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?

Solution:

Trait B is more probable to arise early as this trait has already been existing and replicating in a larger percentage of the population as compared to trait A

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

Solution:

Genetic variations enable the species to better adapt to changes in its environment. Moreover, it is an important force in evolution as it allows the frequency of alleles to increase or decrease through natural selection. These variations will determine the difference between extinction or continuation of the species.

Exercise-9.2 Page: 147

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

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Solution:

Mendel showed that the traits can either be dominant or recessive through his experiments that focused on mono-hybrid cross. The experiment involved him crossing tall (TT) pea plants with dwarf (tt) pea plants. The resultant plants which formed after fertilization represented the F1 (or filial) generation. All the F1 plants were tall. Mendel then proceeded to self-pollinate the filial generation plants and the result was that 1/4th of the plants obtained in the F2 generation were dwarfs. From this experiment, Mendel concluded that the F1 tall plants were not true-breeding, instead they carried the traits for both tall and dwarf heights. A portion of the plants were tall due to the fact that the traits for tallness were dominant over the traits for dwarfness. This cements the notion that traits can either be dominant or recessive.

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

Solution:

Mendel's experiments show that traits are inherited independently through his dihybrid cross experiment. The experiment involved him using two traits –

namely, seed shape and seed colour. The colour yellow (YY) is dominant over green (yy), while the round shape (RR) is dominant over the wrinkled shape (rr). The F2 progeny of the dihybrid cross resulted in a phenotypic ratio of 9:3:3:1; therefore, 9 plants with round yellow (RRYY) seeds, 3 plants with round green (RRyy) seeds and 3 plants with wrinkled yellow (rrYY) seeds and one with wrinkled green seeds (rryy). He further observed that the wrinkled greens and the round yellow are parental combinations while the round green and wrinkled yellow are new. A dihybrid cross between two seeds with dominant traits (RRYY) and non-dominant traits (rryy) resulted in the production of 4 types of gametes (RY, Ry, rY and ry). This means each of the gametes segregate independently of the other; and each with a frequency of 25% of the total gametes produced.

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?

Solution:

Given information is not enough to tell us which characteristics are dominant – blood group A or O. Blood type A is always dominant in ABO blood and blood type O is always recessive. Here, the father's blood group may be genotypically AA (homozygous) or AO (heterozygous), whereas that of mother can be OA or OO.

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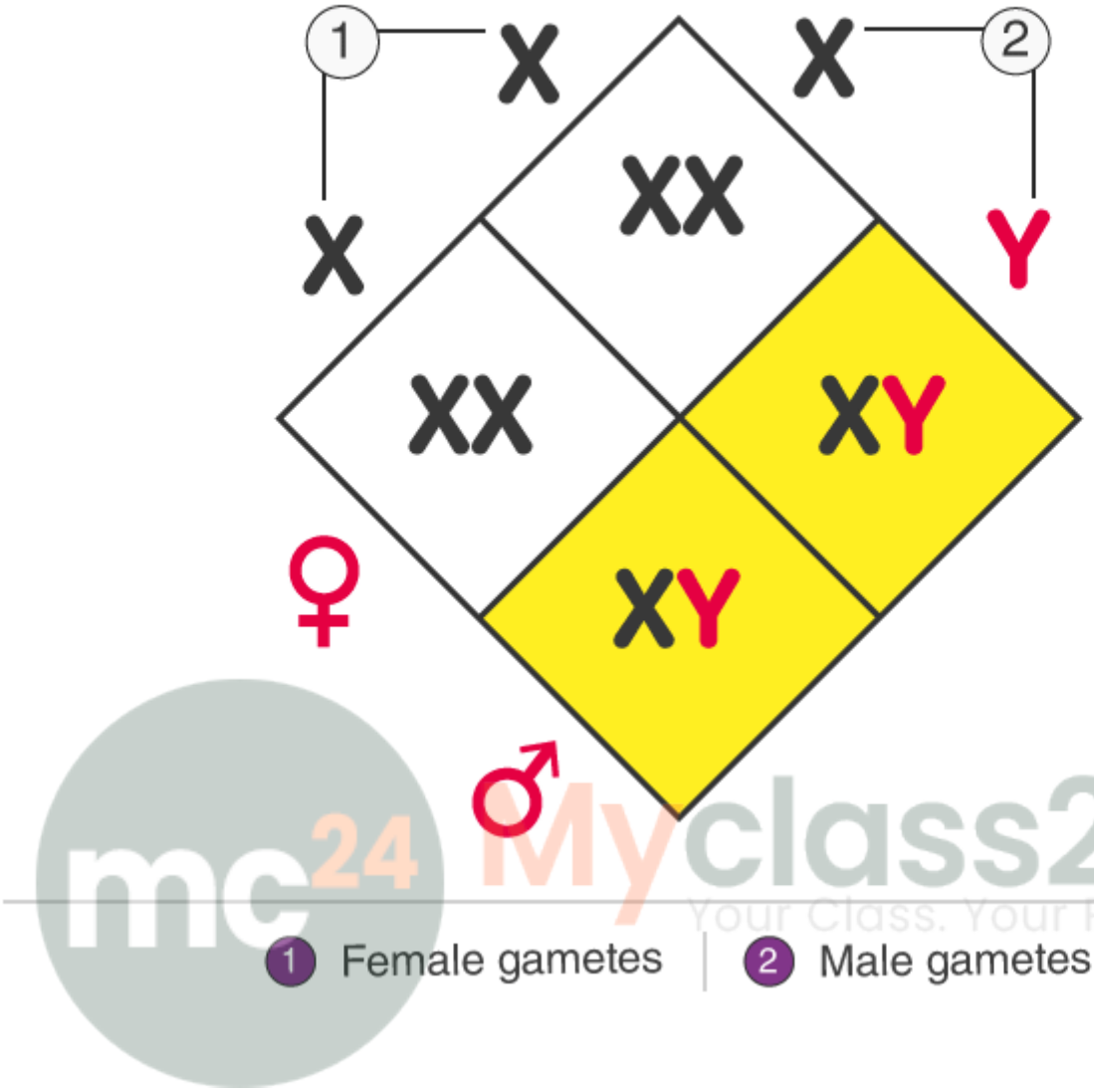
4. How is the sex of the child determined in human beings?

Solution:

Sex of child in humans is determined by the males. Males have XY chromosomes while females have XX chromosomes. Hence, **if**:**–**

- The male's X chromosomes combines with the female's X chromosomes, the mother gives birth to a girl
- The male's Y chromosome combines with the female's X chromosome, the mother gives birth to a boy



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

Solution : The different ways in which individual with a particular trait may increase are:

(a) Natural selection- Certain variations give survival advantage to individuals in a population in a changed situation resulting in increase of their population.

(b) Genetic drift- Accidents in small population even if they give no survival advantage also lead to increase to certain individual in population.

8. Why are traits acquired during the life-time of an individual not inherited?

Solution : Any change in nor-reproductive tissues cannot be passed on to the DNA of the germ cells. Therefore, the traits acquired during life-time on an individual are not inherited.

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

Solution : It will affect the frequency of selection which is essential for survival. For effective selection, the population must consist of an infinitely large number of individual in population.

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

Solution :

Following factors could lead to the rise of new species:

(a) Changes in gene frequency in small breeding isolated populations.

(b) Natural selection

(c) Changes in number of chromosome.

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.

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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, color and looks said to belong to the same species?

Solution:

While human beings do vary in color and general appearance, their genetic makeup is identical to any other human. One of the speculations put forth for our drastic changes is due to evolutionary pressure – where the need to be easily recognized pushed us towards having widely different faces.

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

Solution:

Body designs are the result of environmental needs and pressure. Hence, we can't conclude that one organism has a better body compared to another. For instance, fish have evolved a streamlined design as it is best suited for an aquatic environment. On the other hand, a spider or a chimpanzee might be ill-equipped to survive in such aquatic environments.

Exercises Page: 159

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

Solution:

Correct answer – (c)

TtWW might be the genetic makeup of the tall parent. Since half the progenies are short, this implies that the parent plant also will have a collection of short genes; all progenies bore violet flowers, further suggesting that violet color is dominant over white.

2. An example of homologous organs is

(a) Our arm and a dog's fore-leg.

(b) Our teeth and an elephant's tusks.

(c) Potato and runners of grass.

(d) All of the above.

Solution:

Correct answer – (d)

Homologous organs have the same origin as each of the above organs, but different functions. Homologous organs can be defined as the organs of various animals having similar basic structure but different functions. For example, a whale's flippers, a frog's forelimbs, and man have the same basic structures but perform different functions, which is why they are called homologous organs.

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

(a) A Chinese school-boy.

(b) A chimpanzee.

(c) A spider.

(d) A bacterium.

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Solution:

Correct answer – (a)

Humans and chimpanzees are related since they belong to the identical order (Primates) and same family, (Hominidae). However, a school-boy, regardless of the ethnicity is still a Homo sapien

21. 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?

Solution : No, since two copies of traits are inherited from parents, one from mother and the other form father. Unless we know the nature of these two variants of traits we cannot tell which is dominant and which is recessive. Recessive traits appear when both the parents contribute recessive allele. From this statement we can only presume are that both parents are contributing recessive allele.

22. How are the areas of study- evolution and classification interlinked?

Solution : When we classify organism we look for similarities among organism which allows us to group them. Based on these principles we can work out the evolutionary relationship to the species.

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

Solution : Analogous organs: Such organs which perform similar function but are different in structure and origin. Example- Wings of birds and wings of insects. Homologous organs: Such organs which may have different functions but similar structure and origin. Example- fore arm of frog, lizard and bird.

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

Solution :

Dogs have a variety of genes that govern coat colour. There are at least eleven identified gene series (A, B, C, D, E, F, G, M, P, S, T) that influence coat colour in dog.

A dog inherits one gene from each of its parents. The dominant gene gets expressed in the phenotype. For example, in the B series, a dog can be genetically black or brown.

Let us assume that one parent is homozygous black (BB), while the other parent is homozygous brown (bb)

	BB	
	B	B
bb		
b	Bb	Bb
b	Bb	Bb

In this case, all the offsprings will be heterozygous (Bb).

Since black (B) is dominant, all the offsprings will be black. However, they will have both B and b alleles.

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

	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.

(Image will be uploaded soon)

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 (H2OH2O), carbon dioxide (CO2CO2), methane (CH4CH4), ammonia (NH3NH3), 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◦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.

(Image will be uploaded soon)

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?

Solution:

The statement holds true – only variations provide an advantage to individual organisms that will survive in a population. For example, variations that lead to the increase in heat-resistance in bacteria is very useful for survival if it finds itself in an environment where there is a sudden increase in ambient temperature. This will determine the difference between life and death for the bacteria.

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

Solution : Equal contribution of male and female parents is ensured in progeny during sexual reproduction. Each trait of progeny is determined by a pair of alleles and gametes of male and female contain one allele. Each allele pairs during fertilisation combine together to determine traits. Thus, the traits of progeny are determined by equal genes from male and female.

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