CBSE Class 10 Science Chapter 9 Heredity and Evolution Notes

Introduction

Heredity refers to the passing of characteristics from one generation to the next. Evolution is defined as the gradual process by which a simple life form leads to the development of complex organisms over a period of time, spanning several generations.

Here in this chapter, we will learn about the mechanism by which variations are created, the rules of heredity determining their pattern of inheritance, and how the accumulation of these variations leads to evolution.

Heredity

The transfer of traits from one generation to the next is termed heredity. Genes are the functional units of heredity that transfer characteristics from parents to offspring. Genes are short stretches of DNA that code for a specific protein or RNA.

Genetics is the branch of biology that deals with the study of genes, heredity and variations.

Sexual Reproduction

- The mode of reproduction involves two individuals; one male and one female.
- They produce sex cells or gametes, which fuse to form a new organism.

For more information on Heredity and Evaluation, watch the below videos

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Genes

- Gene is the functional unit of heredity.
- Every gene controls one or several particular characteristic features in living organisms.

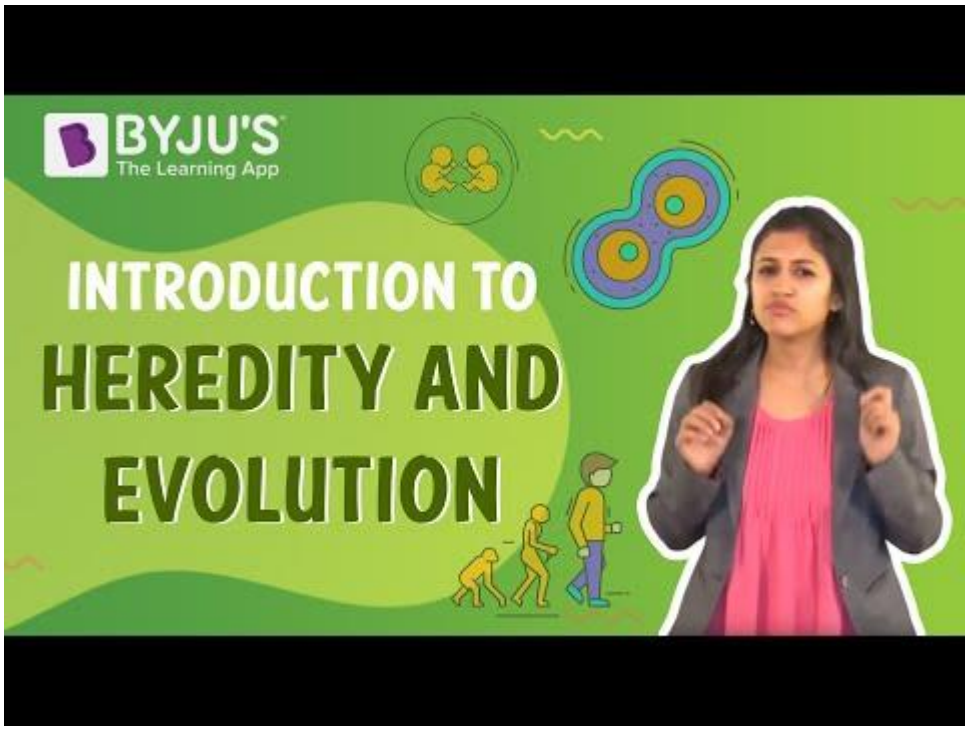
Read more: Genes

Heredity

The process by which the features of an organism are passed on from one generation to another is called heredity.

- The process is done by genes, which define the characters in the organism.

For more information on Introduction to Heredity and Evaluation, watch the below video



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To know more about Heredity, visit here.

Mendel's Work

- Gregor Johann Mendel, known as the 'Father of Genetics', was an Austrian Monk who worked on pea plants to understand the concept of heredity.
- His work laid the foundation of modern genetics.
- He made three basic laws of inheritance – The Law of Dominance, The Law of Segregation and The Law of Independent Assortment.

PEA PLANTS IN MENDEL EXPERIMENT

Seed shape	Seed colour	Pod shape	Pod colour	Flower colour	Flower location	Plant size
Round	Yellow	Inflated	Green	Purple	Axial	Tall
Wrinkled	Green	Constricted	Yellow	White	Terminal	Dwarf

Dominant Traits

The traits that express themselves in an organism in every possible combination and can be seen are called Dominant traits.

- In Mendel's experiment, we see that the tall trait in pea plants tends to express more than the short trait.
- Therefore, the tall trait of the plant is said to be dominant over the short trait.

Recessive Traits

A trait which is not expressed in the presence of a dominant allele is known as recessive.

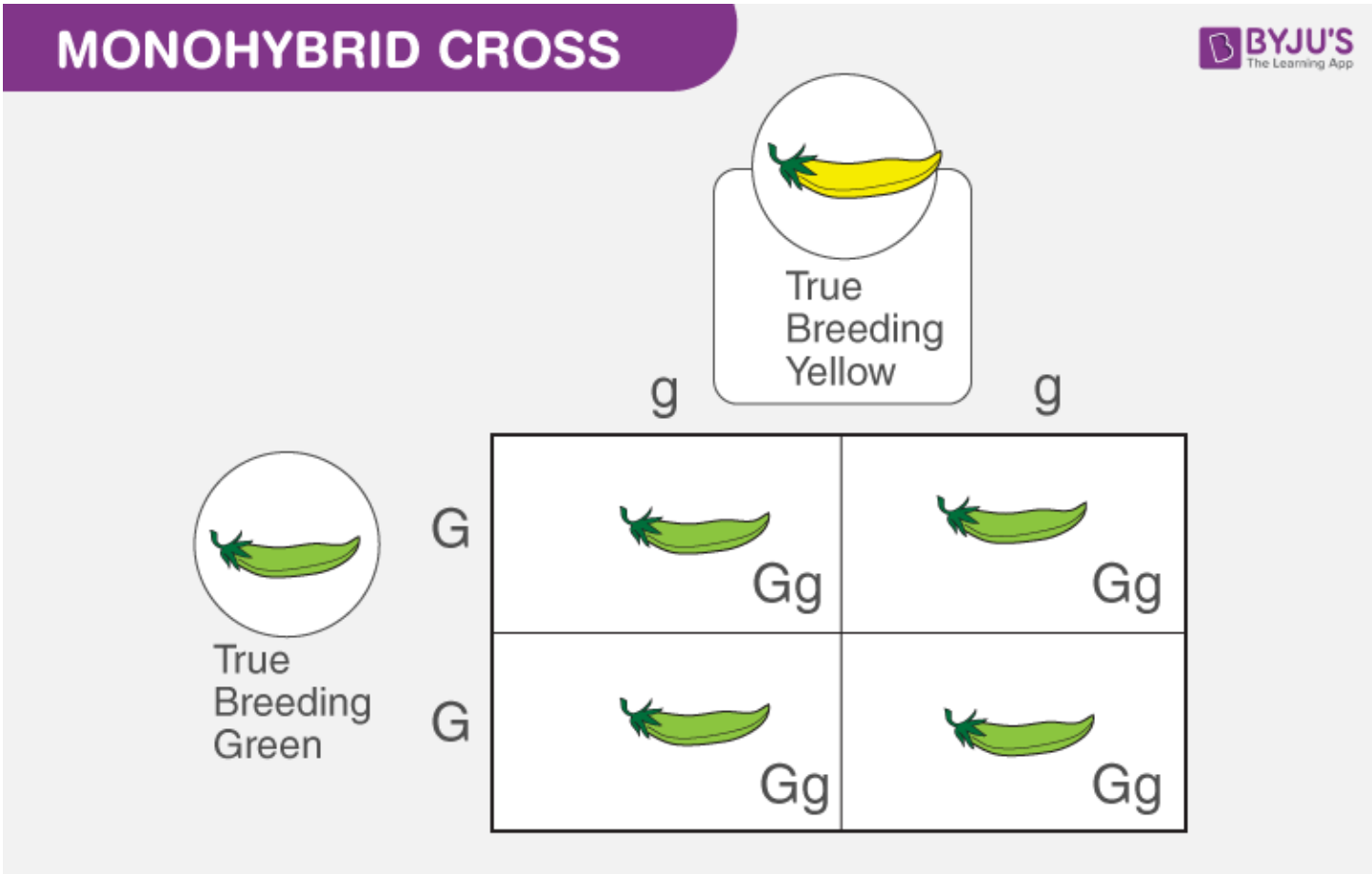
- So, a recessive character/trait is present in an organism but cannot be seen if a dominant allele exists.

To know the difference between Dominant traits and Recessive traits, visit here.

Monohybrid Cross

- When only one character is considered while crossing two organisms, then such a cross is known as a monohybrid cross.
- The ratio of characters arising out of this cross at F2 generation is called the monohybrid ratio.
- E.g., If a tall plant (TT) is crossed with a dwarf plant (tt), we get 3 tall:1 short plant at the end of the F2 generation.
- So, 3:1 is a monohybrid ratio.
- Here, the height of the plant is considered at a time.

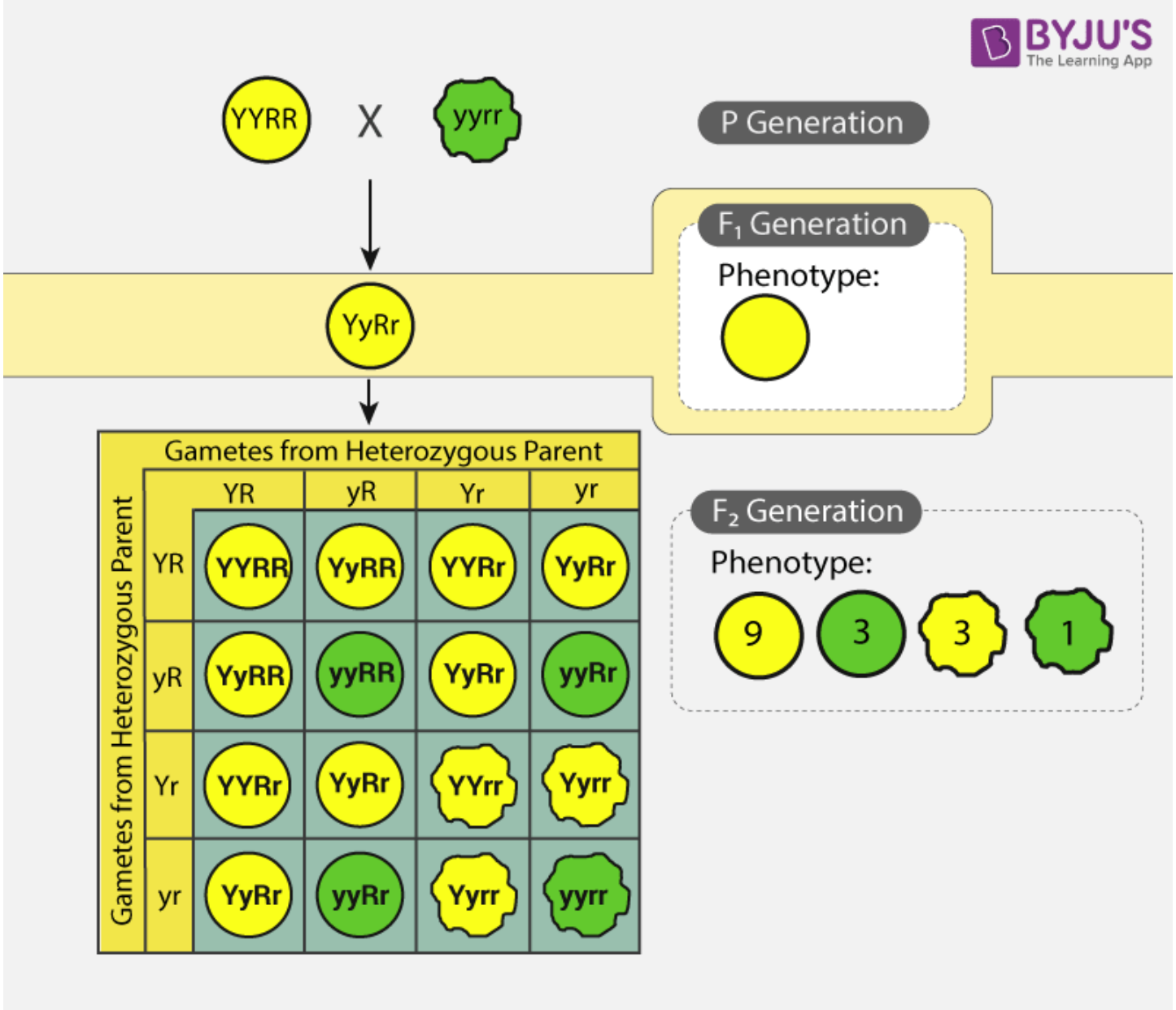
Below is an example of a monohybrid cross between a true-breeding pea plant with green pods (GG) and yellow pods (gg). Here, the green colour of the pod is the dominant trait. Hence, in the F1 generation, all plants contain green pea pods.



To know more about Monohybrid cross, visit here.

Dihybrid cross

- When two characters are considered while crossing two organisms, then such a cross is known as a dihybrid cross.
- The ratio of characters arising out of this cross at F2 generation is called the dihybrid ratio.
- E.g., If a plant with round and green pea is crossed with a plant with wrinkled and yellow pea,
- The first-generation plants would all have round and green peas.
- On crossing the same for an F2 generation, we would observe four combinations of characters in the ratio of 9:3:3:1.
- Thus, 9:3:3:1 is the dihybrid ratio.



To know more about the Dihybrid Cross, visit here.

Inheritance

In Biology, inheritance pertains to the transfer of traits from one generation to another.

To know more about Mendel's laws of inheritance, visit here.

Laws of Mendel

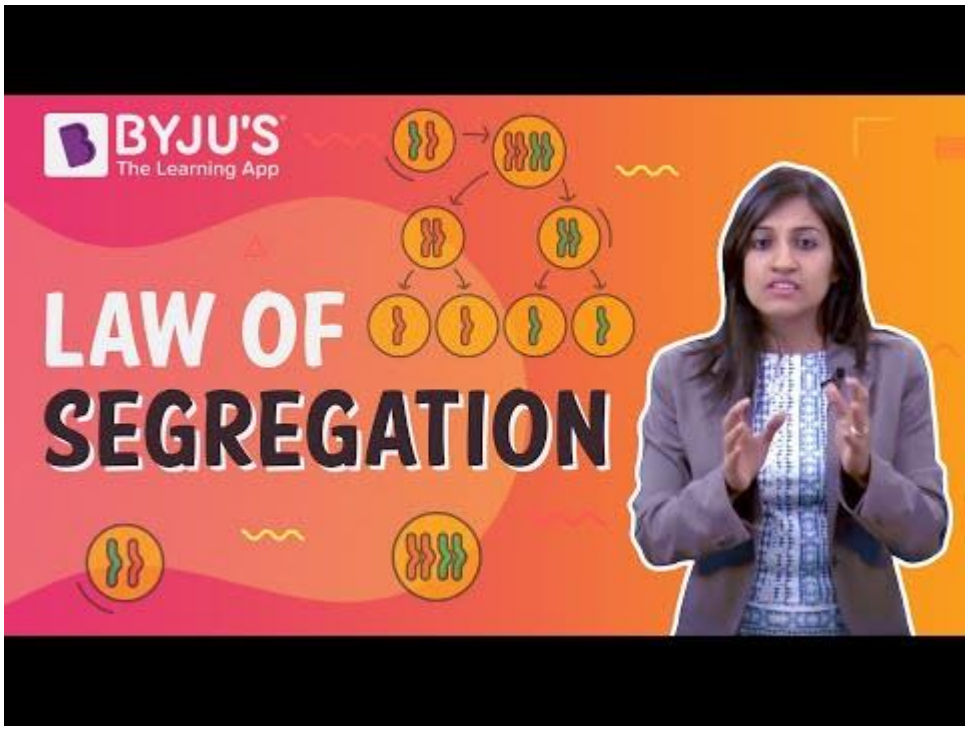
Law of Dominance says that a gene has two contrasting alleles and one always expresses itself in the organism.

It is called the dominant gene, and it expresses in any possible combination.

Law of Segregation says that traits get segregated completely during the formation of gametes without any mixing of alleles.

Law of Independent Assortment says that the traits can segregate independently of different characters during gamete formation.

For more information on Segregation, watch the below video



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Sex Determination

- The process of determining the sex of an individual based on the composition of the genetic material is called sex determination.
- In different animals, the sex of an embryo is determined by different factors.
- In humans, sex determination happens on the basis of the presence or absence of the Y chromosome.
- XX is female, and XY is male
- An ovum always contains an X chromosome.
- An ovum, upon fusion with the Y-containing sperm, gives rise to a male child and upon fusion with the X-containing sperm, gives rise to a girl child.

To know more about Sex determination, visit here.

Traits

Traits are characteristic features of an organism, manifested in a physical form that is visible or in a physiological aspect of the organism.

Acquired Characters

- The traits that are acquired by an organism over the period of its lifetime are termed acquired characteristics.

- These characteristics that are not passed on to the DNA of germ cells do not get transferred to the next generation. E.g. loss of muscles and less weight due to starvation, loss of limb or tails due to injury, etc.

Inherited Characters

- The traits that are inherited from the parents are called inherited characters.
- These traits always get transferred to the next generation but depending on the dominance or recessiveness, they may or may not be expressed.
- Examples are height, skin colour and eye colour.

To know more about Acquired and Inherited Traits, visit here.

Variation

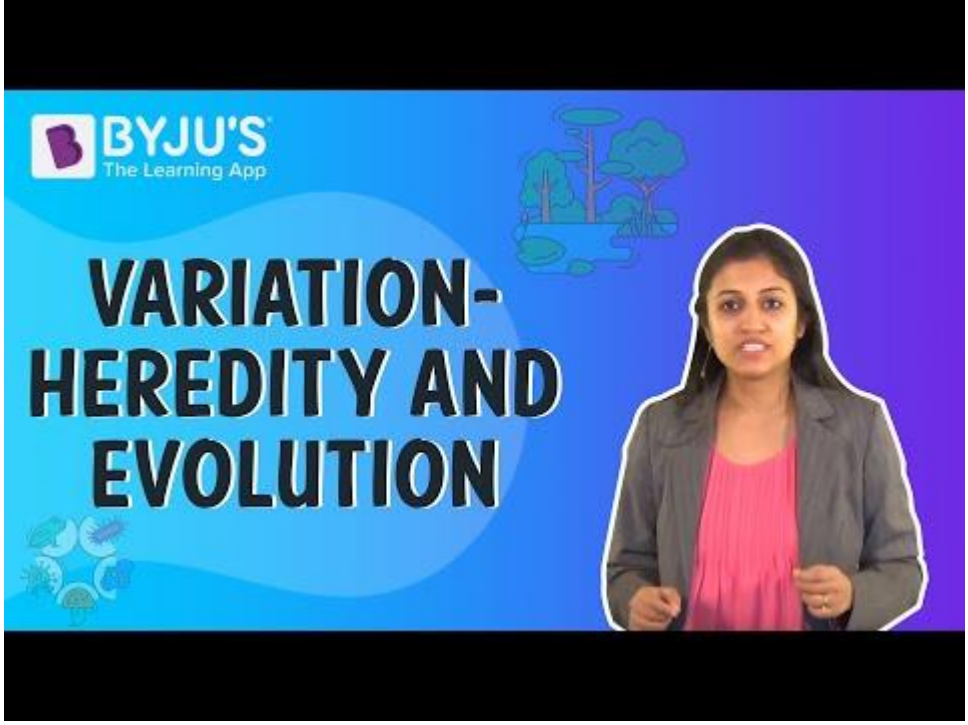
Variation is the measure of the difference between individuals of the same species. Offspring is not identical to parents, there exist some variations. Each individual in a population differs from the others. Recombination and mutation are the main causes of variations.

Sexually reproducing organisms show great variation among individuals of a species and the long-term accumulation of variations plays a significant role in evolution. The selection of variants by environmental factors is one of the driving factors of evolutionary processes.

Genetic Variations

The differences in the DNA sequences among every organism leading to the diverse gene pool are called genetic variations. These differences lead to different/varied physical characters or biochemical pathways.

For more information on Variation – Heredity and Evaluation, watch the below video



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To know more about Genetics, visit here.

Natural Selection

- It is the phenomenon by which a favourable trait in a population of a species is selected.
- Changing natural conditions exert equal pressure on all the existing species.
- The species/organisms which are better adapted to the changing conditions survive and reproduce i.e. selected by nature and species/organisms which cannot adapt perish i.e. rejected by nature.

Speciation

Genetic Drift

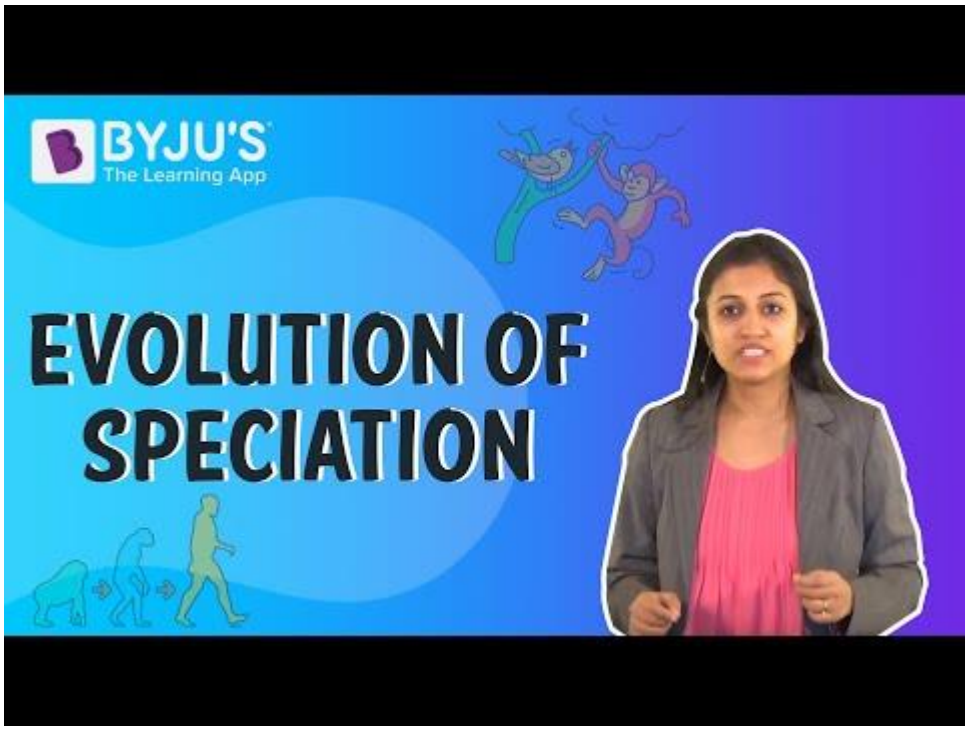
Natural selection can play an important role in deciding the traits that survive in a population. However, random fluctuations in gene variants are seen on many occasions. This phenomenon is known as genetic drift. Thus, genetic drift is a change in the frequency of an existing allele in a small population.

Genetic drift may cause a gene variant to disappear from the population and thus reduce genetic variation.

Speciation

It is the process of formation of a new species from existing ones due to several evolutionary forces like genetic drift, isolation of populations, natural selection, etc. Speciation leads to diversity in the ecosystem and the diversity and diversity lead to evolution.

For more information on Speciation, watch the below video



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To know more about Speciation and evolution, visit here.

Gene Flow

Gene flow is the transfer of genes from one population to the next. This occurs due to migration or the introduction of organisms to a new population. This results in the change in gene frequencies of a population.

Population

A population is a community or a group of animals, plants or any living organism that can reproduce with each other and have fertile, viable offspring.

Charles Darwin

- Charles Darwin, also called the **"Father of Evolution",** was an English Naturalist and Biologist.
- Five years of the expedition in a ship called HMS Beagle to Galapagos Island helped him write his theory of evolution.
- In 1859 he published a book called Origin of Species, in which he put his theory of evolution in detail.

To know more about Charles Darwin's Contribution to the Theory of Evolution, visit here.

Evolution and Fossils

Evolution

Evolution is a tangible change in the heritable characteristics of a population over several generations. These changes can give rise to a new species or the species might change themselves to become better adapted to the surrounding environment.

Read more: Evolution

Origin of Species

- After a successful expedition on HMS Beagle, Charles Darwin wrote a book on what he observed on the Galapagos Islands.
- In the book named 'The Origin of Species, he wrote a detailed theory of evolution which was mostly based on Natural Selection.

Origin of Life – Haldane's Theory

- JBS Haldane was a British Scientist who theorized that life originated from organic and lifeless matter.
- His theory was proved to be correct by Urey and Miller's experiment.
- It was called the theory of abiogenesis.

Evolutionary Evidence – Fossils

- There are plenty of pieces of evidence to support the theory of evolution.
- Fossils happen to be the biggest of them.
- Fossils are the preserved remains of ancient animals or plants that died millions of years ago.
- The fossils help us understand the anatomy and even physiology of these organisms and understand how evolution worked and led to the formation of organisms that we see today.

Formation of Fossils

Fossils are important pieces of evolutionary evidence and are formed by the following steps:

- Organisms die, and they get buried in mud and silt.
- The soft tissues of the body get quickly leave behind the hard bones or shells
- Over time sediments build over it and harden into rock
- As the bones decay, minerals seep in to replace the contents cell by cell, a process called petrification
- If bones decay completely, it leaves behind the cast of the animal.

To know more about Fossils, visit here.

Evolutionary Relationships

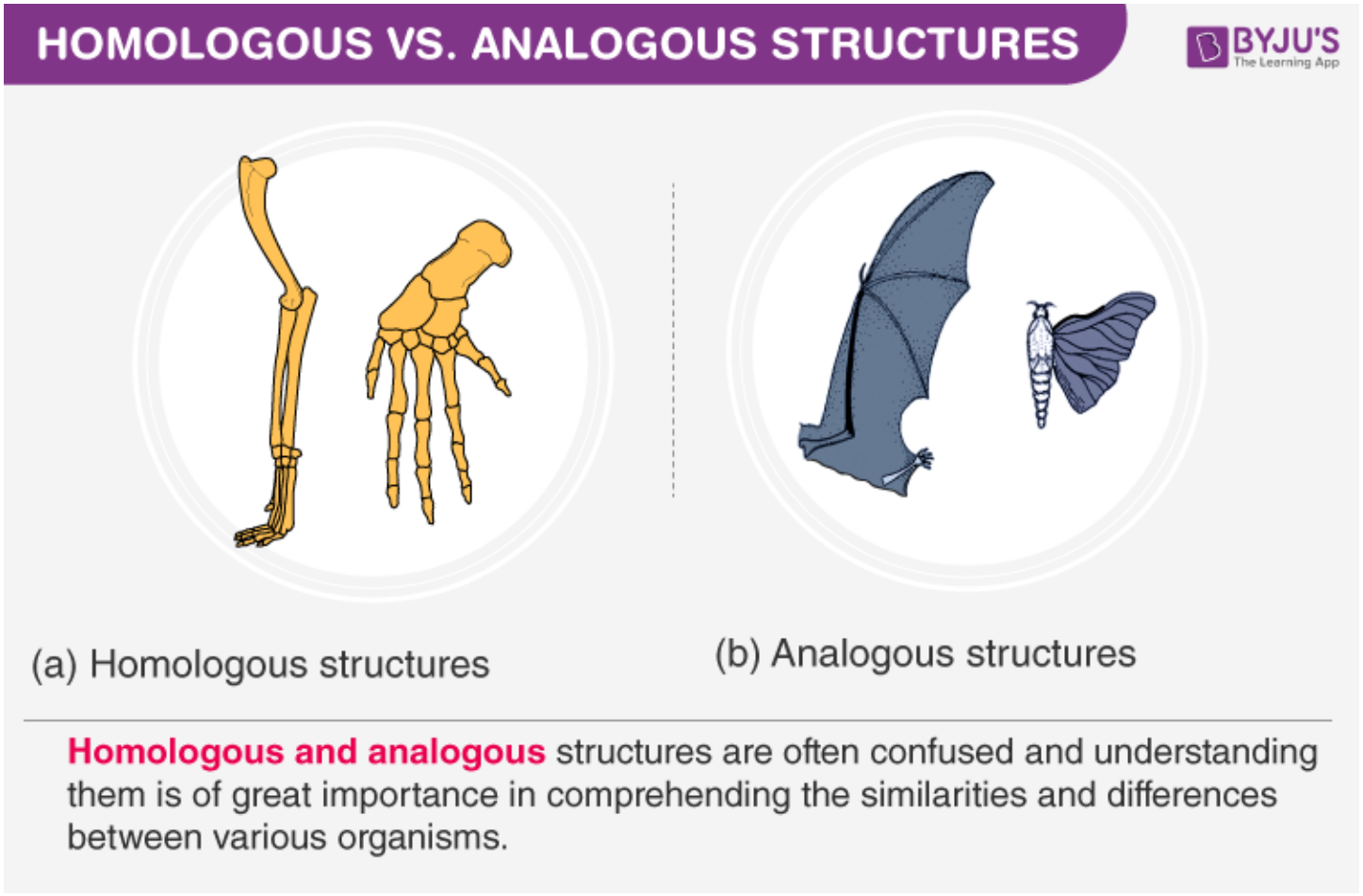
Evolutionary relationships of animals can be deduced by studying the homologous organs and analogous organs.

Homologous organs are those which have a similar structure but different function

- Wings of birds and forelimbs of mammals: have similar structures but are modified to suit different functions.
- A tendril of the pea plant and spine of the barberry plant: both are modified leaves but perform different functions.

Analogous organs are those which have a similar function but a different structure and origin too

- Wings of bats, birds and wings of insects: both are used for flying, but structurally are very different.
- Leaves of opuntia and peepal: both perform photosynthesis, but leaves of Opuntia are modified stems, whereas peepal leaves are normal leaves.



To know more about Fossils' Evolutionary Relationships, visit here.

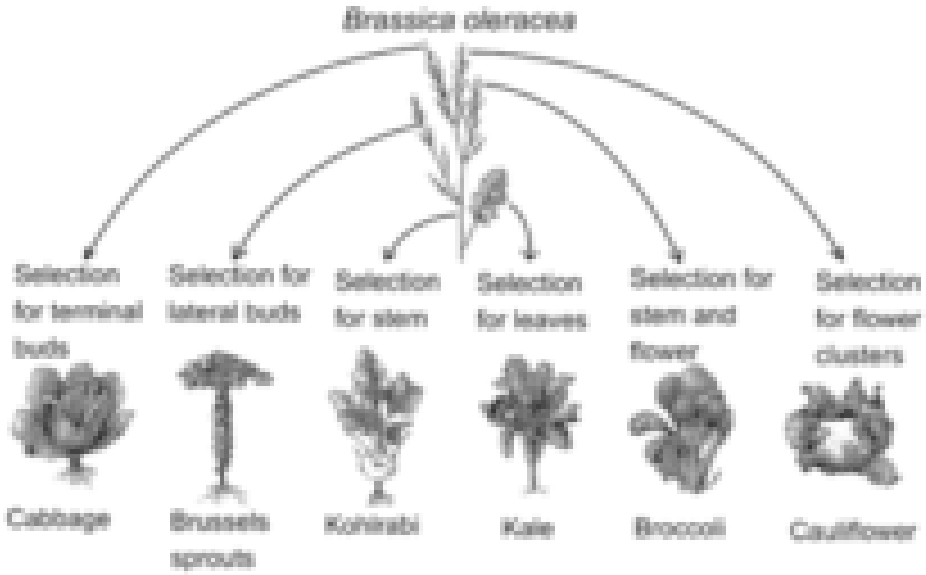
Evolution by Stage

- Evolution is a slow process and does not happen overnight.
- There are several stages in the evolution of almost every animal that we see today.
- Complexities do not evolve suddenly but evolve bit by bit and may have limited use at certain stages.
- This gradual evolutionary process is called evolution by stages.

To know more about Evolution by Stages, visit here.

Artificial Selection

- Sometimes a single species can evolve into several different species due to artificial selection.
- E.g. the cabbage family. A single ancestor in the cabbage family gave rise to several different species due to the selection of different traits.



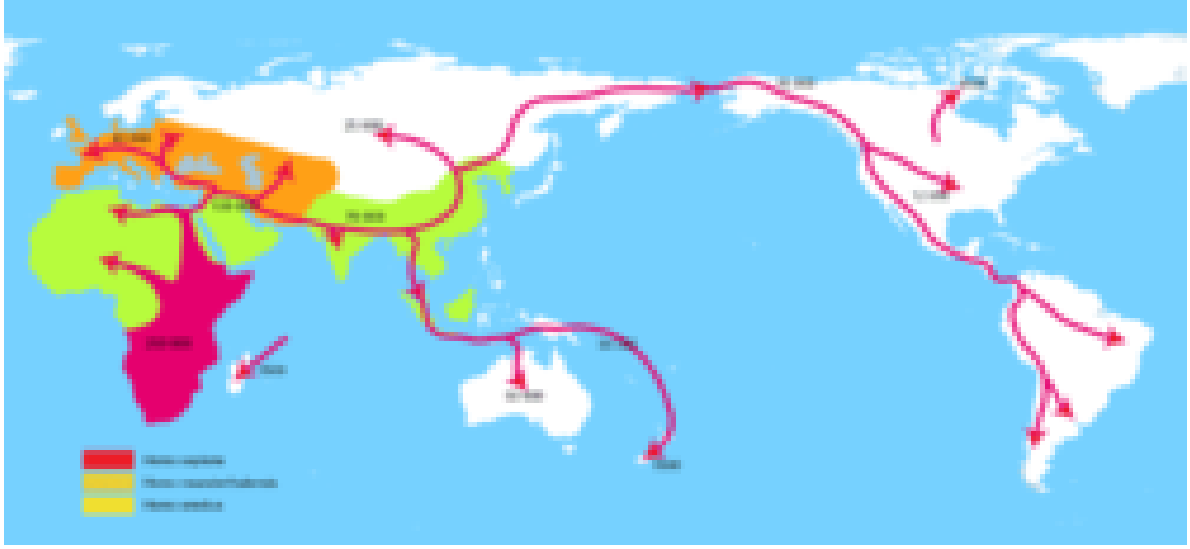
Artificial selection in the cabbage family

Molecular Phylogeny

- The evolutionary relationship among different biological species is called phylogeny.
- It gives rise to an evolutionary tree.
- In molecular phylogeny, these relationships are studied at the hereditary molecular level, mainly using DNA sequences.
- It involves the analysis of DNA composition and gene comparison between different species.

Human Evolution

- Humans are known to belong to the primate family.
- Humans today have a very close genetic connection to chimps and other primates.
- While the complete evolutionary process of Humans from Primates is still a mystery, a larger picture of human evolution has been formed.
- Some of the ancestors of Humans include Dryopithecus, Ramapithecus, Australopithecus, Homo erectus, Homo sapiens neanderthalensis, Cro-magnon man, and finally, us, the Homo sapiens.
- **Human evolution traces back to Africa**. Then they migrated all over the world.



Migration of Early Humans

Access Answers to Science NCERT Solutions for Class 10 Chapter 9 Heredity and Evolution

Exercise-9.1 Page: 143

1. If a trait A exists in 10% of a population of an asexually reproducing species and 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?

Solution:

Mendel showed that the traits could either be dominant or recessive through his experiments that focused on the mono-hybrid cross. The experiment involved him crossing tall (TT) pea plants with dwarf (tt) pea plants. The resultant plants which formed after fertilisation 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 was 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 segregates 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:

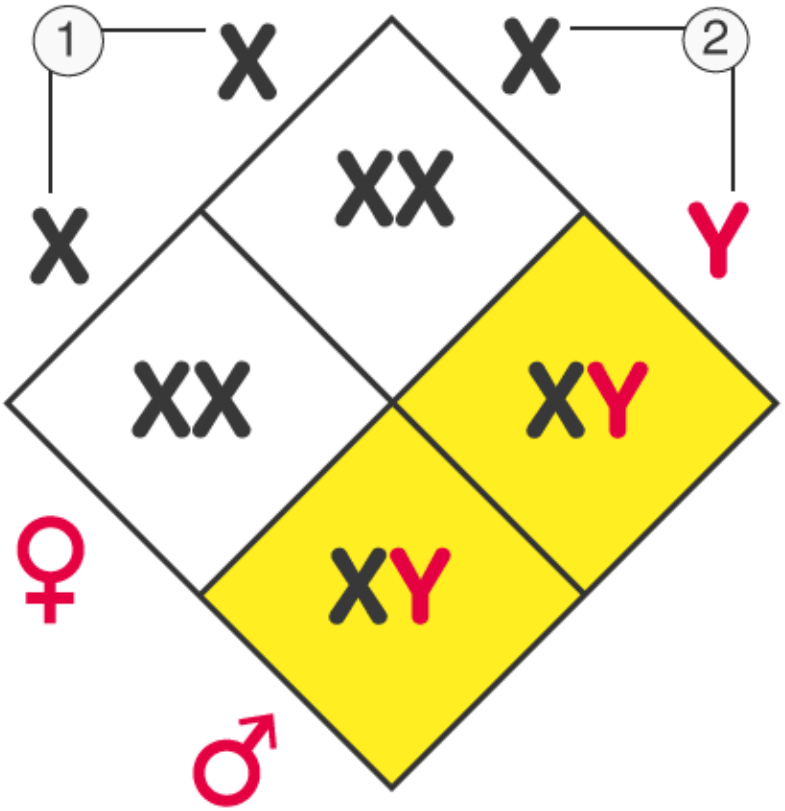
Given information is not enough to tell us which characteristics are dominant – blood group A or O. Blood type A is always dominant in ABO blood, and blood type O is always recessive. Here, the father's blood group may be genotypically AA (homozygous) or AO (heterozygous), whereas that of the mother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

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

Solution:

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

- The male's X chromosomes combine 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



1 Female gametes | 2 Male gametes

Exercise-9.3 Page: 150

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

Solution:

An individual attribute could increase a population in 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 their 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 in the attribute within the population.

2. Why are traits acquired during the lifetime of an individual not inherited?

Solution:

Traits acquired during a lifetime cannot be inherited by 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.

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

Solution:

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.

Exercise – 9.4 Page: 151

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

Solution:

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

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

Solution:

In the pollination of plant species, geographical isolation is usually not a major factor, as no new trait will become part of the genetic makeup of a self-pollinating plant species.

However, there are some possibilities of some environmental changes which could result in some variations.

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

Solution:

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.

Exercise – 9.5 Page: 156

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

Solution:

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 aeons ago. It is also important to note that chimpanzees are the closest living relatives to humans.

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

Solution:

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 the wings of a bat are composed of a bony skeleton, complete with blood vessels. Hence, these aren't homologous organs but rather analogous organs.

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

Solution:

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.

Exercise – 9.6 Page: 158

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?

Solution:

While human beings do vary in colour 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 recognised 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 makeup 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 colour is dominant over white.

2. An example of homologous organs is

(a) Our arm and a dog's foreleg

(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 structures but different functions. For example, a whale's flippers, a frog's forelimbs, and a 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 schoolboy

(b) A chimpanzee

(c) A spider

(d) A bacterium

Solution:

Correct answer – (a)

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

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?

Solution:

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

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

Solution:

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.

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

Solution:

Homologous organs are those organs that have the basic structural design as well as the origin; however, they 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, they perform similar functions. For example, the wings of birds and insects.

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

Solution:

Dogs have a certain set of genes that govern coat colour. 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	
	B	B
bb		
b	Bb	Bb
b	Bb	Bb

In this case, all the offspring are going to be heterozygous (Bb).

Since black (B) is dominant, all the offspring 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) offspring.

	B	b
B	BB	Bb
b	Bb	Bb

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

Solution:

Fossils give evidence about:

(a) The organism and their paleobiology

(b) Even the behaviour of an organism can be deduced to some extent (for example, palaeontologists) have unearthed a site with more than 10,000 skeletons of a dinosaur called Hadrosaurus. This implies that the dinosaur lived in herds.

(c) Fossils also provide insight into the evolutionary history of animals and plants (for instance, palaeontologists have discovered that whales had evolved from goat-sized land-dwelling animals called Pakicetus).

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

Solution:

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 are required for life.

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:

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 chromosomes 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 the case of asexual reproduction, variation is severely limited as there is only one parent involved. Hence, the offspring is genetically similar to the parent

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

Solution:

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 are 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 one X-chromosome and one Y-chromosome.

During the process of reproduction, fertilisation 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 one X or Y chromosome. The female contributes 22 autosomes plus one X-chromosome.

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 are very useful for survival if they find themselves in an environment where there is a sudden increase in ambient temperature. This will determine the difference between life and death for the bacteria.

Multiple-choice Questions

1. Exchange of genetic material takes place in

(a) vegetative reproduction

(b) asexual reproduction

(c) sexual reproduction

(d) budding

Soln:

The answer is (c) sexual reproduction

Explanation:

Apart from sexual reproduction, other options are a type of asexual reproduction where only a single parent is involved. Hence, the correct answer is sexual reproduction, where exchange of genetic material takes place.

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

(a) double fertilisation

(b) self-pollination

(c) cross-fertilisation

(d) no fertilisation

Soln:

The answer is (b) self-pollination

3. A cross between a tall plant (TT) and a short pea plant (tt) resulted in progeny that was 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 the pea plant is not governed by gene 'T' or 't'

Soln:

The answer is (a) tallness is the dominant trait

Explanation:

A cross between a tall plant (TT) and a short pea plant (tt) results in the progeny that is all tall plants but with Tt genotype. In the heterozygous plants the dominant trait is expressed phenotypically. Single copy of the 'T' is enough to make the plant tall.

4. Which of the following statements is incorrect?

(a) For every hormone, there is a gene.

(b) For every protein, there is a gene.

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

(d) For every molecule of fat, there is a gene

Soln:

The answer is (d) for every molecule of fat, there is a gene

Explanation:

Every protein, enzyme and hormone is controlled by a specific gene, whereas fats are not controlled by a gene; hence, option d is a wrong statement.

5. If a round, green-seeded pea plant (RR yy) is crossed with a wrinkled, yellow-seeded pea plant (rr YY), the seeds produced in the F1 generation are

(a) round and yellow

(b) round and green

(c) wrinkled and green

(d) wrinkled and yellow

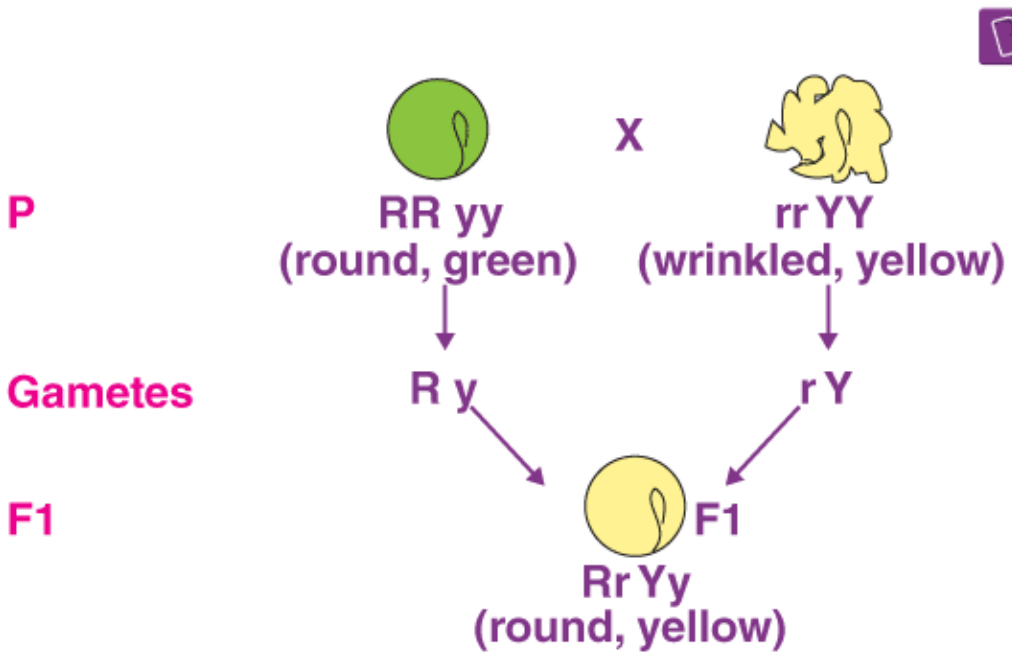
Soln:

The answer is (a) round and yellow

Explanation:

When round, green-seeded pea plant (RRyy) is crossed with a wrinkled, yellow-seeded pea plant, (rrYY) the seeds produced in the F1 generation are with RrYy genotype. Round and yellow are the dominant characters hence in F1 generation all seeds will be round

and yellow.



6. In human males, all the chromosomes are paired perfectly except one. This/these unpaired chromosome/s is/are

(i) large chromosome

(ii) small chromosome

(iii) Y-chromosome

(iv) X-chromosome

(a) (i) and (ii)

(b) (iii) only

(c) (iii) and (iv)

(d) (ii) and (iv)

Soln:

The answer is (c) (iii) and (iv)

Explanation:

Humans have 22 pairs of autosomes and a sex chromosome. Autosomes make perfect pair. Sex chromosomes, arenot always a perfect pair. Women have a perfect pair of sex chromosomes, i.e. XX. But men have a mismatched pair, i.e. XY in which X is a normal-sized X while Y is short.

7. The maleness of a child 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

Soln:

The answer is (b) the Y chromosome in the zygote

Explanation:

If sperm with a Y chromosome fertilises the egg, the zygote will develop into a male child. If sperm with an X chromosome fertilises the egg, the zygote will develop into a female child.

8. 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

Soln:

The answer is (b) girl

Explanation:

If sperm with the Y chromosome fertilises the egg, the zygote will develop into a male child. If sperm with an X chromosome fertilises the egg, the zygote will develop into a female child.

9. Select the incorrect statement.

(a) Frequency of certain genes in a population changes over several generations resulting in evolution

(b) Reduction in weight of the organism due to starvation is genetically controlled

(c) Low-weight parents can have heavyweight progeny

(d) Traits which are not inherited over generations do not cause evolution

Soln:

The answer is (b) Reduction in weight of the organism due to starvation is genetically controlled

Explanation:

Option b) is a wrong statement because weight loss and gain are controlled by external factors, and they are not controlled genetically.

10. New species may be formed if

(i) DNA undergoes significant changes in germ cells

(ii) chromosome number changes in the gamete

(iii) there is no change in the genetic material

(iv) mating does not take place

(a) (i) and (ii)

(b) (i) and (iii)

(c) (ii), (iii) and (iv)

(d) (i), (ii) and (iii)

Soln:

The answer is (a) (i) and (ii)

Explanation:

Evolution will not take place without change and variation in the genetic material. Hence, the change in genetic material and variation in chromosomes are required for the evolution of new species.

11. Two pea plants, one with round green seeds (RRyy) and another with wrinkled yellow (rrYY) seeds, produce F1 progeny that has round, yellow (RrYy) seeds. When F1 plants are selfed, the F2 progeny will have a new combination of characters. Choose the new combination from the following.

(i) Round, yellow

(ii) Round, green

(iii) Wrinkled, yellow

(iv) Wrinkled, green

(a) (i) and (ii)

(b) (i) and (iv)

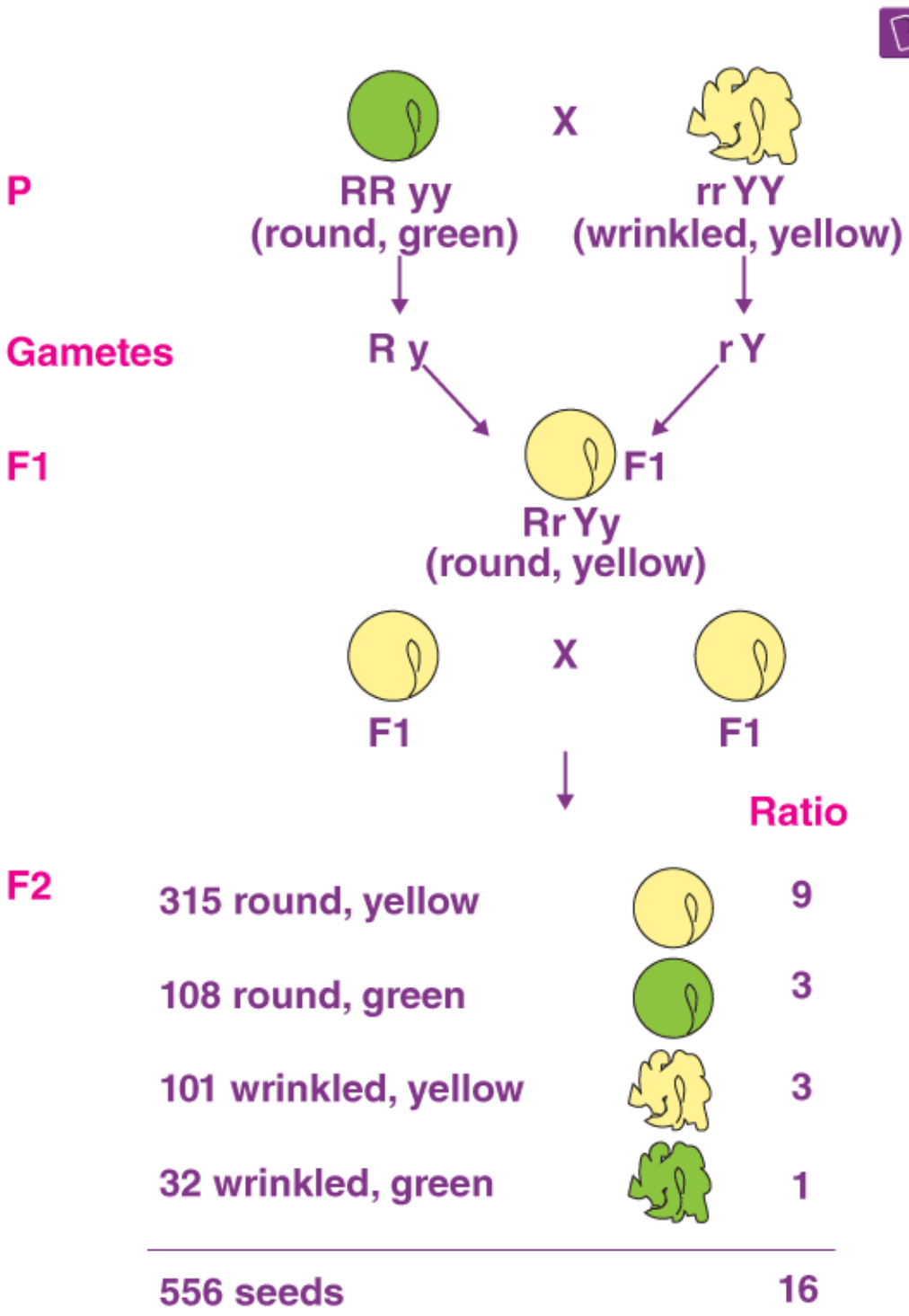
(c) (ii) and (iii)

(d) (i) and (iii)

Soln: The answer is

The new combinations in F2 progenies will be round yellow and wrinkled green. When F1 progeny that has round yellow (RrYy) seeds is selfed, we get the phenotypic ratio of 9:3:3:1 for round yellow, round green, wrinkled yellow and wrinkled green seeds in the

F2 generation.



12. A basket of vegetables contains carrot, potato, radish and tomato. Which of them represents the correct homologous structures?

(a) Carrot and potato

(b) Carrot and tomato

(c) Radish and carrot

(d) Radish and potato

Soln:

The answer is (c) Radish and carrot

Explanation:

Homologous structures have a common origin. Among the given options, carrot and radish are the modified roots that store food, potato is a modified stem and tomato is a fruit. Hence, carrot and radish are examples of homologous structures.

13. Select the correct statement

(a) Tendril of a pea plant and phylloclade of Opuntia are homologous

(b) Tendril of a pea plant and phylloclade of Opuntia are analogous

(c) Wings of birds and limbs of lizards are analogous

(d) Wings of birds and wings of bats are homologous

Soln:

The answer is (a) Tendril of a pea plant and phylloclade of Opuntia are homologous

Explanation:

Homologous structures share a common origin but may have evolved to perform similar or different functions. Tendrils in the pea plant are modified leaves that help in climbing, whereas the phylloclade of Opuntia is a flattened stem with leaves modified into spines to reduce transpiration. Since, tendrils and spines share the same origin, they are homologous structures.

14. If the fossil of an organism is found in the deeper layers of the 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 the earth is not related to its time of extinction

(d) time of extinction cannot be determined

Soln:

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

Explanation:

Older fossils are found deep in the earth. Hence option b) is the right answer.

15. Which of the following statements is not true with respect to variation?

(a) All variations in a species have an equal chance 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

Soln:

The answer is (a) All variations in a species have an equal chance of survival

Explanation

Statement a) is wrong because only useful variations have a chance of survival. Nature chooses the fittest variation to survive.

16. A trait in an organism is influenced by

(a) paternal DNA only

(b) maternal DNA only

(c) both maternal and paternal DNA

(d) neither by paternal nor by maternal DNA

Soln:

The answer is (c) both maternal and paternal DNA

Explanation:

DNA is contributed to an offspring by both parents hence traits are influenced by both parents.

17. Select the group which shares the 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

Soln:

The answer is (a) two individuals of a species

Explanation:

Species is the lowest taxon hence members of the same species share a maximum number of common characteristics.

18. According to the evolutionary theory, the 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

Soln:

The answer is (b) accumulation of variations over several generations

Explanation:

New species are formed due to variations in the DNA for several generations. Asexual reproduction will not result in variation as there are no gametes involved. The movement of individuals from one habitat to another will not affect DNA change; hence it cannot be the right answer.

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

(a) colour of eye

(b) colour of skin

(c) size of body

(d) nature of hair

Soln:

The answer is (c) size of body

Explanation:

A person's food habits decide the nature of the body. Regular exercise helps in building a muscular body. Body nature is not transferred to offspring; hence, the size of the body is not inherited.

20. The two versions of a trait (character) which are brought in by the male and female gametes are situated on

(a) copies of the same chromosome

(b) two different chromosomes

(c) sex chromosomes

(d) any chromosome

Soln:

The answer is (a) copies of the same chromosome

Explanation:

Each diploid individual inherits two copies of a chromosome, one from each parent. Hence the two versions of a trait or alleles of a gene, which are contributed by the male and female gametes are present on a pair of homologous chromosomes.

21. Select the statements that describe the characteristics of genes

(i) genes are a 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) (ii) and (iv)

Soln:

The answer is (b) (i) and (iii)

Explanation:

Statement ii) is wrong because genes code for specific proteins. Statement 4 is wrong because chromosomes have any number of genes.

22. In peas, a pure tall plant (TT) is crossed with a short plant (tt). The ratio of pure tall plants to short plants in F2 is

(a) 1:3

(b) 3:1

(c) 1:1

(d) 2:1

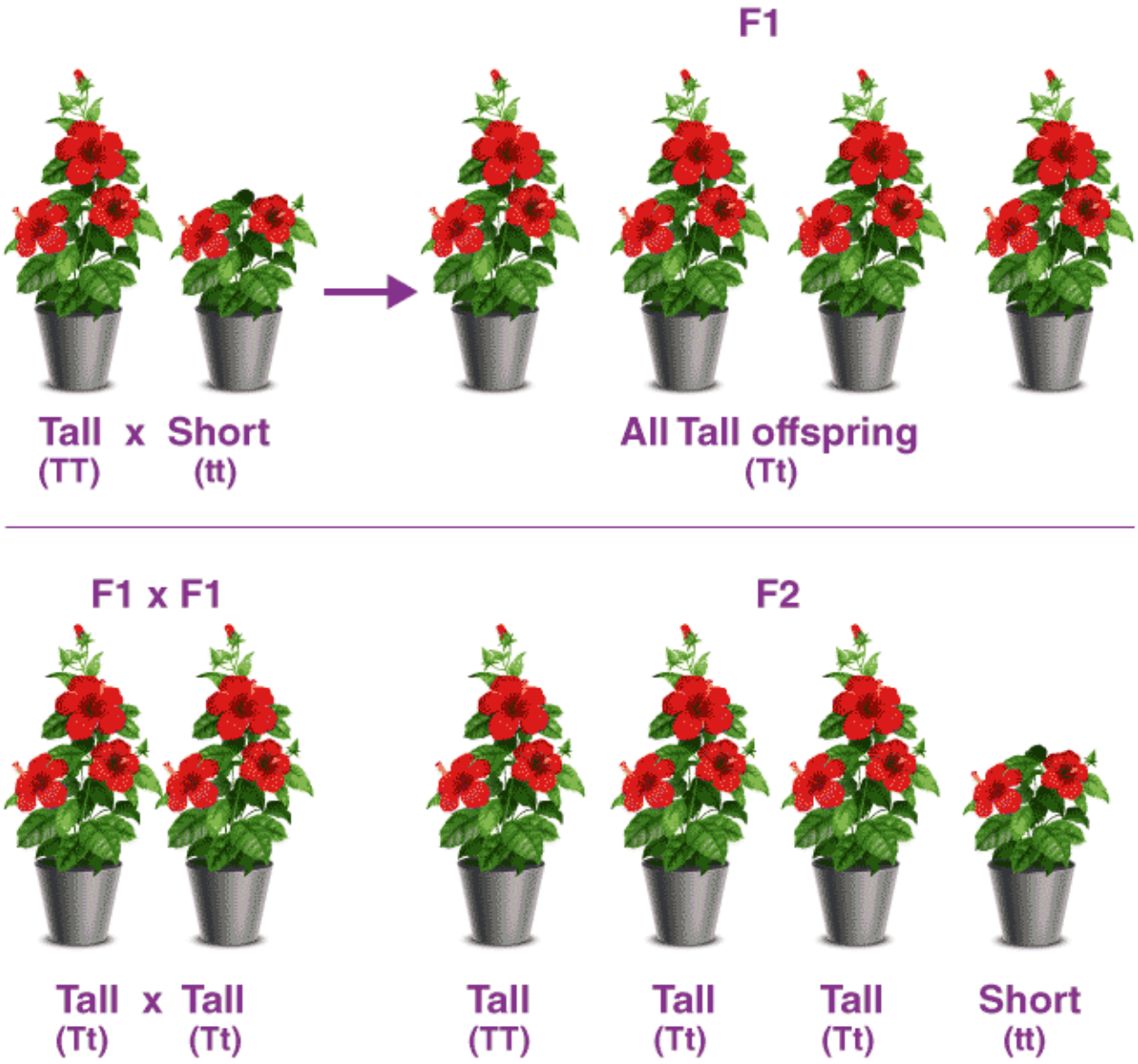
Soln:

The answer is (c) 1:1

Explanation:

A cross between a homozygous or pure tall plant (TT) and a short plant (tt) will produce all tall plants in the F1 generation but with the genotype 'Tt', i.e., heterozygous. When F1 progeny (Tt) is selfed, we get tall and short plants in the ratio of 3:1. The genotypes of progenies produced in the F2 generation are TT (pure tall), Tt (heterozygous tall) and tt

(short) in the ratio of 1:2:1. Hence, the ratio of pure tall plants (TT) and short plants (tt) is 1:1.



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

(a) one

(b) two

(c) three

(d) four

Soln:

The answer is (a) one

Explanation:

The 23rd pair of chromosomes determines the sex of the offspring; hence, it is called a sex chromosome.

24. The theory of the evolution of species by natural selection was given by

(a) Mendel

(b) Darwin

(c) Morgan

(d) Lamarck

Soln:

The answer is (b) Darwin

Explanation:

Mendel proposed laws of heredity.

Morgan discovered a mutation in drosophila.

Lamarck proposed the use and disuse theory.

25. Some dinosaurs had feathers, although they could not fly; 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 organisms

(d) birds have evolved from reptiles

Soln:

The answer is (d) birds have evolved from reptiles

Explanation:

Dinosaurs were reptiles. Some dinosaurs had feathers, but they could not use them to fly. Feathers in dinosaurs started as providing insulation in cold weather, and later, birds adapted them to flight. So, in the context of evolution, this means that birds have evolved from reptiles.

Short Answer Questions

26. How is the sex of a newborn determined in humans?

Soln:

The sex of the individual is determined by the genes inherited from the parents. If a newborn acquires X chromosomes from the father, the child will be a female, and if the newborn receives a Y chromosome from the father, it will be a male.

27. Do the genetic combination of mothers play a significant role in determining the sex of a newborn?

Soln:

No, the sex of a newborn will be determined by the chromosome contributed by the father. Mothers have XX in their 23rd chromosome pair, and they always contribute one X chromosome. But fathers have X And Y in their 23rd chromosome pair. If the father inherits X, the child will be a girl, and if the father inherits Y, the child will be a boy.

28. Mention three important features of fossils which help in the study of evolution.

Soln:

- Fossils are the preserved ancient species.
- Fossils help determine evolutionary differences between organisms and their ancestors.
- Fossils determine the living period of specific species.

29. Why do all the gametes formed in human females have an X chromosome?

Soln:

Females possess XX in their 23rd chromosome pair. During meiosis, one X chromosome enters each gamete; hence all female gametes possess X chromosomes.

30. In human beings, the statistical probability of getting either a male or female child is 50:50. Give a suitable explanation.

Soln:

The sex of the offspring is determined by the gamete donated by the male. Males possess X and Y chromosomes in their 23rd pair. The ratio between X and Y is 1:1. Hence, the probability of getting either a male or female child is 50:50.

31. A very small population of a species faces a greater threat of extinction than a larger population. Provide a suitable genetic explanation.

Soln:

A very small population of a species faces a greater threat of extinction than a larger population because of the following reasons:

Inbreeding depression:

Small population promotes inbreeding. It results in lesser variations.

Genetic drift:

A small population is vulnerable to a sudden change in the environment. Because of genetic drift there is more chance that the species with a small population may wipe out.

32. What are homologous structures? Give an example. Is it necessary that homologous structures always have a common ancestor?

Soln:

Homologous structures are those which have a common basic structure but may perform different functions. For example, the forelimbs of reptiles, amphibians and mammals. They have common ancestry, but are modified and adapted to carry out various functions.

33. Does the occurrence of the diversity of animals on earth suggest their diverse ancestry also? Discuss this point in the light of evolution.

Soln:

In spite of the fact that animals have a different variety of structures, they do not have a common ancestry. This is because common ancestry may greatly limit the extent of diversity. Many of the animals inhabit the same habitat; their evolution by geographical isolation and speciation is also not likely. Hence, common ancestry for all animals is not the likely theory.

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

(i) yellow seed (ii) round seed

Soln:

1. Yellow-dominant

Green-recessive

1. Round-dominant

Wrinkled-recessive

35. Why did Mendel choose the pea plant for his experiments?

Soln:

Mendel chose the pea plant for his experiments for the following reasons:

- Pea plants are easy to grow
- They have a short lifespan
- They have larger size flower
- Pea plants are self-pollinated
- Easily identified characters

36. A woman has only daughters. Analyse the situation genetically and provide a suitable explanation.

Soln:

A woman has only daughters: It means the egg always received X chromosomes from the sperm. If sperm donates X chromosomes, the resultant child will be female, and if sperm donates Y chromosome, the baby will be male.

Long Answer Questions

37. Does geographical isolation of individuals of a species lead to the formation of a new species? Provide a suitable explanation.

Soln:

The geographical isolation of individuals of a species leads to genetic drift. This limits the sexual reproduction of the separated population. This results in separated individuals reproducing among themselves. This leads to the formation of a new variation. Accumulation and transfer of these variations through generation will lead to the formation of new species.

38. 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.

Soln:

This is an issue of debate. It depends on the way we evaluate evolution. If the complexity of the body is a parameter, then humans are far superior to bacteria. Bacteria have a cellular level of organisation, and humans have an organ-system level organisation.

On the other hand, if we consider the ability to survive, bacteria have evolved more than human beings. Humans can live in any environment but with artificial protection. Humans cannot live in a harsher climate, whereas bacteria can be found anywhere on earth. They can survive even harsh climates, such as hydrothermal vents and sulphur springs.

39. All the human races, like Africans, Asians, Europeans, Americans and others, might have evolved from a common ancestor. Provide a few pieces of evidence in support of this view.

Soln:

All human races appear to be different, but they have evolved from common ancestry. The following is the evidence to support this view:

- Common body plan.
- Same physiological and metabolic characteristics.
- Fixed number of chromosomes.
- Freely interbreeding.
- Common genetic blueprint

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

Soln:

Inherited Characters	**Acquired Characters**
Characters that are passed on from parents to offspring	Characters appear in an individual's lifetime but cannot be transmitted to the next generation
Alters genotype and phenotype	Alters phenotype only
Transmitted to future generation	Cannot be transmitted to future generation
Results due to genetic recombination	Results due to response to environmental changes
Example: the colour of seeds, the colour of eyes.	Example: obese body, loss of a finger in an accident.

41. Give reasons why acquired characters are not inherited.

Soln:

Acquired characters are the results of our body's response to external stimuli such as food, disease, and climate change. This results in the development of a particular trait where a change of phenotype is observed. But for characters to get inherited through

generations, the genotype of an organism should be changed. In acquired characters, there is no change in the DNA of germ cells. Hence, acquired characters cannot be inherited.

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

Soln:

Structures which are apparent to our eyes are called morphological structures. Molecular structures are those biomolecules which are the integral components of organisms. We see a lot of diversity all around us. This diversity is possible because of diversity in morphological structures. This shows that morphological structures are the least stable. Life, which began as simple forms on the earth, is now composed of many complex forms.

Life has evolved for millions of years, but the structure of basic biomolecules such as DNA remains the same. DNA is the same in a human and in a mouse. A protein has the same structure in a bird and a fungus. So, the molecular basis of life has not changed through all these years. This proves that evolution has exhibited a greater stability of the molecular structure when compared with the morphological structure.

43. In the following crosses, write the characteristics of the progeny.

Cross	**Progeny**
1. **RR YY x RR YY ..... Round, yellow Round, yellow**	2.
1. **Rr Yy x Rr Yy ..... Round, yellow Round, yellow**	2.
1. **rr yy x rr yy ..... Wrinkled, green wrinkled, green**	2.
1. **RR YY x rr yy ..... Round, yellow wrinkled green**	2.

Soln:

Cross	**Progeny**
1. RR YY x RR YY ..... Round, yellow Round, yellow	Round, yellow
1. Rr Yy x Rr Yy ..... Round, yellow Round, yellow	Round, yellow Round, green Wrinkled, yellow Wrinkled, green

1. rr yy x rr yy ..... Wrinkled, green wrinkled, green	Wrinkled, green
1. RR YY x rr yy ..... Round, yellow wrinkled green	Round, yellow

44. Study the following cross and show self-pollination in F1, fill in the blank and answer the question that follows.

Parents RRYY x rryy

Round, yellow wrinkled, green

F1 — Rr Yy x ?

Round, yellow

Soln:

Parents RRYY x rryy

Round, yellow wrinkled, green

F1 — Rr Yy x RrYy

Round, yellow Round, yellow

rryy

	ry	ry	ry	ry
RY	RrYy	RrYy	RrYy	RrYy
RY	RrYy	RrYy	RrYy	RrYy
RY	RrYy	RrYy	RrYy	RrYy
RY	RrYy	RrYy	RrYy	RrYy

RRYY

45. In question 44, what are the combinations of character in the F2 progeny? What are their ratios?

Soln:

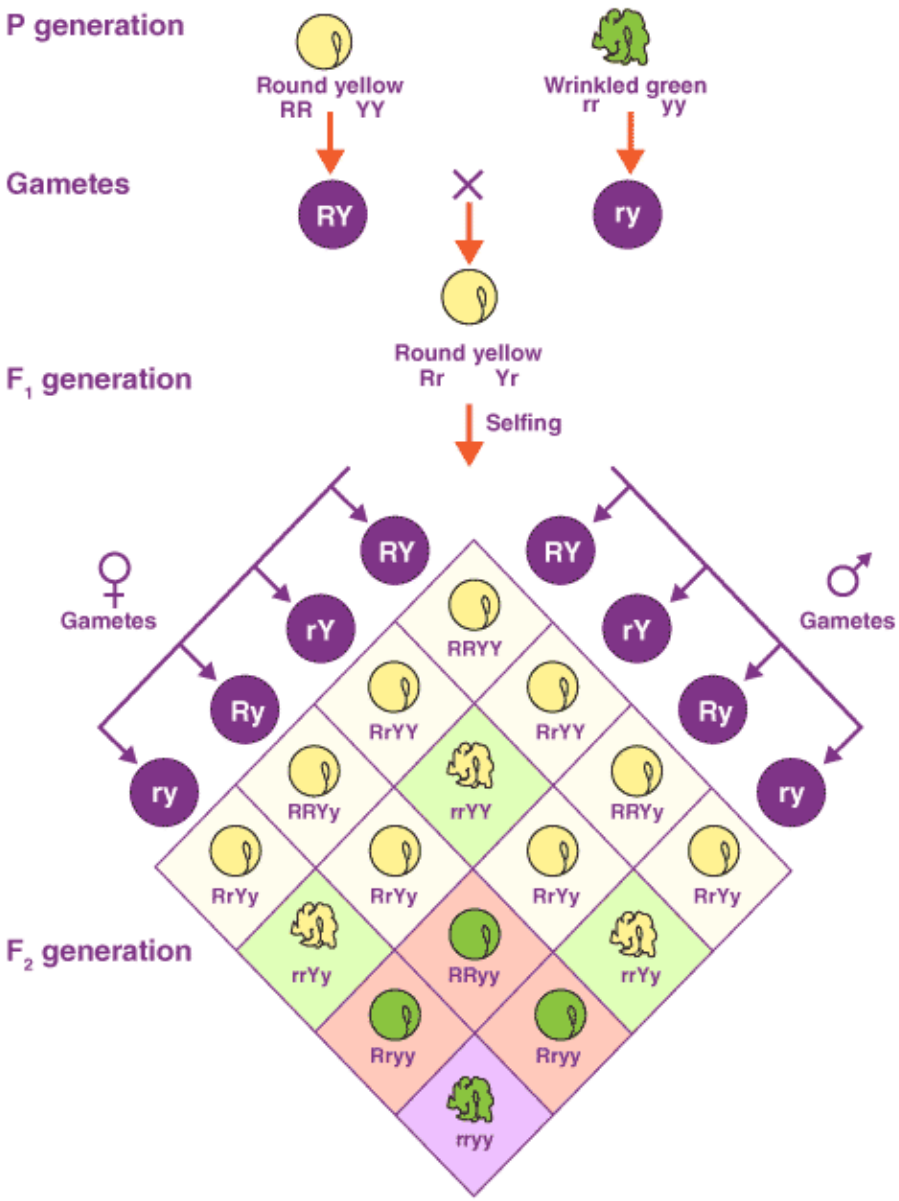
(i) Round yellow — 9

(ii) Round green — 3

(iii) Wrinkled yellow — 3

(iv) Wrinkled green — 1

The ratio of these four combinations is 9:3:3:1



46. Give the basic features of the mechanism of inheritance.

Soln:

The basic features of the mechanism of inheritance are as follows:

- Genes control the characters
- Genes are present in two or more forms
- One form of a gene may be dominant over another

- Genes are present in chromosomes
- Individual genes exist in two forms that may be similar or dissimilar
- Two forms of the gene separate at the time of gamete formation
- Two forms of genes are brought together in the zygote

47. Give reasons for the appearance of new combinations of characters in the F2 progeny.

Soln:

The appearance of new combinations in the F2 generation can be explained through the law of independent assortment, according to which when two traits are combined in a hybrid, one pair of character segregates independent of the other pair of characters. The two genes segregate independently at the time of gamete formation and recombine at the time of fertilisation to produce zygote with combinations different from parents as well.

E.g. when a tall pea plant with round seeds is crossed with a short plant with wrinkled seeds, we get all tall plants with round seeds in the F1 generation, because tallness and round seeds are dominant characters. When these plants are self-pollinated, we get new combinations in F2 progeny along with the parental combinations. The gene controlling the height and seed shape segregate independently and recombine to produce new combinations other than the parental combinations, i.e. tall plants with wrinkled seeds and short plants with round seeds. Therefore, we can conclude that the tall/short and round/wrinkled seed traits are inherited independently.