

Chapter 9: Heredity and Evolution

NCERT Exemplar · Class 10 · Science

Questions

Question 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

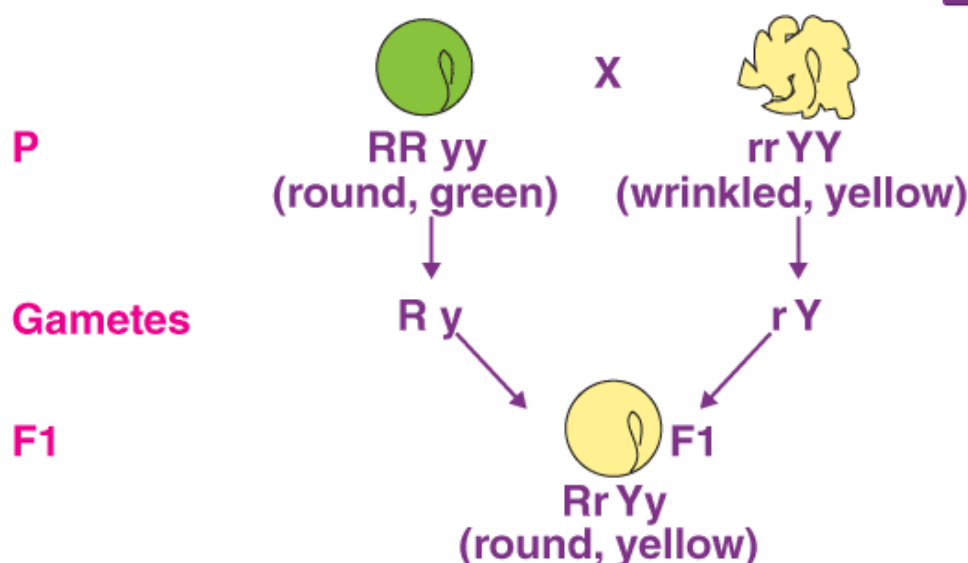
- (a) round and yellow
- (b) round and green
- (c) wrinkled and green
- (d) wrinkled and yellow

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, are not 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)

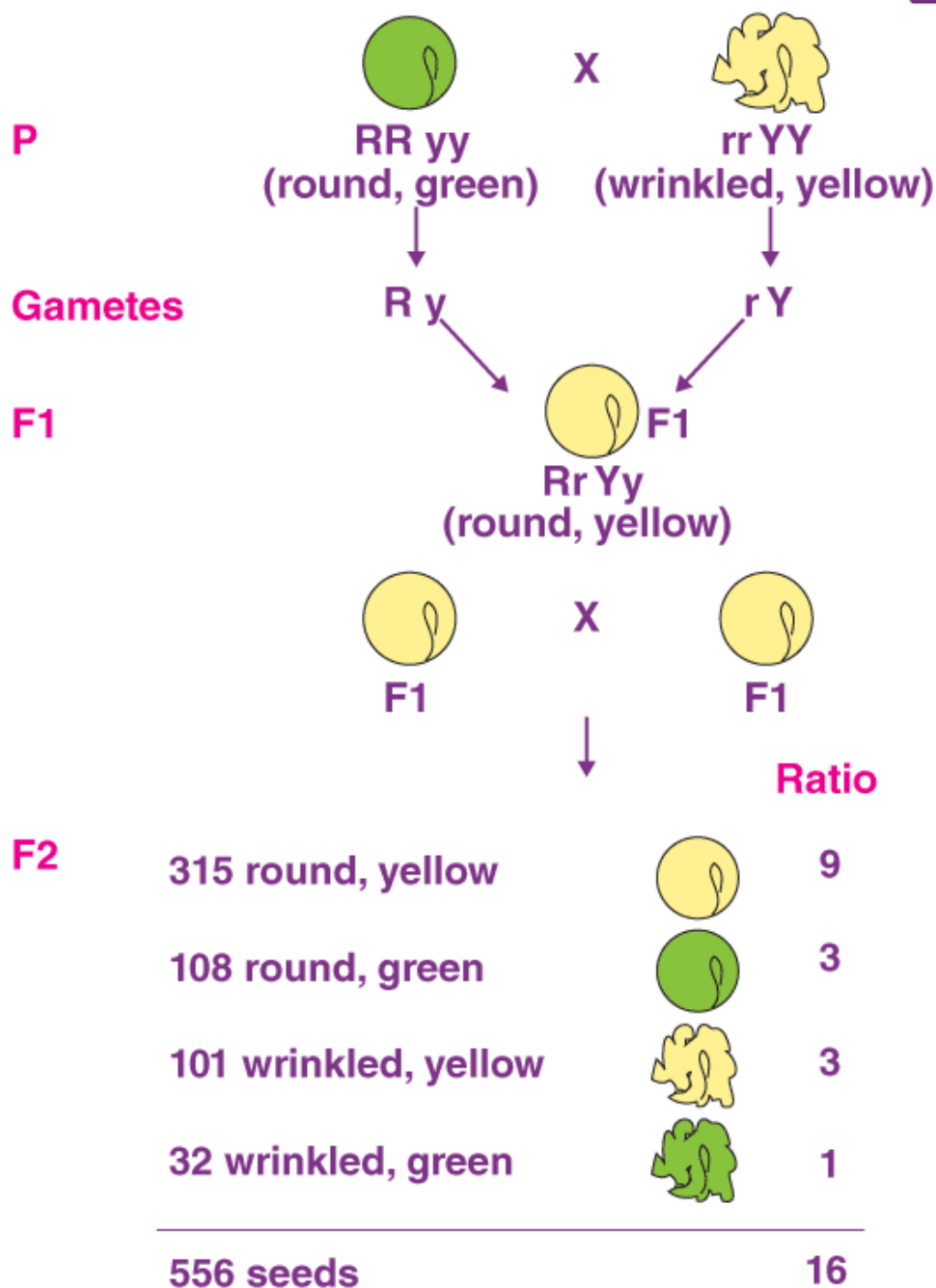
(c) (ii) and (iii)

(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

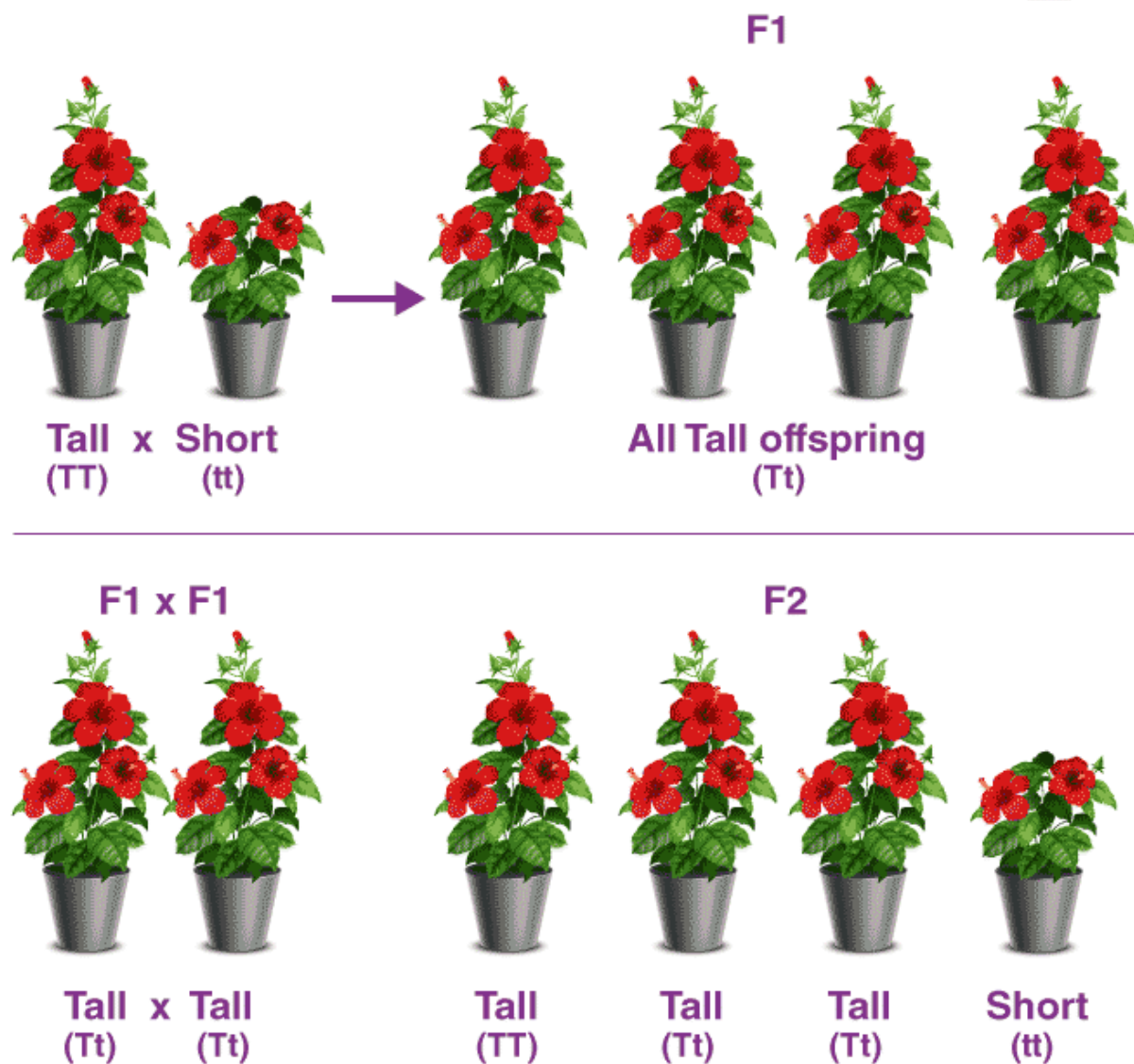
(d) 2:1

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

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:

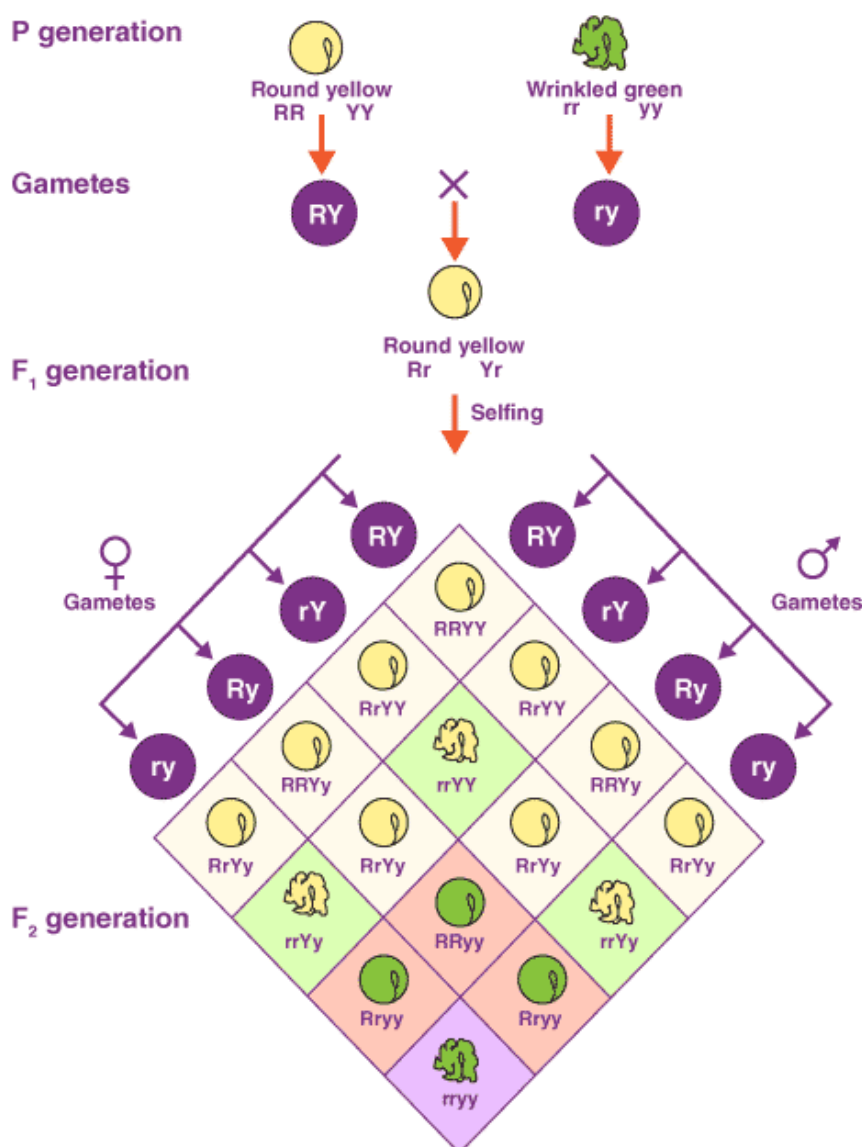
(i) Round yellow — 9

(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.

Solution

Solution coming soon.
