and t, which when crossed with a short plant (tt) would result in 50 % plants with genotype Tt and 50 % with genotype tt.

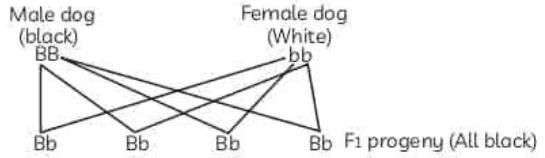
This type of cross can be used to confirm that the F_2 generation did in fact have a 1:2:1 ratio of TT, Tt and tt trait combinations.

(E) *(d) (A) is false, but (R) is true.*

Explanation: When pure tall pea plants are crossed with pure short pea plants, all plants in the first filial generation will be tall. Therefore, percentage of short pea plants in the F_1 generation will be 0%.

Example 3. Outline a project which aims to find the dominant coat colour in dogs. [NCERT]

Ans. Select a homozygous black (BB) male dog and a homozygous white (bb) female dog. Allow them to mate and produce offspring (F1 generation). If all of the F1 offspring are black, we can conclude that black coat cover is dominant than white coat in the dog.



Dihybrid inheritance:

(1) It concerns the inheritance of characteristics when pea plants showing two different characteristics, rather than just one, are bred with each other.

(2) The F1 progeny of a tall plant with round seeds and a short plant with wrinkled-seeds are all tall and have round seeds. Tallness and round seeds are thus dominant traits.

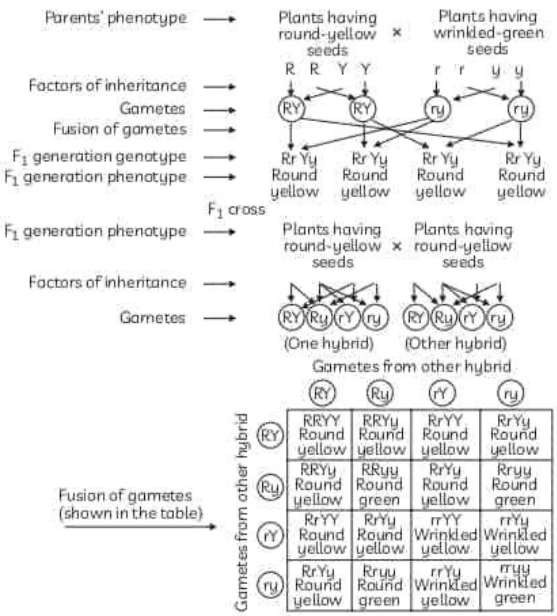
(3) When these F1 progeny are used to generate F2 progeny by self-pollination, some F2 progeny are tall plants with round seeds, and some were short plants with wrinkled seeds.

(4) There would also be some F2 progeny that showed new mixtures. Some of them would be tall, but have wrinkled seeds, while others would be short, but have round seeds.

(5) The tall/short trait and the round seed/wrinkled seed trait are independently inherited.

Independent Inheritance of two separate traits: In the inheritance of more than one pair of traits in a cross simultaneously, the factors responsible for each pair of traits are distributed independently to the gametes. The dihybrid cross can be shown by drawing a chart as shown:

Parental Cross



Example 4. 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** **[NCERT]**

Ans. *(c) TtWW*

Explanation: This is dihybrid cross of a plant involving two characters in the same plant. As the progeny had violet flowers, therefore,

dominant. Also, almost half of the plants were short which means that the genotype is Tt.

Important Terms used in Heredity

Chromosome: Chromosomes are the carriers of genes and are long thread like structures present in the nucleus of a cell. Each gene set is present as separate independent pieces, each called a chromosome.

DNA: Cellular DNA is the information source for making proteins in the cell. DNA is the genetic material. DNA is the carrier of genetic information from generation to generation. Every chromosome contains one molecule of DNA and genes are segments of DNA.

Genes: Gene is a segment of a large molecule called deoxyribonucleic acid (DNA) which forms the most important constituent of chromosome. Genes are located on the chromosomes at fixed positions and their number is estimated to be between 30, 000 to 40, 000. Genes control characteristics or traits.

Allele: One of the different forms of a particular gene occupying the same position on a chromosome.

Factor: The carriers of hereditary information were called as factors by Mendel. He considered each and every character as a unit, which was controlled by a 'factor' based on his experiments with garden pea.

F1 generation: When two parents cross or breed to produce progeny, then their progeny is called first filial generation.

F2 generation: When the first generation progeny cross among themselves to produce second progeny, then this progeny is called second filial generation.

Diploid: The paired condition of chromosomes is called diploid. The diploid number of chromosomes is specific for a species and every cell has diploid number of chromosomes.

Haploid: It is the set of unpaired chromosomes. Gametes have haploid set of chromosomes.

Homologous chromosome: Members of a pair of chromosomes are exactly identical as far as shape and size are concerned and hence called homologous chromosomes.

Genotype: It is the description of genes present in an organism. It is always a pair of letters such as TT, Tt or tt (where T and t are the different forms of the same gene).

Phenotype: The characteristic or trait which is visible in an organism is called its phenotype. Being tall or dwarf are phenotypes of a plant as these traits are visible.

Dominant and recessive traits: In this explanation, both TT and Tt are tall plants, while only tt is a short to make the plant tall, while both copies have to be 't' for the plant to be short. So, a tall plant will have genotype TT or Tt, whereas a short plant will have genotype tt. Traits like 'T' are called dominant traits or expressed traits, while those that behave like 't' are called recessive traits or repressed traits.

Mendel's Laws of Inheritance

Law	Definition
Law of Segregation	During gamete formation, the alleles for each gene segregate from each other so that each gamete carries only one allele for each gene.
Law of Independent Assortment	Genes for different traits can segregate independently during the formation of gametes.
Law of Dominance	Some alleles are dominant while others are recessive; an organism with at least one dominant allele will display the effect of the dominant allele.

Expression of Traits

Genes control characteristics or traits in all organisms. Cellular DNA is the information source for making proteins in the cell. Each trait is governed by a particular hormone and the amount of the hormone made depends on the efficiency of the process for making it which in turn depends on a particular enzyme that is important for this process. If this enzyme works efficiently, a lot of hormone will be made and if the gene for that enzyme has an alteration that makes the enzyme less efficient, the amount of hormone will be less.

Example 5. 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?[NCERT]

Ans. No, we cannot say with certainty about whether the light eye colour trait is dominant or recessive without knowing the genotype of the variants. Moreover, atleast three generations are required for determining whether trait is dominant or recessive.

Example 6. 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 or why not? [NCERT]

which of the traits – blood group A or O – is dominant. In blood heredity, blood Type A is always dominant and blood Type O is always recessive.

Father's Blood group can be AA (homozygous) or AO (heterozygous), and that of mother can be OA or OO. For daughter to be born with blood group O, she must receive O type gene one each from father and mother. For this father must have heterozygous AO blood group and mother must have homozygous blood group OO.

Related Theory

Research carried out in Heidelberg, Germany by Ludwik Hirszfeld and Emil von Dungern in 1910 and 1911 showed that the ABO blood types are inherited. An individual's ABO type results from the inheritance of 1 of 3 alleles (A, B, or O) from each parent. The possible outcomes are shown below:

Parent Alleles	*A*	*B*	*O*
A	*AA (A)*	*AB (AB)*	*AO (A)*
B	*AB (AB)*	*BB (B)*	*BO (B)*
C	*AO (A)*	*BO (B)*	*OO (O)*

Both A and B alleles are dominant over O. As a result, individuals who have an AO genotype will have an A phenotype. People who are type O have OO genotypes. In other words, they inherited a recessive O allele from both parents. The A and B alleles are codominant. Therefore, if an A is inherited from one parent and a B from the other, the phenotype will be AB. Agglutination tests will show that these individuals have the characteristics of both type A and type B blood.

Mechanism of Inheritance

The rules for inheritance of traits in sexually reproducing organisms are related to the fact that both the parents contribute practically equal amounts of genetic material to the offspring. This means that each trait can be influenced by both paternal and maternal DNA. Thus, for each trait there will be two versions in each offspring.

Every germ cell takes one chromosome from each pair and these may be of maternal or parental origin. When two germ cells combine, they will restore the normal number of chromosomes in the progeny and in this way the DNA of the species becomes stable.

Example 7. How is the equal genetic contribution of male and female parents ensured in the progeny? [NCERT]

of male and female parents is ensured in the progeny through inheritance of equal number of chromosomes from both parents. The chromosome number is halved during gamete formation.

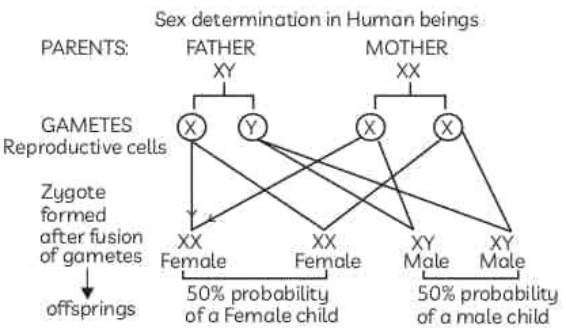
During the course of reproduction, as fertilization process takes place, the male gamete (haploid) fuses with the female gamete(haploid) resulting in formation of the diploid zygote. The zygote in the progeny receives an equal contribution of genetic material from the parents.

Sex Determination

In human beings, the sex of the offspring in the zygote after fertilization of the male and female gamete is determined by the sex chromosome. The rest of the chromosomes are called autosomes. Human beings have 22 pairs of autosomes and one pair of sex chromosome. The females carry two X- chromosomes but the males carry a single X and a Y chromosome. Among the male gametes, half of the sperms carry X-chromosome and half carry Y-chromosome. In human beings, the sex of the individual is largely genetically determined.

(1) When a sperm carrying X-chromosome fertilizes an egg, the zygote develops into female (XX).

(2) When a sperm carrying Y-chromosome fertilizes an egg, the zygote develops into male (XY).



Effect of environmental factors on sex determination:

In some reptiles, the temperature at which the fertilized egg is incubated before hatching is important for sex determination.

(1) In a turtle high incubation temperature results in development of female progeny.

(2) In the case of lizard, high incubation temperature results in development of male progeny.

We have seen that there is an inbuilt tendency to variation during reproduction, both because of errors in DNA copying and as a result of sexual reproduction.

(1) A rare variation can become a common characteristic in a population when the frequency of an inherited trait changes over generations. Since genes control traits, we can say that the frequency of certain genes in a population changed over generations. This is the essence of the idea of evolution.

(2) A particular variation may become common if it gives survival advantage to the population. This is known as Natural selection which can direct evolution in a population. It results in adaptations in the population to fit their environment better.

(3) Accidents in small populations can change the frequency of some genes in a population, even if they give no survival advantage. This is the notion of genetic drift, which provides diversity without any adaptations.

Example 8. 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? [NCERT]

Ans. Sexual reproduction gives rise to more viable variations as compared to asexual reproduction. It is because there is an inbuilt tendency to variation during reproduction because of errors in DNA copying. In asexual reproduction, genes cannot be separated from the parent organism.

The resulting variation in traits out of sexual reproduction not only help in survival of species but also support diversity in long run. Drift in genetic traits get accumulated spanning across generations, this gives rise to formation of new species.

Example 9. Why are the small numbers of surviving tigers a cause of worry from the point of view of genetics? [NCERT]

Ans. A small number of surviving tigers is the cause of worry from the point of view of genetics because the size of its population plays a dominant role for its evolutionary expansion. For a small population of tigers, diversity of traits will be adversely affected as gene pool will be less and hence there will be less variations. In the event of a disease or natural disaster possibility of survival against numbers will be greatly reduced. Small number of surviving tiger will affect the diversity negatively and will result in an ecological imbalance.

Acquired and Inherited Traits

Acquired Trait is a phenotypic characteristic, acquired during growth and development, that is not genetically based and therefore cannot be passed on to the next generation (for example, the large muscles of a weight lifter).

For evolution to take place, there must be changes in the DNA of the germ cell. Change in non-reproductive tissues cannot be passed on to the DNA of the germ cells. Therefore the experiences of an individual during its lifetime cannot be passed on to its progeny, and cannot direct evolution.

Example: If we breed a group of mice, all their progeny will have tails, as expected. Now, if the tails of these mice are removed by surgery in each generation, then these tailless mice do not produce tailless progeny because removal of the tail cannot change the genes of the germ cells of the mice.

Differences between acquired traits and inherited traits:

Acquired Traits	Inherited Traits
(1) These traits or characteristics are not transmitted from one generation to the next	(1) These traits are transmitted from parents to their progeny.
(2) These traits do not bring about any changes in the germ cells or DNA as these are changes in non-reproductive tissues.	(2) Genes of inherited traits are present in the germ cells or DNA
(3) These cannot direct evolution as these are experiences of an individual acquired during its lifetime.	(3) These may direct evolution as these bring about changes in the germ cells or DNA.
Example: Acquiring a new hair style	Example: Hair texture

J.B.S. Haldane suggested in 1929 that life must have developed from the simple inorganic molecules which were present on earth soon after it was formed. He speculated that the conditions on earth at that time, which were far from the conditions we see today, could have given rise to more complex organic molecules that were necessary for life. The first primitive organisms would arise from further chemical synthesis.

assembled an atmosphere similar to that thought to exist on early earth (this had molecules like ammonia, methane and hydrogen sulphide, but no oxygen) over water. This was maintained at a temperature just below 100°C and sparks were passed through the mixture of gases to simulate lightning. At the end of a week, 15% of the carbon (from methane) had been converted to simple compounds of carbon including amino acids which make up protein molecules.

TOPIC 4

SPECIATION

A species is a population of organisms consisting of similar individuals which can breed together and produce fertile offsprings. The process by which new species develop from existing species is known as speciation.

The important factors which could lead to the rise of a new species are:

(1) Geographical isolation of a population caused by various types of barriers such as mountain, rivers etc.

(2) Genetic drift caused by drastic changes in the frequencies of particular genes by chance alone.

(3) Variations caused in individuals due to natural selection.

There can be a number of ways by which this can happen.

(1) If the DNA changes are severe enough, such as a change in the number of chromosomes, eventually the germ cells of the two groups cannot fuse with each other.

(2) A new variation may emerge in which green females will not mate with red males, but only with green males. This allows very strong natural selection for greenness. Now, if such a green female beetle meets a red male from the other group, her behaviour will ensure that there is no reproduction between them. Effectively, new species of beetles are being generated.

Some Important Terms

Genetic drift: Changes in the frequencies of alleles in a population that occur by chance, rather than because of natural selection.

Gene flow: The movement of genes into or through a population by interbreeding or by migration and interbreeding.

Geographical isolation: Two populations or individuals of opposite sex are considered reproductively isolated from one another if they cannot together produce fertile offspring.

Natural selection: The differential survival and reproduction of classes of organisms that differ from one another in one or more usually heritable characteristics. Through this process, the forms of organisms in a population that are best adapted to their local environment increase in frequency relative to less well-adapted forms over a number of generations. This difference in survival and reproduction is not due to chance.

Example 10. Will geographical isolation be a major factor in the speciation of a self pollinating plant species? Why or why not? [NCERT]

Ans. No, geographical isolation will not be a major factor in the speciation of a self-pollinating plant species as these plants receive pollen grains from the same flower or another flower on the same plant due to which new gene variants will not be introduced in the population and there will be no evolution of a new species. On the other hand, in cross pollinated species, when geographical isolation is there, accumulation of variations in traits will take place.

Example 11. Will geographical isolation be a major factor in the speciation of an organism that reproduces asexually? Why or why not? [NCERT]

Ans. No, asexual reproduction involves only one parent and hence there is very little variation over generations. As asexual reproduction is carried out within the same organism, resulting organism in next generation will have identical copies of DNA, so there will be very less genetic variant to be a cause of the speciation of an organism.

EVOLUTION AND CLASSIFICATION

(1) Similarities among organisms allow us to group them and then study the groups. Characteristics are details of appearance or behaviour; or a particular form or a particular function. Some basic characteristics will be shared by most organisms.

(2) The more characteristics two species will have in common, the more closely they are related. And the more closely they are related, the more recently they will have had a common ancestor.

(3) Two organisms belonging to the same genus are generally very similar and are likely to have common ancestor in the recent past.

Example: Dogs, jackals, wolves belong to the genus Canis.

(4) Classification of species is a reflection of their evolutionary relationship.

Example 12. How are the areas of study – evolution and classification – interlinked? [NCERT]

Ans. The more characteristics two species have in common, the more closely they are related. And they are likely to have a common ancestor more recently. Classification of organisms necessarily involves organizing them in different groups, based on the similarities and differences of characteristics. Classifying organisms helps us in recognizing the basic arrangement of a hierarchical structure among diverse species. It tells us about the similarities and evolutionary relationships between various organisms. Classification of species is a reflection of their evolutionary relationship. Thus, we can say, the areas of study – evolution and classification – interlinked

Tracing Evolutionary Relationships

Homologous Organs

Those organs which are similar in structure, have the same developmental origin but perform different functions are known as homologous organs.

Example: forelimbs of mammals, birds, reptiles and amphibians.

The basic structure of the limbs is similar though it has been modified to perform different functions in various vertebrates. Such a homologous characteristic helps to identify an evolutionary relationship between apparently different species.

Analogous Organs

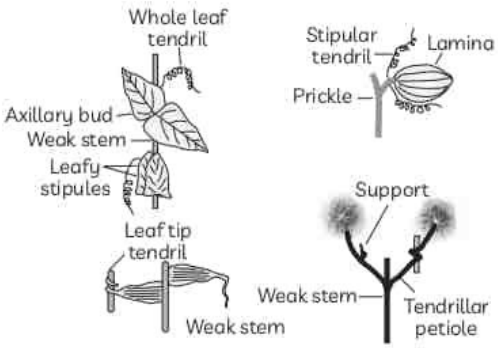
Those organs which perform similar functions but are structurally dissimilar are known as analogous organs.

Example: Wings of bats and wings of birds.

The wings of bats are skin folds stretched mainly between elongated fingers. But the wings of birds are a feathery covering all along the arm. The designs of the two wings, their structure and components, are very different. They look similar because they have a common use for flying, but their origins are not common.

Similarly thorns and spines seen in plants are also analogous structures. Both are pointed structures that are protective in function. However, thorn is modification of stem and spine is modified leaf.

Another example of analogous structures in plants is the tendrils of different types carrying out similar function.



Analogy in tendrils

Fossils

Fossils are the preserved traces of living organisms that lived millions of years ago.

Formation of fossils: Usually, when organisms die, their bodies will decompose and be lost. But every once in a while, the body or at least some parts may be in an environment that does not let it decompose completely. If a dead insect gets caught in hot mud, for example, it will not decompose quickly, and the mud will eventually harden and retain the impression of the body parts of the insect.

Analysis of the organ structure in fossils allows us to make estimates of how far back evolutionary relationships go.

Example: The fossil Archaeopteryx is considered to be the connecting link between birds and reptiles as it

teeth and tail-like structures (like those of reptiles).

Estimation of age of fossils:

(1) One method is relative. If we dig into the earth and start finding fossils, the fossils we find closer to the surface are more recent than the fossils we find in deeper layers.

(2) The second way of dating fossils is by detecting the ratios of different isotopes of the same element in the fossil material.

Example 13. Explain the importance of fossils in deciding evolutionary relationships. [NCERT]

Ans. Fossils are the remains or preserved traces of dead plants or animals, which died millions of years ago and some of them are already extinct. The remains or impressions of body part, sometimes can be found between different layers of earth under its surface. The study of fossils have helped us to know about the evolution or the link between two species. Fossils tells us how new species are developed from the old. So fossils have an importance in deciding evolutionary relationship.

Comparing DNA

Changes in DNA during reproduction are the basic events in evolution. Comparing the DNA of different species give us a direct estimate of how much the DNA has changed during the formation of these species. This method is now extensively used to define evolutionary relationships.

Evolution by Stages

Evolution of Eyes: The complex body organs of animals such as eyes have been created in stages over many generations. Firstly, the rudimentary eye like that of a flatworm (Planaria) was formed, which are very simple and are just eye spots which can detect light. Starting from this basic design, more and more complex eyes were then evolved in various organisms. The evolution of eye is an example of evolution by stages.

Evolution by Artificial Selection

Farmers have been cultivating wild cabbage as a food plant for a very long time and have produced or evolved entirely different looking vegetables like cabbage, broccoli, cauliflower, kohlrabi and kale from it by artificial selection.

Evolution should not be Equated with Progress

Evolution is the production of diversity of life forms and shaping of this diversity by environmental selection due to which more and more complex body designs have emerged. It is not as of when a new species is formed, the old species will disappear.

were inefficient.

This is because many of the older and simpler forms of organisms still survive on earth. For example, one of the simplest and primitive life forms called 'bacteria' still inhabit some of the most inhospitable (or unfavourable) habitats such as hot springs, deep-sea thermal vents and the ice in Antarctica. Most other organisms cannot survive in such harsh environments.

Example 14. In evolutionary terms, can we say which among bacteria, spiders, fish and chimpanzees have a 'better' body design? Why or why not? [NCERT]

Ans. In evolutionary terms, we can not say which among bacteria, spiders, fish and chimpanzees have a 'better' body design. Because evolutionary process takes into account the development of most efficient and suitable features in body designs of organisms for survival and adaptation favoring to a particular niche. For example, organisms with Complex and seemingly better body design, may not survive particular situation. Where as, organisms like bacteria with its primitive body design and simple microbial life form may survive in the most inhospitable and extreme environmental conditions that are extraordinarily hot, cold or acidic.

Molecular phylogeny: Changes in the DNA during cell division would lead to changes in the proteins that are made from this new DNA and these changes would accumulate from one generation to the next. The idea behind molecular phylogeny is based on the idea that organisms which are more distantly related will accumulate a greater number of differences in their DNA. Such studies trace the evolution.

Human Evolution

(1) The same tools for tracing evolutionary relationships – excavating, time-dating and studying fossils, as well as determining DNA sequences – have been used for studying human evolution.

(2) There is a great diversity of human forms and features across the planet. Over recent years, the evidence has become very clear. There is no biological basis to the notion of human races.

(3) All humans are a single species.

(4) The earliest members of the human species, Homo sapiens, can be traced to Africa. Our genetic footprints can be traced back to our African roots. A couple of hundred thousand years ago, some of our ancestors left Africa while others stayed on.

OBJECTIVE Type Questions

[1 mark]

Multiple Choice Questions

1. In peas, a pure tall plant (TT) is crossed with a pure short plant (tt). The ratio of pure tall plants to pure short plants in F_2 generation will be:

(a) 1 : 3 (b) 3 : 1

(c) 1 : 1 (d) 2 : 1

Ans. *(c) 1 : 1*

Explanation: The genotype ratio of F_2 generation is: TT : Tt : tt = 1 : 2 : 1. Therefore, the ratio of TT and tt plants of F_2 generation will be the same.

2. Two pink coloured flowers on crossing resulted in 1 red, 2 pink and 1 white flower progeny. The nature of the cross will be:

(a) Double fertilization

(b) Self pollination

(c) Cross fertilization

(d) No fertilization [NCERT Exemplar]

Ans. *(c) Cross fertilization*

Explanation: The nature of the cross will be cross fertilization, which is the transfer of pollen from one plant to the stigma of flower; borne on a different plant of the same species.

Related Theory

- ***Self pollination:*** *Transfer of pollen grains from the anther to the stigma of the same flower of the same plant.*
- ***Cross pollination:*** *Transfer of pollen grains from the anther of one flower to the stigma of another flower.*
- ***Double fertilization:*** *This process occurs when one male nucleus fertilizes (fuses) with the egg cell to form zygote cell and the other male nucleus fuses (fertilizes) with two polar nuclei to cause triple fusion. These two types of fertilizations take place at the same time in the ovule of the plant.*

3. In human males, all the chromosomes are paired perfectly except one. These unpaired chromosomes are:

(I) Large chromosome

(II) Small chromosome

(III) Y chromosome

(IV) X chromosome

(a) (I) and (II) (b) (III) and (II)

(c) (III) and (IV) (d) (II) and (IV)

4. Which of the following statement is incorrect?

(a) For every hormone there is a gene.

(b) For every protein there is a gene.

(c) For production of every enzyme there is a gene.

(d) For every molecule of fat there is a gene. [NCERT]

Ans. *(d) For every molecule of fat there is a gene.*

Explanation: A section of DNA that provides information for one protein is called the gene for that protein. Hormones and enzymes are proteins, and the formation of any particular protein is controlled by a particular gene. Fat biosynthesis occurs through metabolic reaction. They are not related to genes.

5. Which one is a possible progeny in F2 generation of pure bred tall plant with round seed and dwarf plant with wrinkled seeds?

(a) Tall plant with round seeds

(b) Tall plant with wrinkled seeds

(c) Dwarf plant with round seed

(d) All of the above

6. If a round, green-seeded pea plant (RR yy) is crossed with wrinkled, yellow seeded pea

generation are:

(a) Round and yellow

(b) Round and green

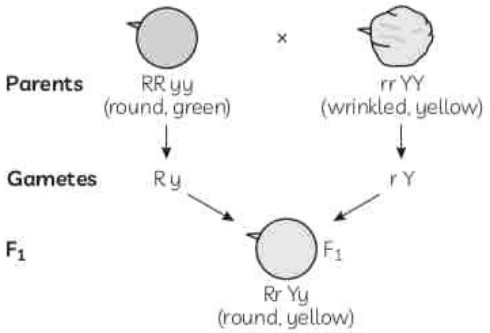
(c) Wrinkled and green

(d) Wrinkled and yellow

[CBSE 2017, 16, 14, 13]

Ans. *(a) Round and yellow*

Explanation: The cross between RR yy and rr YY seeds will obtain RrYy offspring which will exhibit round and yellow phenotype, as these traits are the dominant ones.



7. **A zygote which has an X chromosome inherited from the father will develop into a:**

(a) Boy

(b) Girl

(c) X chromosome does not determine the sex of a child

(d) Either boy or girl [CBSE 2014, 12]

Ans. *(b) Girl*

Explanation: Humans follow XX- XY mechanism of sex determination *i.e.*, women are XX while men are XY. All children will inherit an X chromosome from their mother regardless of whether they are boys or girls.

Thus, the sex of the children will be determined by what they inherit from their father. A child who inherits an X chromosome from her father will be a girl and the one who inherits a Y chromosome from him will be a boy.

8. **Select the incorrect statement:**

(a) The frequency of certain genes in a population change over several generations resulting in evolution.

(b) The reduction in the weight of an organism due to starvation is genetically controlled.

(c) Low weight parents can have heavy weight progeny.

(d) Traits which are not inherited over generations do not cause evolution. [NCERT Exemplar]

(a) The tendril of a pea plant and the phylloclade of Opuntia are homologous.

(b) The tendril of a pea plant and the phylloclade of Opuntia are analogous.

(c) The wings of birds and the limbs of lizards are analogous.

(d) The wings of bird and the wings of bats are homologous. [NCERT Exemplar]

10. **If the fossil of an organism is found in the deeper layers of earth, then we can predict that:**

(a) The extinction of the organism occurred recently.

(b) The extinction of the organism occurred thousands of years ago.

(c) The fossil position in the layers of Earth is not related to its time of extinction.

(d) The time of extinction cannot be determined. [NCERT Exemplar]

Ans. *(b) The extinction of the organism occurred thousands of years ago.*

Explanation: If we dig into the earth and start finding fossils, the fossils we find closer to the surface are more recent than the fossils we find in deeper layers.

Related Theory

➥ *Depth of each stratum signifies the relative age of fossils present in it. The deeper the stratum, the older the rock and the fossils present in it*

11. **A trait in an organism is influenced by:**

(a) Paternal DNA only

(b) Maternal DNA only

(c) Both maternal and paternal DNA

(d) Neither paternal nor maternal DNA [NCERT Exemplar]

Ans. *(c) Both maternal and paternal DNA*

Explanation: DNA is contributed to an offspring by both the parents; hence, traits are influenced by both maternal and paternal DNA. During sexual reproduction, both mother and father pass their genes to their children, thus determining their traits; or characteristic features.

12. **New species may be formed if:**

(I) DNA undergoes significant changes in germ cells.

(II) The chromosome number changes in the gamete.

(III) There is no change in the genetic material.

(a) (I) and (II)
(b) (I) and (III)
(c) (II), (III) and (IV)
(d) (I), (II) and (III)
[CBSE 2015, 14, 12, NCERT Exemplar]

13. Which of the following statements is not true with respect to variation?
(a) All variations in a species have equal chances of survival.
(b) Change in genetic composition results in variation.
(c) Selection of variants by environmental factors forms the basis of evolutionary processes.
(d) Variation is minimum in asexual reproduction.
[CBSE 2020, 14, 11, 10, NCERT Exemplar]

14. According to the evolutionary theory, formation of a new species is generally due to:
(a) Sudden creation by nature.
(b) Accumulation of variations over several generations.
(c) Clones formed during asexual reproduction.
(d) Movement of individuals from one habitat to another.
[CBSE 2012, 10, NCERT Exemplar]

15. The theory of the evolution of species by natural selection was given by:
(a) Mendel (b) Darwin
(c) Morgan (d) Lamarck
[CBSE 2020, 14, NCERT Exemplar]

16. 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:
(a) Reptiles have evolved from birds.
(b) There is no evolutionary connection between reptiles and birds.
(c) Feathers are homologous structures in both the organisms.
(d) Birds have evolved from reptiles.
[NCERT Exemplar]

17. Select a set of homologous organs from the following:
(a) Wings of a bat and wings of a butterfly
(b) Wings of a pigeon and wings of a bat
(c) Wings of a bat, wings of a butterfly and wings of a pigeon
(d) Forelimbs of a duck, forelimbs of a cow and forelimbs of a lizard [CBSE 2017]

Ans. *(d) Forelimbs of a duck, forelimbs of a cow and forelimbs of a lizard*

Explanation: Wings of a bat and wings of a butterfly (A), Wings of a pigeon and wings of a bat (B) and Wings of a butterfly and wings of a pigeon (C) are analogous organs as they all use wings for flying but the wings have different structures.

Bat wings consist of flaps of skin stretched between the bones of the fingers and arm, wings of pigeon consist of feathers extending all along the arm whereas butterfly wings are covered in scales.

On the other hand, Forelimbs of a duck, forelimbs of a cow and forelimbs of a lizard are homologous organs as they all have similar structures which have been modified to perform different functions.

18. Select the correct statements regarding monohybrid cross between a pure tall pea plant and pure short pea plant performed by Mendel:
(I) All plants of F1 generation were tall.
(II) The tall plants in the F1 generation were exactly the same as the tall plants of the parent generation
(III) One quarter of the F2 progeny of the F1 tall plants were short.
(IV) Both the tallness and shortness traits were inherited in the F1 plants
(a) Both (I) and (II)
(b) Both (II) and (III)
(c) (I), (II) and (III)
(d) (I), (III) and (IV)

Ans. *(d) (I), (III) and (IV)*

Explanation: When a pure tall pea plant is crossed with a pure short plant, it was observed that all plants of F1 generation were tall. But the tall plants in the F1 generation were not exactly the same as the tall plants of the parent generation. The genotype of pure tall plant is TT, whereas genotype of tall plant in F1 generation was Tt. The ratio of the tall and short plants in F2 generation was 3 : 1. As 25 % of the pea plants in F2 generation were tall, it means that both the shortness (t) and tallness (T) trait were inherited in the F1 plants.

(I) Attached or free earlobe
(II) Muscular body of a wrestler
(III) Body weight of starving animals
(IV) Brown and curly hair
(a) Both (I) and (III)
(b) Both (II) and (III)
(c) Both (I) and (IV)
(d) Both (II) and (IV)

20. Consider the plants the pitcher plant, venus fly trap, poinsettia and cactus.

Select the row containing incorrect information regarding the leaves of these plants in terms of evolutionary relationships.

(a)	Leaves of these plants are homologous organs	The leaves are structurally similar but modified to perform different functions
(b)	Leaves of these plants are analogous organs	The leaves are structurally dissimilar but perform similar functions
(c)	Leaves of these plants are vestigial organs	Leaves are homologous to similar leaves in other plants
(d)	Leaves of these plants are neither homologous nor analogous	The leaves have no structural or functional similarity

21. Study the organs and evolutionary relationship mentioned alongside. Select the row containing incorrect information.

	Organs	Evolutionary Relationship
(a)	limbs of human being and frog	Homologous organs
(b)	wings of bird and bat	Analogous organs
(c)	Thorns and spines in plants	Analogous organs
(d)	Tendril of pea plant and grape plant	Homologous organs

Ans. *(d) Organs: Tendril of pea plant and grape plant; Evolutionary Relationship: Homologous organs*

stem and spine is modification of leaf. Tendrils in plant show similar function but they are different in origin.

Pea plant has Leaf tendril whears. Grape plant has Stem tendril

22. Which of the statements regarding evolution is correct?

(a) One species is always eliminated in order to give rise to a new species.
(b) The newly formed species are better than the old species.
(c) Evolution is the generation of diversity and the shaping of the diversity by environmental selection.
(d) More and more complex body designs have emerged over time as the older designs are ineffcient.

23. Which of the following cannot be an outcome of Mendel's Experiment on crossing a tall pea plant with a short pea plant??

(a) 3 tall 1 short plant
(b) 4 tall plants and 1 medium height plant.
(c) 24 tall and 8 short plants
(d) 8 tall and 0 short plants

24. Which of the following have a perfect pair of sex chromosomes?

(a) Only Girls
(b) Only Boys
(c) Both girls and boys
(d) It depends on many other factors

Ans. *(a) Only Girls*

Explanation: Girls have a perfect paired 23rd chromosome, which is XX, whereas boys have a mismatched 23rd pair of chromosome, which is XY.

25. Select the incorrect option.

Genetic drift is:

(a) A mechanism of evolution in which allele frequencies of a population remain constant over generations.
(b) It occurs in all populations of non-infinite size, but its effects are strongest in small populations.
(c) It may result in the loss of some alleles.
(d) It can have major effects when a population is sharply reduced in size by a natural disaster.

maximum number of common characters:

(a) Two individuals of a species
(b) Two species of a genus
(c) Two genera of a family
(d) Two genera of two families

[NCERT Exemplar]

27. Select the statements that describe the 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.

(a) (I) and (II) (b) (I) and (III)
(c) (I) and (IV) (d) (III) and (IV)

[NCERT Exemplar]

Ans. *(b) (I) and (III)*

Explanation: Genes are units of heredity and are responsible for inheritance. Genes control the expression of a trait or a character in an organism. Genes are located on the chromosomes, which is present inside the nucleus of the cell in the crytoplasm.

28. The number of pair(s) of sex chromosomes in the zygote of humans is:

(a) One (b) Two
(c) Three (d) Four

[NCERT Exemplar]

Assertion-Reason Questions

For the following questions, two statements are given: one labeled Assertion (A) and the other labeled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

(a) Both (A) and (R) are true and (R) is the correct explanation of the assertion.
(b) Both (A) and (R) are true, but (R) is not the correct explanation of the assertion.
(c) (A) is true, but (R) is false.
(d) (A) is false, but (R) is true.

29. Assertion (A): Wing of an insect and wing of a bird are analogous organs

Reason (R) : The organs which are quite different in fundamental structure and origin but different species are called analogous organs

[CBSE 2020]

30. Assertion (A) : The sex of a child in human beings will be determined by the type of chromosome he/she inherits from the father.

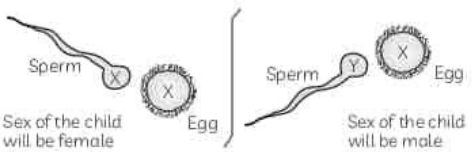
Reason (R) : A child who inherits 'X' chromosome from his father would be a girl (XX), while a child who inherits a 'Y' chromosome from the father would be a boy (XY).

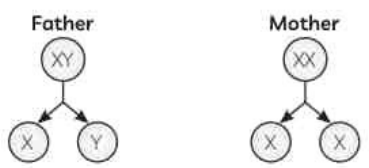
[CBSE 2020]

Ans. *(a) Both (A) and (R) are true and (R) is correct explanation of the (A).*

Explanation: Human beings have 23 pairs of chromosomes. Out of which one pair is sex chromosomes and 22 pairs are autosomes. In men, sex chromosome pair is mismatched pair 'XY', 'X' is normal sized and Y is shorter than 'X' chromosomes. Human females have 'XX' chromosomes. Males produce two types of sperms whereas females produce only one ovum having 'X' chromosomes. A child who inherits 'X' chromosome from a father would be a girl '(XX)'.

While a child who inherits a 'Y' chromosome from the father would be a boy (XY).





Female gametes → / Male gametes ↓	X	X	
Y	XY	XY	→ Male child
X	XX	XX	→ Female child

31. Assertion : A geneticist crossed a pea plant having violet flowers with a peaplant with white flowers, he got all violet flowers in first generation.

passed on to next generation.

[CBSE SQP 2020]

32. **Assertion (A) : New combination of traits are observed in F2 offspring when tall plants with round seeds are crossed with short plants with wrinkled seeds.**

Reason (R) : Tallness and round seed are both dominant traits.

Very Short Answer Type Questions

33. Mendel took tall pea plants and short pea plants and produced F_1 progeny through cross-fertilisation. What did Mendel observe in the F_1 progeny? [CBSE 2018]

Ans. When Mendel cross fertilized tall pea plants and short pea plants, he observed that all plants in the F_1 progeny were tall.

Related Theory

- *When these F_1 progeny are self crossed, he observed that the F_2 progeny are not all tall. The ratio of tall plants to dwarf plants comes to be approximately*
- *This indicates that both the tallness (T) and shortness (t) traits were inherited in the F_1 plants, but only the tallness trait was expressed.*
- *Above experiment led Mendel to propose that two copies of factor (now called genes) controlling traits are present in sexually reproducing organisms.*
- *Traits like 'T' which are expressed are called dominant traits, while traits like 't' are called recessive traits.*

34. How is the normal number of chromosomes restored in the progeny of sexually reproducing organisms?

Ans. Each cell has two copies of each chromosome, one each from the male and female parents. Each germ cell or gamete takes one chromosome from each pair and when two germ cells combine, the original number of chromosomes is restored in the progeny.

35. Do all variations in a species have equal chances of surviving in the environment in which they find themselves?

Ans. No, all variations in a species do not have equal chances of surviving in the environment in which they find themselves. Depending upon the nature of variations, each individual would have different advantages of survival.

COMPETENCY BASED Questions (CBQs)

[1, 4 & 5 marks]

36. *Lokesh was very fond of dogs. So, one day his friend called him to show a white dog and a black dog which he had recently got from his friend. Lokesh was wondering as to how different dogs have different colours!*

Dogs having black coat colour when crossed with dogs having same colour, produced 200 offsprings. Out of this 150 were black and 50 were white. The genotype of dogs is:

(a) BB and bb (B: Black; b: white)

(b) Bb and bb (B: Black; b: white)

(c) Bb and Bb (B: Black; b: white)

(d) BB and Bb (B: Black; b: white)

Ans. *(a) BB and bb (B: Black; b: white)*

Explanation: As the ratio of black : white dogs = 150 : 50 = 3 : 1, black coat colour is dominant over white. Further, both black and white dogs are homozygous (BB and bb).

37. *A giant 70 million year old fossil of a fish that lived amongst dinosaurs has been discovered in Argentine Patagonia, a team of researchers said on Monday.Argentine paleontologists "found the remains of a predator fish that was more than six meters long," the researchers said in a statement.The discovery was published in the scientific journal Alcheringa: An Australasian Journal of Palaeontology.The fish "swam in the Patagonian seas at the end of the Cretaceous Period, when the temperature there was much more temperate than now," the statement said.*

Mention any two methods of estimating life of a fossil.

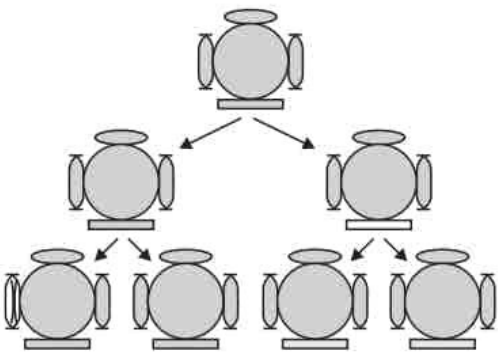
Ans. The two methods of estimating the life of a fossil are:

(1) By digging the earth and start finding fossils. The fossils found closer to the surface are more recent as compared to the fossils found in deeper layers.

(2) By detecting the ratios of different isotopes of a radioactive element in the fossil material, such as Carbon-14.

38. *Inheritance from the previous generation provides both a common basic body design, and subtle changes in it, for the next generation. The original organism at the top will give rise to two individuals, similar in body design, but with subtle differences. Each of them, in turn, will give rise to two individuals in the next generation. Each of the four individuals in the bottom row will be different from each other.*

While some of these differences will be unique, others will be inherited from their respective parents, who were different from each other. Selection of variants by environmental factors forms the basis for evolutionary processes.



(A) 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 population, which trait is likely to have arisen earlier?

(C) Give any one factor that could lead to the rise of a new species?

(D) Which of the processes, sexual reproduction or asexual reproduction, brings about maximum variations in the offsprings?

Ans. (A) Trait B is likely to have arisen earlier because in asexual reproduction traits are carried from parents to offspring with least variations so since trait B has higher percentage it is likely to have arisen earlier.

(C) The factors could lead to the rise of a new species are:

(1) Natural Selection

(2) Method of Genetic Drift

(3) Gene Variation on Mutation

(4) Geographical and environmental factors

Related Theory

Specialtion is the process by which new species form. It occurs when groups in a species become reproductively isolated and diverge.

39. *When Simran visited the hospital maternity ward to see her little brother born just a day before, she was pleasantly surprised to see so many new born babies in the hospital nursery. So, she thought, how many of these are male babies and how many are female?*

The genetic makeup of a male embryo is determined by

(a) The X chromosome in the zygote

(b) The Y chromosome in the zygote

(c) The cytoplasm of the germ cell which determines the sex

(d) Sex is determined by chance

[CBSE 2014, 12]

Explanation: A child who inherits an X chromosome from her father will be a girl and the one who inherits a Y chromosome from him will be a boy. Thus the maleness of a child is determined by the presence of the Y chromosome in the zygote inherited from the father.

40. *In the F2 generation of a cross, progeny having different traits are produced in the ratio 3 : 1.*

(A) State whether it is a monohybrid cross or a dihybrid cross? Give one example of such a cross.

(B) Exchange of genetic material takes place in:

(a) Vegetative reproduction

(b) Asexual reproduction

(ci) Sexual reproduction

(d) Budding

(C) A cross between a tall plant (TT) and short pea plant (tt) resulted in progeny that were all tall plants because:

(a) Tallness is the dominant trait

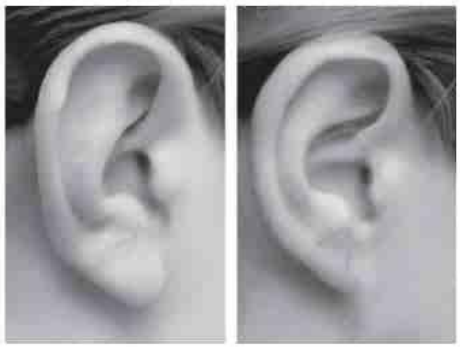
(b) Shortness is the dominant trait

(c) Tallness is the recessive trait

(d) Height of pea plant is not governed by gene 'T' or 't'

Ans. (A) It is a monohybrid cross.
Example: when two hybrids tall Pea plants cross breed with each other they will produce three tall plants and one dwarf plant in F_2 generation.

41. *Observe the ears of all the students in the class. The lowest part of the ear, called the earlobe, is closely attached to the side of the head in some of us, and not in others. Free and attached earlobes are two variants found in human populations.*

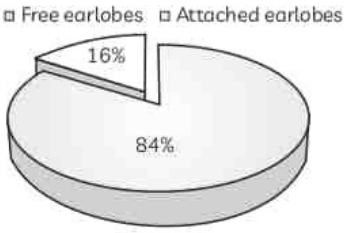


(a) (b)

or attached earlobes and calculate the percentage of students having each. Find out about the earlobes of the parents of each student in the class. Correlate the earlobe type of each student with that of their parents. Based on this evidence, suggest a possible rule for the inheritance of earlobe types.

[NCERT Activity 9.1.]

The percentage of people having free earlobes and attached earlobes is shown below:



(A) Based on the findings in the NCERT activity, it can be concluded that:

(I) The gene responsible for free earlobes in dominant.

(II) The gene responsible for free earlobe may be dominant or recessive.

(III) The gene responsible for attached earlobe may be dominant or recessive.

(IV) The gene responsible for attached earlobe is recessive.

Select the correct statements.

(a) Both (I) and (III)

(b) Both (II) and (III)

(c) Both (I) and (IV)

(d) Both (II) and (IV)

(B) The earlobes of a child whose parents have free earlobes will be:

(a) Free earlobe

(b) Attached earlobe

(c) Can be free or attached earlobe

(d) Neither free nor attached

(C) The shape of the earlobe in an offspring is determined by:

(a) Variation **(b) Chromosome**

(c) DNA **(d) Gene**

Three of them have attached earlobes like their father, and the other three have free earlobes like their mother.

attached earlobes, select the row containing the correct genotype of parents and children from the table below:

	Mrs. Sharma	Mr. Sharma	Children with free earlobes	Children with attached earlobes
(a)	FF	ff	FF	ff
(b)	Ff	ff	Ff	ff
(c)	FF	Ff	FF	Ff
(d)	Ff	Ff	Ff	ff

(E) **A child has attached earlobes.**

Select the most appropriate statement regarding the earlobe of his/her parents.

(a) Earlobes of either parent may be attached or free.

(b) Both parents have attached earlobes.

(c) One parent has attached earlobes

(d) Cannot be determined.

Ans. (B) *(c) Can be free or attached earlobe*

Explanation: Parents with free earlobes can have both a copy of the dominant and recessive allele and they may give birth to a baby with free or attached earlobes.

(D) *(b) Mrs. Sharma: Ff; Mr. Sharma: Ff; Children with free earlobes: Ff; Children with attached earlobes: ff*

Explanation: All of the individuals with attached earlobes must be ff. All of the individuals with free earlobes can be FF or ff. In this particular case, the parent having free earlobe has children who have attached earlobes, so that parent must have a f, and is thus Ff. And all of the children have one parent with attached earlobes, so they must also all have at least one f, and are thus Ff. So the answer is, Mr. Sharma is ff, Mrs. Sharma is Ff. The three children with attached earlobes are ff, and the three with free earlobes are Ff.

42. *Natural selection is the differential survival and reproduction of individuals due to differences in phenotype. It is a key mechanism of evolution, the change in the heritable traits characteristic of a population over generations.*

Charles Darwin popularised the term "natural selection", contrasting it with artificial selection, which in his view is intentional, whereas natural selection is not.

Natural selection can cause microevolution (change in allele frequencies), with fitness-increasing alleles becoming more common in the population. Fitness is a measure of reproductive success (how many offspring an organism leaves in the next generation, relative to others in the group). Natural selection can act on traits determined by alternative alleles of a single gene, or on polygenic traits (traits determined by many genes). Natural selection on traits determined by multiple genes may take the form of stabilizing selection, directional selection, or disruptive selection.

(A) **Which of the following are examples of natural selection?**

(I) In an ecosystem, lizards that had long legs could climb better to avoid floods and reach food.

(II) Insects become resistant to pesticides very quickly, sometime in one generation and if an insect is resistant to the chemical, most of the offspring will also be resistant.

(III) Cultivation of wild cabbage as a food plant, and generation of different vegetables from it

(IV) Dog breeding for various desired characteristics.

(a) Both (I) and (II)

(b) Both (I) and (III)

(c) Both (II) and (IV)

(d) (I), (II) and (III)

organism's:

(a) Environment

(b) Chromosome

(c) Phenotype

(d) Genotype

(C) Imagine a population of brown and white rabbits, whose coat color is determined by dominant brown (B) and recessive white (b) alleles of a single gene. A predator such as a hawk can see white rabbits more easily than brown rabbits against the backdrop of a grassy field.

What is likely to happen? Select the incorrect answer:

(a) Brown rabbits are more likely than white rabbits to survive hawk predation.

(b) The b alleles may disappear from the population after several generations due to selection.

(c) The next generation will probably contain a higher frequency of B alleles.

(d) The next generation will probably contain a higher frequency of b alleles.

(D) Humans have, over more than two thousand years, cultivated wild cabbage as a food plant, and generated different vegetables from it by selection.

Select the row containing incorrect information.

	Desirable Characteristic	Name of Vegetable Evolved from Wild Cabbage
(a)	Short distances between leaves	Cabbage
(b)	For sterile flowers	Kale
(c)	For arrested flower development	Broccoli
(d)	For swollen parts	Kohlrabi

green bugs. The birds prefer the taste of the red bugs, so soon there are many green bugs and few red bugs. The green bugs reproduce and make more green bugs and eventually there are no more red bugs.

The above is an example of:

(a) Natural selection

(b) Genetic drift

(c) Geographical isolation

(d) Speciation

Ans. (C) *(d) The next generation will probably contain a higher frequency of b alleles.*

Explanation: Natural selection can shift allele and phenotype frequencies to make a population better-suited to its environment. If we imagine that half of the white rabbits (but none of the brown rabbits) are eaten by hawks, then the frequency of B allele will increase.

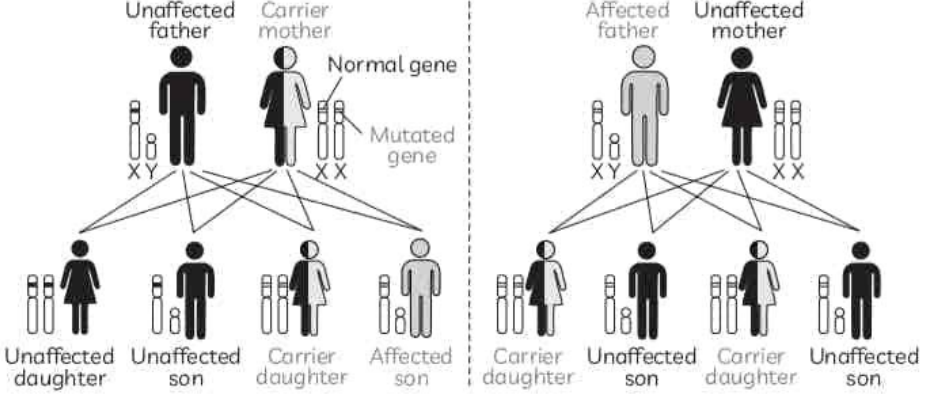
Natural selection acts on phenotypes, not genotypes, as a hawk can tell a brown rabbit from a white rabbit, but it can't tell an BB rabbit from an Bb rabbit.

(D) *(b) Desirable characteristic: For sterile flowers; Name of vegetable evolved from wild cabbage: Kale*

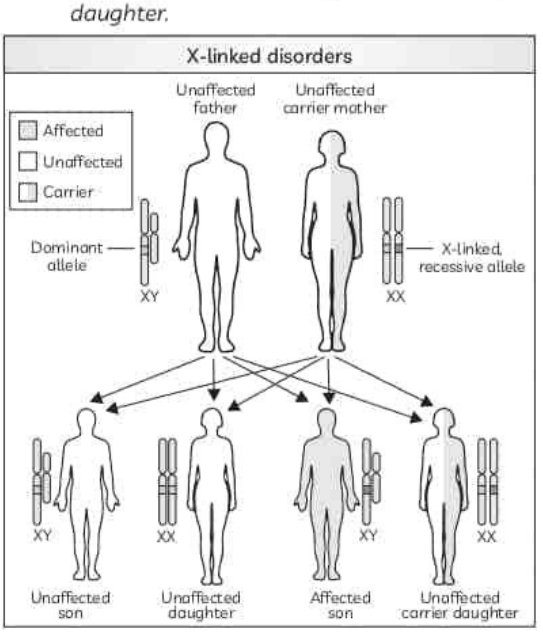
Explanation: For sterile flowers, man of made cauliflower and for leafy vegetable, made kale.

43. *X-linked recessive inheritance is a mode of inheritance in which a mutation in a gene on the X chromosome causes the phenotype to be always expressed in males (who are necessarily homozygous for the gene mutation because they have one X and one Y chromosome) and in females who are homozygous for the gene mutation. Females with one copy of the mutated gene are carriers. X-linked inheritance means that the gene causing the trait or the disorder is located on the X chromosome.*

In humans, inheritance of X-linked recessive traits follows a unique pattern as shown below:



The first is that affected fathers cannot pass x-linked recessive traits to their sons because fathers give Y chromosomes to their sons. Second, x-linked recessive traits are more commonly expressed in males than females. This is due to the fact that males possess only a single X chromosome, and therefore require only one mutated X in order to be affected. The last pattern seen is that x-linked recessive traits tend to skip generations, meaning an affected grandfather will not have an affected son, but could have an affected grandson through his daughter.



(A) In the cross shown above, if the father is unaffected and mother is also unaffected, but mother is a carrier (X-linked recessive allele present), then which of the following statements are correct about their children:

(I) Both sons will be unaffected but will be carriers.

(II) One son will be unaffected and one son will be affected.

(III) Both daughters will be unaffected

(IV) One daughter will be unaffected and one daughter will be affected.

(a) Both (I) and (III)

(b) Both (II) and (III)

(c) Both (I) and (IV)

(d) Both (II) and (IV)

(B) Study the cross shown above and select the row containing incorrect information:

	Mother	Father	Son	Daughter
(a)	Unaffected	Unaffected	All unaffected	All unaffected
(b)	Unaffected	Affected	50 % affected	All carriers
(c)	Carrier	Unaffected	50 % affected	50 % carrier
(d)	Carrier	Affected	50 % affected	50 % affected and 50 % carriers

(C) Sex-linked genetically inherited traits:

(a) can appear in both males and females

(b) are only found in males

(c) are only found in females

(d) appear only in F2 generation

commonly expressed in males than females because:

(a) Females have both X chromosomes which will be mutated at the same time

(b) Males possess a Y chromosome which can be mutated

(c) Males possess only a single X chromosome, and therefore require only one mutated X in order to be affected

(d) Chances of mutation of both X chromosomes in females is very low

(E) Insects also follow an XY sex-determination pattern and like humans, Drosophila males have an XY chromosome pair and females are XX. Eye color in Drosophila was one of the first X-linked traits to be identified. In fruit flies, the wild-type eye color is red (XW) and is dominant to white eye color (Xw).

In a cross between a white-eyed female fruit fly and red-eyed male, what percent of the female offspring will have white eyes? (White eyes are X-linked, recessive)

(a) 100 % **(b) 50 %**

(c) 25 % **(d) 0 %**

Ans. (A) *(b) Both (II) and (III)*

Explanation: Females have two X chromosomes while males have one X and one Y chromosome. Carrier females who have only one copy of the mutation do not usually express the phenotype. So, the son who receives the X chromosome containing the dominant allele will be unaffected whereas the son who receives X chromosome containing the recessive allele will be affected. Both daughters will be unaffected, but the daughter who receives the recessive allele from her mother will be carrier.

This means that males affected by an x-linked recessive disorder inherited the responsible X chromosome from their mothers.

Women possess two X chromosomes, and thus must receive two of the mutated recessive X chromosomes (one from each this pattern of inheritance is that of the descendants of Queen Victoria and the blood disease hemophilia.

(E) *(d) 0 %*

Explanation: The genotype of a white-eyed female fruit fly will be X^wX^w and of red eyed male will be X^WY. When we cross them, the genotype of offsprings will be:

X^wX^W (Red eyed female), X^wY (White eyed male), X^wX^W (Red eyed female) and X^wY (white eyed male).

All of the females are thus red-eyed and heterozygous. All of the males are white-eyed and hemizygous.

44. *In mice, black coat colour (B) is dominant over brown coat colour (b), and a solid pattern (S) is dominant over white spotted (s). Colour and spotting are controlled by genes that assort independently. A homozygous (both alleles identical) black, spotted mouse is crossed with a homozygous brown, solid mouse.*

(A) The genotypes of the parents is:

(a) Bbss and bbSS

(b) BBss and bbSs

(c) BbSs and BbSs

(d) BBss and bbSS

(B) Select the incorrect statements regarding the F1 progeny obtained:

(I) Phenotype of all mice of F1 generation is brown coat with solid pattern.

(II) Phenotype of all mice of F1 generation is black coat with solid pattern.

(III) Genotype of all mice of F1 generation is BbSs.

(IV) Genotype of all mice of F1 generation is BBSs.

(a) Both (I) and (III)

(b) Both (II) and (III)

(c) Both (II) and (IV)

(d) Both (I) and (IV)

(C) The table below shows the phenotypic ratio of F2 generation when mice of F1 generation are crossed with each other.

Select the row containing correct information:

	solid pattern	spotted pattern	spotted pattern	solid pattern
(a)	9	1	3	3
(b)	9	3	1	3
(c)	3	1	9	3
(d)	9	3	3	1

(D) **From the cross mentioned in (B) above, it can be concluded that:**

(a) **The phenotype of progeny is independent of inherited genes.**

(b) **The black/brown colour of coat and solid/spotted pattern are inherited independently.**

(c) **The genotype of progeny does not decide the phenotype.**

(d) **The phenotype and genotype of progeny are independently inherited.**

(E) **Suppose a test cross is carried out by mating F1 mice with brown, spotted mice. The percentage of progeny having black coat with solid pattern will be;**

(a) 75 % (b) 50 %

(c) 25 % (d) 0 %

Ans. (B) *(d) Both (I) and (IV)*

Explanation: Genotype of homozygous black, spotted mouse is BBss and of homozygous brown, solid mouse is bbSS.

When these are crossed, all F1 progeny will be black coat with solid pattern (BbSs) as gametes of homozygous black, spotted mouse will be Bs and of homozygous brown, solid mouse is bS.

(D) *(b) The black/brown colour of coat and solid/spotted pattern are inherited independently.*

Explanation: The genes responsible for colour (black or brown) and spotting (solid pattern or spotted) are assorted independently.

45. *Remember the Hindi film Ghajini where Aamir Khan had sported a new hair style? It became a rage and later, several boys started to experiment with their hair style in unique ways.*

From the list given below, select the character which can be acquired but not inherited:

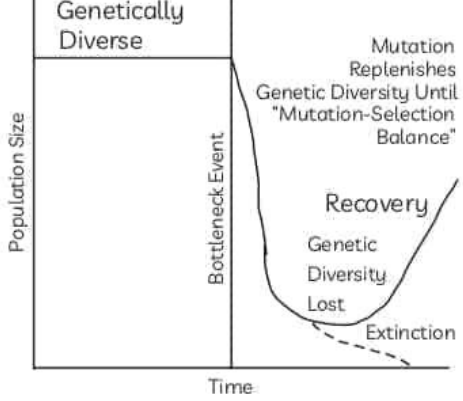
[NCERT Exemplar]

(a) **Colour of eyes** (b) **Colour of skin**

(c) **Size of body** (d) **Nature of hair**

46. *A big challenge with species conservation is trying to limit and reduce the negative genetic effects of small or isolated populations. Founder's effect or bottleneck effect can lead to small populations which are highly susceptible to genetic drift. This means there is a serious reduction in genetic variation within the population, making that population less able to adapt to new selective pressures ("Bottleneck and founder effects"). Even if the species' numbers were to rebound, the new generations would only carry the limited set of alleles passed down by the small population.*

A population bottleneck is an event that drastically reduces the size of a population. The bottleneck may be caused by various events, such as an environmental disaster, the hunting of a species to the point of extinction, or habitat destruction that results in the deaths of organisms. The population bottleneck produces a decrease in the gene pool of the population because many alleles, or gene variants, that were present in the original population are lost. Due to the event, the remaining population has a very low level of genetic diversity, which means that the population as a whole has few genetic characteristics.



(A) Select the correct statements:

(I) A population bottleneck decreases genetic variation in a species or subspecies.

(II) Gene flow increases genetic diversity by introducing new alleles into the population.

(III) Mutation decreases genetic diversity in a population.

(IV) Species can become extinct if genetic diversity recovers after bottleneck.

(a) Both (I) and (II)

(b) Both (I) and (III)

(c) Both (II) and (III)

(d) (I), (II) and (IV)

(B) Which of the following statements is true?

(a) Gene pool frequencies do not change as a result of migrations in or out of a population.

(b) Gene flow occurs only as a result of migrations.

(c) Gene flow can cause new alleles to enter a population's gene pool.

(d) Gene flow is possible only in aquatic ecosystem.

(C) Which of the following is not true of genetic drift?

(a) It can lead to alleles being fixed in a

(b) It results from the random transmission of alleles from parents to offspring in a population

(c) It can lead to loss of alleles from a population

(d) It can increase the genetic diversity of a population

(D) In a population where the allele frequency shifts by random chance, the mechanism of evolution at work is:

(a) mutation

(b) genetic drift

(c) natural selection

(d) migration

(E) Mutation may be described as:

(a) Continuous genetic variation

(b) Phenotypic change

(c) Discontinuous genetic variation

(d) Change due to hybridization

Ans. (B) *(c) Gene flow can cause new alleles to enter a population's gene pool.*

Explanation: Since gene flow alters the recipient population`s gene pool, it causes evolution independent of any other evolutionary mechanism.

(D) *(b) genetic drift*

Explanation: Genetic drift occurs as a result of chance events causing changes in the allele frequency of a population. It doesn't favor the most fit individuals, but occurs at random.

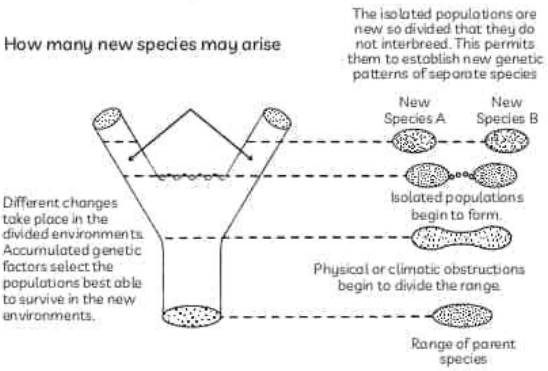
47. *When a friend showed Uma two photographs and asked her to identify the relation between the persons shown in the photograph, she immediately replied that the photographs are of identical twins as they had identical features. But to her surprise, the photograph was of a father when he was a kid and of his daughter. The similarity in their features was remarkable!*

How can we say that DNA controls a character expression in an organism?

Ans. Cellular DNA is the information source for making proteins in the cell. As genes are responsible for controlling various processes in an organism and are made up of DNA, we can say that DNA is the carrier of basic genetic information in organisms.

48. *Speciation, the formation of new and distinct species in the course of evolution. Speciation involves the splitting of a single evolutionary lineage into two or more genetically independent lineages. Speciation occurs when a group within a species separates from other members of its species and develops its own unique characteristics. The demands of a different environment or the characteristics of the members of the new group will differentiate the new species from their ancestors.*

There are many hypotheses about how speciation starts, and they differ mainly in the role of geographic isolation and the origin of reproductive isolation (the prevention of two populations or more from interbreeding with one another).



Speciation is possible in isolated populations of the parent species because:

(a) There will be accumulation of different changes in each sub-population due to genetic drift.

(b) Natural selection may operate differently in these different geographic locations.

(c) Isolated populations are no longer able to interbreed.

(d) Increased gene flow

(B) Two separate squirrel species inhabit the north and south rims of the canyon when Arizona's Grand Canyon formed. This is an example of:

(a) Genetic Drift

(b) Geographical isolation

(c) Natural selection

(d) Variation

(C) New species may be formed if

(I) DNA undergoes significant change in germ cells

(II) Chromosome number changes in the gamete

(III) There is no change in the genetic material

(IV) Mating is no longer possible

(a) Both (I) and (III)

(b) Both (II) and (IV)

(c) (I), (II) and (III)

(d) (I), (II) and (IV)

(D) Wild cabbage has evolved into new varieties like cabbage, broccoli and cauliflower by

(a) genetic drift

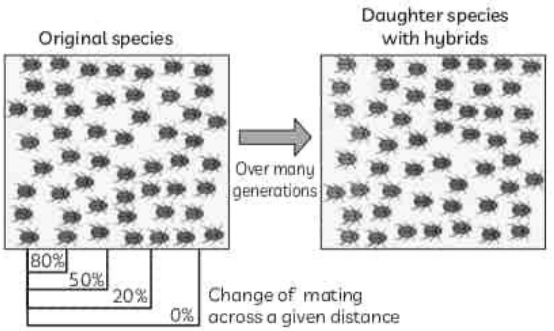
(b) natural selection

(c) reproductive isolation

(d) artificial selection

(E) Imagine a situation in which a population extends over a broad geographic range, and mating throughout the population is not

would have zero chance of mating with individuals in the far eastern end of the range.



Which of the following can lead to the formation of a new species in such a situation?

Select the most appropriate answer in the given context.

(a) Geographical isolation

(b) Reduced gene flow

(c) Increased gene flow

(d) Genetic drift

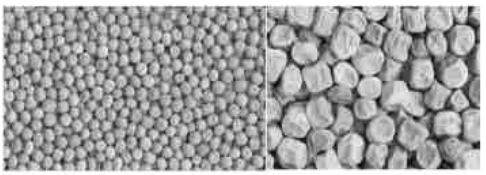
Ans. (A) *(d) Increased gene flow*

Explanation: Speciation is possible when the parent species is subdivided into sub populations. Each sub population has different gene pool and accumulation of different changes due to genetic drift. Moreover, different variations may be selected in the sub populations by environmental factors. Eventually the organisms belonging to the sub populations may no longer be able to inter breed. However, if gene flow decreases, then the groups will evolve along separate paths.

(C) *(d) (I), (II) and (IV)*

Explanation: New species may be formed due to significant change in DNA such that the organisms are no longer able to inter breed. Then, a new species is said to have been formed.

49. *When Priyanka went to the market to buy some pulses, she was quite surprised when the shopkeeper mentioned the different varieties well as yellow and wrinkled and also yellow and round varieties!*



Round and green seeds of pea plant were crossed with wrinkled and yellow seeds. Progeny of F1 generation were all having round and green seeds. These F1 progeny were used to generate F2 progeny. Select the row containing incorrect observation or remarks:

	Observation	Remarks
(a)	Genotype of parents of F1 progeny was RRyy (Round, green) and rrYY (Wrinkled, yellow)	Roundness and yellow were dominant as all F1 progeny had round and yellow seeds
(b)	Genotype of 50 % F1 progeny was RRYY and RrYy for the remaining 50% F1 progeny.	As all F1 progeny had round/yellow seeds, roundness and yellow were dominant.
(c)	Some F2 progeny showed new combinations	The round seed/ wrinkled seed trait and yellow/ green trait are independently inherited.
(d)	Phenotype ratio of F2 progeny was 9:3:3:1	9 (round/yellow)
		3 (round green)
		3 (wrinkled yellow)
		1 (wrinkled green)

Ans. *(b) Observation: Genotype of 50% F1 progeny was RRYY and RrYy for the remaining 50% F1 progeny; Remarks: As all F1 progeny had round/yellow seeds, roundness and yellow were dominant.*

[2 marks]

50. In a study it was found that fused ear lobes were found in more numbers within a population rather than free ear lobes. What can you infer from the above observation with respect to dominant/recessive trait?

Ans. It can be inferred from the observation that fused ear lobes were found in more numbers within a population that fused ear lobes is a dominant trait whereas free ear lobes is a recessive trait.

51. 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.

52. If a pure tall pea plant is crossed with a pure dwarf pea plant, then in F_1 generation only tall plants appear. What happens to the traits of the dwarf plant?

Ans. Although in F_1 generation only the tall plants appear, both the tallness and dwarfness traits are inherited in the F_1 plants but as the tallness trait is dominant, it is expressed, whereas, dwarfness trait being recessive is not expressed. It is expressed in F_2 generation.

53. Why do all the gametes formed in human females have an X chromosome? [NCERT]

Ans. Women have a perfect pair of sex chromosomes, both called X. Women are XX, while men are XY. All children will inherit an X chromosome from their mother regardless of whether they are boys or girls. Thus, the sex of the children will be determined by what they inherit from their father. A child who inherits an X chromosome from her father will be a girl. During meiosis, one X chromosome enters each gamete. Hence, all the gametes formed in human females have an X chromosome.

54. (A) Why did Mendel carry out an experiment to study inheritance of two traits in garden-pea?

(B) What were his findings with respect to inheritance of traits in F_1 and F_2 generation?

(C) State the ratio obtained in the F_2 generation in the above mentioned experiment. [CBSE 2020]

55. Does the occurrence of diversity of animals on Earth suggest their diverse ancestry also? Discuss this point in the light of evolution. [NCERT Exemplar]

56. In a pea plant, the trait of flowers bearing purple colour (PP) is dominant over white colour (pp). Explain the inheritance pattern of F_1 and F_2 generations with the help of a cross following the rules of inheritance of traits. State the visible characters of F_1 and F_2 progenies.

57. Give the pair of contrasting traits of the following characters in pea plant and mention which is dominant and recessive:

(A) Yellow seed

(B) Round seed [CBSE 2012]

Character	Contrasting traits	
	Dominant	Recessive
Seed Colour	Yellow	Green
Seed Shape	Round	Wrinkled

58. Mention three important features of fossils which help in the study of evolution. [CBSE 2017, 15, 13, 12, 11, NCERT Exemplar]

Ans. Fossils help in the study of evolution in the following ways:

(1) Fossils are the preserved remains or traces of animals, plants, and other organisms from the past, thus representing the modes of preservation of ancient species.

(2) Fossils are important evidence for evolution because they show that life on earth was once different from life found on earth today. Fossils help in establishing evolutionary traits among organisms and their ancestors. For example, the discovery of Archaeopteryx fossil showing characters of both reptiles and birds provided a clue that birds have evolved from reptiles.

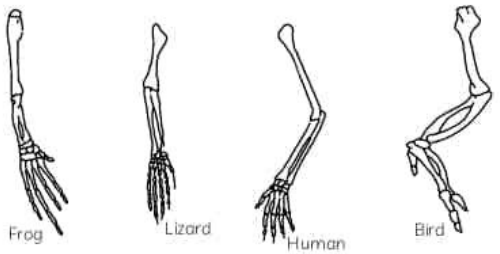
(3) Fossils help in establishing the time period in which organisms lived. Scientists determine the age of fossils that are discovered by studying other clues found in the same soil layers where they found the fossils.

faces a greater threat of extinction than a larger population. Provide a suitable genetic explanation.

60. What are homologous structures? Give an example. Is it necessary that homologous structures always have a common ancestor. Justify your answer. [CBSE 2020]

Ans. Homologous structures which are also known as homologous organs are one of important sources which provide evidence for evolution. The organs which have the same basic structure or same basic design, same development but different functions are called homologous organs/ homodogous structures.

For example, the forelimbs of men, birds, Eptiles, amphibians seem to be built from the same basic design of bones but they perform different functions.



The forelimbs of men (humans) are used for grasping, the forelimbs of birds are used for flying, lizards for crawling and frogs for jumping.

It is necessary that homologous structures always have a common ancestor the basic similarity in forelimbs of these vertebrates indicates that all these vertebrates had common ancestor i.e. evolved from a common ancestor who are made of similar type of bones—radius, ultra, carpets, metacarpets and humerus and are pentadactyle.

Related Theory

- *Later on in subsequent generations the pentadoctyle limbs of vertebrates get modified according to the needs of the subsequent generations. The modifications in the limbs include :*
- *reduction in number of digits.*
- *fusion of certain bones*
- *external form*
- *Both Tendril of Passiflora and thorn of Bongain-viller are modified branches but have different functions. It means plants also have homologous organs*

cannot be equated with progress." Justify this statement.

62. "During the course of evolution, organs or features may be adapted for new functions." Explain this fact by choosing an appropriate example. [CBSE 2020]

63. A green stemmed rose plant denoted by GG and brown stemmed rose plant denoted by gg are allowed to undergo a cross with each other:

(A) List your observations regarding

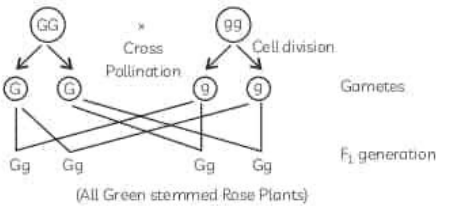
(i) Colour os stem in their F_1 progeny

(ii) percentage of brown stemmed plants in F_2 progeny if F_1 plants are self pollinated.

(iii) Ratio of GG and Gg in the F_2 progeny.

(B) Based on the findings of this cross, what conclusion can be drawn? [CBSE 2020]

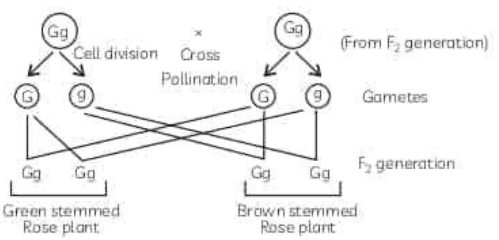
Ans. (A) A green stemmed rose plant denoted by GG and a brown stemmed rose plant denoted by gg are allowed to undergo a cross with each other.



(i) The sterms of all the rose plant in their F_1 progeny was found to be green.

Explanation: When a single pair of contrasting characteristics homozygous green stemmed and homozygous brown stemmed plants are crossed. Only dominat character was expressed and recessive did not. The phenomenon of appearance of only one of the two contrasting traits in F_1 generation is termed as dominance.

(ii) F_1 plants are self pollinated to produce the F_2 generation.



Green stemmed Rose plant Brown stemmed Rose plant

stemmed plants is 25%.

When F_1 offsprings were allowed to self pollinate, both the parental traits were expressed in definite proportion in F2 generation.

(iii) In F_2 generation, 1 plant having genotype GG, 2 plants having genotype 2 Gg and 1 plant having type gg were produced. So the genetypic ratio was

GG : Gg : gg

1 : 2 : 1

Ratio of GG and Gg in F_2 progency is 1 : 2.

(B) Based on the findings of above cross, we can conclude:

(1) It is a monoly brid cross between green stemmed rose plant and brown stemmed rose plant.

(2) There are always a pair of factors (GG or gg) which control the character, one inherited from each parent.

(3) Only one character is expressed and that is called dominant character, and it follows law of dominance.

(4) The characters are not lost even when they are not expressed.

(5) They are expressed in definite proportion in F_2 generation and is follows law of segregation.

64. (A) Classify the following as homologous or analogous pairs:

(i) Broccoli and Cabbage

(ii) Ginger and Raddish

(iv) Wings of a bat and Wings of a bird

(B) State the main feature that categories a given pair of organs as homologous or analogous. [CBSE 2020]

65. What is the phenotypic ratio obtained in Mendels dihybrid cross? [Diksha]

66. Mention the function of cellular DNA. Taking tallness as a characteristic for a plant, explain how proteins control the characteristic. [Diksha]

67. A group of grass hoppers - some green and some brown-lived in grassland having dry bushes and dry grass.

(A) Which one would normally be picked up by predatory birds and why?

(B) Population of which grasshopper will increase?

(C) Name this phenomenon. [Diksha]

Ans. (A) Green grasshoppers would be normally picked up by predatory birds because they can be easily seen in dry bushes and grasses as compared to brown grasshoppers.

(B) As brown grasshoppers would be eaten less, their population will increase.

(C) This phenomenon is called 'Natural Selection'. It is based on the 'Theory of Evolution' proposed by Charles Darwin.

68. Evolution has exhibited a greater stability of molecular structure when compared with morphological structures. Comment on the statement and justify your opinion.] [CBSE 2020, NCERT Exemplar]

SHORT ANSWER Type-II Questions (SA-II)

[3 marks]

69. Out of potato, sweet potato, pea tendril and spinach, which two are analogous structures and why? [CBSE 2016]

Ans. Out of potato, sweet potato, pea tendril and spinach, potato and sweet potato are analogous species.

Because they perform similar function but have different origins. Potato is a modified stem meant for storage of food. Sweet potato is a modified root also meant for storage of food. Therefore, potato and sweet potato are analogous structure of plant.

Related Theory

➥ *Analogous structures are those who have similar functions but are different in their structure and origin. Analogous structures indicate different ancestry.*

identical at times. Give reason. **[Diksha]**

Ans. The replication of DNA in the cell is done by biochemical reactions. No biochemical reaction can reproduce exactly the same result. So, when the DNA present in the nucleus of the parent cell undergoes replication, then slight variations occur in the two DNA copies formed. Due to this, the two DNA molecules formed will be similar but may not be exactly identical to the parent DNA.

These variations in the replication of DNA molecule will also lead to slight variations in the offspring produced by asexual reproduction.

71. **Bacteria have a simpler body plan when compared with human beings. Does it mean that human beings are more evolved than bacteria? Provide a suitable explanation.** **[NCERT]**

72. **(A) What is the law of dominance of traits? Explain with an example.**

(B) Why are the traits acquired during the life time of an individual not inherited? Explain. **[CBSE 2020]**

73. **Name the plant Mendel used for his experiment. What type of progeny was obtained by Mendel in F_1 and F_2 generations when he crossed the tall and short plant? Write the ratio he obtained in F_2 generation plants.** **[CBSE 2019]**

Ans. Name of plant used by Mendel for his experiments was: Garden Pea (Pisum sativum)

When Mendel crossed pure Tall plant having genotype 'TT' with pure dwarf plant having genotype 'tt', progeny obtained in F1 generation were all Tall.

Mendel then crossed the tall pea plants of the first generation and found that 75 % or three quarter of the F2 progeny were tall and 25 % or one quarter of them were short.

Ratio obtained in F2 generation:

Tall : Short = 3 : 1

Genotype:

TT : Tt : tt = 1 : 2: 1

74. **Differentiate between inherited and acquired traits by giving one example of each. Give reason why the traits acquired during the life time of an individual are not inherited?** **[CBSE 2019, 18, 17]**

75. **List two differences in tabular form between dominant trait and recessive traits. What percentage/proportion of the plants in the F_2 generation/progeny were round, in Mendel's cross between round and wrinkled pea plants?** **[CBSE 2016]**

76. **Does geographical isolation of individuals of a species lead to the formation of a new species? Provide a suitable explanation.** **[NCERT Exemplar]**

Ans. Yes, geographical isolation of individuals of a species leads to speciation. Splitting of existing species into two new species, followed by their geographical isolation brings about reproductive isolation. Populations of a species get separated into two groups by the accumulation of genetic variations in them. These newly formed groups are then isolated by any geographical barrier, such as sea, mountain, etc.

Geographical isolation leads to a genetic drift which limits sexual reproduction of the separated population. Gradually these separated individuals will reproduce among themselves generating new variations. This may lead to the formation of a new species.

77. **Bacteria have a simpler body plan when compared with human beings. Does it mean that human beings are more evolved than bacteria? Provide a suitable explanation.** **[NCERT Exemplar]**

LONG ANSWER Type Questions (LA)

[5 marks]

78. **All the human races like Africans, Asians, Europeans, Americans and others might have evolved from a common ancestor. Provide a few evidences in support of this view.** **[NCERT Exemplar]**

Ans. All human beings have evolved from a common ancestor as they have the maximum number of common characters. Moreover, all human beings can interbreed with each other, which shows that all of them belong to the same species. Some of the common characters of all human beings are:

and metabolism.

(2) All of them have a constant chromosome number *i.e.*, 46.

(3) Their genetic makeup is also similar *i.e.*, almost 99.9% DNA is nearly the same in all humans.

(4) All the humans; can freely inter-breed to produce offspring.

All these evidences clearly indicate that all of us, whether Africans, Asians, Europeans, Americans, etc., have evolved from a common ancestor.

79. Differentiate between inherited and acquired characters. Give one example for each type.

[CBSE 2020, 19, 14, 13, NCERT Exemplar]

80. Evolution has exhibited a greater stability of molecular structure when compared with morphological structures. Comment on the statement and justify your opinion.

[CBSE 2020, NCERT Exemplar]

81. What is meant by speciation? List four factors that could lead to speciation. Which of these cannot be a major factor in the speciation of a self-pollinating plant species. Give reason to justify your answer.

[CBSE 2016]

82. State which of the following are homologous and which are analogous :

(A) Wings of bird and an insect

(B) Forelimbs of frog, a reptile, a bird, and a human.

(C) Flippers of whale and fins of fish.

Give reason for your answer.

[CBSE 2016]

83. (A) What are fossils? How are fossils formed? Describe in brief, two methods of determining the age of fossils.

(B) List any two roles of fossils in tracing evolutionary relationships. [CBSE 2016]

84. Explain with the help of an example each, how the following provide evidences in favour of evolution:

(A) Homologous organs

(B) Analogous organs

(C) Fossils [CBSE 2017]

of a bat be regarded as homologous? Give reason in support of your answer.

[CBSE 2017]

Ans. No, the wings of a butterfly and wings of a bat are not homologous organs. They are analogous organs as they are all used for flying but the wings have different structures. Butterfly wings are covered in scales whereas Bat wings consist of flaps of skin stretched between the bones of the fingers and arm.

86. Define evolution. How does it occur? Explain how fossils provide evidences in support of evolution. [CBSE 2017]

Ans. Evolution is defined as the process of gradual changes which takes place in organisms over millions of years due to change in frequency of an inherited trait over generations.

Evolution takes place through occurrence and subsequent accumulation of variations in the offsprings during sexual reproduction. Sub-populations are formed due to genetic drift and geographical isolation. When natural selection acts on them, most suitable variation survives leading to evolution of a new species.

Fossils are the naturally preserved remains or traces of animals or plants that lived in the geologic past.

Fossils show the evolution of complex life forms from simple ones over millions of years by providing evidence that organisms from the past are not the same as those found today.

An example of Fossil is the bird Archaeopteryx which has many characteristics of reptiles and seems to be evolved from reptiles.

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

[CBSE 2017]

88. Birds and bats are more closely related to each other than to squirrels or lizards. Comment.

89. With the help of Mendel's experiments show that:

(A) traits may be dominant or recessive, and

(B) traits are inherited independently.

[CBSE 2019, 17]

90. Gregor Johon Mendel was the first to give scientific explanation for the mechanism of transmission of characters from parents to the oppsprings. He is called the Father of

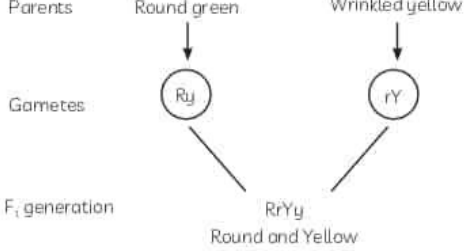
(cross breeding) experiments on Garden pea Pisum in the garden of a monastry in Austria, continuously for eight years. He studied the inheritance of one character at a time and introduced the concept that each character is controlled by a factor. Mendel made a cross between pure breeding pea plants one with round and green seeds and the other with wrinkled and yellow seeds.

Answer the following questions on the basis of your understanding about mendel's laws:

(A) Write the phenotype of F_1 progeny. Give reason for your answer.

(B) Write the different types of F_2 progeny obtained along with their ratio when F_1 progeny was selfed.

Ans. In the given cross, two traits were taken into account, which is a dihybrid cross. The round shape and yellow colour of seed is dominant over the wrinkled shape and green colour of seed in pea plant as observed by Mendel. Suppose R and Y denote dominant trait and r and y denote recessive trait. Genotype of the parent plant with round and green seeds – RRyy.



Genotype of the parent plant with wrinkled and yellow seeds – rrYY Therefore, the cross involved in the given question is

The above cross shows round and yellow seeds in the F_1 generation. It occurs because dominant traits (round and yellow) express itself, whereas recessive traits (wrinkled and green) get suppressed.

(B) On selfing of F_1 generation:

Phenotypic ratio 9:3:3:1

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

	RrYy	RrYy
Gametes	RY, rY,	RY, rY,
	Ry, ry	Ry, ry

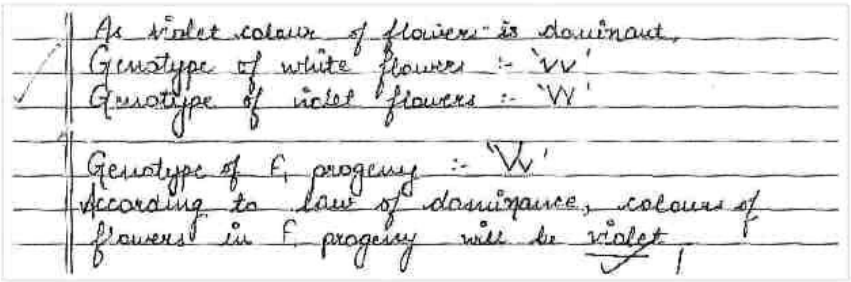
F_2	RY	rY	Ry	ry
RY	RRYY Round yellow	RrYY Round yellow	RRYy Round yellow	RrYy Round yellow
rY	RrYY Round yellow	rrYY Wrinkled yellow	RrYy Round yellow	rrYy Wrinkled yellow
Ry	RRYy Round yellow	RrYy Round yellow	RRyy Round green	Rryy Round green
ry	RrYy Round yellow	rrYy Wrinkled yellow	Rryy Round green	rryy Wrinkled green

VERY SHORT ANSWER Type Questions

[1 mark]

1. A Mendelian experiment consisted of breeding pea plants bearing violet flowers with pea plants bearing white flowers. What will be the result in F_1 progeny?

Ans.



[CBSE Topper 2018]

2. What is a gene ?

Ans. A gene is the functional unit of DNA, with a specific biological function. One gene is responsible for the synthesis of one protein.

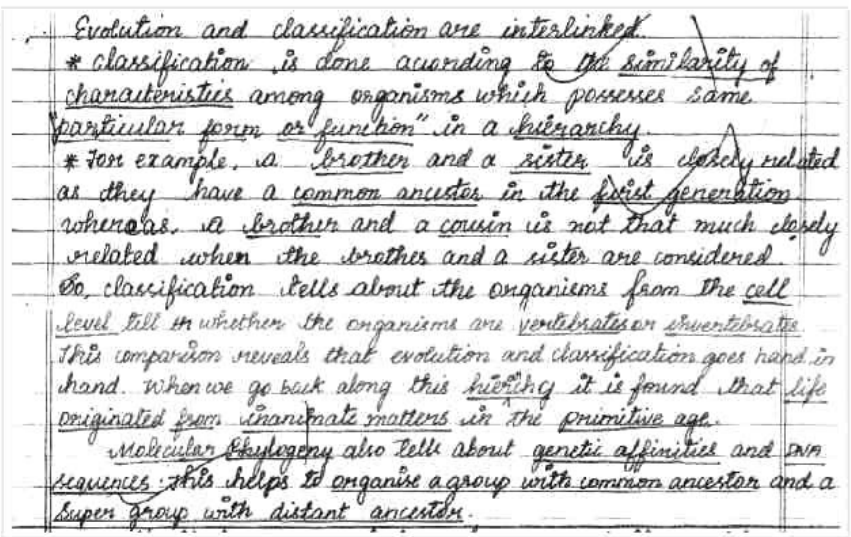
[CBSE Topper 2014]

SHORT ANSWER Type-II Questions (SA-II)

[3 marks]

3. "Two areas of study namely 'evolution' and 'classification' are interlinked". Justify this statement.

Ans.



[CBSE Topper 2016]

example.

Ans. ① Populations of organisms live in well defined places or niches.
② They are native to that area. ~~The rare~~
③ Reproduction involves DNA replication which can generate errors that is the main source of variations
④ This Consistency of DNA is responsible for maintainence of body design.

⑤ Suppose the temperature in that region increases or decreases, water level changes or there is a meteorite hit, the population may get wiped out.
⑥ But if there are some organisms that can tolerate the heat, they would survive.

⑦ They would further reproduce and survive in nature.
⑧ For e.g. Bacterias are one of the oldest surviving organisms.
Due to variations in their body designs, they ~~op~~ adapt most of the inhospitable climates like deserts, ice etc.

[CBSE Topper 2019]

5. **What is speciation ? List four factors that could lead to speciation. Which of these cannot be a major factor in the speciation of a self-pollinating plant species ? Explain.**

Ans. Fossils are preserved traces of living organisms Eg. If a dead insect gets trapped in hot mud, it doesn't decompose easily. Eventually the mud will harden and retain the impressions of the body parts of the insect. Thus, the insect is fossilised into rocks.
Excavating This is a relative method. As we dig into the soil, the fossils we find closer to the surface are more recent than the fossils we ~~fo~~ find in the deeper layers.
Radio-Carbon Dating - The ratio of different isotopes of the same element present in the fossil can tell us how old the fossil is.

Fossils give the palentological evidence for evolution. For eg: Dinosaur fossils reveal that they had feathers millions of years ago, to protect them from cold. These feathers have now been adapted by birds for flight. This suggests that dinosaurs & birds were closely related. Fossils thus help us in tracing evolutionary relationships and origins.

[CBSE Topper 2015]

LONG ANSWER Type Questions (LA)

[5 marks]

6. Define evolution. How does it occur? Describe how fossils provide us evidences in support of evolution.

Ans.

Evolution the process of change from simple life forms to complex life forms by gradual change. It is generating diversity and shaping the diversity.

* It occurs over the course of time and generations by variation, Speciation, Natural Selection, Genetic drift etc.
* Fossils are the preserved traces of living organisms.
* It helps us to find the intermediate forms inbetween two classes etc. For example fossil of Archeopteryx helps us to know better about the intermediate form between reptiles and Aves.
* It it tells us about the extinct specips through the fossil or their retained body impressions.
* It helps to know the evolutionary relationships.
* This also shows the line of development from primitive to complex organisms. eg: Ammonite, trilobite, Rajasaurus etc. according to the depth of the layer in which it is found.

[CBSE Topper 2016]

7. With the help of one example for each, distinguish between the acquired traits and the inherited traits. Why are the traits/experiences acquired during the entire lifetime of an individual not inherited in the next generation? Explain the reason of this fact with an example.

Ans.

ACQUIRED TRAITS	INHERITED TRAITS
1) These traits are acquired by a person during his lifetime.	1) These traits are inherited by the individual from his/her parents.
2) They donot pass to next generations.	2) They pass to next generations.
3) They donot direct evolution.	3) They direct evolution.
4) eg ↦ Body weight, knowledge.	4) eg ↦ eye colour, skin colour, height etc.

The traits which are acquired by individual during his lifetime can't be passed to future generations as they donot bring any change in the DNA of germ cells. Any change in non-reproductive tissue cannot lead to change in DNA of germ cells. for eg ↦ there were red beetles living in green bushes and the bushes were hit by plant disease. This caused reduction in the available food to red beetles and made them poorly nourished. But if the bushes will become free from any plant disease, the new generation will be healthy & of normal weight as low weight donot causes any change in the DNA of germ cells of red beetles.

[CBSE Topper 2017]

example for each.

(i) Homologous organs (ii) Analogous organs (iii) Fossils

(b) Explain two methods to determine the age of fossils.

Ans.

I Homologous organs

1. They are the organs that are similar in structure but have been modified to perform different functions

2. a) For eg.

forelimbs of humans, frog and lizard have similar structure Frog uses it to hop and as a shock absorber, humans use it to write, hold etc and lizards use it to creep on walls.

They explain that maybe the reptiles, mammals and amphibians had common ancestors and evolved to be in the present form.

Analogous Organs

① They have different structures and appearance but perform similar function.

② For eg. wings of a bat and a bird have different structure, but perform function of flying. [bat - thin flap like membrane wings; birds have feathers and wings all over body.]

③ They do not have common ancestory but trace evolution due to which they became capable of flying.

(iii) Fossils

① They are the remains of plants and animals found under earth that lived in remote past.

② They tell us about the evolutionary relationships in the past

③ For eg. Archaeopteryx has cranium and wings similar to birds but claws and beak similar to reptiles

④ This also shows relation between reptiles and aves as maybe aves evoluting from reptiles

(b) Fossils can be determined by

(i) Carbon-14 Dating

① All organisms have some percentage of carbon which decrease as we die

② The percentage of fossil is compared with the present percentage in living organisms to determine their age.

(ii) Relative method

① The earth is dug, the fossils found closer to earth are recent whereas the ones found in deeper layers are the older ones.

For eg. Dinosaurs are found in deeper layers.

[CBSE Topper 2019]