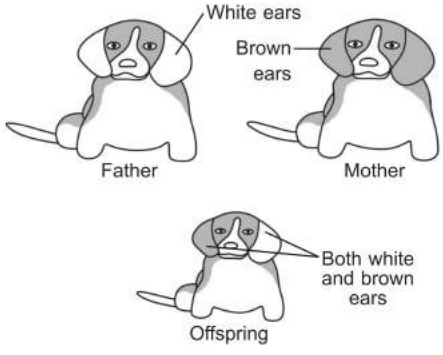
Heredity

TOPIC COVERED

Accumulation of Variation During Reproduction

Multiple Choice Questions 1 Mark

1. **Which of the following is an example of genetic variation?**
   (*a*) One person has a scar, but his friend does not.
   (*b*) One person is older than another.
   (*c*) Reeta eats meat, but her sister Geeta is a vegetarian.
   (*d*) Two children have different eye colours.
2. **Differences between organisms in a species are described as variation. Which of the following would you describe as continuous variation?**
   (*a*) Hair colour (*b*) Eye colour
   (*c*) Weight (*d*) Sex
3. **The image shows the model of a family of dogs. It can be observed that the offspring is similar to the parent but not identical. What is the likely reason for this?** [KVS]



   (*a*) Variation in the genetic material
   (*b*) Fast multiplication of body cells
   (*c*) Asexual mode of reproduction
   (*d*) Effect of environment on the offspring

Answers

1. (*d*)
2. (*c*) Continuous variation has no limit on the value it can have in a population. Weight, height are some of the examples of continuous variation.
3. (*a*)

Very Short Answer Type Questions 2 Marks

4. **Why is variation beneficial for the species, but not necessarily for the individual?** [Foreign 2013, HOTS]

Ans. Accumulation of variation in a species enables them to adapt according to the changes and the new needs. This provides survival advantage to the species. But an individual does not get any advantage due to variation that takes place on him. Thus, variation is beneficial for a species, but not necessary for the individual.

5. **Define variation in relation to a species. Why is variation beneficial to the species?** [HOTS, DoE]

Ans. Variation refers to the differences in the characters or traits among the individuals of a species. Variation is beneficial to the species because:
   (*i*) It enable the organisms to adapt themselves in changing environment.
   (*ii*) It forms the basis of heredity.
   (*iii*) It forms the raw materials for evolution and development of new species.

6. **Describe briefly four ways in which individuals with a particular trait may increase in a population.** [HOTS]

Ans. The four ways in which individuals with a particular trait may increase in a population are as follows:
   (*i*) Sexual reproduction results into increase in population.
   (*ii*) The individuals with special traits survive the attack of their predators and multiply while the other will perish.
   (*iii*) Genetic drift provides diversity without any adaptation.
   (*iv*) Variations in the species may lead to increased survival of the individuals with a particular trait.

7. **Mustard was growing in two fields- A and B. While Field A produced brown coloured seeds, field B produced yellow coloured seeds.**
   It was observed that in field A, the offsprings showed only the parental trait for consecutive generations, whereas in field B, majority of the offsprings showed a variation in the progeny.
   What are the probable reasons for these?
   [CBSE Sample Paper 2022]

Ans. In field A, the reason for parental trait in consecutive generations of the offsprings is self-pollination. **(1 Mark)**

In field B, variation is seen to occur because of recombination of genes as cross-pollination is taking place. **(1 Mark)** [CBSE Marking Scheme]

8. **In an asexually reproducing species, if a trait X exists in 5% of a population and trait Y exists in 70% of the same population, which of the two trait is likely to have arisen earlier? Give reason.**

[CBSE Sample Paper 2022]

Ans. Trait Y which exists in 70% (larger fraction) of the population, is likely to have arisen earlier because in asexual reproduction, identical copies of DNA are produced and variations do not occur. **(1 Mark)** New traits come in the population due to sudden mutation and then are inherited. 70% of the population with trait Y is likely to have been replicating that trait for a longer period than 5 % of population with trait X. **(1 Mark)** [CBSE Marking Scheme]

9. **(*a*) All the variations in a species do not have equal chances of survival. Why?** [Foreign 2014]
(*b*) Why variations are more in human beings?

Ans. (*a*) All the variations do not have equal chances of survival as some variations might not be beneficial and would ultimately be eliminated.

(*b*) Because human being reproduce sexually and variation are more in sexually reproducing organisms.

Short Answer Type Question 3 Marks

10. **Explain with an example how variation took place due to inheritance.**

Ans. **Variation in Population:**

An example. Few red beetles live on a green leafy bush, grows by sexual reproduction and generate variation.

- Crows eat these beetles, leaving only fewer beetles available for reproduction.
- Due to colour variation during reproduction, only one green beetle evolved and therefore, all its progeny beetles become green.
- Crows cannot see green coloured beetles on green leaves and hence, cannot eat them, resulting in more green beetles than red ones in the beetle population.
- This type of variation gives a survival advantage.

PRACTICE QUESTION

1. Name the scientific terms used to represent the following:
   (*a*) The branch of biology which studies heredity and variation.
   (*b*) The transmission of traits from parents to offspring.
   (*c*) Differences in a trait in human beings.
   (*d*) A recognisable feature of an organism.

TOPIC COVERED

Heredity

Multiple Choice Questions 1 Mark

1. **To study the natural phenomenon of inheritance, Mendel selected the pea plants. Which of the following properties were suitable for their studies?**
   (*i*) Plants would easily self pollinate or cross pollinate in nature.
   (*ii*) Plants were easily grown in garden soil with a considerably shorter generation time.
   (*iii*) Pea plants do not require the true-breeding for hybridisation experiments.
   (*iv*) Many parts of the plant such as pod, seed, flower, cotyledons showed distinct phenotypes.
   (*a*) (*i*), (*ii*) and (*iii*) (*b*) (*ii*) and (*iv*)
   (*c*) (*i*) and (*ii*) (*d*) (*ii*), (*iii*) and (*iv*)

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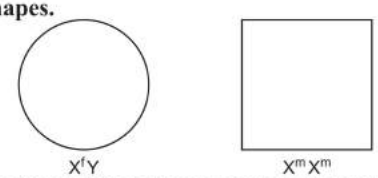
2. **Two individuals are as shown using geometric shapes.**



X^fY X^mX^m

Their sex chromosomes are respectively denoted by X^f, X^m and Y. What are the possible combinations of sex chromosomes for their male and female offspring respectively? [CBSE T.E.R.M.*]
(*a*) X^fX^m and X^mX^m (*b*) X^mY and X^mX^m
(*c*) X^fY and X^mY (*d*) X^mY and X^mX^f

3. **If a tall pea plant is crossed with a pure dwarf pea plant then, what percentage of F_1 and F_2 generation respectively will be tall?**

[CBSE Sample Paper 2023]

(*a*) 25%, 25% (*b*) 50%, 50%
(*c*) 75%, 100% (*d*) 100%, 75%

4. **Attached earlobes in humans is an inherited condition. The allele for attached earlobes is recessive.**
What are the chances of parents, both having attached earlobes, to have a child with attached earlobes? [CFPQ, CBSE]
(*a*) 0% (*b*) 25% (*c*) 75% (*d*) 100%

5. **Humans have two different sex chromosomes, X and Y. Based on Mendel's laws; a male offspring will inherit which combination of chromosomes?** [CBSE T.E.R.M.*]
(*a*) Both the X chromosomes from one of its parents.
(*b*) Both the Y chromosomes from one of its parents.
(*c*) Combination of X chromosomes from either of its parents.
(*d*) Combination of X and Y chromosome from either of its parents.

6. **A monohybrid cross is conducted between one variety of pea plants having pods that are full (FF) and another having pods that are constricted (ff). What is the percentage of heterozygous offsprings in F_1 generation?** [CFPQ, CBSE]
(*a*) 100% (*b*) 75% (*c*) 50% (*d*) 25%

7. **A zygote which has an X-chromosome inherited from the father will develop into a** [KVS]
(*a*) girl
(*b*) boy
(*c*) either boy or girl
(*d*) X-chromosome does not influence the sex of a child.

8. **A trait of an organism is influenced by**
(*a*) paternal DNA only
(*b*) maternal DNA only
(*c*) both maternal and paternal DNA
(*d*) none of these

9. **A cross between pea plant with white flowers (vv) and pea plant with violet flowers (VV) resulted in F_2 progeny in which ratio of violet (VV) and white (vv) flowers will be:** [CBSE 2023]
(*a*) 1 : 1 (*b*) 2 : 1 (*c*) 3 : 1 (*d*) 1 : 3

Answers

1. (*b*) Pea plant can be grown easily at home. It also has many distinct phenotypes.
2. (*d*) 3. (*d*) 4. (*d*) 5. (*d*)
6. (*a*)
7. (*a*) When the zygote inherits X chromosome from the father, it develops into girl. If the zygote inherits Y chromosome from the father, it develops into boy.
8. (*c*) Both parents DNA influences the trait of their offspring.
9. (*c*)

Very Short Answer Type Questions 2 Marks

10. **Sex determination in humans happens through sex chromosomes. Along with other parameters, such processes often help in forensic studies in crime investigation and / or identification of accidents and natural calamities, In order to determine whether an accident victim is male or female, which cells can be used and why?** [CFPQ, CBSE]

Ans. • Any cell of the body can be used.
• It is because every cell has the sex chromosomes as the 23rd pair.

11. **Why did Mendel select pea plants for conducting his experiments on inheritance?** [DoE]

Ans. Mendel selected pea plant for his experiment because-
(*i*) Many varieties of pea plants are available with observable contrasting traits.
(*ii*) Peas are normally self pollinating and the flower structure is also suitable for cross-pollination.

12. **What are 'chromosomes'? Where are they located in the cell?** [HOTS]

Ans. 'Chromosomes' are long thread-like structures which contain hereditary information of the individual and are therefore the carriers of genes.
Chromosomes are located in the nucleus of a cell.

13. **"The sex of the children is determined by what they inherit from their father and not their mother." Justify.** [HOTS, DoE]

Ans. It is because a child who inherits an X chromosome from father will be a girl and one who inherits a Y chromosome from father will be a boy. But all children will inherit an X chromosome from their mother regardless of whether they are boys or girls.

14. **What is a sex chromosome?** [HOTS]

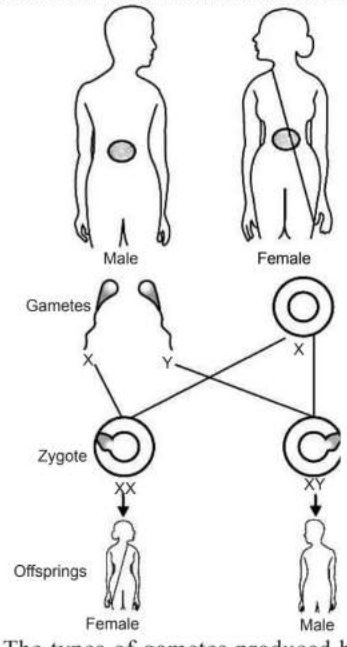
Ans. Sex chromosome is a chromosome that operates in the sex-determining mechanism of a species. Many animals have two different types of sex chromosomes. For example, in humans there is a large X chromosome and a much smaller Y chromosome.

Short Answer Type Questions 3 Marks

15. **(*a*) Name the two types of gametes produced by men.**
(*b*) Does a male child inherit X chromosome from his father? Justify.
(*c*) How many types of gametes are produced by a human female? [CBSE 2022]

Ans. (*a*) The gametes produced by men are sperms. The two types of sperms (gametes) produced by men are 50% carrying 'X' chromosomes and 50% carrying 'Y' chromosomes. Thus, two types of gametes having X and Y chromosomes are produced by males.

(*b*) No, a male child does not inherit X chromosome from his father. Humans have 23 pairs of chromosomes, out of which 1 pair is sex chromosomes and 22 pairs are autosomes. Women have a perfect pair of sex chromosome, both called X. But men have a mismatched pair, out of which X is normal size while Y is a shorter sex chromosome. So women have XX and men have XY chromosomes. A male child inherits a Y chromosome from his father whereas an X chromosome from his mother as shown in the figure.



(*c*) The types of gametes produced by a human female are only XX sex chromosomes.

16. In one of his experiments with pea plants Mendel observed that when a pure tall pea plant is crossed with a pure dwarf pea plant, in the first generation (F_1) only tall plants appear.

(*a*) What happens to the trait of dwarfness in this case?

(*b*) When the F_1 generation plants were self-fertilised, he observed that in the plants of second generation, F_2 both tall plants and dwarf plants were present. Why it happened? Explain briefly.

Ans. (*a*) In the F_1 generation, the trait of dwarfness is recessive.

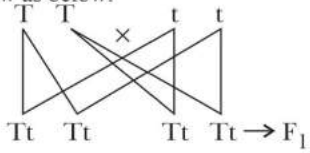
(*b*) Both parents contribute equally in sexual reproduction. So each pea plant inherited genes of both tallness and dwarfness in the F_1 generation. But only the dominant trait, tallness got expressed. When F_1 plants are crossed, in the F_2 generation, there are some plants (25%) which carry only the dwarfness character and hence the same got expressed in the F_2 generation.

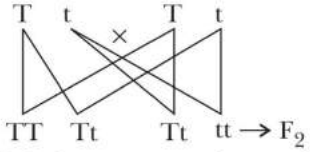
17. How did Mendel explain that it is possible that a trait is inherited but not expressed in an organism? **[AI 2017]**

Ans.
- Mendel crossed a tall pea plant with a short pea plant.
- All the plants produced in the F_1 generation were tall.
- When the F_1 tall plants were self-pollinated, the F_2 generation consisted of both tall and short plants.
- It explains that the dominant trait expresses itself in the F_1 plants, where the recessive trait (shortness) is hidden.
- The appearance of short plants in the F_2 indicates that the trait shortness has been inherited by the F_1 plants, but not expressed.

18. In a monohybrid cross between tall pea plants (TT) and short pea plants (tt) a scientist obtained only tall pea plants (Tt) in the F_1 generation. However, on selfing the F_1 generation pea plants, he obtained both tall and short plants in F_2 generation. On the basis of above observations with other angiosperms also, can the scientist arrive at a law? If yes, explain the law, if not, give justification for your answer.

Ans. On the basis of the experiment, the scientist can arrive at a law as below:





(*i*) Both the parents must be contributing a copy of the same gene.

(*ii*) For each trait, a plant carries two copies, one from each parents.

(*iii*) If the copies of the traits are not same, the dominant trait shall gets expressed.

(*iv*) When F_1 generation are crossed, the recessive trait of F_1 generation shall also get expressed in the F_2 generation at a ratio of 3:1.

19. (*a*) What is F_2 generation?
(*b*) Why traits such as intelligence and knowledge cannot be passed on to the next generation?
(*c*) "The sex of the children is determined by what they inherit from their father and not their mother." Justify. [HOTS, DoE]

Ans. (*a*) The generation produced by the offspring to F_1 generation, i.e. first generation as parent is called F_2 generation.

(*b*) Trait such as intelligence and knowledge are acquired traits wich do not bring any change in the DNA of the germ cell and therefore, cannot be passed to next generation.

(*c*) It is because a child who inherits an X chromosome from father will be a girl and one who inherits a Y chromosome from father will be a boy. But all children will inherit an X chromosome from their mother regardless of whether they are boys or girls.

20. "We cannot pass onto our progeny the experiences and qualifications earned during our life time". Justify the statement giving reason and examples. [Delhi 2015]

Ans. Experiences of life and qualifications we earn donot make any change in the genes of the individual. Changes made in the gene are only passed on from one generation to the next. These qualities are acquired by an individual in his life, and are called acquired traits which cannot be passed on to future progeny. For example, if a person reads a book on birds, the knowledge he earns by reading the book does not make any change in his genes. Hence, this knowledge will not get automatically transmitted to his next generation.

21. Explain Mendel's experiment with peas on inheritance of characters, considering only one visible contrasting character. [DoE, Foreign 2014]

Ans. Mendel crossed tall pea plants with dwarf pea plants:

Parents	:	(TT)	×	(tt)	
		Pure tall plant		Pure short plant	
F_1 generation	:	(Tt)	(Tt)	(Tt)	(Tt)
Selfing of F_1	:	(Tt)	×	(Tt)	
F_2 generation	:	(TT)	(Tt)	(Tt)	(tt)

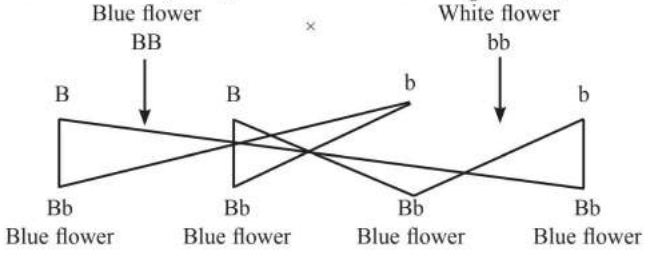
Observation: F_1 generation—No 'medium-height' plants were there. All plants were tall. Only one of the parental traits was seen, not some mixture of the two. F_2 progeny— Not all plants were tall. One quarter of them were short. This indicates that both the tallness and shortness traits were inherited in the F_1 plants, but only the tallness trait was expressed. Mendel proposed that something was being passed unchanged from generation to generation which we called 'factors'. Factors contain and carry hereditary information.

22. How do Mendel's experiment show that traits are inherited independently? [AI 2016]

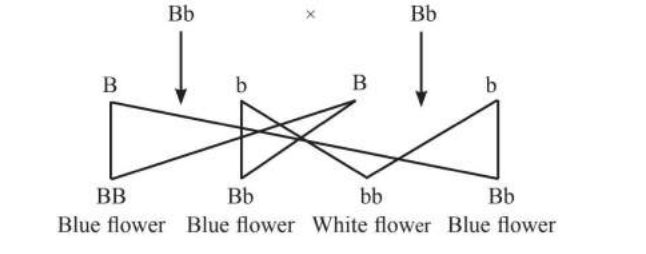
Ans. Mendel performed an experiment in which he took two different traits like tall and dwarf plant and round and wrinkled seeds. In second (F_2) generation, some plants were tall with round seeds and some were dwarf with wrinkled seeds. There would also be dwarf plants having round seeds. Thus, the tall/short traits and round/wrinkled seed traits are independently inherited.

23. A blue coloured flower plant denoted by BB is crossbred with that of white coloured flower plant denoted by bb.
(*a*) State the colour of flower you would expect in their F_1 generation plants.
(*b*) What must be the percentage of white flower plants in F_2 generation if flowers of F_1 plants are self-pollinated?
(*c*) State the expected ratio of the genotypes BB and Bb in the F_2 progeny. [AI 2013]

Ans. Parents: Blue flower (BB) × White flower (bb)



F_1 generation: Bb (Blue flower) × Bb (Blue flower)



F_2 generation:

(*a*) The colour of all the flowers in F_1 generation will be blue.
(*b*) Percentage of white flower plants in F_2 generation will be 25.
(*c*) The ratio of genotypes BB and Bb in F_2 progeny will be 1 : 2

24. If we cross-bred tall (dominant pea plant with pure-breed dwarf (recessive) pea plant, we will get plants of F_1 generation. If we now self-cross the pea plant of F_1 generation, we obtain pea plants of F_2 generation.
(*a*) What do the plants of F1 generation look like?
(*b*) State the ratio of tall plants to dwarf plants in F_2 generation.
(*c*) State the type of plants not found in F_1 generation but appeared in F_2 generation. Write the reason for the same. **[AI 2017C, 13]**

Ans. (*a*) The plants of F_1 generation will be tall like the dominant parent.
(*b*) Tall plants 3 : Dwarf plants 1, i.e., 3 : 1.
(*c*) – Dwarf plants are not found in F_1 generation.
– It is because, when two copies of a gene (alleles) exist together in the F_1 plants, only the trait; tallness is expressed, i.e. it is dominant.
– The other trait dwarfness remains hidden as it is a recessive trait.

25. List two differences in tabular form between dominant trait and recessive traits. What percentage/proportion of the plants in the F_2 generation/progeny were round, in Mendel's cross between round and wrinkled pea plants? **[Foreign 2016]**

Ans.

Dominant Trait	Recessive trait
(*i*) When both dominant and recessive traits are inherited, the dominant trait gets expressed.	(*i*) When both dominant and recessive traits are inherited, the recessive trait does not get expressed.
(*ii*) A single copy of dominant trait is enough to get it expressed.	(*ii*) Both the copies of a trait should be recessive to get it expressed.

75% of the plants in F_2 generation were round in Mendel's cross between round and wrinkled pea plants.

26. "It is possible that a trait is inherited but may not be expressed." Give a suitable example to justify this statement. **[Foreign 2015]**

Ans. The statement "It is possible that a trait is inherited but may not be expressed" can be explained with the help of Mendel's experiment on pea plant with one visible contrasting character.
Mendel took pure breeding pea plant with one visible contrasting character viz. height of the plant (tall and short plant). The pure breed tall and short plant were crossed and it was found that all the plants in the F_1 progeny were tall. Mendel then allowed the F_1 progeny plants for self-pollination. It was found that all the F_2 progeny plants are not tall, some are short. This indicates that both tallness and shortness traits were inherited separately in the F_1 progeny but shortness trait was not expressed in the F_1 progeny.

27. List in tabular form distinguishing features between acquired traits and inherited traits, with one example of each. **[DoE, Delhi 2017, 16, 15]**

Or

List two differences between acquired traits and inherited traits by giving an example of each. **[Delhi 2019]**

Ans.

Acquired traits	Inherited traits
(*i*) These traits are the characteristics which are developed during the lifetime of an individual.	(*i*) These are the characteristics transmitted from parent to the offspring.
(*ii*) These traits are not passed on to the next generation.	(*ii*) Inherited trait is genetically determined characteristic that distinguishes a person.
(*iii*) Their effect is only in the somatic cells, which does not get inherited to another generation. e.g. **Acquired trait:** Loss of body weight due to starvation.	(*iii*) These have effects on the non-somatic cells which pass to the progeny. e.g. **Inherited trait:** Colour of hair and eye.

28. What are acquired traits? Why are these traits generally not inherited over generations? Explain. **[CBSE 2018C]**

Ans. Acquired traits are those traits which an individual acquired after birth during its life-time.
– These are changes in the non-reproductive tissues.
– The DNA or gene of the germ cells is not influenced/changed by these characters; hence, they cannot be passed on to the next generation.

29. What are chromosomes? Explain how in sexually reproducing organisms the number of chromosomes in the progeny is maintained.

[Delhi 2017C]

Ans. Chromosomes are the structures that bear the DNA or genes; they carry the DNA or genes to the progeny cells.

- There are special type of cells in the sexually-reproducing organisms.
- These cells undergo a special type of cell division, called meiosis; consequently, the germ cells formed have only half the number of chromosomes as the parents cell.
- When two such germ cells (with half the number of chromosomes) fuse, a zygote/new individual is formed with the same number of chromosomes as the parent organsism.

30. Two pea plants - one with round yellow seeds (RRYY) and another with wrinkled green (rryy) seeds produce F_1 progeny that have round, yellow (RrYy) seeds.

When F_1 plants are self-pollinated, which new combination of characters is expected in F_2 progeny? How many seeds with these new combinations of characters will be produced when a total 160 seeds are produced in F_2 generation? Explain with reason. **[CBSE Sample Paper 2022]**

Ans. Round green **(½ Mark)** : 30 **(½ Mark)**
Wrinkled yellow **(½ Mark)** : 30 **(½ Mark)**
New combinations are produced because of the independent inheritance of seed shape and seed colour trait. **(1 Mark)**

[CBSE Marking Scheme]

Long Answer Type Questions 5 Marks

31. Consider a pea plant that is recessive for plant height. Its 'genotype' is tt and 'phenotype' is dwarf.

(*a*) Assuming that the gene for plant height obeys the Mendel's laws of inheritance, indicate the genotypes and phenotypes of ALL the possible parent pairs that could have dwarf offspring.

(*b*) Using any of the parent pairs mentioned by you in (*a*), perform a cross to show the genotypes of the offspring that might arise in the next generation. **[CFPQ, CBSE]**

Ans. (*a*) (*i*) Tt × Tt, Tt × tt and tt × tt

(*ii*) Tt (tall) × Tt (tall), Tt (tall) × tt (dwarf) and tt(dwarf) × tt (dwarf)

(*b*) Tt × Tt

	T	t
T	TT	Tt
t	Tt	tt

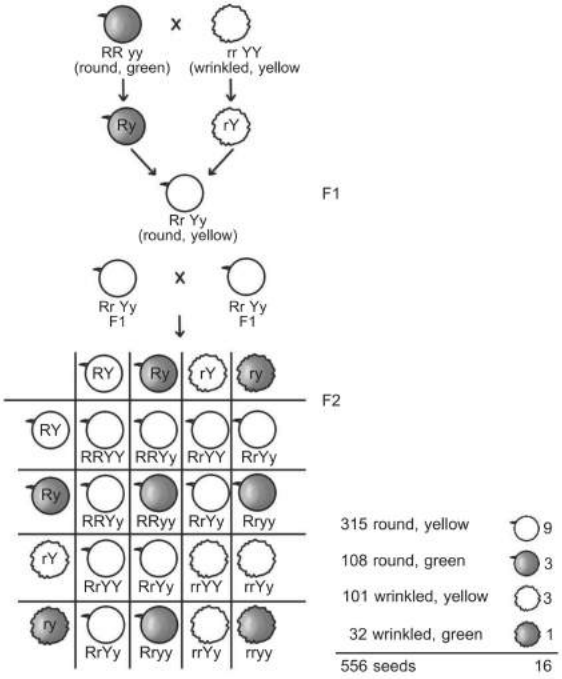
32. How do Mendel's experiments show that the

(*a*) traits may be dominant or recessive

(*b*) traits are inherited independently?

[Delhi 2017(C); DoE, AI 2015]

Ans. Mendel's Experiments on Inheritance of Traits. Mendel used a number of visible contrasting characters of garden pea like round/wrinkled seeds, tall/short plants, white/violet flowers, etc.



Independent inheritance of two separate traits, shape and colour of seeds

(*a*) Traits may be dominant or recessive:

- Mendel used a number of visible contrasting pairs of characters in garden pea.
- He made crosses between pea plants with different characters; there were no halfway or intermediate characters.
- Only one of the parental traits appeared in the F_1 generation; it is called dominant trait and the trait which remains hidden, is called recessive trait.
- When the F_1 plants were self-pollinated, the F_2 progeny consists of plants with the dominant trait and recessive trait in the ratio of 3 : 1; it proves that traits may be dominant or recessive.

(*b*) Traits are inherited independently:
- When a cross is made between a tall plant with round seeds, (when inheritance of two traits is considered), with a short plant with wrinkled seeds, the F_1 progeny plants were all tall with round plants.
- When the F_1 plants are self-pollinated, the F_2 progeny consisted of some tall plants with round seeds and some short plants with wrinkled seeds; these two are the parental types of combinations of traits.
- There were also some new combinations like tall plants with wrinkled seeds and short plants with round seeds.
- Thus it is clear that the tall and short traits and round and wrinkled seed traits are inherited independently of each other.

33. (*a*) With an example, explain how genes control the characteristics.

(*b*) Which of the following traits can be passed on to the progeny and which cannot?

(*i*) Hair type and colour.

(*ii*) The cut tail of a mouse.

(*iii*) Preferance for certain types of food.

(*iv*) Red colour of beetles.

(*c*) Define species. Give two examples of plant species and two of animals.

Ans. (*a*) Genes are the units of heredity. Each gene exercise its function by synthesizing specific protein which is responsible for the expression of characteristic.

For example, consider the height as a characterstic of the plant. We know that plants have hormones that can trigger growth. So, height of plants depend upon the amount of particular hormone. However, if the gene has alteration that makes the enzyme less efficient, the amount of the hormone will be less and plant will be dwarf. This clearly indicates that characterstics are under the control of genes.

(*b*) Traits which can be passed on to progeny are:

(*i*) Hair type and colour.

(*ii*) Red colour of beetles.

Traits which cannot be passed on to progeny are:

(*iii*) The cut tail of a mouse.

(*iv*) Preferance for certain types of food.

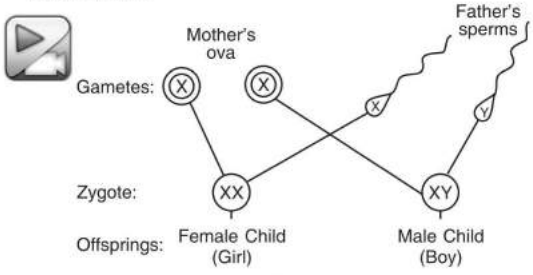
(*c*) It refers to a population of organism consisting of similar individuals which can breed together and produce fertile offsprings.

Two examples of plants species are rose and lily.

Two examples of animal species are lion and elephant.

34. "The sex of a newborn child is matter of chance and none of the parents may be considered responsible for it". Justify this statement with the help of a flow chart showing sex-determination in human beings. **[Allahabad 2019]**

Ans. Sex of a child depends on what happens during fertilization:



Determination of sex in humans beings

(*i*) The female gamete, ova always contributes an X chromosome during fertilization.

(*ii*) The male gamete, sperm contributes either X or Y chromosome during fertilization. Whether sperm will contribute the X chromosome or Y chromosome is a matter of chance and the man does not have any control on it.

(*iii*) If a sperm carrying X chromosome fertilizes an egg which always carries a X chromosome, then the child born will be a girl. But if a sperm carrying Y chromosome fertilizes an egg which always carries X chromosome, then the child born will be a boy.

(*iv*) Thus, sex of a newborn child is a matter of chance and none of the parents may be considered responsible for it.

35. (*a*) What is the law of dominance of traits? Explain with an example.

(*b*) Why are the traits acquired during the life time of an individual not inherited? Explain.

[CBSE 2020]

Ans. (*a*) **Law of Dominance:** Mendel took pea plant and carried two contrasting characters (tall and short) and cross pollination done among them . The traits which get expressed in F_1 generation are called dominant and which are unexpressed are called recessive which reappears in F_2 generation. This is called law of dominance.

Traits may be dominant or recessive.

- When Mendel crossed a tall pea plant with a dwarf pea plant, all the F_1 plants were tall.
- When the F_1 plants were self-pollinated and an F_2 progeny raised, there were tall plants and dwarf plants.
- The trait (tallness) which has appeared in the F_1 plants is called a dominant trait, while

dwarfness that remained hidden in F_1 plants, but appeared in F_2 plants, is called a recessive trait.

(*b*) Certain experiences and traits acquired by people during their lifetime are not passed on to their next generations because these traits do not change the gene/DNA of the germ cells. For example,

(*i*) Losing weight due to starvation.

(*ii*) Cutting the tails of mice for a few generation can not produce tailless mice. Such traits can only be passed on to the next generation when they alter/change the DNA of the germ cells.

36. "Sex determination is an important developmental event in the life cycle of all sexually reproducing plants. Recent studies of sex determination in many plant species, from ferns to maize, have been fruitful in identifying the diversity of genetic and epigenetic factors that are involved in determining the sex of the flower or individual. "
The above is an excerpt from an article by two scientists Cristina Juarez and Jo Ann Banks.

(*a*) What is the most likely genetic factor for sex determination in unisexual plants?

(*b*) Epigenetic factors refer to factors external to the genetic component of an individual. Name evidence of ONE epigenetic condition that determines sexuality in animals.

(*c*) State Mendel's law of segregation and explain how sex determination violates the law.

(*d*) Which parent determines the sex of the offspring in human beings? Why? [CFPQ, CBSE]

Ans. (*a*) Sex chromosomes

(*b*) In some reptiles temperature of the fertilised egg determines sex of the embryo.

(*c*) The law of segregation states that a diploid organism passes a randomly selected allele for a trait to its offspring, such that the offspring receives one allele from each parent. If sex determination in plants is governed by genetic factors, the offspring will get one copy of a gene from each parent. Sex determination violates the law of segregation as the human female does not have any copy of the Y-chromosomal genes.

(*d*) The father determines the sex of the offspring in human beings. It is because the father can pass either X or Y chromosome to the offspring.

PRACTICE QUESTIONS

1. Out of tallness and dwarfness of pea plants, tallness is more prominent among pea plants, because
   (*a*) tallness is dominant over dwarfness.
   (*b*) dwarfness is dominant over tallness.
   (*c*) tallness is determined by one gene having many effects.
   (*d*) tallness is determined by many genes having multiple effects.
2. How many types of gametes will be produced in F_2 generation in a dihybrid cross?
   (*a*) 3 (*b*) 4 (*c*) 8 (*d*) 16
3. A pea plant with round green (RRyy) pea seed is crossed with another pea plant with wrinkled yellow (rrYY) seeds. What would be the nature of seeds in the first generation?
   (*a*) Round Green (*b*) Round Yellow
   (*c*) Wrinkled Green (*d*) Wrinkled Yellow
4. The genotypic ratio of monohybrid cross in F_2 generation is
   (*a*) 3 : 1 (*b*) 9 : 3 : 3 : 1
   (*c*) 1 : 1 (*d*) 1 : 2 : 1
5. Gametes contain
   (*a*) haploid chromosomes
   (*b*) diploid chromosomes
   (*c*) homologous chromosomes
   (*d*) no chromosomes
6. "Genes and chromosomes have similar behaviour." Justify.
7. Explain Mendel's experiment with peas on inheritance of traits considering two visible contrasting characters.
8. On the basis of the possibilities of combination of the sex chromosomes, what percentage probability does a couple have of having a son or a daughter? Show the same by making a cross.
9. "It is a matter of chance whether a couple will have a male or a female child." Justify this statement by drawing a flow chart. **[Foreign 2015]**
10. With the help of a flow chart explain in brief how the sex of a newborn is genetically determined in human beings. Which of the two parents, the mother or the father, is responsible for determination of the sex of a child? **[Delhi 2013]**
11. Sameer's father is a wrestler and has a well-built body. He was awarded as Mr. India when he was young. Sameer is his only son. As Sameer grew older, everyone expected him to have the same body build up as his father. But he is thin. His friends tease him and he feels depressed by it.
    (*a*) Is it true that a wrestler's son should also have heavy muscles?
    (*b*) What type of character is it; acquired or inherited?
    (*c*) What are the values shown by Sameer's friends? **[KVS]**
12. When a tall plant is crossed with a dwarf plant what will be the ratio of tall to dwarf plants in F_1 generation? Show with a help of Mendel's cross. **[HOTS, KVS]**

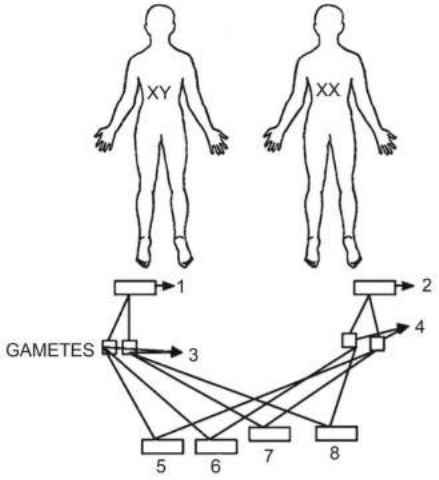
INTEGRATED (MIXED) QUESTIONS

1. (*a*) What is variation? How is variation created in a population? How does the creation of variation in a species promote survival?

   (*b*) Explain how, offspring and parents of organisms reproducing sexually have the same number chromosomes. **[CBSE 2018C] (5 Marks)**

2. (*a*) How do variations arise in organisms? "Variation is useful for the survival of species." Justify this statement with the help of an example. **[Foreign 2017]**

   (*b*) Identify male and female in the figures given below. Also fill in the blanks 3 to 8 and then clarify about the misconception that mother and not father is responsible for bearing daughters and not sons. **[HOTS] (5 Marks)**



ASSERTION AND REASON QUESTIONS

Direction: In the following Questions, the Assertion and Reason have been put forward. Read the statements carefully and choose the correct alternative from the following:

(*a*) Both the Assertion and the Reason are correct and the Reason is the correct explanation of the Assertion.

(*b*) The Assertion and the Reason are correct but the Reason is not the correct explanation of the Assertion.

(*c*) Assertion is true but the Reason is false.

(*d*) The statement of the Assertion is false but the Reason is true.

1. **Assertion:** When pure breed tall plants are crossed with pure breed short plants, all the plants in F_1 progeny are tall. When the tall plants of F_1 progeny are crossed, short plants re-appear in F_2 progeny.
   Reason: Traits are independently inherited.
2. **Assertion:** Variation is high in sexually reproducing organisms compared to asexually reproducing organisms.
   Reason: Inaccuracies during DNA copying give rise to variation.
3. **Assertion:** Acquired trait cannot be passed on from one generation to next generation.
   Reason: Inaccuracy during DNA copying of acquired trait is minimum.
4. **Assertion:** Height in pea plants is controlled by efficiency of enzymes and is thus genetically controlled.
   Reason: Cellular DNA is the information source for making proteins in the cell. **[CBSE Sample Paper 2023]**
5. **Assertion:** Variation is beneficial to species.
   Reason: Variation enables a species for its survival.
6. **Assertion:** In human beings, males produce similar gametes.
   Reason: Males have a pair of sex chromosomes XY and 22 pairs of autosomes.
7. **Assertion:** Each and every child has two versions of DNA-both paternal and maternal.
   Reason: Both the father and the mother contribute equal amounts of genetic materials to their child.
8. **Assertion:** When pure breed tall plants are crossed with pure breed short plants, all the plants in F_1 progeny are tall. When the tall plants of F_1 progeny are crossed, short plants re-appear in F_2 progeny.
   Reason: Traits are independently inherited.
9. **Assertion:** The sex of a new born individual is always genetically determined.
   Reason: Snails can change their sex depending on the temperature at which the fertilized eggs are kept.

CASE-BASED QUESTIONS

The following questions are case-based questions with 2-3 short sub-parts.

1. Mendel blended his knowledge of Science and Mathematics to keep the count of the individuals exhibiting a particular trait in each generation. He observed a number of contrasting visible characters controlled in pea plants in a field. He conducted many experiments to arrive at the laws of inheritance. **[CBSE 2022]**
   (*a*) What do the F_1 progeny of tall plants with round seeds and short plants with wrinkled seeds look like?
   (*b*) Name the recessive traits in above case.
   (*c*) Mention the type of the new combinations of plants obtained in F_2 progeny along with their ratio, if F_1 progeny was allowed to self pollinate.
   Or
   (*c*) If 1600 plants were obtained in F_2 progeny, write the number of plants having traits:
   (*i*) Tall with round seeds.
   (*ii*) Short with wrinkled seeds.
   Write the conclusion of the above experiment.
2. The most obvious outcome of the reproductive process is the generation of individuals of similar design, but in sexual reproduction they may not be exactly alike. The resemblances as well as differences are marked. The rules of heredity determine the process by which traits and characteristics are reliably inherited. Many experiments have been done to study the rules of inheritance. **[CBSE 2023]**
   (*a*) Why an offspring of human being is not a true copy of his parents in sexual reproduction?
   (*b*) While performing experiments on inheritance in plants, what is the difference between F_1 and F_2 generation?
   (*c*) (*i*) Why do we say that variations are useful for the survival of a species over time?
   Or
   (*ii*) Study Mendel's cross between two plants with a pair of contrasting characters.
   RRYY × rryy
   Round Yellow × Wrinkled Green
   He observed 4 types of combinations in F_2 generation. Which of these were new combinations? Why do new features which are not present in the parents, appear in F_2 generation?
3. If we cross-bred tall (dominant) pea plant with pure-bred dwarf (recessive) pea plant, we will get plants of F_1 generation. If we now self-cross the pea plant of F_1 generation, we obtain pea plants of F_2 generation.
   (*a*) What name is given to such type of cross.
   (*b*) Make a flow diagram cross between the parents showing F_1 and F_2 generation.
   (*c*) Write the genotype of (*i*) parents (*ii*) F_2 generation.
   Or
   (*c*) If we take round and wrinkled seeds, what will be the phenotypic ratio and genotype ratio of F_1 and F_2 generation?
4. Gregor Johann Mendel was an Austrian monk who studied Science and Mathematics at the University of Vienna. He conducted hybridisation experiments on garden pea plant and arrived at laws of inheritance. On the other hand, Charles Darwin believed that organisms which can utilise natural resources better than others have more chances of being successful in the struggle for existence and better chances of survival. He could give a number of examples for that but he could not explain why organisms become different. This would not have been the situation, if he had seen the significance of Mendel's experiments. But then, Mendel too did not notice Darwin's work as relevant to his.
   (*a*) A scientist crossed the F_1 generation of pure breeding parents for round and wrinkled seeds and found the number of offsprings produced is 12,420. Write the correct ratio of round seeds and wrinkled seeds (As roundness of seeds is a dominant trait and wrinkled is recessive trait).
   (*b*) Which condition is mainly required for F_2 generation?
   (*c*) Mendel obtained four different combinations of shape and colour. Write those phenotypic ratio with its particular combination of shape and colour.
   Or
   (*c*) Who is known as father of genetics and why?
5. Pooja has green eyes while her parents and brother have black eyes. Pooja's husband Ravi has black eyes while his mother has green eyes and father has black eyes. **[CBSE Sample Paper 2023]**
   (*a*) On the basis of the above given information, is the green eye colour a dominant or recessive trait? Justify your answer.
   (*b*) What is the possible genetic make up of Pooja's brother's eye colour?
   (*c*) What is the probability that the offspring of Pooja and Ravi will have green eyes? Also, show the inheritance of eye colour in the offspring with the help of a suitable cross.
   Or
   (*c*) 50% of the offspring of Pooja's brother are green eyed. With help of cross show how this is possible.

6. It has been established that in human beings, sex is genetically determined, mothers should not be blamed for giving birth to a girl child. Also both male and female babies have equal right to live and illegal absorption of female foetus is a crime. But in some of the animals, sex determination is also controlled by the environmental factors. For examples in a turtle (*Chrysema picta*), high incubation temperature leads to the development of female offsprings. On the other hand lizard (*Agama agama*), high incubation temperature results in male progeny.
(*a*) What are sex chromosomes? How many chromosomes are present in a sperm and an ovum?
(*b*) Why do all the gametes formed is human females have an X chromosome?
(*c*) Explain how in sexually producing organisms the number of chromosomes in the progeny remains the same.

Or

(*c*) A woman has only daughters. Analyse the situation genetically and explain.

NCERT ZONE

NCERT INTEXT QUESTIONS

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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?**

Ans. In a population of asexually reproducing species, the chances of appearance of new traits (that is variation) is very low, so, the trait which is already present in the population in higher percentage has arisen earlier. As the trait B is present in 60% of the population, thus, this trait is likely to have arisen earlier.

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

Ans. Variations take place in response to the changes in the environment. Such variations enable a species to cope with the new changes in the environment. Thus, variations help a species to survive.
For example, if the temperature of water increases suddenly, most of the bacteria living in that water would die. Only few variants resistant to heat would be able to survive. If these variations were not there, then the entire species of bacteria would have been destroyed. Thus, these variations help in the survival of the species.

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

Ans. Mendel conducted experiments on garden pea plants, selecting several visible contrasting characters. He selected and crossed the pure-bred tall pea plants having the genotype TT with a pure-bred dwarf pea plant having the genotype tt. F_1 generation consists of only tall plants having the genotype Tt. Then, Mendel self-pollinated the F_1 generation plants and observed that all plants obtained in F_2 generation were not tall. Instead, one-fourth of the F_2 plants were short. Hence, Mendel concluded that F_1 tall plants were not true breeding. They were carrying traits of both short height and tall height. The trait of tallness is dominant character, while the trait of dwarfness is recessive character. Thus, Mendel's experiments show that trait may be dominant or recessive.

2. **How do Mendel's experiments show that traits are inherited independently?** [KVS]

Ans. In a dihybrid cross made by Mendel, it was observed that when two pairs of traits or characters were considered; each trait expressed itself independent of the other. Thus, Mendel was able to propose the law of independent assortment which says about independent inheritance of traits.

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?**

Ans. A person having blood group A may have two genotypes which are IA IA, IA Io, so, this information is not sufficient to tell which of the traits — blood group A or O — is dominant.

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

Ans. In human beings, somatic cells contain 23 pairs of chromosomes. Out of them the 23rd pair is the sex chromosome which is composed of different types of chromosomes which are named as X and Y chromosomes. This pair has one X and one Y chromosome in a male sperm. On the other hand, in a female egg, it has two X chromosomes. When a sperm with X chromosome fertilises the egg, the resulting zygote would develop into a female child. When a sperm with Y chromosome fertilises the egg, the resulting zygote would develop into a male child.

NCERT EXERCISES

1. **A Mendelian experiment consisted of breeding tall pea plants bearing violet flowers with short pea plants bearing white flowers. In the progeny all bore violet flowers, but almost half of them are short. This suggests that the genetic make-up of the tall parent can be depicted as**
   (*a*) TTWW (*b*) TTww
   (*c*) TtWW (*d*) TtWw

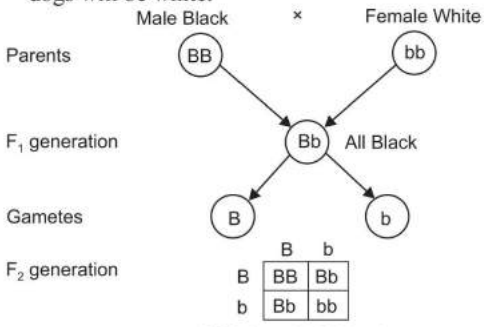
Ans. (*c*) Genetic make-up of the tall plant can be depicted by TtWW.

2. **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?**

Ans. No, we cannot say whether light colour trait is a dominant trait or a recessive trait. However, since both parents and children have light coloured eye, light coloured eye may be recessive trait. Had light coloured eye been a dominant trait, heterozygus light eye parents might have some dark eye children of recessive trait.

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

Ans. A homozygous black (BB) male dog and a homozygous white (bb) female dog are taken and given to mate and produce offspring in F_1 generation. In F_1 generation all the dogs will be black if black colour is dominant. However all the dogs will be white if white colour is dominant. If F_1 generation dogs are allowed to interbreed, in F_2 generation if black colour is dominant, out of every 4 dogs, 3 will be black, and if white colour is dominant, 3 out of 4 dogs will be white.



3 Black and 1 White dog.

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

Ans. The equal genetic contribution of male and female parents in a progeny is ensured through gametes which have only half the amount of DNA as compared to other body cells. The normal body cells of human being contain 46 chromosomes each.
During sexual reproduction, a female gamete or egg cell fuse with a male gamete or sperm cell (which are haploid) to form zygote. Zygote is diploid which contains 23 chromosomes from mother and 23 from father in humans. In this way, an equal genetic contribution of male and female parents is ensured in the progeny.

SELECT NCERT EXEMPLAR PROBLEMS

1. **Two pink coloured flowers on 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

Ans. (*c*)

2. **Select the incorrect statement:**
   (*a*) Frequency of certain genes in a population change 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 heavy weight progeny
   (*d*) Traits which are not inherited over generations do not cause evolution

Ans. (*b*)

3. **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

Ans. (*a*)

4. **The maleness of a child is determined by**
   (*a*) the X chromosome in the zygote
   (*b*) the Y chromosome in zygote
   (*c*) the cytoplasm of germ cell which determines the sex
   (*d*) sex is determined by chance

Ans. (*b*)

5. **Do genetic combination of mothers play a significant role in determining the sex of new born?**

Ans. No, mothers have no role in determining the sex of the new born. Mothers have a pair of X chromosome and all children will inherit an 'X' chromosome from their

mother regardless of whether they are boys or girls. Only presence or absence of 'Y' chromosome present in male gametes determine the sex of new born.

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

Ans. All the gametes formed in human females have an 'X' chromosome because during meiosis at the time of gamete formation, one X chromosome enters each gamete.

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

Ans. The sex of a child is determined by the type of sex chromosome contributed by male gamete. The statistical probability of getting either a male or female child is 50 : 50, because the ratio of male gametes containing X chromsome and those containing Y chromosome is 50 : 50.

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

(*a*) yellow seed (*b*) round seed

Ans. (*a*) Seed colour — Yellow (dominant), green (recessive)

(*b*) Seed shape — Round (dominant), wrinkled (recessive)

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

Ans. The women produces ova with both 'X' chromosome and man produces sperms with X and Y chromosome. If the husband of the woman transfer X chromosome, then child will be a girl. On the other hand, if the husband transfer Y chromosome, the child will be a boy. In the case, the husband is always transferring X chromosome and hence, all the children are girl.

10. In the following crosses write the characteristics of the progeny: [HOTS]

Cross	Progeny
(*a*) RR YY × RR YY	.....
Round, yellow and Round, yellow	....
(*b*) Rr Yy × Rr Yy	.....
Round, yellow and Round, yellow	....
(*c*) rr yy × rr yy	.....
wrinkled, green and wrinkled, green	....
(*d*) RR YY × rr yy	.....
Round, yellow and wrinkled green	....

Ans. (*a*) Round yellow

(*b*) Round yellow, Round green
Wrinkled yellow, Wrinkled green

(*c*) Wrinkled green

(*d*) Round yellow

11. Study the following cross and showing self-pollination in F_1, fill in the blank and answer the question that follows: **(5 marks)**

Parents	**RRYY**	×	**rryy**
	Round, yellow		**wrinkled, green**
F_1 —	**Rr Yy**	×	**?**
	Round, yellow		

Ans. Rr Yy Round, yellow.

12. In previous question, what are the combinations of character in the F_2 progeny? What are their ratios?

Ans. Round yellow – 9 ; Round green – 3
Wrinkled yellow – 3 : Wrinkled green – 1
i.e. 9 : 3 : 3 : 1.

13. Give reasons for the appearance of new combinations of characters in the F_2 progeny.

Ans. An organism can inherit each character independently. So, in the F_2 progeny new combination of character appears. Tall/Short and Round/Wrinkled seed trait are independently inherited.

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

Ans. Basic features for the mechanism of Inheritance are as follows:

(*i*) Characters are controlled by genes.
(*ii*) Each gene controls one character.
(*iii*) Genes are located on chromosomes.
(*iv*) There may be two or more forms of gene.
(*v*) An individual possess two forms of genes whether similar or dissimilar.
(*vi*) One form may be dominant over the other.
(*vii*) The two alleles separate at the time of gamete formation.
(*viii*) The two forms are brought together in the zygote.
(*ix*) Alleles of different genes located on separate chromosomes behave independent of one another.