

HEREDITY - CBSE BOARD MASTER WORKSHEET

Class X Science • Comprehensive PYQ Bank (2011 – 2024)

Max Marks: 60

Duration: 2 Hours

Syllabus: Strict NCERT Rationalised

Student Name: _____

Roll No: _____

Class / Sec: X - ____

Score: / 60

Exam Focus & Syllabus Note: In accordance with the rationalised CBSE curriculum, the chapter covers *Heredity: Mendel's contributions, Laws for inheritance of traits, Sex determination in humans*. The questions below represent real board exam questions mapped over the past 14 years.

SECTION A: MULTIPLE CHOICE QUESTIONS (1 MARK EACH)

10 × 1 = 10 Marks

Q1. In an experiment with pea plants, a pure tall plant (TT) is crossed with a pure short plant (tt). The ratio of pure tall plants to pure short plants in the F_2 generation is: **CBSE 2023**

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

Q2. A cross between a pea plant with white flowers (vv) and a pea plant with violet flowers (VV) resulted in an F_2 progeny. The ratio of homozygous violet (VV) to white (vv) flowers will be: **CBSE 2023, 2018**

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

Q3. A zygote that inherits an 'X' chromosome from the father will develop into a: **CBSE 2024, 2020**

- (a) Boy
- (b) Girl
- (c) Either boy or girl
- (d) Child with intersex karyotype

Q4. Which of the following statements about sex determination in human beings is correct? **CBSE 2024**

- (a) Mother determines the sex of the child
- (b) Probability of having a girl child is higher
- (c) Sperm carries either X or Y chromosome
- (d) Ovum contains XY chromosomes

Q5. How many autosomes are present in a human sperm cell? **CBSE 2024, 2020 C**

- (a) 44 autosomes
- (b) 23 autosomes
- (c) 22 autosomes
- (d) 11 autosomes

Q6. Two pea plants, one with round yellow seeds (RRYY) and another with wrinkled green seeds (rryy), produce F_1 progeny that are self-pollinated. The number of seeds with recombinant phenotypes in F_2 out of 16 is: **CBSE 2020, 2017**

- (a) 9
- (b) 6
- (c) 10
- (d) 1

Q7. Which of the following is a cellular information source for making proteins? **CBSE 2014, 2019**

- (a) Rough Endoplasmic Reticulum
- (b) Cellular DNA
- (c) Mitochondria
- (d) Cytoplasmic enzymes

Q8. The number of chromosomes in parents and offspring of a particular species undergoing sexual reproduction remains constant due to: **CBSE 2023, 2016**

- (a) Doubling of chromosomes during zygote formation
- (b) Halving of chromosomes during gamete formation
- (c) Mitotic replication of somatic cells
- (d) Equal replication of cellular RNA

Direction for Q9 – Q10: (a) Both A and R are true, and R is correct explanation of A. (b) Both A and R are true, but R is not correct explanation. (c) A is true, R is false. (d) A is false, R is true.

Q9. Assertion (A): The sex of a child in humans is determined by the chromosome inherited from the father.

Reason (R): Human males have a heteromorphic mismatched pair of sex chromosomes (XY), producing two types of sperms. **CBSE 2020, 2023**

Q10. Assertion (A): A trait that is inherited may not necessarily express itself in the F_1 generation.

Reason (R): Recessive alleles express their phenotypic character only in a homozygous condition. **CBSE 2022, 2017**

SECTION B: VERY SHORT ANSWER QUESTIONS (2 MARKS EACH)**6 × 2 = 12 Marks**

Q11. Define Heredity. Name the plant selected by Gregor Mendel for his hybridization experiments, and state two key reasons for this choice. **CBSE 2021 C, 2019, 2014**

Q12. (a) Name the two types of gametes produced by human males in terms of sex chromosomes.

(b) Does a male child inherit an X chromosome from his father? Justify your answer. **CBSE 2022**

Q13. Differentiate between inherited traits and acquired traits based on: (i) Cellular site of variation, and (ii) Heritability to the subsequent generation. Give one example of each. **CBSE 2019, 2017, 2015**

Q14. What is DNA? Where is it located inside an animal cell? State its fundamental biological role in reproduction. **CBSE 2016, 2015, 2014**

Q15. A cross was made between pure-breeding violet-flowered pea plants (VV) and white-flowered pea plants (vv).

(a) What phenotypic character is observed in the F₁ progeny?

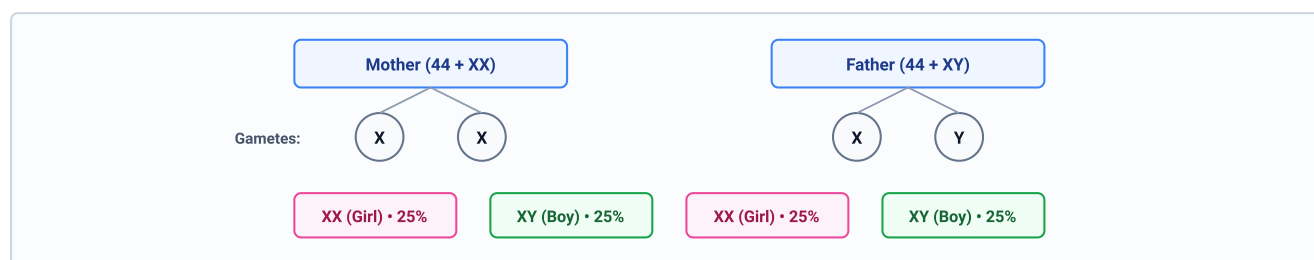
(b) If 100 plants are obtained in F₂ generation by selfing F₁, how many plants are expected to bear white flowers?

CBSE 2022 Term II, 2018

Q16. "Variations are beneficial to the species even if they may not be beneficial to the individual organism." Justify this statement with a suitable biological illustration. **CBSE 2023, 2018 C, 2014**

SECTION C: SHORT ANSWER QUESTIONS (3 MARKS EACH)**6 × 3 = 18 Marks**

Q17. "The statistical probability of getting either a male or a female child in humans is exactly 50%." Justify this statement by drawing an accurate genetic flow-chart showing sex determination in human beings. **CBSE 2023, 2021-22 C, 2019**



Q18. How did Mendel explain that it is possible that a trait is inherited but not expressed in an organism? Explain with the help of a monohybrid cross between a homozygous tall pea plant and a homozygous dwarf pea plant. **CBSE 2017, 2016-17 C, 2015**

Q19. A green-stemmed rose plant denoted by **GG** and a brown-stemmed rose plant denoted by **gg** are crossed.

- (a) Write your observation regarding the stem colour of the F_1 progeny.
- (b) What percentage of the F_2 progeny will have brown stems when F_1 plants undergo self-pollination?
- (c) Deduce the genotypic ratio of GG, Gg, and gg in the F_2 generation. **CBSE 2020**

Q20. (a) Why is the sex chromosome pair in human males referred to as a "mismatched pair"?

- (b) How is the original diploid number of chromosomes restored in a zygote when both parents possess 46 chromosomes?

CBSE 2023, 2018 C

Q21. In a pea plant, the allele for round seeds (R) is dominant over wrinkled seeds (r), and yellow cotyledon colour (Y) is dominant over green cotyledon colour (y).

- (a) State the phenotype and genotype of the F_1 progeny resulting from a cross between RRYy and rryy.
- (b) Name and define the Mendelian law that explains the emergence of new phenotypic combinations in the F_2 generation. **CBSE 2024, 2020, 2016**

Q22. A blue-flowered plant denoted by **BB** is crossed with a white-flowered plant denoted by **bb**.

- (a) State the colour of flowers expected in their F_1 generation.
- (b) What will be the percentage of plants bearing white flowers in the F_2 generation if F_1 plants are selfed?
- (c) State the expected ratio of genotypes BB : Bb in the F_2 progeny. **CBSE 2015, 2013, 2012**

SECTION D: LONG ANSWER QUESTIONS (5 MARKS EACH)

2 × 5 = 10 Marks

Q23. Mendel carried out hybridization experiments to study the inheritance of two traits simultaneously in garden pea (dihybrid cross).

- (a) Why did Mendel choose to study two contrasting traits at the same time?
- (b) Complete the 16-cell Punnett square shown below for the F_2 generation resulting from a cross between pure round-yellow (RRYY) and wrinkled-green (rryy) seeded pea plants.
- (c) State the phenotypic ratio obtained in the F_2 progeny and write the four distinct phenotypes observed. **CBSE 2020, 2017 C, 2014**

Gametes ($\text{♀} \downarrow / \text{♂} \rightarrow$)	RY	Ry	rY	ry
RY	RRYY (Round Yellow)	RRYy (Round Yellow)	RrYY (Round Yellow)	RrYy (Round Yellow)
Ry	RRYy (Round Yellow)	RRyy (Round Green)	RrYy (Round Yellow)	Rryy (Round Green)
rY	RrYY (Round Yellow)	RrYy (Round Yellow)	rrYY (Wrinkled Yellow)	rrYy (Wrinkled Yellow)
ry	RrYy (Round Yellow)	Rryy (Round Green)	rrYy (Wrinkled Yellow)	rryy (Wrinkled Green)

Q24. In human societies, females are frequently blamed and tortured for giving birth to girl children.

- (a) Provide a rigorous scientific explanation to refute this practice, highlighting the male and female sex chromosome contributions.
- (b) Are sex chromosomes present in all cells of our body or only in the gametes? Clarify.
- (c) Mention two species in which sex determination is controlled by non-genetic or environmental factors. **CBSE 2023, 2021-22 Term II, 2019**

SECTION E: CASE-BASED / DATA-BASED QUESTIONS (4 MARKS EACH)

2 × 4 = 8 Marks

Q25. Read the passage and answer the questions that follow: **CBSE 2024 Sample Paper & 2022 Term II**

Gregor Johann Mendel, often termed the 'Father of Genetics', used pea plants (*Pisum sativum*) with distinct contrasting physical traits. In one of his monohybrid crosses, he crossed pure-breeding tall plants (height > 180 cm) with pure-breeding short/dwarf plants (height < 45 cm). When the F₁ plants were grown, he observed that no plants were of intermediate height; they were all tall. When these F₁ tall plants were self-pollinated to generate the F₂ progeny, a total of 1,064 plants were collected and counted.

- (i) State the genotype of the parents and the F₁ generation. (1 Mark)
- (ii) Why did intermediate plants not appear in the F₁ generation? Which law of inheritance does this substantiate? (1 Mark)
- (iii) Out of the 1,064 plants obtained in the F₂ generation, calculate mathematically the expected number of: (a) Phenotypically tall plants, and (b) Genotypically pure dwarf plants. (2 Marks)

Q26. Read the case below regarding chromosomal inheritance: **CBSE 2023, 2020**

A human cell contains 23 pairs of chromosomes. During sexual reproduction, each parent donates one set of genetic instructions. A research laboratory analyzed the karyotypes and gene distribution in human gametes and autosomal chromosomes.

Cell Type	Total Chromosomes	Autosomes	Sex Chromosomes	Ploidy
Somatic cell (Skin / Muscle)	46 (23 pairs)	44 (22 pairs)	2 (1 pair: XX or XY)	Diploid (2n)
Male Germ cell (Sperm)	23	22	1 (either X or Y)	Haploid (n)
Female Germ cell (Ovum)	23	22	1 (always X)	Haploid (n)

- (i) Explain why gametes must undergo meiotic reduction division rather than mitotic division during their formation. (1 Mark)
- (ii) What would happen to the chromosome count in progeny across successive generations if gametes were diploid? (1 Mark)
- (iii) What is the probability that a human couple will have a son who inherits his X chromosome from his maternal grandfather? Justify your answer genetically. (2 Marks)

KEY TERMINOLOGY & MENDELIAN RATIOS QUICK REFERENCE

Revision Aid

Concept / Cross	Parents Involved	F ₁ Phenotype / Genotype	F ₂ Phenotypic Ratio	F ₂ Genotypic Ratio
Monohybrid Cross (Height)	TT × tt (Tall × Dwarf)	All Tall (Tt)	3 Tall : 1 Dwarf (3:1)	1 TT : 2 Tt : 1 tt (1:2:1)
Monohybrid Cross (Flower Colour)	VV × vv (Violet × White)	All Violet (Vv)	3 Violet : 1 White (3:1)	1 VV : 2 Vv : 1 vv (1:2:1)
Dihybrid Cross (Seed Shape & Colour)	RRYY × rryy (Round Yellow × Wrinkled Green)	All Round Yellow (RrYy)	9 Round Yellow : 3 Round Green : 3 Wrinkled Yellow : 1 Wrinkled Green	[1:2:1:2:4:2:1:2:1] (9 distinct genotypes)

Q. No.	Model Answer / Value Points	Allotted Marks
Q1 – Q5	Q1: (c) 1 : 1 (Pure tall TT = 1, Pure dwarf tt = 1). Q2: (a) 1 : 1 (VV = 1 part, vv = 1 part in F ₂). Q3: (b) Girl (XX combination formed). Q4: (c) Sperm carries either X or Y chromosome. Q5: (c) 22 autosomes (22 autosomes + 1 allosome = 23 chromosomes).	[5 × 1 = 5 M] 1 mark each
Q6 – Q10	Q6: (b) 6 recombinant seeds (3 Round green + 3 Wrinkled yellow). Q7: (b) Cellular DNA. Q8: (b) Halving of chromosomes during gamete formation via meiosis. Q9: (a) Both A and R are true, and R correctly explains A. Q10: (a) Both A and R are true, and R correctly explains A.	[5 × 1 = 5 M] 1 mark each
Q11 – Q13	Q11: Heredity is the transmission of characters/traits from parents to their progeny. Mendel chose garden pea (<i>Pisum sativum</i>) because: (i) Short life cycle, (ii) Distinct bisexual flowers with easily visible contrasting traits, (iii) Easy self- and cross-pollination. [1+1 M] Q12: (a) Two types of sperms: 50% carrying 'X' chromosome and 50% carrying 'Y' chromosome. (b) No, a male child always inherits the 'Y' chromosome from his father and the 'X' chromosome from his mother. [1+1 M] Q13: Inherited traits occur due to changes in DNA/germ cells and are passed on to progeny (e.g., eye colour). Acquired traits develop in somatic tissues during lifetime, involve no DNA change, and cannot be inherited (e.g., pierced ears, body weight). [1+1 M]	[6 M] 2 marks each
Q14 – Q16	Q14: DNA (Deoxyribonucleic Acid) is the genetic polymer located inside the nucleus. It carries genetic blueprints and directs the synthesis of cellular proteins controlling traits. [1+1 M] Q15: (a) All plants will have violet flowers (Vv). (b) In F ₂ , 25% show white flowers: 25% of 100 = 25 plants. [1+1 M] Q16: Variations provide differential survival advantage during environmental shifts. <i>Illustration:</i> In a population of heat-intolerant bacteria in temperate water, a sudden rise in temperature would kill most bacteria, but a few variants resistant to heat survive and propagate the species. [1+1 M]	[6 M] 2 marks each
Q17 – Q19	Q17: Ovum is homogametic (all 22+X). Sperms are heterogametic (50% 22+X, 50% 22+Y). Fertilization with X-sperm produces female (XX); with Y-sperm produces male (XY). Both events have an exact 1:1 statistical chance (50%). [Flowchart + explanation: 3 M] Q18: When pure tall (TT) and dwarf (tt) plants are crossed, F ₁ plants inherit both 'T' and 't' alleles (Tt). However, only 'T' (tall) expresses itself because it is dominant; 't' remains latent/recessive. When F ₁ selfs, the recessive 'tt' combination reappears in F ₂ producing 25% dwarf plants, proving the trait was inherited though unexpressed in F ₁ . [3 M] Q19: (a) All F ₁ plants have green stems (Gg). (b) Percentage of brown-stemmed plants (gg) in F ₂ = 25% (1/4). (c) Genotypic ratio GG : Gg : gg = 1 : 2 : 1. [1+1+1 M]	[9 M] 3 marks each
Q23 & Q25	Q23: (a) To investigate whether contrasting traits are inherited together or independently. (b) 9 Round-Yellow, 3 Round-Green, 3 Wrinkled-Yellow, 1 Wrinkled-Green. Ratio: 9:3:3:1. (c) Proves Mendel's Law of Independent Assortment. [1+3+1 M] Q25: (i) Parents: TT (tall), tt (dwarf); F ₁ : Tt. (ii) Law of Dominance – in heterozygous condition, only the dominant allele expresses. (iii) Total = 1,064 plants. Tall plants (3/4) = 1064 × 0.75 = 798 plants. Pure dwarf (tt, 1/4) = 1064 × 0.25 = 266 plants. [1+1+2 M]	[9 M] Long & Case

• Worksheet compiled strictly according to the latest CBSE Class 10 Science Examination Specifications. •