Chapter 9
Hereditary and Evolution

Intext Questions

On Page 143

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?

Solution: Trait B. In asexual reproduction traits which are present in the previous generation are carried over to next generation with minimal variations. Therefore, the traits present in higher percentage have greater chances of persisting earlier.

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

Solution: Depending on the nature of variation different individuals would have different genetic set up. However, not all variations are beneficial.

Consider an example, suppose there are two strains of bacteria. One which can withstand heat and the other that cannot. Bacteria that can withstand heat will survive better in the heat wave.

Significance of Variations:

- They are the primary source of evolution.
- Animals are able to adapt themselves to the changing environment.
- Variation gives the organism the individuality of its own.
- Without variations, there would be no concept of heredity. All the individuals would be identical in all aspects.

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

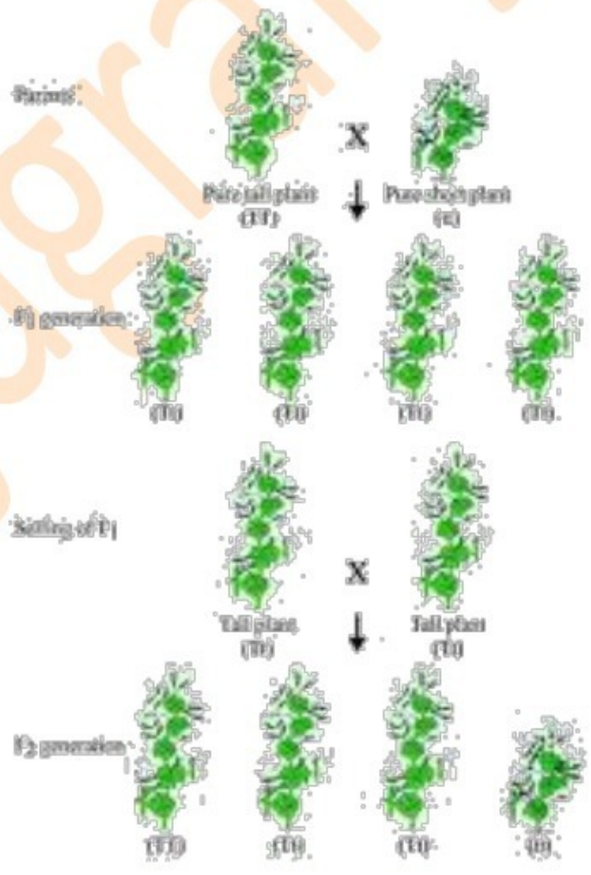
Solution: Mendel took pea plants with different characteristics – a tall plant and a short plant, produced progeny from them and then calculated the percentages of the tall and short progeny.

Mendel first crossed pure bred tall plants with pure bred dwarf pea plants and found that only tall pea plants were produced in the first generation or F_1. No dwarf pea plants were obtained in the first generation of progeny.

Thus, Mendel concluded that F_1 showed the traits of only one of the parent plant : tallness. The trait of the other parent plant did not show up in the progeny.

Mendel then crossed the tall pea plants of the F1 generation and found that tall plants and dwarf plants obtained in the F_2 generation are in the ratio 3:1. Mendel noted that the dwarf trait of the parent pea plant which had seemingly disappeared in the first generation progeny, re appeared in the second generation.

Mendel called the repressed trait of dwarfness as recessive trait and expressed trait of tallness as dominant trait.



Question 2: How do Mendel's experiments show the traits are inherited independently?

Solution: The two pairs of contrasting characteristics chosen by Mendel were shape and color of the seeds: round- yellow seeds and wrinkled green seeds. Mendel crossed pea plants having

round-yellow seeds with pea plants having wrinkled green seeds and noted their occurrence in the succeeding generations.

Mendel first crossed pure bred pea plants having round yellow seeds with pure bred pea plants having wrinkled green seeds and found that only round yellow seeds were produced in the first generation.

He concluded that round shape and yellow color of seeds were dominant traits over wrinkled and green color of the seeds.

When the F_1 generation were cross bred, four types of seeds having different combinations of shape and color were formed.

Round yellow : round green: wrinkled yellow: wrinkled green

9 : 3: 3: 1

On the basis of this observation, Mendel concluded that though the two pairs of original characteristics combine in F1 generation but they separate and behave independently in subsequent generations.

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?

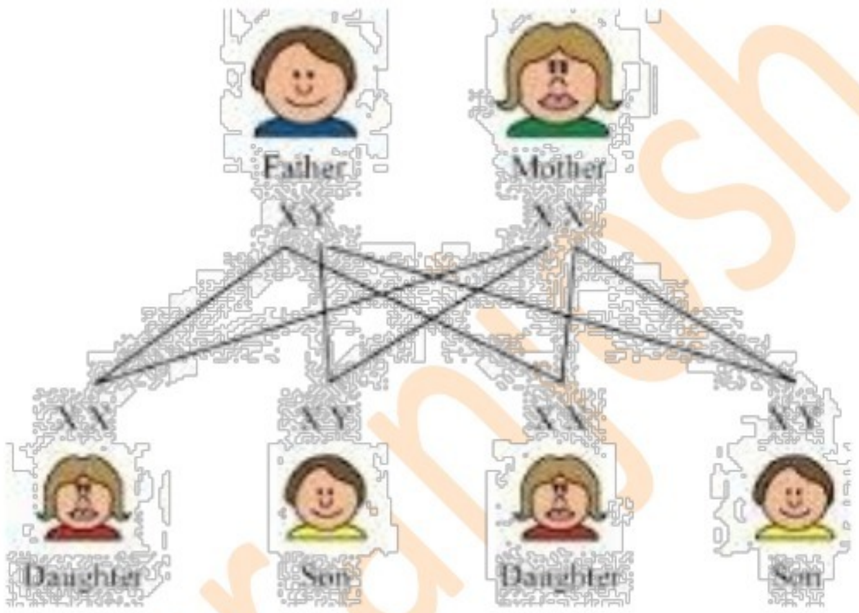
Solution: No this information is not enough to determine which trait is dominant. The blood group is determined by a pair of genes. The gene responsible for the daughter's O blood group might have been inherited either from father or mother.

One probability is father having OA pair and mother having OO pair of genes.

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

Solution: In humans, we have 22 homologous pairs of autosomes each with one paternal and maternal copy respectively. 23 rd pair called the sex chromosomal pair is the odd one. It is responsible for the sex of the child. Women or a girl child have a perfect pair, both the chromosomes are XX. While males or boys have a mismatched pair, one normal sized X and short one called Y.

Thus women are XX and men are XY.



On page 150

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

Solution: Following are the ways through which individuals with a particular trait may increase in a population:

Natural Selection: Certain variations give survival chances to individuals in a population in a changed environment resulting in increase in their population.

Genetic Drift: External calamity or accidents in small populations may lead to increase in number of certain individuals in a population.

Question 2: Why are traits acquired during the life time of an individual not inherited?

Solution: Any changes in the somatic cells cannot be passed to DNA of germ cells. Hence, these traits are not inherited.

Question 3: Why are the small numbers of surviving tigers a cause of worry from the point of view of genetics?

Solution: Smaller number means fewer variations. Number of variation is directly related to the frequency of natural selection. For effective selection, population must consist of infinite number of individuals in a population. For any reason, if these tigers died, chances of their becoming extinct are very high.

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Question 1: What factors could lead to the rise of new species?

Solution: There are mainly three factors responsible for the rise of new species. They are:

Genetic variation – Changes in the gene frequency of an organism particularly in small breed in the isolated population can bring about variations.

Natural Selection – Individuals having favorable variations will survive and pass on these variations to their progeny.

Genetic Drift – immigration, emigration or certain natural calamity may cause permanent increase or decrease in certain small population from the gene pool.

Question 2: Will geographical isolation be a major factor in the speciation of a self pollinating plant species? Why or why not?

Solution: Geographical isolation will not act as a major factor in the speciation of a self pollinating plant species. Since the plant is self pollinating, pollens can transfer to the stigma of the same flower or to another flower of the same plant.

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

Solution: The answer can be either yes or no.

In first case, since the organism reproduces asexually, the offsprings have identical DNA. (variations are minimum in case of asexual reproduction). So, here geographical isolation alone cannot be a major factor in the speciation.

In second case, geographical isolation can be a major contributing factor if it increases the probability of a change to develop in the gene flow leading to the formation of new species.

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

Solution: Analyzing the organ's structure in fossils helps us to judge how far the evolutionary relationship exists. E.g presence of feathers in some fossil dinosaurs indicates that birds and reptiles are closely related. Dinosaurs had feathers not for flying but instead these feathers provided insulation to their body, whereas feathers in birds are used for flying purpose.

So, such a homologous characteristic helps to identify an evolutionary relationship between apparently different species.

Question 2: Can the wing of a butterfly and a wing of a bat be considered homologous organs? Why or why not?

Solution: No, though the function of wings in both the case is same but they are structurally different. They are analogous organs.

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

Solution: The remains or impressions of dead animals and plants that lived in remote past are known as fossils. Fossils provide an evidence for evolution. Fossils help us in studying evolution in number of ways. Some of them are listed below:

These are the clues to the past and thus trace the path of the evolution.

They help in building evolutionary relationships among present and past animals and plants.
Example: Archeopteryx

Fossils help us in learning the diversity of life and animal behavior in past.

These help in understanding previous climate and environment, thus helps in categorizing geological time scale.

On Page 158

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?

Solution: Although human beings look so different from each other in terms of size, color and looks but all of them belong to the same species (*homo sapiens*) because of the following reasons:

All human beings belong to the same species and are able to interbreed.

Fossil evidences prove that earliest *homo sapiens* arose in South Africa and moved across the continents and developed into different races during the ice age.

Fossil evidence shows that humans have not changed much anatomically over last 200,000 years.

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

Solution: Evolution cannot be considered as progress in better body designs, but it states that more and more complex body designs have emerged over time. It does not say that older designs are inefficient. Many of the older and simpler designs still survive. For example, Bacteria. Bacteria is the simplest form of life which inhabit the most inhospitable habitats like hot springs, deep sea thermals, vents and ice in Antarctica.

Spiders, fish, chimpanzees etc are yet another species in terms of spectrum of evolving life. Thus, no one can be named better one.

Exercise

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

Solution: (c) , the genetic make up of the tall parent can be depicted as TtWW. Since all the progeny bore violet flowers, it means that the tall plant having violet flowers has WW genotype for violet flower color. Since the progeny is tall and short, parent plant was not a pure tall plant (Tt).

TtWw X ttww -------→ TtWw X ttww

Therefore, half of the progeny is tall but all of them have violet flowers.

Question 2: An example of homologous organs is

Our arm and a dog's fore leg

Our teeth and an elephant's tusk

Potato and runners of the grass

All of the above.

Solution: (b) our teeth and an elephant's tusk.

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

Solution: (a) In evolutionary terms we are more close to a chineese boy.

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?

Solution: Let us suppose that children with light colored eyes can either have LL and Ll or ll genotype. If the children have LL genotype, then their parents will also be of LL genotype.

LL X LL --------→ LL

If the children with light colored eyes have ll genotype then their parents will also have ll genotype.

ll X ll ----------→ ll

Therefore, it cannot be concluded whether light eye color is dominant or recessive.

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

Solution: Classification involves grouping of organism into a formal system based on similarities in internal and external structure or evolutionary history. Two species are more closely related if they have more characteristics in common. And if two species are more closely related, that means they have a more recent ancestor.

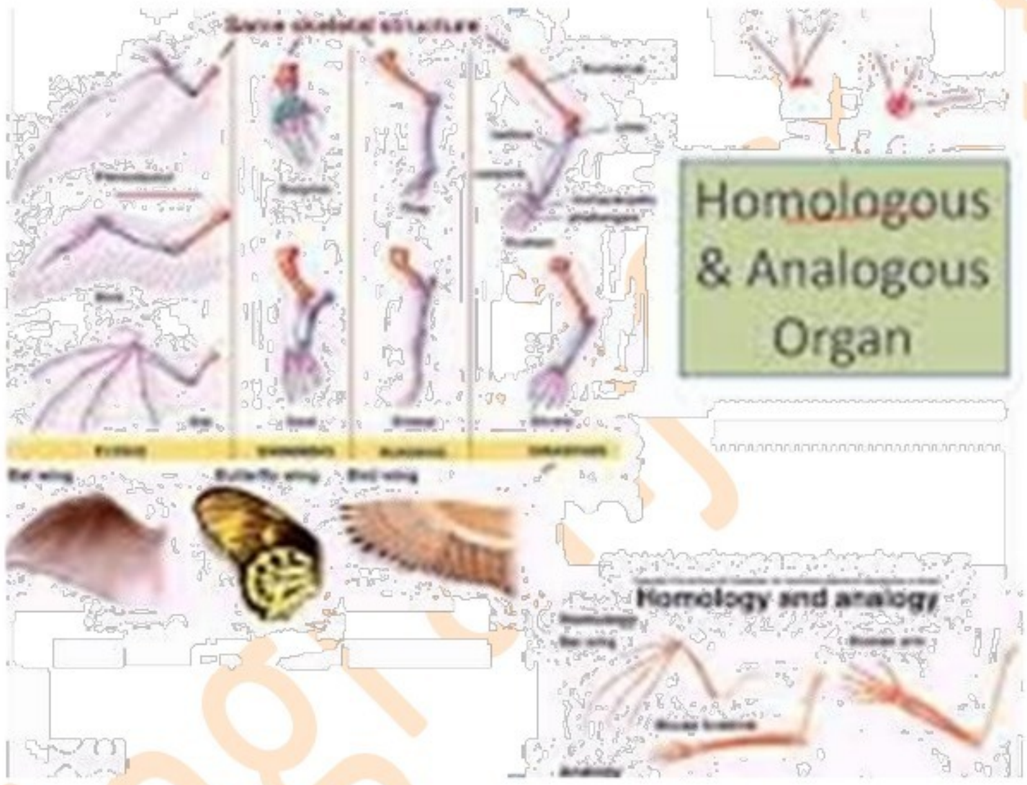
For example: In a family, a brother and sister are closely related as they are siblings and have a common ancestor, their parents. Similarly, a brother and a cousin are also related but less than the previous relationship. This is because they have a common ancestor i.e. their grand parents in the second generation.

With subsequent generations, the variations make organisms more different than their ancestors. So we conclude that we classify organisms according to their resemblance which is similar to create an evolutionary tree.

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

Solution: Homologous organs – these organs are similar in origin (embryologically similar) but perform different functions. For example, the fore limbs of humans and the wings of birds look different externally but their skeletal structure is similar. Wings of birds are the modification of forearms. The two perform two different function – wings help in flight whereas human forearm helps in various functions.

Analogous organs: These are from different origin but perform similar function. For example, the wings of a bird and that of a bat are similar in function but wings of the bat are the folds of the skin that are stretched between the fingers whereas the wings of the birds are present all along the arm.



Question 7: Outline a project which aims to find the dominant coat color in dogs?

Solution: Dogs have a variety of genes that govern coat color. There are atleast eleven identified genes – A, B, C, D, E, F, G, M, P, S, T that influence the coat color of the dog.

A dog inherits one gene from each of its parents. We know, that the dominant gene will get expressed in the phenotype.

Now suppose, one parent is homozygous for black BB, while the other parent is homozygous brown bb.

Now, BB X bb ----→ Bb, Bb, Bb, Bb ……..F_1 generation

Since black is dominant over brown, all the offsprings will be black in color.

Bb X Bb ----------→ Gametes formed would be

B , b, B, b

F_2 generation = BB, Bb, Bb,bb

Thus we conclude, out of four, three would be black and one would be brown.

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

Solution: Fossils are the remains of the organisms that once existed on earth. These represent the ancestors of plants and animals which are alive today. They provide evidences of evolution by revealing the characteristics of the past organisms and the changes that have occurred earlier.

Fossils help us in studying evolution in number of ways. Some of them are listed below:

These are the clues to the past and thus trace the path of the evolution.

They help in building evolutionary relationships among present and past animals and plants. E.g *Archeopteryx*

Fossils help us in learning the diversity of life and animal behavior in past.

These help in understanding previous climate and environment, thus helps in categorizing geological time scale.

Let us explain the importance of fossils in deciding evolutionary history with the help of an example. Around 100 million years ago some organisms died and were buried in the soil in that area. More sediment accumulated on the top of it turning it into sedimentary rock. By studying the basic structure of the fossils found, paleontologists determined the link between them and therefore the evolutionary relationships.

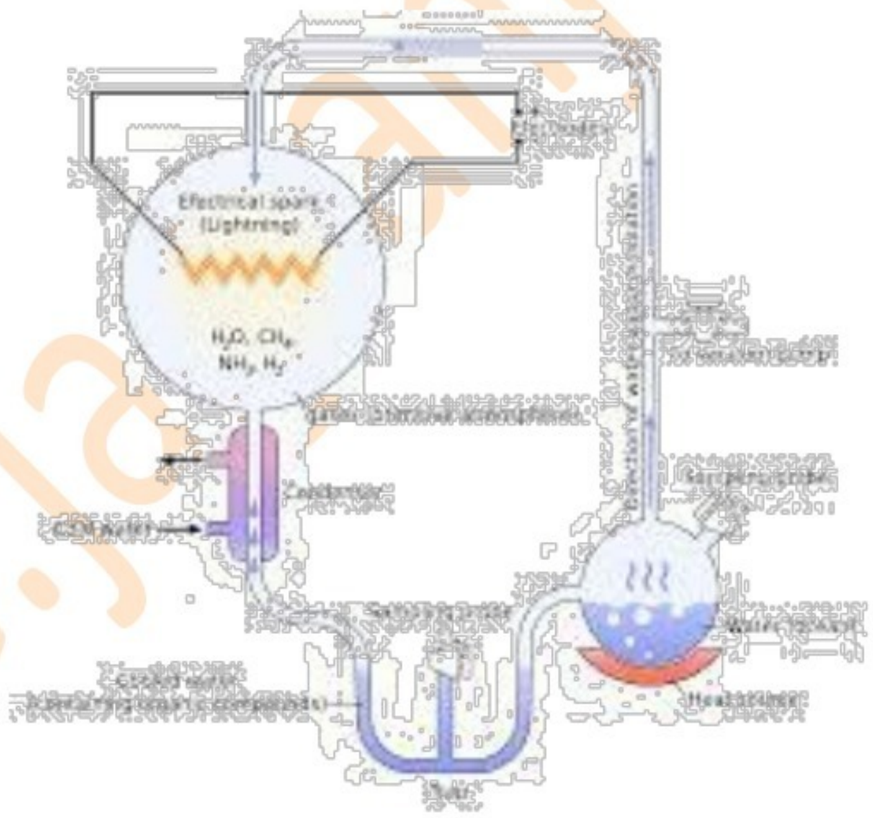
Question 9: What evidence do we have for the origin of life from inanimate matter?

Solution: A british Scientist J.B.S Haldane, suggested that life originated from simple inorganic molecules. He believed that when the earth was formed it was hot gaseous mass containing elements such as nitrogen, oxygen , carbon, hydrogen etc. these elements combined to form carbon dioxide, hydrogen sulphide, methane and ammonia and water etc.

After the formation of water, slowly the earth surface cooled and inorganic molecules interacted with one another to form simple organic molecules. The energy for these reactions was provided by solar radiations, lightning and volcanic eruptions etc.

This theory was confirmed by experiments conducted by Stanley L. Miller and Harold C. Urey in 1953.

They assembled an apparatus to create an early earth atmosphere which was supposed to consist of gases like methane, ammonia and hydrogen sulphide etc. They kept the temperature just below 100 degree Celsius and electric sparks were then passed through the mixture of gases for about one week. At the end of one week, they found that 15% of carbon had been converted into amino acids which make up the protein molecules found in living organisms.



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?

Solution: We know the fact during sexual reproduction variations arise as the offspring is bi parental. On the contrary, variations are minimal in case of asexually reproducing organisms as it is uni parental.

After studying the theory of variations and natural selection, we can say that variants help the species to survive in all conditions. Environmental conditions such as heat, light, pests and food availability can change suddenly at any place at any time. At that time only those variants which are resistant to these conditions would be able to survive. Hence, this will slowly lead to the evolution of a better adapted species.

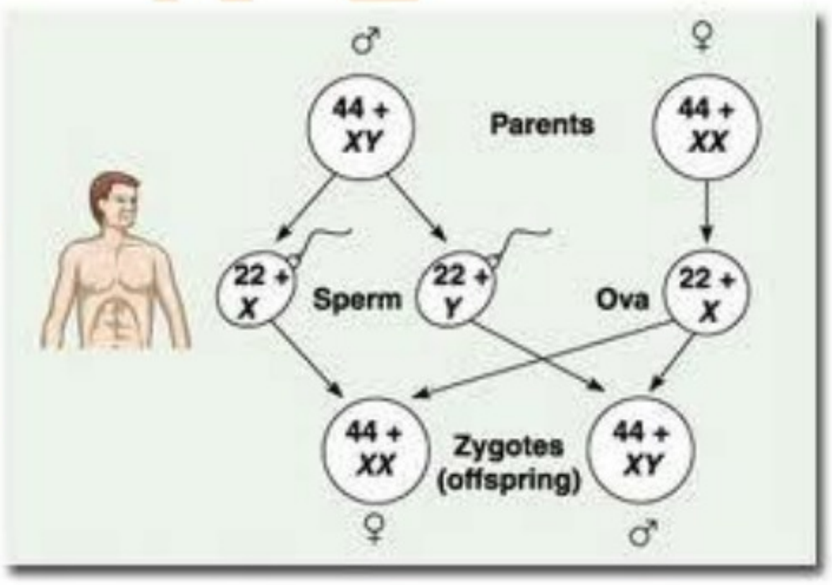
Thus variations help in evolution of sexually reproducing organisms.

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

Solution: In human beings , every somatic cell of the body contains 23 pairs of chromosomes. Out of these 23 pairs , first 22 are known as autosomes and the remaining one is called the sex chromosome represented by X or Y.

Females have two X chromosomes and males have one X and one Y chromosome.

Therefore, the male gamete will have 22 autosomes and either X or Y chromosome. Similarly, female gamete will have 22 autosomes and X chromosome only. During reproduction, the male and female gametes fuse to form a diploid zygote containing 22 autosomes and one X or Y chromosome from male and 22 autosomes and one X chromosome from female.



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?

Solution: In species, variations that offer survival advantages are naturally selected. Individuals adjust to their environments with the help of these selected variations and consequently these

variations are passed to their future progeny. Evolution of organisms occur as a result of this natural selection.

However, there can be some other variations which do not offer any survival advantage and arise only accidentally. Such variations in small populations can change the frequency of some genes even if they are not important for survival.

This accidental change in the frequency of genes in small populations is referred to as genetic drift. Thus, genetic drift provides diversity without any survival advantage.