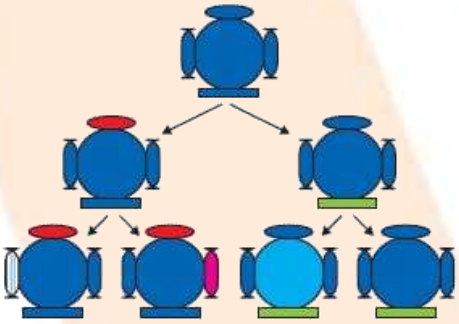
NCERT Solution for Class 10

Biology

Chapter 9 -Heredity and Evolution

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?

Ans: Asexual reproduction requires the involvement of a single parent and does not involve the fusion of haploid gametes. In this, the offspring produced are identical to the parents i.e., they are a nearly exact copy of their parents DNA. However, sometimes, copying of DNA is similar but not identical to the original which leads to change in variations. Hence, the newly formed DNA has some variations giving rise to a new trait. Thus, future generations inherit this trait and successive generations keep accumulating variations. Thus, if 10% of the population exists in trait A and 60% of the same population exists in trait B, it can be concluded that trait B has arisen earlier because the trait continued to replicate and exist in a higher percentage of the population.

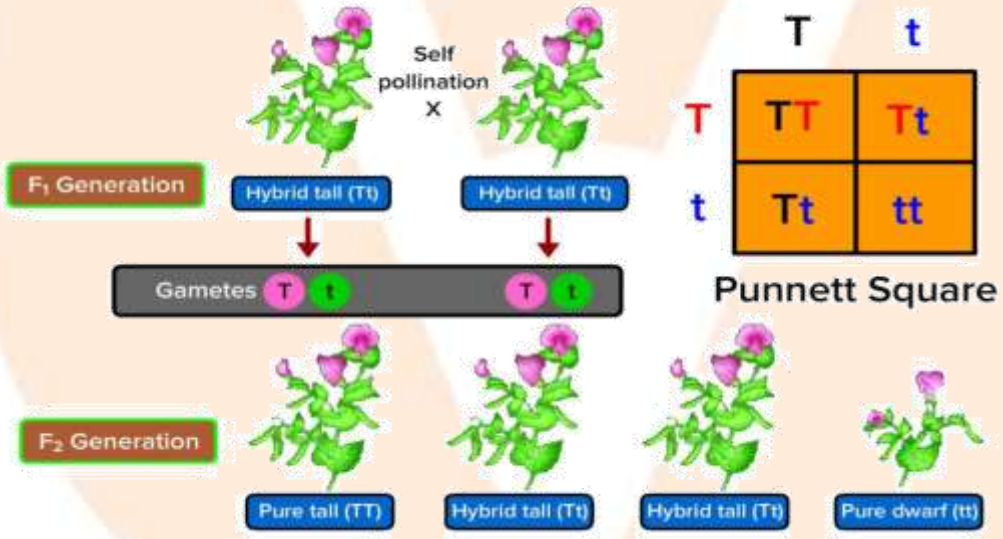


2. How does the creation of variations in a species promote survival?

Ans: In any circumstances, species get adapted to survive in a particular habitat. Sometimes, the habitat gets disturbed due to drastic changes in the environment and proves fatal for certain species. For example, many microorganisms inhabit freshwater ponds. The bacteria living in freshwater will get killed if there is a sudden temperature rise. it. However, some of the species will be able to survive in the heat of those who are resistant to it. These species will survive and reproduce within the changing environment. If there have been no heat-resistant variants, the whole species of bacteria would be extinct. Hence, the survival of species is promoted.

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

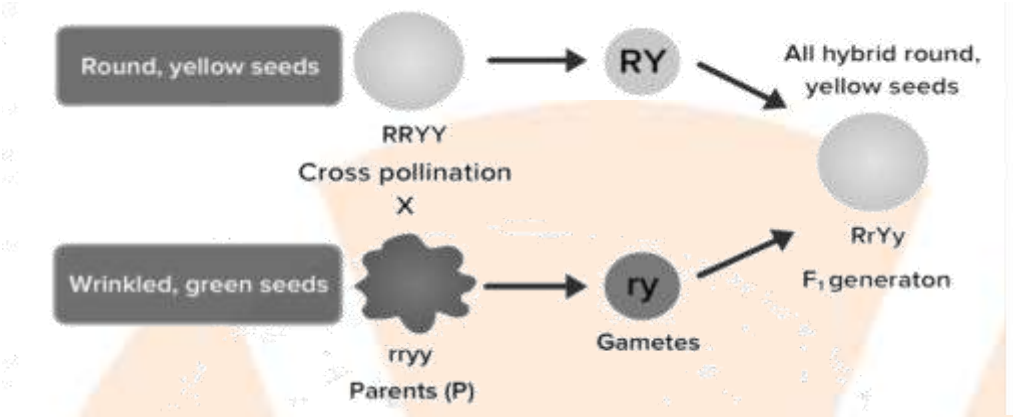
Ans: Mendel began his genetic experiment on pea plants in 1856 with a single character (with two alternative traits) called a monohybrid cross. The crossing was done between true-breeding tall plants (TT) and true breeding dwarf plants. In the first filial generation, he received only tall plants, no dwarf trait was seen. Now, Self-pollination of the F1 progeny was done which resulted in both tall and dwarf plants. Based on the monohybrid cross, Mendel's conclusion was made that out of the two traits of a character, one is dominant and the other is recessive. The dominant trait is an allele that always expresses itself externally while the expression of the recessive trait is masked in the presence of the dominant trait when present in homozygous or heterozygous conditions. Thus, the recessive trait is expressed only in homozygous conditions. Eventually, the tall plants present in F1 were not true-breeding. They were heterozygous (Tt) tall plants. Hence, the expression of the recessive allele (t) gets suppressed by the dominant allele.



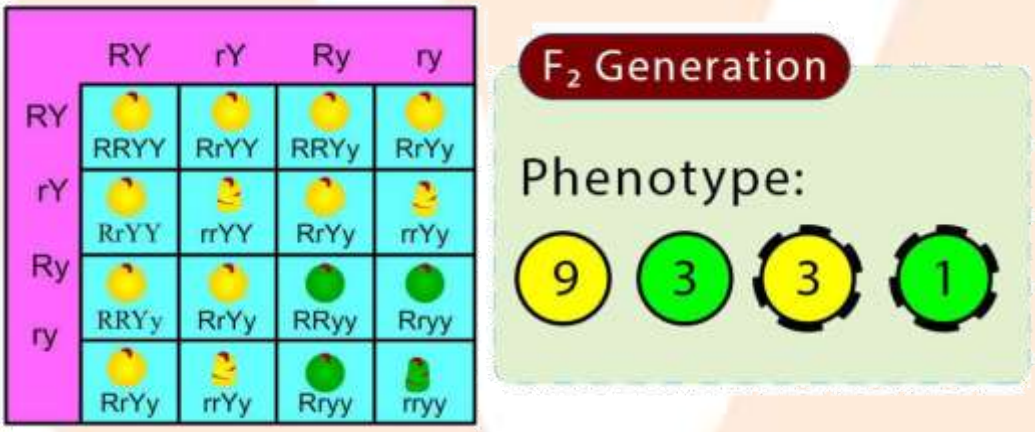
2. How do Mendel's experiments show that traits are inherited independently?

Ans: Mendel directed his attention to two pairs of contrasting characters. The cross which involves two pairs of alleles is known as a dihybrid cross. He did a hybrid cross on pea, taking two characters at a time. His dihybrid cross demonstrated an independent assortment of genes. Mendel chose seed colour and seed shape as the two characters for his experiment. Mendel crossed round and yellow seeds (RRYY) with wrinkled and green seeds (rryy) (parental generation). First filial generation (F1) showed all round and yellow seeds (law of dominance) since round seed shape

is dominant over wrinkled seed shape and yellow seed colour is dominant over green seed colour.



Self-pollination is the F1 generation that resulted in the F2 generation that showed a variety of seeds. In F2 progeny the yellow round seeds, green round seeds, yellow wrinkled seeds, and green wrinkled seeds were seen in the ratio of 9:3:3:1.



The F2 generation had two new variants of seeds - round green and yellow wrinkled (different from the parental types). Thus, the conclusion can be made that the genes for the two characters are assorted independently.

3. 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?

Ans: No, the given information is not enough to tell whether which of the traits is dominant, either A or O.

Blood groups are inherited from our biological parents. It has three alleles A, B and O. This can be explained via two cases:

CASE I: When A is dominant and O is recessive
Combination of man can be I^AI^A OR I^AI^O
A combination of women will be I^OI^O

The blood group of a child is A when A is dominant and father is pure I^AI^A but the Blood group of children if the father is I^AI^O:

	I^o	I^o
I^A	I^A I^o	I^A I^o
I^o	I^o I^o	I^o I^o

Here 50% of the progeny is blood group A while 50% has blood group O when the father is heterozygous $_IA_IO$.

CASE II: When A is recessive and O is dominant
Combination of father - I^AI^A
Combination of the mother can be I^AI^O OR I^OI^O

Blood group of the child when a mother is I^AI^O:

	I^A	I^o
I^A	I^A I^A	I^A I^o
I^A	I^A I^A	I^A I^o

Here also 50% of the progeny has blood group A while 50% Of them has blood group O. The blood group of the child would have been O, mother was homozygous I^OI^O.
From the above cases, we conclude that the blood group of the child will be O if any of the characters are dominant. Thus, it is difficult to determine the dominant character.

4. How is the sex of the child determined in human beings?
Ans: In human beings, the sex of the child is determined by the chromosomal combination of parents. An ideal pair of sex chromosomes i.e. XX is seen in women, and a mismatched pair i.e. XY is seen in men. The eggs produced in females will carry the X chromosome and half of the sperms will carry the Y chromosome and the other half will carry the X chromosome in the case of males. Now, when

fertilization is done between them, two cases can be considered:
Case 1: when the egg fuses with a sperm carrying the Y chromosome, the child will be a boy.
Case 2: when the egg fuses with a sperm carrying an X chromosome, the offspring will be a girl.

Parents XX (Female) XY(Male)

↓

↓

Gametes X X Y

Female → Male↓	X	X
X	XX (female)	XX(female)
Y	XY (male)	XY (male)

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

I. Natural selection – Certain variations give a survival advantage to individuals in a population in a changing environment increasing their population. Natural selection fits individuals having better adaptability.

II. Genetic drift: An increase of certain individuals is seen in a population even if they give no survival advantage in case of Accidents in small populations.

III. There are cases in which some traits are not inherited but acquired by an individual during its lifetime. The acquired characters help the individual to survive better and increase its population.

2. Why are traits acquired during the lifetime of an individual not inherited?
Ans: In the case of reproduction, Progeny receives the germ cells from the parent. So, any changes within the germ cells (leading to variation or new traits) are inherited by the progeny. Some traits are acquired by an individual during its lifetime

due to environmental influences or other external factors. An acquired trait involves changes in non-reproductive tissues (somatic cells). Thus, these traits cannot be inherited because acquired traits do not involve changes in the germ cells.

3. Why are the small numbers of surviving tigers a cause of worry from the point of view of genetics?
Ans: Fewer variations will be accumulated by species of small populations. When such a species reproduces, there are fewer chances of having progeny with some useful variations (that will give a better survival advantage). Thus, in case of disease, they will not be able to survive. Extinction will take place and the genes will be lost forever.

1. What factors could lead to the rise of a new species?
Ans: The one or more new species formed from an existing species by evolutionary means is called speciation. Factors leading to the formation of new species are:

(i) Genetic drift
(ii) Natural selection
(iii) Severe DNA change.
(iv) Reproductive isolation.

2. Will geographical isolation be a major factor in the speciation of self-pollinating plant species? Why or why not?
Ans: Geographical isolation helps in the prevention of the transfer of genes between two species. In a self-pollinating plant, pollen is transferred from the anther of one flower to the stigma of the same flower or another flower of the same plant. No external agent is required for pollination, neither is it dependent on another plant for pollination. So, geographical isolation cannot affect the species and cannot be affected by geographical isolation in self-pollinating plants.

3. Will geographical isolation be a major factor in the speciation of an organism that reproduces asexually? Why or why not?
Ans: Geographical isolation helps in the prevention of the transfer of genes (gene flow) between populations of a species. In asexual reproduction, A single organism can give rise to new individuals. When there is an error during the copying of DNA, variation occurs in these reproducing organisms. Therefore, the formation of new species cannot be affected by geographical isolation in an asexually reproducing organism.

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

Ans: Evolutionary relationships in organisms can be traced by similarities in characteristics. Few characteristics In different organisms, few of the characters are similar as they are inherited from a common ancestor. And a link is created between different stages of the evolution of species. Feathers were also present on dinosaurs that are seen on birds today. However, feathers were not used by dinosaurs to fly but as insulation. Later birds seemed to adapt the feathers for flight. Thus, this is an indication that birds are very closely related to reptiles since dinosaurs were reptiles. This also proves that reptiles and birds are closely related and that the evolution of wings started in reptiles.

2. Can the wing of a butterfly and the wing of a bat be considered homologous organs?

Ans: The organs having the same fundamental structure but different functions are called homologous organs**.** For example, the wings of a butterfly and the wings of a bat are not homologous organs as they do not have the same origin or the same basic structure. The wings of a butterfly and the wings of a bat are analogous organs as they perform the same function of flight even though their origin and structure are different.

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

Ans: Fossils are the remains or imprints of hard parts of the animals like skeletal structures. These structures were once inhabited on earth. Fossils provide one of the most acceptable pieces of evidence in support of evolution because we can study the evolutionary past of organisms in the form of their fossils. By studying the fossils, the changes can be identified that had occurred in these organisms to give rise to the present-day forms. Thus, a connecting link is observed between the organisms of the past and the organisms of the present.

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

Ans: A species is a group of interbreeding individuals. are all the Observable features of human beings like Skin colour, looks, and size are generally environmentally controlled. Thus, various human races are formed based on these features. However, all human beings are capable of reproducing with each other and producing offspring irrespective of skin colour, height, language, race etc.

Therefore, all human beings belong to one species, *Homo sapiens.*

2. In evolutionary terms, can we say which among bacteria, spiders, fish and chimpanzees have a 'better' body design? Why or why not?
Ans: In evolutionary terms, it is difficult to say that among bacteria, spiders, fish and chimpanzees which has a 'better' body design as it involves the development of the most efficient and appropriate features in a body design for survival and adaptation. One of the examples is, organisms having a complex body design face several difficulties while surviving in particular situations whereas, organisms with the simplest body design like bacteria can survive in extreme habitats. Thus, Evolution only leads to the development of complex body designs and it cannot be equated with progress.

1. A Mendelian experiment consisted of breeding tall pea plants bearing violet flowers with short pea plants bearing white flowers. The progeny all bore violet flowers, but almost half of them were short. This suggests that the genetic make-up of the tall parent can be depicted as
(a) TTWW
(b) TTww
(c) TtWW
(d) TtWw
Ans. (c) There are two flower colours violet and white but F1 showed only violet flowers which means that violet flower colour (V) is the dominant trait that masks the recessive trait (v) (white flower colour). The F1 progeny had half tall and half short plants. Thus, both dominant and recessive traits are expressed in the F1 progeny. So, it can be said that the tall plants were not true-breeding and must be genetically heterozygous for the character height (Tt). Hence, the genetic make-up of the tall parent can be represented as TtVV. Therefore, the cross involved in the given question is:
TtVV × ttvv
↓
TtVv − ttVv
Therefore, half the progeny is tall, but all of them have violet flowers.

2. An example of homologous organs is
(a) our arm and dog's fore-leg
(b) our teeth and an elephant's tusks

(c) potato and runners of grass
(d) all the above

Ans: (d) All of the Above.

In all the examples mentioned above, the basic internal structure and origin of the organs are the same but their functions are different. Thus, it is called a homologous organ. For example, an elephant's tusk is considered to be a modified incisor hence, it has the same origin but different function. Tubers of potato and grass runners are both stem modifications but differ in function, hence these are homologous organs.

3. In evolutionary terms, we have more in common with
(a) a Chinese schoolboy.
(b) a chimpanzee.
(c) a spider.
(d) a bacterium

Ans: (a) In evolutionary terms, we have more in common with a Chinese schoolboy. As, both belong to the same species, Homo *sapiens*. Chimpanzees and humans are two different species having a common ancestor.

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

Ans: Children with light-coloured eyes can either have LL or Ll or ll genotypes. An assumption can be taken that the children have LL (both dominant alleles) genotype. This can be only when both the parents are also of the LL genotype.

LL × LL

↓

LL

If ll genotype is present in children with light-coloured eyes, then their parents will also have ll genotype.

II × II

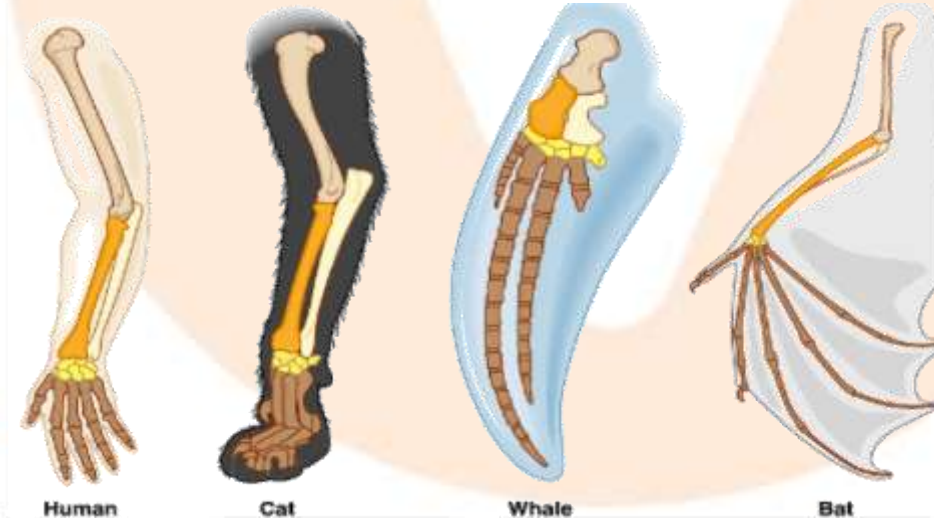
↓

II

Therefore, it would be difficult to conclude whether light eye colour is dominant or recessive.

5. How are the areas of study − evolution and classification − interlinked?
Ans: Classification is the process by which scientists group two living organisms based on their similarities. Those species that have more characteristics in common are closely related. And if two species are more closely related, which means they have a more recent ancestor.
For example, in a family, brothers and sisters are more closely related than their cousins. So, we can say that brother and sister have recent common ancestors i.e., their parents. The common ancestors for brother, sister and cousin are their grandparents. Due to sexual reproduction, there is an accumulation of variation over generations which leads to the creation of different phenotypes and genotypes as we move down a family (evolution) tree.

6. Explain the terms analogous and homologous organs with examples.
Ans: Homologous organs are similar in origin (or are embryologically similar) but perform different functions. Forelimbs of frogs, lizards, pigeons, bats, whales, horses and humans have the same basic structural plan but different functions. For example, the wings help in flight whereas the human forearm helps in various activities.



The organs having similar functions, different structural details and origin are called analogous organs. For example, the wings of a bird and a bat are similar in function, but the similarity does not signify that these animals are more closely related. The

general structure of the wings of insects is different from that of a bird and a bat but have a similar. Also, when carefully observed, we find that the wings of a bat are just the folds of skin that are stretched between its fingers whereas the wings of birds are present all along the arm. Likewise, the fins of fishes and flippers of whales are also examples of analogous organs. Therefore, these organs are analogous.

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

Ans: There are a variety of genes present in dogs that govern coat colour. At least eleven identified gene series (A, B, C, D, E, F, G, M, P, S, T) are present that influence coat colour in dogs.

One gene from each of its parents is inherited by the dog. The dominant gene gets expressed in the phenotype. For example, If, the "B" gene is inherited by a dog, it can be genetically either black or brown. Let us assume that :

(i) one parent is homozygous black (BB),

(ii) the other parent is homozygous brown (bb).

bb	BB		
		B	B
	b	Bb	Bb
	b	Bb	Bb

Since. Thus, the phenotype is black as black (B) is dominant so, all the offspring are black i.e. However, genotypically they are heterozygous for the B allele (Bb). That is all offspring are heterozygous black.

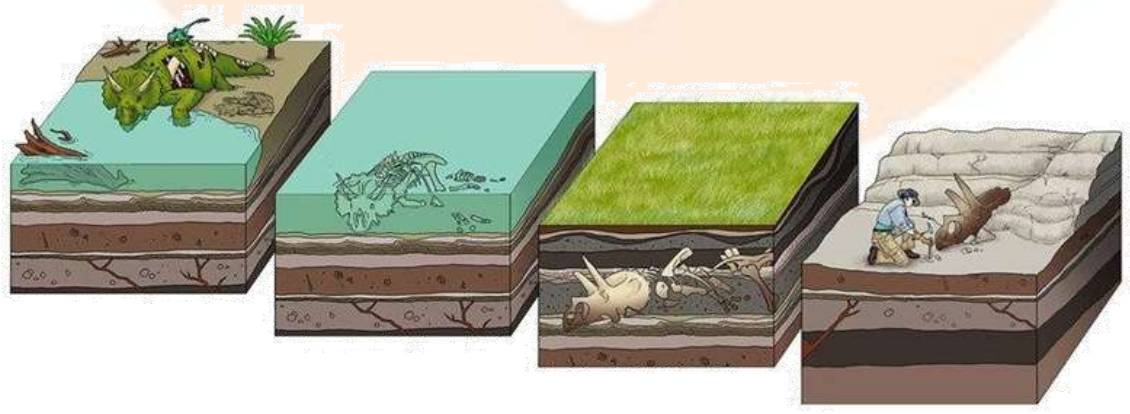
If the F1 heterozygous pups are crossed, they will produce 25% homozygous black (BB), 50% heterozygous black (Bb), and 25% homozygous brown (bb) offspring.

	B	b
B	BB	Bb
b	Bb	Bb

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

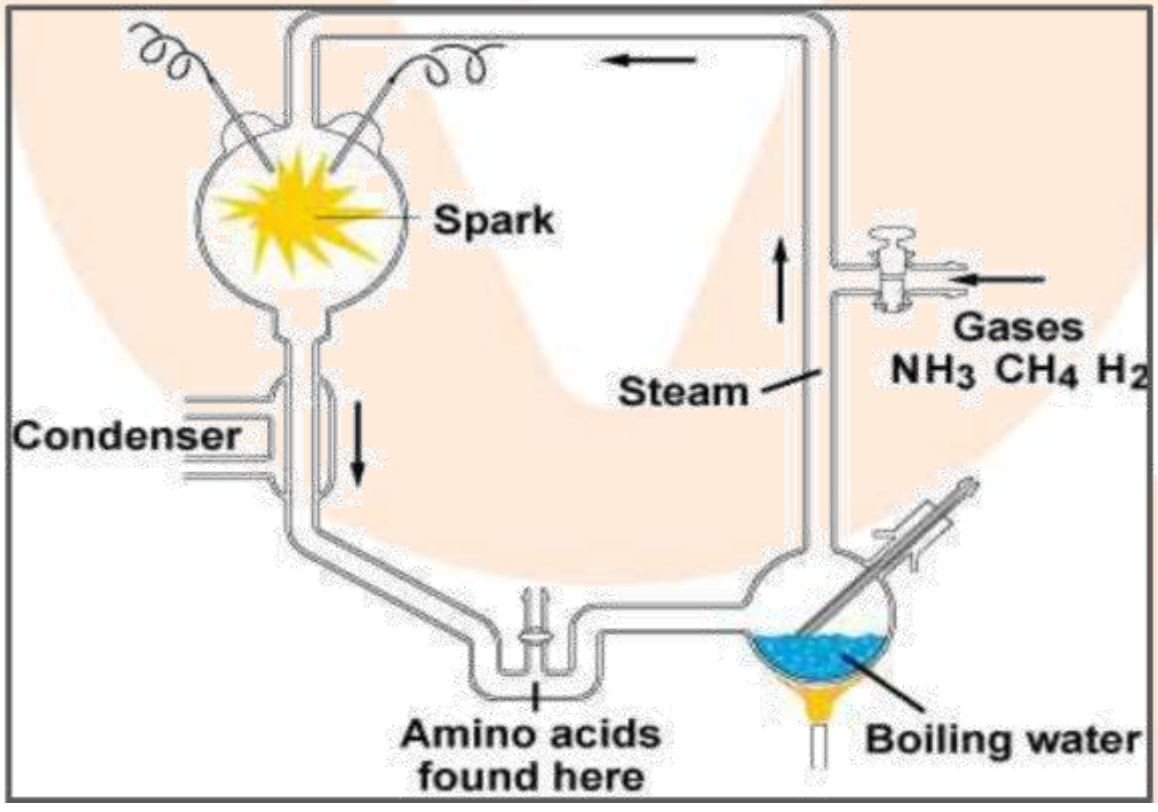
Ans: Remains of the organism that once existed on earth are called fossils. They represent the ancestors of the plants and animals that are alive today are represented by fossils. They get buried under the layers of earth, mud and silt and remain preserved for millions of years. When an animal dies and gets buried, fossils are formed. The soft tissue of an individual quickly decomposes leaving the hard bones or shells behind. Further, the sediment builds over and hardens into rock. Thus by digging, we can find that the fossils which are closer to the surface are more recent than the fossils we find in deeper layers.

Let us start 100 million years ago. Few invertebrates on the sea-bed die are buried in the sand. Sandstones are formed under pressure by the accumulation of sands. After millions of years, dinosaurs living in the area die, and their bodies, too, are buried in mud. The mud gets compressed into rock, above the rock containing the earlier invertebrate fossils. Further, millions of years later, some horse-like creatures died in that area and got fossilized in rocks above the dinosaur fossils. In the next coming years, the bodies of horse-like creatures dying in the area are fossilised in rocks above these earlier rocks. Dinosaur and invertebrate fossils can also be found when the area is excavated deeper. Thus, scientists can easily predict that horse-like animals evolved later than the dinosaurs and the invertebrates by digging that area. Thus, from the above example, it can be concluded that the fossils found closer to the surface of the earth are more recent than the fossils present in deeper layers.



Layers of fossils

9. What evidence do we have for the origin of life from inanimate matter?
Ans: An experiment was conducted in 1953 by Stanley L. Miller and Harold C. Urey to understand the origin of life on the earth. It was suggested by J.B.S. Haldane that life originated from simple inorganic molecules. According to him, when the earth was formed, it was a hot gaseous mass containing elements such as nitrogen, oxygen, carbon, hydrogen, etc. Molecules like water (H2O), carbon dioxide (CO2), methane (CH4), ammonia (NH3), etc were formed by these elements. As the water was formed, the earth surface cooled slowly and the inorganic molecules interacted with one another in water to form simple organic molecules such as sugars, fatty acids, amino acids, etc. Thus, for these reactions energy was provided. It was provided by solar radiation, lightning, volcanic eruptions, etc.
An atmosphere was assembled by Miller and Urey that was similar to the early earth (this had molecules like ammonia, methane and hydrogen sulphide, but no oxygen) over water. It 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 the week, 15% of the carbon (from methane) was converted to simple compounds of carbon including amino acids which make up protein molecules.



Miller and Urey experiment

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

Ans: In sexual reproduction, two parents are involved. The genes are contributed by both the parents to the offspring. Half the number of chromosomes from the father and half from the mother is obtained. which means that one copy of a gene is inherited from the father and another copy from the mother. So, two individuals having different variations give rise to a new individual by the combination of their DNA. Therefore, sexual reproduction leads to variations. In asexual reproduction, when the copying of DNA is not accurate, variation occurs. However, Sexual reproduction allows more variations and the resultant DNA is also able to survive, thus making the variations viable.

Sexual reproduction plays an important role for the organism to adapt better to the environment. Variations help the species to survive In all these conditions, variation helps the species to survive. Environmental conditions such as disease, pests, and food availability can suddenly affect a place. In this situation, only those variants can survive who are resistant to it. Gradually, it will lead to the evolution of a better-adapted species. Thus, variation helps in the evolution of sexually reproducing organisms.

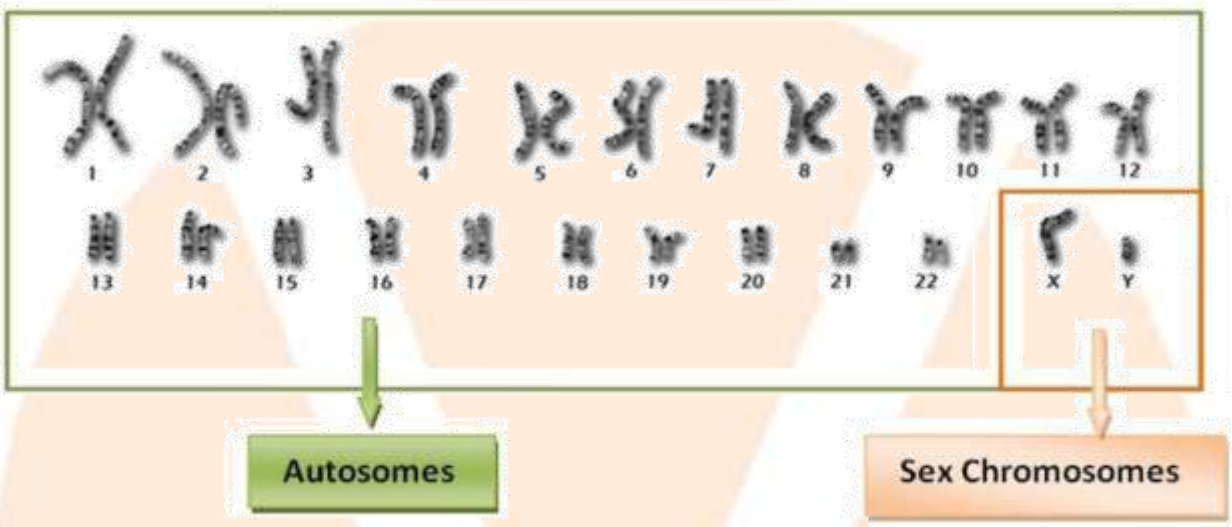
However, in case of a sudden change in the environment of asexually reproducing species can cause their extinction.

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

Ans: The somatic cell of the body of each human being contains 23 pairs of chromosomes. Out of the 23 pairs of chromosomes, 22 pairs are known as autosomes and the remaining one pair is called sex chromosomes which are represented as X and Y. Two X chromosomes are present in females and one X and one Y chromosome are present in males. In the process of gametogenesis (gamete formation), meiosis occurs and the gametes receive half the number of chromosomes. Therefore, the male gametes have 22 autosomes and either X or Y chromosomes. The female gamete, on the other hand, has 22 autosomes and X chromosomes.

In the process of sexual reproduction, male and female gametes fuse and the number of chromosomes is again restored in the zygote. Thus,

(i)From male- the progeny receives 22 autosomes and one X or Y chromosome from male parent and
(ii) From female- the progeny receives 22 autosomes and one X chromosome from the female parent.



12. Only variations that confer an advantage to an individual organism will survive in a population. Do you agree with this statement? Why or why not?
Ans: One of the basic mechanisms of evolution is 'Natural selection'. It offers survival advantages that favour variation. The individuals that have survival advantage reproduce within the population and pass on the favourable variation to the progeny. The evolution that is occurring within the organisms is a result of this natural selection. However, there can be some other variations that occur accidentally and do not offer any survival advantage. The frequency of the genes can be changed in some populations if such variations occurred even if they are not important for survival. This accidental change in small populations is referred to as genetic drift. So it can be said that both types of variations can survive in a population.