Chapter 9
Heredity and Evolution

Exercise9.1

Question 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?

Answer:

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

Question 2

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

Answer:

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.

Exercise9.2

Question1

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

Answer:

Mendel showed that the traits can either be dominant or recessive through his experiments that focused on monohybrid 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 truebreeding, 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.

Question 2

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

Answer:

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.

Question 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?

Answer:

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.

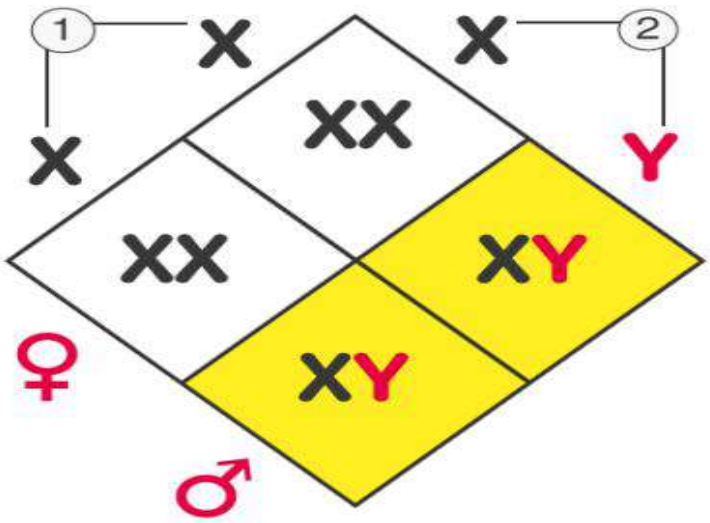
Question 4

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

Answer:

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

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



Exercise9.3

Question 1

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

Answer:

An individual attribute could increase in a population within the following 2 ways:
(a) Natural selection: if an attribute is useful to a population, it'll increase naturally.
For example – mosquitoes which are resilient against a particular pesticide will pass on its genes, so that future generations become resistant as well. The mosquitoes which are affected by the pesticide die out .
(b) Genetic drift: if a species faces a catastrophic event where most of the population is wiped out, the surviving population can pass on their traits to the following generations. This may result in a rise of the attribute within the population.

Question 2

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

Answer:

Traits acquired during a life-time cannot be inherited for successive generations as the changes do not reflect in the DNA of the germ cells. For instance, a football player cannot pass on his skills to his offspring as they are limited to non-reproductive cells only.

Question 3

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

Answer:

As the size of the tiger population decreases, the genetic pool of the species decreases too. This results in a limitation on the variations which will be introduced within the genetic makeup of the tigers. This lack of variation will result in serious implications. For example, if an illness spreads within the tiger population, it can potentially wipe out the whole population, possibly causing their extinction.

Exercise9.4

Question 1

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

Answer:

Factors that would result in a new species are as follows:
(a) Mutation.
(b) Genetic drift.
(c) Natural selection.
(d) Geographical isolation.
(e) Generative isolation for prolonged periods
(f) Environmental factors on the isolated populations.
(g) Quantum of genetic variant transmissible from one generation to the following generation.

Question 2

Will geographical isolation be a major factor in the speciation of a self-pollinating plant species? Why or why not?

Answer:

In a pollination of plant species, geographical isolation is usually not a major factor as no new trait will become part of the genetic makeup in a self-pollinating plant species. However, there are some possibilities of some environmental changes which could result in some variations.

Question 3

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

Answer:
In the case of asexually reproducing organisms, geographical isolation can't be considered a factor. This is due to the fact that meiosis does not occur during asexual modes of reproduction.

Exercise9.5

Question 1

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

Answer:

Let us take the instance of humans and chimpanzees. chimpanzees are able to express a wide range of emotions - such as busting out in laughter or smiling - this trait was once thought to be a feature exclusive to humans. The smile can be linked to the activation of the brain's limbic system - where the orbicularis oculi muscle involuntarily contracts and raises the cheeks, forming wrinkles around the eyes. This implies that the smile is a true and genuine smile. Interestingly, this type of reflex has a name - the Duchenne smile. Moreover, research has shown that chimpanzees share 98.6% of our DNA - This means that humans and chimpanzees shared a common ancestor eons ago. It is important to also note that chimpanzees are the closest living relatives to humans.

Question 2

Can the wing of a butterfly and the wing of a bat be considered homologous organs? Why or why not?

Answer:

The wing of a butterfly and the wing of a bat cannot be considered homologous organs as they do not share a common ancestor. Even though both structures aid in flying, they have evolved separately. To prove this, the wings of a butterfly are composed of two chitinous membranes, whereas wings of a bat are composed of bony skeleton, complete with blood vessels. Hence, these aren't homologous organs but rather analogous organs.

Question 3

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

Answer:

Fossils are the preserved remains of animals or plants or other organisms that died out millions of years ago. These fossils tell us about a lot of extinct animals and also give insights into how evolution might have occurred. Fossils can be used to understand how an organism would have lived and what it may have looked like. More importantly, we can correlate with fossils as well as extant organisms to understand their relationships. For instance, scientists were able to recover protein sequences from a dinosaur called the T-rex, which confirmed its avian lineage. This means birds are the extant relatives of (avian) dinosaurs. Moreover, the pattern of fossil distribution gives us an idea of the time in history when various species were formed or become extinct.

Exercise9.6

Question 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?

Answer:

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.

Question 2

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

Answer:

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 Questions

Question 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

Answer:

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.

Question 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.

Answer:

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.

Question 3

In evolutionary terms, we have more in common with

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

Answer:

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.

Question 4

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

Answer:

Knowledge of at least 3 generations is required for finding if an attribute is dominant or recessive. Hence, it is not possible to identify if the given trait is dominant or recessive.

Question 5

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

Answer:

Classification and evolution are two related fields of biology. Evolution pertains to how organisms evolve and classification deals with finding out how two species are related to each other. For example, evolution and fossil evidence point to the fact that Australopithecus afarensis is considered one of our earliest ancestors. And
classification tells us that Australopithecus afarensis belongs to the genus Homo, which is also the same genus as modern humans.

Question 6

Explain the terms analogous and homologous organs with examples.

Answer:

Homologous organs are those organs that have the basic structural design as well as origin, however, serve different functions. For example: The forelimbs of humans and the wings of bats are anatomically similar.
Analogous organs are those organs that have a different structural design as well as origin, however perform similar functions. For example: The wings of birds and insects.

Question 7

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

Answer:

Dogs have a certain set of genes that govern coat color. There are a minimum of eleven known sequence series (A, B, C, D, E, F, G, M, P, S, T) that influence the colour of a dog. A dog inherits one copy from each of its parents. As an example, within the B series, a dog is genetically black or brown. Assume that one parent is homozygous black (BB), whereas the other parent is homozygous brown (bb).

bb	BB		
		B	B
	b	Bb	Bb
	b	Bb	Bb

In this case, all the offsprings are going to be heterozygous (Bb).
Since black (B) is dominant, all the offsprings are going to be black. However, they are going to have each B and b alleles. If such heterozygous pups are crossed, they are going to produce 25 homozygous blacks (BB), 15 heterozygous black (Bb), and 25 homozygous brown (bb) offsprings.

	B	b
B	BB	Bb
b	Bb	Bb

Question 8

Explain the importance of fossils in deciding evolutionary relationships.

Answer:

Fossils give evidence about:
(a) The organism and their paleobiology
(b) Even behavior of an organism can be deduced to some extent (for example, paleontologists) had unearthed a site with more than 10,000 skeletons of a dinosaur called Hadrosaurus. This implies that the dinosaur lived in herds
© Fossils also provide insight into the evolutionary history of animals and plants (for instance, paleontologists have discovered that whales had evolved from goat-sized land dwelling animal called Pakicetus)

Question 9

What evidence do we have for the origin of life from inanimate matter?

Answer:

The evidence on the origin of life from inanimate matter was provided by Stanley L. Miller and Harold C. Urey's experiment, which was conducted in 1953. They created an artificial environment which was reminiscent of the early earth's atmosphere - it contained ammonia, hydrogen and other gases which were thought to have existed during primordial earth.
This concoction of gases was kept at a temperature slightly below 100 ° C. Additionally, sparks were generated to simulate lightning, which was also thought to be common during that period. At the end of the experiment, he was able to create 11 out of the 20 amino acids which is required for life.

Question 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?

Answer:

Sexual reproduction causes a lot of viable variations because of the following reasons:
(a) Error in copying of DNA (though it was rare)
(b) Random segregation of paternal and maternal chromosome at the time of sex cell formation.
(c) Exchange of genetic material between homologous chromosomes during the formation of gametes.
(d) Accumulation of variations occurred because of reproduction over generation after generation and choice naturally created wide diversity.
(e) In case of asexual reproduction, variation is severely limited as there is only one parent involved. Hence, the offspring is genetically similar to the parent

Question 11

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

Answer:

Equal genetic contribution of male and female parents is ensured in progeny through the inheritance of equal numbers of chromosomes from both parents. There are 23 pairs of chromosomes but not all is paired. The 22 pairs are called autosomes while the remaining 1 pair is called the sex chromosomes (represented as X and Y.)
Females have two sets of X-chromosomes while males have 1 X-chromosome and 1 Y-chromosome. During the process of reproduction, fertilization takes place, where the male gamete fuses with the female gamete and it results in the formation of a diploid zygote. Furthermore, the zygote receives an equal contribution of genetic material from both parents. The male contributes 22 autosomes plus, 1 X or Y chromosomes. The female contributes 22 autosomes, plus 1 X-chromosome.

Question 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?

Answer:

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.