

# Heredity

Class 10 - CBSE Science | Chapter 8 | Worksheet & Test Paper

16 MCQs | 8 board questions | 7 practice problems

Video lesson, notes and an interactive quiz: [learn.ultimatetools.io](https://learn.ultimatetools.io)

## SECTION A - Multiple Choice Questions (1 mark each)

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**1. A cross between a pure tall pea plant (TT) and a pure short one (tt) gives an F1 generation that is:**

- (a) All of medium height
- (b) All tall
- (c) Half tall and half short
- (d) All short

**2. In the F2 generation of a monohybrid cross, the PHENOTYPIC ratio is:**

- (a) 3 : 1
- (b) 1 : 2 : 1
- (c) 9 : 3 : 3 : 1
- (d) 1 : 1

**3. The genotypic ratio of the F2 generation of a monohybrid cross is:**

- (a) 3 tall : 1 short
- (b) 1 TT : 1 tt
- (c) 2 TT : 1 Tt : 1 tt
- (d) 1 TT : 2 Tt : 1 tt

**4. Two pea plants, both tall, are crossed and some of their offspring are short. What are the genotypes of the two parents?**

- (a) TT and TT
- (b) TT and Tt
- (c) Tt and Tt
- (d) Tt and tt

**5. Which pair correctly describes genotype and phenotype?**

- (a) Tt is the phenotype; tall is the genotype
- (b) Both Tt and tall describe the genotype
- (c) Tt is the genotype; tall is the phenotype
- (d) Both Tt and tall describe the phenotype

**6. A plant with the genotype Tt is best described as:**

- (a) Homozygous tall
- (b) Heterozygous tall
- (c) Homozygous short
- (d) Heterozygous short

**7. Mendel chose the garden pea for his experiments mainly because:**

- (a) peas simply cannot be cross-pollinated, so results stay pure
- (b) pea plants have no contrasting characters to confuse the results
- (c) peas take several years to grow, giving time for careful study
- (d) it grows fast, has contrasting characters, and can be hand-crossed

**8. In a dihybrid cross between RRYy and rryy plants, the F1 generation consists of:**

- (a) all round and yellow seeds
- (b) 9 round-yellow : 3 round-green : 3 wrinkled-yellow : 1 wrinkled-green
- (c) half round-yellow and half wrinkled-green
- (d) all wrinkled and green seeds

**9. A plant of genotype RrYy produces which gametes?**

- (a) RY and ry only
- (b) Rr and Yy only
- (c) RY, Ry, rY and ry
- (d) RRYy and rryy

**10. The appearance of round-green and wrinkled-yellow seeds in the dihybrid F2 shows that:**

- (a) the two pairs of characters are inherited independently
- (b) the two pairs of characters are always inherited together
- (c) green and wrinkled are both dominant characters
- (d) a new gene was created during the cross

**11. According to the chapter, a gene controls a characteristic by:**

- (a) changing the number of chromosomes in the cell
- (b) directly shaping the physical structure of the organ
- (c) carrying the information for making a protein
- (d) being passed on only from the father to the offspring

**12. A pea plant is short because the gene for the height-controlling enzyme is in an altered form. This means the plant has:**

- (a) no gene for that enzyme at all
- (b) a more efficient enzyme, so more growth hormone
- (c) an extra chromosome carrying the enzyme
- (d) a less efficient enzyme, so less growth hormone

**13. In which of the following is the sex of the offspring NOT determined genetically?**

- (a) In some animals, where egg temperature decides it
- (b) In human beings, where the father contributes X or Y
- (c) In pea plants, where Mendel studied seven characters
- (d) In all mammals, where the mother contributes the X

**14. How many pairs of chromosomes are present in a human cell, and how many of these are autosomes?**

- (a) 23 pairs in total, of which 21 pairs are autosomes
- (b) 22 pairs in total, of which 22 pairs are autosomes
- (c) 46 pairs in total, of which 44 pairs are autosomes
- (d) 23 pairs in total, of which 22 pairs are autosomes

**15. Which statement about human sex determination is correct?**

- (a) The mother determines the sex, since she carries the child
- (b) The father determines the sex, since he contributes either X or Y
- (c) The sex is decided by whichever parent is genetically stronger
- (d) The sex depends on which ovary released the egg that month

**16. A couple already has three daughters. What is the probability that their fourth child will be a boy?**

- (a) 1 in 4, because they already have three girls
- (b) 50%
- (c) 75%
- (d) Close to zero

## SECTION B - Board-style Questions

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**1. A pure tall pea plant is crossed with a pure short one. Show the cross up to the F<sub>2</sub> generation using a Punnett square, and give both the phenotypic and the genotypic ratio of the F<sub>2</sub>. [5 marks]**

**2. Define the following, giving an example of each from Mendel's work: (a) dominant trait (b) recessive trait (c) genotype (d) phenotype (e) alleles. [5 marks]**

**3. What is a dihybrid cross? Explain, with the F<sub>2</sub> ratio, how such a cross shows that two pairs of characters are inherited independently. [5 marks]**

**4. Explain how the sex of a child is determined in human beings. Why is it scientifically wrong to blame the mother for the birth of a girl? [5 marks]**

**5. How does a gene control a characteristic such as the height of a plant? Explain why an altered gene results in a short plant. [3 marks]**

**6. How do variations accumulate in a population, and why is variation useful for the survival of a species? [3 marks]**

**7. In a monohybrid cross, why do the characters not blend? Support your answer with what Mendel observed in the F1 and F2 generations. [3 marks]**

**8. A tall pea plant is crossed with a short one and the offspring are 50% tall and 50% short. What are the genotypes of the parent plants? Justify with a Punnett square. [3 marks]**

## **SECTION C - Practice Problems**

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**1. You are given a tall pea plant, but you do not know whether it is TT or Tt. Describe a single cross that would tell you which it is, and state the result you would expect in each case.**

Hint: Cross it with the genotype that has nothing to hide.

**2. In the dihybrid F2 of 16 seeds, work out how many would be expected to be (a) round and yellow, (b) wrinkled and green, (c) round in shape regardless of colour. Explain how you obtained (c).**

Hint: Handle the two characters separately, then combine.

**3. A woman blames herself for having given birth to three daughters and no son. Using your knowledge of chromosomes, explain carefully why she is not responsible, and state the probability that a fourth child would be a son.**

Hint: Work out what each parent can possibly contribute to a gamete.

**4. Two pea plants that both have round seeds are crossed. Among their offspring, some seeds are wrinkled. What does this tell you about (a) which character is dominant and (b) the genotypes of the two parents? Show the cross.**

Hint: A recessive character can only appear when both copies are present.

**5. Explain why two plants with different genotypes can look exactly alike, while two plants that look different must have different genotypes. Use pea height as your example.**

Hint: Think about which combinations produce which appearance.

**6. A gene controls the enzyme that makes a growth hormone in pea plants. Predict what would happen to plant height if (a) the plant had two efficient copies of the gene, (b) one efficient and one altered copy, (c) two altered copies - and relate your answer to the terms dominant and recessive.**

Hint: How much enzyme does one working copy produce?

**7. A population of beetles living on a green bush is all green. Explain how variation could allow the species to survive if a bird that hunts by sight arrives, and state clearly what variation does NOT guarantee.**

Hint: Think about the niche and about who survives to reproduce.

# ANSWER KEY

Heredity - Class 10 CBSE Science

## Section A - MCQ answers

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### 1. (b) All tall

Tallness is dominant, so every F<sub>1</sub> plant is Tt and looks tall. Mendel's key observation was that the characters do NOT blend - no medium-height plants appear - and the recessive short character simply stays hidden.

### 2. (a) 3 : 1

By appearance, 3 out of every 4 F<sub>2</sub> plants are tall and 1 is short - that is the phenotypic ratio. 1 : 2 : 1 is the GENOTYPIC ratio (1 TT : 2 Tt : 1 tt) of the very same square, and 9 : 3 : 3 : 1 belongs to a dihybrid cross.

### 3. (d) 1 TT : 2 Tt : 1 tt

The four boxes of the Punnett square give TT, Tt, Tt and tt - that is 1 : 2 : 1. Note that the 2 Tt plants look exactly like the 1 TT plant, which is why the phenotypic ratio collapses to 3 : 1.

### 4. (c) Tt and Tt

A short offspring must be tt, so it received a t from EACH parent. Both parents are tall but must each carry a t, so both are Tt. TT x TT and TT x Tt can never produce a short plant, and Tt x tt would give half short plants but one parent would then be short.

### 5. (c) Tt is the genotype; tall is the phenotype

The genotype is the combination of alleles the organism carries (TT, Tt, tt). The phenotype is the characteristic you can actually observe (tall or short). TT and Tt are different genotypes with the same phenotype.

### 6. (b) Heterozygous tall

The two alleles are different (T and t), so the plant is heterozygous - also called a hybrid. Because T is dominant, it looks tall. A homozygous tall plant would be TT and a homozygous short plant tt.

### 7. (d) it grows fast, has contrasting characters, and can be hand-crossed

Peas grow quickly, show several sharply contrasting characters, and although they normally self-pollinate they CAN be cross-pollinated by hand - which is exactly what gave Mendel control over each cross.

### 8. (a) all round and yellow seeds

Every F<sub>1</sub> plant is RrYy, and since round is dominant over wrinkled and yellow over green, all the F<sub>1</sub> seeds are round and yellow. The 9 : 3 : 3 : 1 ratio appears only in the F<sub>2</sub> generation.

### 9. (c) RY, Ry, rY and ry

Each gamete gets ONE allele from each pair, and the pairs assort independently, so four kinds of gamete are formed in equal numbers - RY, Ry, rY and ry. That is why the dihybrid Punnett square is 4 x 4.

### 10. (a) the two pairs of characters are inherited independently

Neither parent had round-green or wrinkled-yellow seeds, so the characters must have been reshuffled during gamete formation. Seed shape is therefore inherited independently of seed colour - Mendel's second great conclusion.

### 11. (c) carrying the information for making a protein

Cells work through proteins. Each gene carries the information for one protein; for plant height that protein is an enzyme that makes a growth hormone. So the gene acts indirectly - it makes a protein, and the protein does the work.

### 12. (d) a less efficient enzyme, so less growth hormone

The altered gene still makes the enzyme, but a less efficient one. Less enzyme activity means less of the growth hormone is produced, so the plant remains short. The gene is not absent - it is simply a different version.

### 13. (a) In some animals, where egg temperature decides it

NCERT opens this section by noting that different species use very different strategies. In some animals the TEMPERATURE at which the fertilised eggs are kept decides whether the young are male or female, and snails can even change their sex - so sex there is not genetically determined. In human beings, by contrast, it is largely genetic (XX / XY).

### 14. (d) 23 pairs in total, of which 22 pairs are autosomes

Human cells contain 23 pairs of chromosomes. In 22 of those pairs the two chromosomes match - these are the autosomes. The 23rd pair is the sex chromosome pair: XX in a female, XY in a male.

### 15. (b) The father determines the sex, since he contributes either X or Y

The mother is XX, so every egg carries an X and she can only ever contribute an X. The father is XY, so half his sperms carry X and half carry Y - and that is what decides whether the child is XX (girl) or XY (boy).

### 16. (b) 50%

Each fertilisation is an independent event. Half the father's sperms carry X and half carry Y, so the chance of a boy is 50% every single time, no matter how many children the couple already has or what sex they are.

## Section B - Model answers

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### 1. A pure tall pea plant is crossed with a pure short one. Show the cross up to the F2 generation using a Punnett square, and give both the phenotypic and the genotypic ratio of the F2.

PARENTS: pure tall = TT, pure short = tt. Gametes: T and t. F1: every plant is Tt, and since T is dominant, ALL the F1 plants are TALL. F1 x F1 (self-pollination): Tt x Tt. Gametes from each: T and t. PUNNETT SQUARE - writing T and t along the top and T and t down the side gives the four boxes TT, Tt, Tt and tt. F2 RESULTS: TT (tall), Tt (tall), Tt (tall), tt (short). PHENOTYPIC RATIO = 3 tall : 1 short. GENOTYPIC RATIO = 1 TT : 2 Tt : 1 tt. Note that the short character, absent throughout the F1, reappears in the F2 - it was hidden, not destroyed.

### 2. Define the following, giving an example of each from Mendel's work: (a) dominant trait (b) recessive trait (c) genotype (d) phenotype (e) alleles.

(a) DOMINANT TRAIT - the trait that is expressed even when only one copy of its allele is present; for example TALLNESS in pea plants, so a Tt plant is tall. (b) RECESSIVE TRAIT - the trait that is expressed only when both copies of its allele are present; for example SHORTNESS, which appears only in a tt plant. (c) GENOTYPE - the combination of alleles an organism carries, for example TT, Tt or tt. (d) PHENOTYPE - the characteristic that can actually be observed, for example tall or short. Note that TT and Tt are different genotypes with the same phenotype. (e) ALLELES - the alternative forms of the same gene, for example T (tall) and t (short), which occupy the same position on the pair of chromosomes.

### 3. What is a dihybrid cross? Explain, with the F2 ratio, how such a cross shows that two pairs of characters are inherited independently.

A DIHYBRID CROSS is a cross in which TWO pairs of contrasting characters are followed at the same time. Mendel crossed a plant having round, yellow seeds (RRYY) with one having wrinkled, green seeds (rryy). The F1 generation was entirely ROUND and YELLOW (RrYy), showing that round is dominant over wrinkled and yellow over green. When the F1 plants were self-pollinated, the F2 generation contained four kinds of seed in the ratio 9 : 3 : 3 : 1 - 9 round-yellow, 3 round-green, 3 wrinkled-yellow and 1 wrinkled-green. The important point is that ROUND-GREEN and WRINKLED-YELLOW are NEW combinations: neither parent possessed them. The characters must therefore have been reshuffled during gamete formation, which shows that the two pairs of characters are inherited INDEPENDENTLY of each other - how a seed's shape is inherited has no effect on how its colour is inherited.

### 4. Explain how the sex of a child is determined in human beings. Why is it scientifically wrong to blame the mother for the birth of a girl?

Human cells contain 23 pairs of chromosomes; 22 pairs are autosomes and the 23rd pair are the sex chromosomes. A woman has two X chromosomes (XX) and a man has one X and one Y (XY). During gamete formation, each gamete receives one chromosome of the pair. Because the mother is XX, EVERY egg she produces carries an X chromosome - she has no other option. Because the father is XY, HALF his sperms carry an X and half carry a Y. If a sperm carrying X fertilises the egg, the child is XX - a GIRL. If a sperm carrying Y fertilises the egg, the child is XY - a BOY. Therefore the sex of the child is determined entirely by the type of sperm from the FATHER, and the chance of a boy or a girl is equal, 50 : 50. It is scientifically wrong to blame the mother, because she can only ever contribute an X chromosome and so cannot influence the sex of the child in any way.

### 5. How does a gene control a characteristic such as the height of a plant? Explain why an altered gene results in a short plant.

Cells carry out their work through PROTEINS, and each gene carries the information for making one particular protein. The height of a plant depends on the amount of a plant HORMONE it produces, and that hormone is made by an ENZYME, which is itself a protein coded for by a gene. If the gene works EFFICIENTLY, a large amount of the enzyme is made, plenty of hormone is produced, and the plant grows TALL. If the gene is present in an ALTERED form, the enzyme it codes for is LESS EFFICIENT, so less hormone is made and the plant remains SHORT. The gene therefore does not create the trait directly - it makes a protein, and it is the protein that does the work.

### 6. How do variations accumulate in a population, and why is variation useful for the survival of a species?

ACCUMULATION: even in asexual reproduction the copying of DNA is not perfectly accurate, so small variations appear in the offspring. These small differences build up generation after generation. In sexual reproduction, DNA from two different parents is combined, so a much greater amount of variation is produced in a single generation. USEFULNESS: organisms live in a NICHE - a place with particular conditions. If that niche changes drastically, for example if the temperature of a pond rises sharply, a population of identical organisms could be wiped out completely. If variations exist, some individuals may be able to tolerate the new conditions and survive. Variation therefore does not guarantee the survival of any individual, but it gives the SPECIES a chance to survive, and it is the basis of evolution.

### 7. In a monohybrid cross, why do the characters not blend? Support your answer with what Mendel observed in the F1 and F2 generations.

If characters blended, crossing a pure tall plant with a pure short one would give plants of MEDIUM height in the F<sub>1</sub>, and the F<sub>2</sub> would show a range of heights. That is not what Mendel found. Every F<sub>1</sub> plant was FULLY TALL - not medium - showing that the short character was not diluted or mixed. And in the F<sub>2</sub>, fully SHORT plants reappeared, in the ratio 3 tall : 1 short. If blending had taken place, the short character could never have reappeared unchanged. This proves that the two characters are controlled by separate FACTORS (alleles) that stay intact and separate inside the organism, and that one of them (tallness) is simply DOMINANT over the other.

**8. A tall pea plant is crossed with a short one and the offspring are 50% tall and 50% short. What are the genotypes of the parent plants? Justify with a Punnett square.**

The short parent must be tt, since a short plant can only be homozygous recessive. If the tall parent were TT, every offspring would receive a T and all would be tall - which does not match. So the tall parent must be HETEROZYGOUS, Tt. GENOTYPES: Tt x tt. PUNNETT SQUARE: the gametes of the tall parent are T and t; the gametes of the short parent are t and t. The four boxes give Tt, tt, Tt and tt - that is 2 Tt (tall) and 2 tt (short), which is 50% tall and 50% short, exactly as observed. (This cross, between an organism showing the dominant trait and a homozygous recessive one, is the standard way of finding out whether a tall plant is TT or Tt.)

## Section C - Solutions

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**1. You are given a tall pea plant, but you do not know whether it is TT or Tt. Describe a single cross that would tell you which it is, and state the result you would expect in each case.**

Cross the unknown tall plant with a pure SHORT plant (tt), whose genotype is certain. CASE 1 - if the tall plant is TT: its gametes are all T, the short plant's are all t, so every offspring is Tt and ALL of them are TALL. CASE 2 - if the tall plant is Tt: it produces T and t gametes in equal numbers, so the offspring are half Tt (tall) and half tt (short) - about 50% tall and 50% SHORT. So the appearance of even one short offspring proves the tall parent was Tt; if every offspring is tall, the parent was TT.

**2. In the dihybrid F<sub>2</sub> of 16 seeds, work out how many would be expected to be (a) round and yellow, (b) wrinkled and green, (c) round in shape regardless of colour. Explain how you obtained (c).**

(a) ROUND AND YELLOW = 9 out of 16. (b) WRINKLED AND GREEN = 1 out of 16. (c) ROUND REGARDLESS OF COLOUR = 12 out of 16. This is obtained by adding the two round groups together: 9 round-yellow + 3 round-green = 12. Alternatively, treat the shape character on its own: within the F<sub>2</sub> each character separately still follows the monohybrid 3 : 1 ratio, and 3/4 of 16 = 12 round to 4 wrinkled. Both routes agree, which is a useful check on the arithmetic - but be careful: that agreement does NOT by itself prove independent inheritance, because the single-character ratio would still be 3 : 1 even if the two characters always travelled together. What actually PROVES independence is the appearance of the two NEW combinations, round-green (3/16) and wrinkled-yellow (3/16), which neither parent possessed. If shape and colour were always inherited together, only round-yellow and wrinkled-green seeds could ever appear.

**3. A woman blames herself for having given birth to three daughters and no son. Using your knowledge of chromosomes, explain carefully why she is not responsible, and state the probability that a fourth child would be a son.**

The mother's sex chromosomes are XX. When her eggs are formed, each egg receives one chromosome from that pair - and since BOTH are X, every egg she can ever produce carries an X. She therefore has no way of influencing the sex of the child. The father's sex chromosomes are XY, so when sperms are formed, half of them receive the X and half receive the Y. If an X-carrying sperm fertilises the egg the child is XX, a girl; if a Y-carrying sperm does so the child is XY, a boy. The sex of the child is thus determined solely by the father's sperm. PROBABILITY for a fourth child: each fertilisation is an independent event, so the chance of a son remains 50%, exactly as it was for each of the earlier children - previous births have no influence whatsoever.

**4. Two pea plants that both have round seeds are crossed. Among their offspring, some seeds are wrinkled. What does this tell you about (a) which character is dominant and (b) the genotypes of the two parents? Show the cross.**

(a) A wrinkled seed has appeared from two ROUND parents, so wrinkled must be the character that can stay hidden - that is, ROUND is DOMINANT and wrinkled is RECESSIVE. (b) A wrinkled offspring must be rr, so it received an r from EACH parent. But both parents are round, so each must carry one R and one r: both parents are Rr (heterozygous round). THE CROSS: Rr x Rr. Gametes R and r from each. The Punnett square gives RR, Rr, Rr, rr - that is 3 round : 1 wrinkled, so about one quarter of the offspring are expected to be wrinkled.

**5. Explain why two plants with different genotypes can look exactly alike, while two plants that look different must have different genotypes. Use pea height as your example.**

A TT plant and a Tt plant have DIFFERENT genotypes, but both are TALL and look identical, because the dominant allele T is expressed whenever it is present - one copy is enough. So appearance alone cannot tell you whether a tall plant is TT or Tt; only a test cross with a tt plant can. The reverse, however, is not true: a tall plant and a short plant look different, and since shortness only appears in tt while tallness requires at least one T, their genotypes must differ. In short, the same phenotype can arise from more than one genotype, but a different phenotype always means a different genotype.

**6. A gene controls the enzyme that makes a growth hormone in pea plants. Predict what would happen to plant height if (a) the plant had two efficient copies of the gene, (b) one efficient and one altered copy, (c) two altered copies - and relate your answer to the terms dominant and recessive.**

(a) TWO EFFICIENT COPIES (TT): plenty of the enzyme is made, so plenty of growth hormone is produced and the plant is TALL. (b) ONE EFFICIENT, ONE ALTERED (Tt): the single working copy still makes enough enzyme to produce sufficient hormone, so the plant is still TALL - this is precisely why tallness behaves as the DOMINANT character; a single functional copy is enough. (c) TWO ALTERED COPIES (tt): no efficient enzyme is made, so very little hormone is produced and the plant is SHORT - which is why shortness is RECESSIVE and appears only when both copies are altered. This shows that dominance is not a mysterious property: it simply reflects whether one working copy of a gene produces enough protein to give the normal characteristic.

**7. A population of beetles living on a green bush is all green. Explain how variation could allow the species to survive if a bird that hunts by sight arrives, and state clearly what variation does NOT guarantee.**

The beetles live in a NICHE - the green bush, with its particular conditions. Because DNA copying during reproduction is never perfect, small variations arise, and over generations they accumulate; sexual reproduction produces such variation much faster. Suppose a few beetles happen to be a different colour that is harder to see against the bush. When a bird that hunts by sight arrives, the green beetles are eaten in large numbers while the better-camouflaged variants are more likely to survive, reproduce and pass that variation on, so the species persists. WHAT VARIATION DOES NOT GUARANTEE: it gives no guarantee of survival to any individual - an individual with a useful variation may still be eaten by chance. Variation only improves the chance that the SPECIES as a whole will survive a change in its niche.













