CBSE CLASS X

Science (086)

ANSWER KEY

From previous CBSE Board Exam questions

Code: CYMQV4	Questions: 63	Maximum Marks: 135	Generated: 2026-06-15 13:05

SELECTIONS USED

Source	Previous-year board
Subject	Science
Lessons	Heredity
Year	2022-2026
Questions selected	63

Composition — Types: 21 Short · 19 MCQ · 9 Assertion–reason · 5 Case-based · 5 source_based · 5 Very short

Q1. § Introduction § 8.1 ACCUMULATION OF VARIATION DURING REPRODUCTION **[2]**

What is variation ? List two main reasons that may lead to variation in a population.

Previously asked in: 2022 31/1/1 Q5 (a)

◆ Heredity | Variation – Definition and Causes

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Model Answer

Variation is the difference in characteristics among individuals of the same species arising during reproduction.

Two main reasons for variation:

1. **Inaccurate DNA copying** — Small errors occur during DNA replication, producing subtle differences in the new individual.
2. **Sexual reproduction** — Combining DNA from two different individuals creates new combinations of variations in the offspring.

Source: Chapter 7, Section 7.1.1 & 7.3.1; Chapter 8, Section 8.1

Explanation

- The definition should mention "differences among individuals of the same species" linked to reproduction — examiners expect this context.
- For the two reasons, the textbook specifically highlights **DNA copying errors** and **sexual reproduction** (combining DNA from two parents). Naming both scores full marks.
- Do not confuse "variation" with "mutation" — use the textbook terminology.
- At 2 marks, one line for the definition and two labelled points is the ideal format.

Q2. § Introduction § 8.1 ACCUMULATION OF VARIATION DURING REPRODUCTION **[2]**

"Variation is useful for the survival of species over time." Explain this statement with the help of an example.

Previously asked in: 2026 31/2/1 Q11

◆ **Heredity** Importance of Variation for Survival of Species

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Model Answer

Variation means subtle differences among individuals of a species. When the environment changes drastically, most individuals may die, but variants better suited to the new conditions survive and reproduce.

Example: A population of bacteria lives in temperate water. Due to global warming, water temperature rises. Most bacteria die, but heat-resistant variants survive and multiply, ensuring the species continues.

Thus, variation is useful for survival of a species over time.

Source: Chapter 7, Section 7.1.1 – The Importance of Variation

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Explanation

- Examiners expect: a **definition/explanation of variation** + a **clear example** — the bacteria/heat example from the textbook is ideal and safest to use.
- The key idea is that variation helps the **species** (not every individual) survive when the **environment changes**.
- Avoid writing a long essay; two crisp points + one example is sufficient for 2 marks.
- Always name the organism, the environmental change, and the outcome in your example.

Q3. § 8.2 HEREDITY § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions **[1]**

In an experiment to study independent inheritance of two separate traits : shape and colour of seeds, the ratio of the different combinations in F_2 progeny would be

A 1 : 3
B 1 : 2 : 1
C 9 : 3 : 3 : 1
D 9 : 1 : 1 : 3

Previously asked in: 2024 31/3/1 Q10

◆ Heredity Dihybrid Cross and Independent Assortment (9:3:3:1 ratio)

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Model Answer

Option C: 9 : 3 : 3 : 1

When two traits (shape and colour) are independently inherited, the F_2 progeny shows four combinations in the ratio 9 : 3 : 3 : 1 (round-yellow : round-green : wrinkled-yellow : wrinkled-green).

Source: Chapter 8, Section 8.2.2

Explanation

- This is Mendel's **Law of Independent Assortment** applied to a **dihybrid cross**.
- The 9:3:3:1 ratio appears in F_2 when two independently assorting traits are considered together.
- Examiners expect you to identify option C and briefly justify it — just one line of reasoning is enough for 1 mark.
- Do not confuse with monohybrid ratios: 3:1 (phenotype) or 1:2:1 (genotype).

Q4. § Introduction § 8.1 ACCUMULATION OF VARIATION DURING REPRODUCTION § 8.2 HEREDITY **[1]**

Assertion (A) : Human populations show a great deal of variations in traits.
Reason (R) : All variations in a species have equal chances of surviving in the environment in which they live.

(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false, but Reason (R) is true.

Previously asked in: 2023 31/5/1 Q18

◆ Heredity | Survival advantage of variations / Natural selection | Variations in human populations

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Model Answer

(c) Assertion (A) is true, but Reason (R) is false.

A is true — humans show great variation. R is false — not all variations have equal survival chances; environment selects certain variants over others.

Source: Chapter 8, Section 8.1 — Accumulation of Variation During Reproduction

Explanation

The textbook explicitly states: *"Do all these variations in a species have equal chances of surviving in the environment in which they find themselves? Obviously not."* Environmental selection favours certain variants (e.g., heat-resistant bacteria survive a heat wave). So the Assertion is correct, but the Reason directly contradicts the textbook — making option (c) the right choice.

Q5. § Introduction § 8.2.3 How do these Traits get Expressed? **[1]**

If pea plants with round and green seeds (RRyy) are crossed with pea plants having wrinkled and yellow seeds (rrYY), the seeds developed by the plants of F_1 generation will be :

(A) 50% round and green
(B) 75% wrinkled and green
(C) 100% round and yellow
(D) 75% wrinkled and yellow

Previously asked in: 2025 31/1/1 Q11

◆ Heredity | Dihybrid Cross and Law of Independent Assortment

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Model Answer

(C) 100% round and yellow

When RRyy × rrYY are crossed, all F_1 offspring are RrYy — round (R dominant over r) and yellow (Y dominant over y).

Explanation

From the textbook (Fig. 8.4, chapter 8): RRyy (round, green) × rrYY (wrinkled, yellow) → all F_1 = RrYy. Round (R) is dominant over wrinkled (r), and yellow (Y) is dominant over green (y), so 100% of F_1 seeds are round and yellow. Examiners expect you to recall dominant-recessive relationships and the F_1 genotype directly.

Q6. § 8.2 HEREDITY **[1]**

Assertion (A) : A mango seed will germinate to form a mango tree.
Reason (R) : Heredity determines the process by which traits and characteristics are reliably inherited from parents to offspring.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).
(C) Assertion (A) is true, but Reason (R) is false.
(D) Assertion (A) is false, but Reason (R) is true.

Previously asked in: 2025 31/2/1 Q18

◆ **Heredity** Heredity and inheritance of traits from parents to offspring

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Model Answer

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

A mango seed inherits genetic material from parent plant, and heredity ensures traits are reliably passed to offspring, so it germinates into a mango tree only.

Source: Chapter 8, Section 8.2 (Heredity)

Explanation

- The assertion is true: a mango seed carries the genetic blueprint of the mango plant and will always grow into a mango tree.
- The reason is also true and directly explains the assertion: heredity (rules of inheritance) ensures that offspring reliably resemble their parents.
- Since R correctly explains why A is true, option **(A)** is the right choice.
- Key line from textbook: *"The rules of heredity determine the process by which traits and characteristics are reliably inherited."*

Q7. § 8.2 HEREDITY | § 8.2.1 Inherited Traits | § 8.2.4 Sex Determination **[1]**

Assertion (A) : A human child bears all the basic features of human beings.
Reason (R) : It looks exactly like its parents, showing very little variations.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).
(C) Assertion (A) is true, but Reason (R) is false.
(D) Assertion (A) is false, but Reason (R) is true.

Previously asked in: 2025 31/1/1 Q18

◆ Heredity | Heredity and Variation

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Model Answer

(C) Assertion (A) is true, but Reason (R) is false.

A child bears all basic human features, but it does **not** look exactly like its parents — human populations show a great deal of variation.

Explanation

The textbook (Chapter 8, Section 8.2.1) explicitly states: *"a child bears all the basic features of a human being. However, it does not look exactly like its parents, and human populations show a great deal of variation."* So A is correct, but R contradicts the textbook — making R false. Option (C) is the only fit.

Q8. § 8.1 ACCUMULATION OF VARIATION DURING REPRODUCTION **[1]**

Assertion (A) : Bacteria that can withstand heat have better chances of survival in a heat wave.
Reason (R) : Accumulation of variations in a species increases the chances of its survival in changing environment.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(C) Assertion (A) is true, but Reason (R) is false.
(D) Assertion (A) is false, but Reason (R) is true.

Previously asked in: 2026 31/5/1 Q8

◆ Heredity | Accumulation of Variations and Survival Advantage | Natural Selection and Adaptation

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Model Answer

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

Explanation

The textbook (Ch. 8) explicitly states that bacteria able to withstand heat survive better in a heat wave — confirming A. It also states that accumulation of variations gives species better chances of survival in a changed environment — confirming R. R directly explains A because heat-resistant bacteria survive *due to* the presence of accumulated variations in the population. Option (A) is therefore correct.

Q9. § 8.2 HEREDITY **[1]**

Identify the traits that cannot be transmitted from parents to the offsprings :
(i) Swimming technique
(ii) Blood group
(iii) Eye colour
(iv) Dancing skills
Options :

(A) (i) and (ii)
(B) (i) and (iv)
(C) (iii) and (iv)
(D) (ii) and (iii)

Previously asked in: 2026 31/4/1 Q4

◆ **Heredity** Acquired vs Inherited Traits

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Model Answer

(B) (i) and (iv)

Swimming technique and dancing skills are acquired traits (learned through practice) and cannot be transmitted genetically to offspring.

Explanation

The key concept here is the difference between **inherited traits** (determined by genes, e.g., blood group, eye colour) and **acquired traits** (skills learned during one's lifetime, e.g., swimming, dancing). Acquired traits do not cause changes in DNA/genes and therefore cannot be passed on to offspring. Blood group and eye colour are genetically determined and are heritable.

Q10. § Introduction | § 8.2 HEREDITY | § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions **[2]**

In a cross between red coloured and white coloured flowers, when plants with red coloured flowers of F1 generation were self pollinated, plants of F2 generation were obtained in which 75% of plants were with red flowers and 25% plants were with white flowers. Explain the inheritance of traits in the above cross with the help of a flow chart only along with the ratio of plants obtained.

Previously asked in: 2022 31/4/1 Q3 (OR)

◆ **Heredity** | Mendel's Laws – Dominance and Segregation | Monohybrid Cross and F1/F2 Generation Ratios

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Model Answer

Cross between Red (RR) × White (rr) flowers:

$$RR \times rr$$

$$\downarrow$$

$$\text{F}_1 : \text{All } Rr \text{ (Red flowers)}$$

$$\downarrow \text{(Self-pollination)}$$

$$\text{F}_2 : RR : Rr : rr = 1 : 2 : 1$$

Ratio: 3 Red (RR + Rr) : 1 White (rr) → **3:1**

Red (R) is the **dominant** trait; White (r) is the **recessive** trait.

Source: Chapter 8 – Heredity, Section 8.2.2

Explanation

- The examiner wants a **flow chart format** showing P, F1, and F2 generations — not a paragraph. Draw the cross clearly with arrows.
- Write the **genotypes** (RR, Rr, rr) alongside phenotypes.
- Always state the **3:1 phenotypic ratio** and identify which trait is dominant/recessive — these are the likely marking points for 2 marks.
- Since red flowers appear in F1, red is dominant; white reappears in F2, confirming it is recessive.

Q11. § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions **[4]**

> 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.

Read the case and answer the following questions:

(c) If 1600 plants were obtained in F2 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.

Previously asked in: 2022 31/2/1 Q14 (OR-2)

◆ **Heredity** | Dihybrid Cross and F2 progeny ratios | Law of Independent Assortment | Mendel's Laws of Inheritance

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Model Answer

(c)

In F2 progeny from a dihybrid cross, the phenotypic ratio is **9 : 3 : 3 : 1**.

Total plants = 1600

(i) Tall with round seeds (9 parts):

$$\frac{9}{16} \times 1600 = \mathbf{900 \text{ plants}}$$

(ii) Short with wrinkled seeds (1 part):

$$\frac{1}{16} \times 1600 = \mathbf{100 \text{ plants}}$$

Conclusion:
Mendel concluded that two traits (height and seed shape) are inherited **independently** of each other. The F2 generation shows a 9:3:3:1 ratio, which proves that factors (genes) for different characters **assort independently** during gamete formation. This is known as the **Law of Independent Assortment**.

Source: Heredity and Evolution, Mendel's Laws of Inheritance

Explanation

- The dihybrid cross ratio 9:3:3:1 must be stated clearly; examiners expect students to know it by heart.
- Show the calculation (fraction × 1600) for full method marks.
- The conclusion must name the **Law of Independent Assortment** — this is the key scoring point for the last part.
- Do not mix up 9:3:3:1 with the 3:1 monohybrid ratio.

Q12. § Introduction | § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions | § 8.2.3 How do these Traits get Expressed? **[1]**

When a pure-tall pea plant is crossed with a pure-dwarf pea plant, the percentage of tall pea plants in F_1 and F_2 generation pea plants will be respectively :

(a) 100% ; 25%
(b) 100% ; 50%
(c) 100% ; 75%
(d) 100% ; 100%

Previously asked in: 2025 31/4/1 Q9

◆ **Heredity** | Mendel's monohybrid cross – F_1 and F_2 generation ratios

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Model Answer

(c) 100% ; 75%

When pure-tall (TT) is crossed with pure-dwarf (tt), all F_1 plants are Tt (tall) = **100% tall**. In F_2, ratio is 1TT : 2Tt : 1tt, giving 3 tall : 1 dwarf = **75% tall**.

Explanation

Remember: tall is dominant over dwarf. F_1 gives 100% tall (all Tt). In F_2, self-crossing Tt × Tt gives the classic 3:1 Mendelian ratio — 75% tall, 25% dwarf. This is the foundational result of Mendel's monohybrid cross.

Q13. § 8.2 HEREDITY **[4]**

> 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.

Read the following and answer the questions:

(i) Why an offspring of human being is not a true copy of his parents in sexual reproduction ? [1]

(ii) While performing experiments on inheritance in plants, what is the difference between F1 and F2 generation ? [1]

(iii) Answer (A) or (B): [2]

Previously asked in: 2023 31/4/1 Q38

◆ **Heredity** | F1 and F2 generations in Mendel's experiments | Rules of heredity and transmission of traits | Sexual reproduction and variation in offspring

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Model Answer

(i) In sexual reproduction, offspring receive traits from both parents. Since each parent contributes different combinations of genes/traits, the offspring inherits a mix of characteristics from both, making it not an exact copy of either parent.

(ii) The **F1 generation** (first filial) shows only the **dominant trait** — all offspring look alike. The **F2 generation** (second filial), obtained by self-pollinating F1 plants, shows both dominant and recessive traits in a **3:1 ratio**.

(iii) *(Sub-question (A) or (B) text was not provided in the question. Please include the full text of option A or B to receive an answer.)*

Source: Chapter — Heredity and Evolution, Section — Heredity

Explanation

- **(i)** Key point: sexual reproduction involves two parents → genetic mixing → variations. Mention "genes" or "traits from both parents."
- **(ii)** Examiners expect: F1 = only dominant trait visible; F2 = both traits appear in 3:1 ratio. Use correct terminology (dominant/recessive).
- **(iii)** Since sub-question (iii) options (A)/(B) were not included in the question text, they cannot be answered. Always copy the full question when seeking model answers.

Q14. § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions **[4]**

Mendel took garden pea plants with different characteristics, such as height to study the inheritance pattern of factors (genes). He crossed tall pea plant with short pea plant and obtained all the tall plants in the F_1 generation. Answer the following questions :

(a) Why only tall pea plants were observed in F_1 progeny ? [1]

(b) By which method did Mendel obtain F_2 progeny ? [1]

(c) Write one difference between dominant and recessive trait. [2]

Previously asked in: 2026 31/1/1 Q15

◆ **Heredity** Mendel's Monohybrid Cross and Dominant/Recessive Traits

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Model Answer

(a) In the F_1 generation, only tall plants were observed because tallness is the **dominant trait**. When a tall plant (TT) is crossed with a short plant (tt), all F_1 offspring are Tt. Since a single copy of 'T' is enough to make the plant tall, all plants appeared tall.

(b) Mendel obtained F_2 progeny by **self-pollination** of the F_1 tall plants.

(c)

Dominant Trait	Recessive Trait
The trait that expresses itself in the presence of even one copy of the factor (e.g., tallness – T).	The trait that expresses itself only when both copies of the factor are the same recessive type (e.g., shortness – tt).

Source: Chapter 8, Section 8.2.2

Explanation

- **(a)** Always mention the genotypes (TT × tt → Tt) and state that one copy of 'T' is sufficient for expression — this earns full marks.
- **(b)** The key term is **self-pollination** — do not write "cross-pollination."
- **(c)** Two marks means two distinct points — one for dominant, one for recessive. Using a table format is clear and saves time. The examiner looks for the idea that dominant is expressed with one copy, recessive needs two copies of the recessive allele.

Q15. § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions | § 8.2.3 How do these Traits get Expressed? **[3]**

> Table showing Mendelian cross results:
> Parents: A pea plant with red flowers was crossed with a pea plant with white flowers.
> F1: 30 seeds were sown and all bore plants with red flowers.
> F2: 44 seeds were sown, 33 plants bore red flowers and 11 plants bore white flowers.

Study the given table and answer the following questions :

(a) Depict the information given in the table in the form of a cross.

(b) Deduce the F2 phenotypic ratio/F2 ratio showing external look as well as genotypic/genetic makeup ratio.

Previously asked in: 2026 31/4/1 Q14

◆ **Heredity** | Mendel's Monohybrid Cross and Dominant/Recessive Traits

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Model Answer

(a) Cross:

Let Red (R) be dominant over white (r).

P: RR (Red) × rr (White)

F_1: All Rr (Red)

$F_1 \times F_1$: Rr × Rr

F_2:

	R	r
R	RR	Rr
r	Rr	rr

F_2: RR : Rr : rr → 1 : 2 : 1

(b) F_2 Ratios:

- **Phenotypic ratio** (external appearance): Red : White = **3 : 1** (33 red : 11 white, approximately 3:1)
- **Genotypic ratio** (genetic makeup): RR : Rr : rr = **1 : 2 : 1**

Explanation

- **(a)** CBSE expects the actual Punnett square or gamete cross notation. Show P, F_1, and $F_1 \times F_1$ steps clearly using dominant (capital) and recessive (small) letters.
- **(b)** Two separate ratios must be stated: phenotypic (3:1) and genotypic (1:2:1). Examiners deduct marks if either is missing. The 33:11 from the table confirms the 3:1 ratio.

Q16. § Introduction § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions § 8.2.3 How do these Traits get Expressed? **[1]**

Two pea plants, one with round green seeds (RRyy) and another with wrinkled yellow (rrYY) seeds were crossed with each other which produced F1 progeny that have only round yellow (RrYy) seeds. When F1 plants are self-pollinated, the F2 progeny will have which new combination of characters, as compared to the parents :

(i) Round, yellow
(ii) Round, green
(iii) Wrinkled, yellow
(iv) Wrinkled, green

Correct options are :

(A) (i) and (ii)
(B) (i) and (iv)
(C) (ii) and (iv)
(D) (i) and (iii)

Previously asked in: 2026 31/4/1 Q6

◆ Heredity | Mendel's Dihybrid Cross and New Trait Combinations in F2

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Model Answer

(D) (i) and (iii)

The parental combinations were round green (RRyy) and wrinkled yellow (rrYY). The **new** combinations appearing in F2 are **round yellow** and **wrinkled yellow** — wait, re-checking: parents had round green and wrinkled yellow; new combinations are **round yellow (RrYy / RRYY)** and **wrinkled green (rryy)**. So the answer is **(B) (i) and (iv)**.

(B) (ii) and (iii)

The correct answer is **(D) (ii) and (iii)** — No.

Correct Answer: (B)

The parents were round green and wrinkled yellow. New combinations (not seen in parents) in F2 are **(i) round yellow** and **(iv) wrinkled green**.

Explanation

The parents are RRyy (round, green) and rrYY (wrinkled, yellow). So the parental phenotypes are "round green" and "wrinkled yellow." In F2 (from Fig. 8.5), all four combinations appear: round yellow, round green, wrinkled yellow, and wrinkled green. The **new** combinations — those not present in the original parents — are **round yellow** and **wrinkled green**, making option **(B)** correct. Students must carefully distinguish "new combinations" from the parental phenotypes.

Q17. § Introduction § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions **[1]**

In an experiment with pea plants, a pure tall plant (TT) is crossed with a pure short plant (tt). The ratio of pure tall plant to pure short plants in F_2 generation will be

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

Previously asked in: 2023 31/6/1 Q9

◆ Heredity Monohybrid Cross and F_2 Generation Ratios (TT × tt)

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Model Answer

(c) 1 : 1

In F_2, the genotypes are TT : Tt : tt = 1 : 2 : 1. Pure tall (TT) : pure short (tt) = **1 : 1**.

Explanation

Students often confuse the **phenotypic ratio** (3 tall : 1 short) with the **genotypic ratio**. The question asks for *pure* plants only — TT and tt — both present in 1 out of 4 offspring each, giving 1 : 1. Hybrid tall (Tt) plants are tall in appearance but not pure, so they are excluded from the count.

Q18. § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions **[3]**

How did Mendel's experiments show that traits are inherited independently? Explain.

Previously asked in: 2022 31/3/1 Q13

◆ Heredity Dihybrid Cross Mendel's Law of Independent Assortment

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Model Answer

Mendel conducted experiments on pea plants using two traits simultaneously (dihybrid cross). He crossed tall plants with round seeds with short plants with wrinkled seeds. The F1 progeny were all tall with round seeds. When F1 plants were self-pollinated, the F2 generation showed **new combinations** — tall with wrinkled seeds and short with round seeds — in addition to the original combinations.

This proved that the tall/short trait and round/wrinkled seed trait were **inherited independently** of each other, as genes controlling different traits recombine independently during reproduction to form new combinations in offspring.

Source: Chapter 8, Section 8.2.2

Explanation

- The key concept examiners look for is the **dihybrid cross** and the appearance of **new trait combinations in F2**.
- Use the exact phrase "independently inherited" as it appears in the textbook.
- Mention F1 and F2 generations clearly — this shows you understand the experimental design.
- Do not confuse this with the monohybrid cross (tall/short only); the question specifically asks about **independent inheritance**, which requires two traits.

Q19. § Introduction § 8.1 ACCUMULATION OF VARIATION DURING REPRODUCTION § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions **[1]**

A cross between pea plant with white flowers (vv) and pea plant with violet flowers (VV) resulted in F2 progeny in which ratio of violet (VV) and white (vv) flowers will be :

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

Previously asked in: 2023 31/4/1 Q10

◆ Heredity | Monohybrid Cross and F2 Genotypic Ratio

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Model Answer

(c) 3 : 1

Cross: vv × VV → F1 all Vv (violet). F1 × F1: VV : Vv : vv = 1:2:1, so violet (VV + Vv) : white (vv) = **3 : 1**.

Explanation

The cross vv × VV gives all Vv in F1. F2 from Vv × Vv gives 1VV : 2Vv : 1vv. Since V is dominant, both VV and Vv show violet flowers — so violet : white = 3 : 1. This is the classic Mendelian monohybrid ratio. Examiners expect you to pick option (c) and ideally know *why* (F1 × F1 logic).

Q20. § Introduction § 8.1 ACCUMULATION OF VARIATION DURING REPRODUCTION § 8.2.3 How do these Traits get Expressed? **[1]**

The genotype of green stemmed tomato plant is denoted by 'GG' and that of purple stemmed tomato plant as 'gg'. Hybrid of a cross between these two were self-pollinated to obtain F2 progeny. What will be the ratio of GG, Gg and gg in this F2 progeny ?

(A) 2:1:1
(B) 3:1:0
(C) 1:1:2
(D) 1:2:1

Previously asked in: 2026 31/2/1 Q1

◆ Heredity | Monohybrid Cross and F2 Genotypic Ratio

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Model Answer

(D) 1:2:1

F1 hybrid is Gg. On self-pollination: GG : Gg : gg = 1 : 2 : 1.

Explanation

F1 cross is Gg × Gg. The Punnett square gives GG, Gg, Gg, gg — ratio 1:2:1. This is the standard monohybrid F2 genotypic ratio examiners expect students to recall directly.

Q21. § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions | § 8.2.3 How do these Traits get Expressed? **[3]**

Based on Mendel's experiment show the cross between round, yellow seeds of pea plant (RRYY) with wrinkled and green seeds of pea plant (rryy) upto F2 generation. Write the number of seeds/plants with following genetic (Genotype) makeup in F2 generation :
(i) RRYY
(ii) rryy

Previously asked in: 2026 31/5/1 Q13

◆ **Heredity** | Genotypic Ratio in F2 Generation of Dihybrid Cross | Mendel's Dihybrid Cross (RRYY × rryy) up to F2 Generation

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Model Answer

Cross: RRYY × rryy

F₁ Generation:
All F₁ plants are RrYy (round, yellow) — dominant traits appear.

F₂ Generation (F₁ × F₁: RrYy × RrYy):

	RY	Ry	rY	ry
RY	RRYY	RRYy	RrYY	RrYy
Ry	RRYy	RRyy	RrYy	Rryy
rY	RrYY	RrYy	rrYY	rrYy
ry	RrYy	Rryy	rrYy	**rryy**

F₂ phenotypic ratio = 9 : 3 : 3 : 1 (out of 16 combinations)

(i) RRYY — 1 plant out of 16

(ii) rryy — 1 plant out of 16

Source: Chapter 8 – Heredity, Section 8.2.3 (Figure 8.5)

Explanation

- The question asks for a dihybrid cross up to F₂; draw the Punnett square clearly.
- Note: The textbook (Fig. 8.5) shows RRyy × rrYY, but the question uses RRYY × rryy. The F₁ is still RrYy and the F₂ Punnett square is identical.
- Both RRYY and rryy appear **once each** in the 4×4 Punnett square (1/16 each). Examiners award marks for the correct Punnett square AND the specific counts.
- Always state F₁ genotype before drawing F₂.

Q22. § 8.2.4 Sex Determination **[4]**

Draw a flow chart to show that sex is determined genetically in human beings.

Previously asked in: 2022 31/4/1 Q15 (OR)

◆ **Heredity** Genetic determination of sex in human beings

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Model Answer

Flow chart: Sex Determination in Human Beings

```
Parents: Father (44 + XY) × Mother (44 + XX)
↓ ↓
Gametes: 50% sperm with X All eggs with X
50% sperm with Y
↓
Fertilisation
↓
┌──────────────────────────┴──────────────────────────┐
Egg (X) + Sperm (X) Egg (X) + Sperm (Y)
↓ ↓
Child = XX Child = XY
(Girl) (Boy)
```

- All children inherit **X chromosome from mother**.
- Sex is determined by the chromosome inherited **from the father**.
- Father's X → Girl; Father's Y → Boy.
- Half the children will be boys and half will be girls.

Source: Chapter 8, Section 8.2.4 – Sex Determination

Explanation

- Examiners expect a **clearly labelled flow chart** showing parents → gametes → fertilisation → offspring. Draw it neatly in the exam.
- Key point to state: **mother always contributes X**; the **father's contribution (X or Y) determines the sex**.
- Mention the **44 autosomes + sex chromosomes** notation for full marks.
- The conclusion — 50% boys, 50% girls — must appear either in the chart or as a point below it.

Q23. § 8.2.4 Sex Determination **[4]**

> Sex of an individual is determined by different factors in various species. Some animals rely entirely on the environmental cues, while in some other animals the individuals can change their sex during their life time indicating that sex of some species is not genetically determined. However, in human beings, the sex of an individual is largely determined genetically.

Answer the sub-questions based on the case below. Part (a) and (b) are compulsory; an internal choice has been provided in Part (c).

(a) In what way are the sex chromosomes 'X' and 'Y' different in size ? Name the mismatched pair of sex chromosome in humans.

(b) Write the number of pair/pairs of sex chromosomes present in human beings. In which one of the parent (male / female) perfect pair / pairs of sex chromosomes are present ?

(c) Citing two examples, justify the statement "Sex of an individual is not always determined genetically".

Previously asked in: 2022 31/4/1 Q15 (main)

◆ **Heredity**

Environmental and non-genetic sex determination (e.g., temperature-dependent sex determination in reptiles, sequential hermaphroditism in snails)

Sex determination in humans – X and Y chromosomes

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Model Answer

(a) The 'Y' chromosome is shorter/smaller in size compared to the 'X' chromosome. The mismatched pair of sex chromosomes in humans is **XY** (found in males).

(b) There is **1 pair** of sex chromosomes in human beings. In the **female** (XX), a perfect/matched pair of sex chromosomes is present.

(c) Two examples showing sex is not always genetically determined:

1. **Snails** – some individuals can change their sex during their lifetime depending on environmental or social conditions.
2. **Reptiles (e.g., lizards/turtles)** – the temperature of the environment during egg incubation determines the sex of the offspring, not genes.

Source: Heredity and Evolution, Sex Determination

Explanation

- **(a)** Examiners expect mention of relative size difference (Y smaller than X) and identification of XY as the mismatched pair.
- **(b)** Key facts: only 1 pair of sex chromosomes; females have XX (perfect/matched pair), males have XY.
- **(c)** Two distinct examples are required. The passage directly states that "some animals rely on environmental cues" and "some can change their sex during lifetime" — link your examples clearly to these two points. Snails (sex change) and reptiles (temperature-based determination) are standard NCERT examples. Award is typically 1 mark per valid example with brief justification.

Q24. § 8.2 HEREDITY | § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions | § 8.2.4 Sex Determination **[3]**

Answer the following:

(a) Name the two types of gametes produced by men. (½+½)

(b) Does a male child inherit X chromosome from his father ? Justify. (½+1)

(c) How many types of gametes are produced by a human female ? (½)

Previously asked in: 2022 31/2/1 Q10

◆ **Heredity** | Sex determination and sex chromosomes in humans

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Model Answer

(a) Men produce two types of gametes (sperms):

- Sperms carrying **X chromosome**
- Sperms carrying **Y chromosome**

(b) No, a male child does **not** inherit the X chromosome from his father.
Justification: A male child has XY sex chromosomes. He inherits the Y chromosome from his father and the X chromosome from his mother. The father passes the Y chromosome to his son, not the X chromosome.

(c) A human female produces only **one type** of gamete — the egg (ovum) — all carrying the **X chromosome**.

Explanation

- This question is from Chapter 8 (How do Organisms Reproduce?) — specifically the section on sex determination in humans.
- Key point: Father determines the sex of the child (XY father passes either X or Y); mother always contributes X.
- The ½ mark sub-questions need single-line answers; the 1-mark justification needs 2–3 clear lines.
- Examiners look for the correct chromosome names (X and Y), not just "two types."

Q25. § 8.2.4 Sex Determination **[4]**

> All human chromosomes are not paired. Most human chromosomes have a maternal and a paternal copy, and we have 22 such pairs. But one pair called the sex chromosomes, is odd in not always being a perfect pair. Women have a perfect pair of sex chromosomes. But men have a mismatched pair in which one is normal sized while the other is a short one.

Answer the sub-parts based on the given passage about human chromosomes and sex determination.

(a) In humans, how many chromosomes are present in a Zygote and in each gamete ?

(b) A few reptiles rely entirely on environmental cues for sex determination. Comment.

(c) "The sex of a child is a matter of chance and none of the parents are considered to be responsible for it." Justify it through flow chart only.

Previously asked in: 2023 31/6/1 Q38

◆ **Heredity** | Flow chart of sex determination – role of chance | Human chromosomes and sex chromosomes (XX/XY) | Sex determination in humans and environmental sex determination in reptiles

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Model Answer

(a) A zygote has **46 chromosomes** (44 autosomes + 2 sex chromosomes). Each gamete (sperm or egg) has **23 chromosomes**.

(b) In some reptiles like turtles, the temperature at which eggs are incubated determines whether the offspring will be male or female. There are no sex chromosomes involved; sex is determined by environmental factors.

(c)

$$
\underbrace{\text{Mother (44+XX)}}_{\text{Female}} \quad \underbrace{\text{Father (44+XY)}}_{\text{Male}}
$$

$$\downarrow \qquad \downarrow$$

$$\text{Eggs: } 22+\text{X} \quad \text{Sperms: } 22+\text{X} \text{ or } 22+\text{Y}$$

$$\downarrow$$

$$22+\text{X} + 22+\text{X} = \textbf{Girl} \quad 22+\text{X} + 22+\text{Y} = \textbf{Boy}$$

Since the mother always contributes X, the sex of the child depends on whether the sperm carries X or Y — which is a matter of **chance**.

Source: Heredity and Evolution, Sex Determination

Explanation

- **(a)** Remember: gametes are haploid (23), zygote is diploid (46).
- **(b)** This is a direct factbook point — temperature-dependent sex determination in reptiles.
- **(c)** The examiner wants a **flowchart**, not a paragraph. Show both parents, their gametes, and the two possible combinations. The key conclusion is that the father's sperm (X or Y) determines the child's sex, not the mother, so no parent is "responsible."

Q26. § 8.2.4 Sex Determination **[1]**

Assertion (A) : Genes inherited from the parents decide the sex of a child.
Reason (R) : X chromosome in a male child is inherited from his father.

(a) Both (A) and (R) are true and (R) is the correct explanation of (A).
(b) Both (A) and (R) are true, but (R) is not the correct explanation of (A).
(c) (A) is true, but (R) is false.
(d) (A) is false, but (R) is true.

Previously asked in: 2023 31/1/1 Q18

◆ Heredity | Sex Chromosomes (X and Y) | Sex Determination

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Model Answer

(c) (A) is true, but (R) is false.

Assertion is correct — sex is genetically determined by chromosomes inherited from parents. But the Reason is false — a male child inherits his **X chromosome from his mother**, not his father; he inherits the **Y chromosome from his father**.

Explanation

The key fact: men are XY, women are XX. Every child gets X from the mother. The father contributes either X (girl) or Y (boy). So the X in a son comes from the mother, making (R) false. Assertion (A) is true as the textbook clearly states sex is determined by genes (chromosomes) inherited from parents.

Q27. § 8.2.4 Sex Determination **[1]**

Assertion (A) : Human female has a perfect pair of sex chromosome.
Reason (R) : Sex chromosome contributed by the human male in the zygote decides the sex of a child.

(A) Both (A) and (R) are true and (R) is the correct explanation of (A).
(B) Both (A) and (R) are true, but (R) is not the correct explanation of (A).
(C) (A) is true, but (R) is false.
(D) (A) is false, but (R) is true.

Previously asked in: 2024 31/2/1 Q18

◆ **Heredity** Sex determination in humans – sex chromosomes (XX/XY)

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Model Answer

(D) (A) is false, but (R) is true.

Human **female** has a perfect pair of sex chromosomes (XX) — this is true, so (A) is actually **true**. Wait — re-reading: (A) states the female has a perfect pair, which is correct. The sex chromosome contributed by the **father** (X or Y) determines the sex of the child — (R) is also true. However, (R) does not explain (A); both are independent facts.

Answer: (B) — Both (A) and (R) are true, but (R) is not the correct explanation of (A).

Source: Chapter 8, Section 8.2.4 – Sex Determination

Explanation

- **(A) is TRUE**: The textbook clearly states "Women have a perfect pair of sex chromosomes, both called X."
- **(R) is TRUE**: "The sex of the children will be determined by what they inherit from their father."
- But (R) explains **sex determination**, not **why females have a perfect pair** — so (R) does not explain (A). Hence **(B)** is correct.
- Common mistake: Students may choose (A), confusing "correct explanation" with just "both being true."

Q28. § 8.1 ACCUMULATION OF VARIATION DURING REPRODUCTION | § 8.2 HEREDITY | § 8.2.4 Sex Determination **[1]**

Chromosomes :
(i) carry hereditary information from parents to the next generation.
(ii) are thread like structures located inside the nucleus of an animal cell.
(iii) always exist in pairs in human reproductive cells.
(iv) are involved in the process of cell division.
The correct statements are :

(a) (i) and (ii)
(b) (iii) and (iv)
(c) (i), (ii) and (iv)
(d) (i) and (iv)

Previously asked in: 2024 31/1/1 Q9

◆ **Heredity** | Structure and Function of Chromosomes

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Model Answer

(c) (i), (ii) and (iv)

Statements (i), (ii), and (iv) are correct. Statement (iii) is wrong because human reproductive cells (gametes) are haploid — they contain only one set of chromosomes, not pairs.

Explanation

- The key trap here is statement (iii): **somatic (body) cells** have chromosomes in pairs (diploid), but **reproductive cells (gametes)** have half the number — they are haploid. So (iii) is false.
- Statements (i), (ii), and (iv) are standard textbook facts about chromosomes: they carry hereditary/DNA information, are thread-like structures in the nucleus, and are involved in cell division (DNA copies separate during division).
- The source passage confirms chromosomes carry information for inheritance and are involved in DNA copying/cell division.

Q29. § 8.2.4 Sex Determination **[2]**

Explain with the help of a flow chart that in human beings father is responsible for the sex (male or female) of the child.

Previously asked in: 2025 31/4/1 Q24

◆ **Heredity** Sex Determination in Humans – Role of Father

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Model Answer

Flow Chart:

$$\text{Father (XY)} \xrightarrow{\text{produces}} \begin{cases} \text{Sperm with X} \\ \text{Sperm with Y} \end{cases}$$

$$\text{Mother (XX)} \xrightarrow{\text{produces}} \text{Egg with X only}$$

- X sperm + X egg → **XX** → **Girl**
- Y sperm + X egg → **XY** → **Boy**

Since the mother always contributes X, the sex of the child depends on whether the father contributes X or Y chromosome. Thus, the **father is responsible** for determining the sex of the child.

Source: Chapter 8, Section 8.2.4 – Sex Determination

Explanation

- The examiner wants a **flow chart** (arrows showing the cross) plus a one-line conclusion — both are needed for full 2 marks.
- Key point: mother is always XX, so only the **paternal chromosome (X or Y)** decides the sex.
- Avoid writing long paragraphs; the flow chart itself carries most marks here.

Q30. § 8.2.4 Sex Determination **[1]**

Assertion (A) : In reptiles, the temperature at which the fertilized eggs are kept decides the sex of the offsprings.
Reason (R) : Sex is not genetically determined in some animals.

(a) Both, Assertion (A) and Reason (R) are true, and Reason (R) is the correct explanation of Assertion (A).
(b) Both, Assertion (A) and Reason (R) are true, and Reason (R) is not the correct explanation of Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false, but Reason (R) is true.

Previously asked in: 2025 31/4/1 Q19

◆ Heredity | Environmental sex determination in reptiles | Sex determination – genetic vs. environmental factors

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Model Answer

(a) Both, Assertion (A) and Reason (R) are true, and Reason (R) is the correct explanation of Assertion (A).

In reptiles, temperature determines sex of offspring because sex is not genetically determined in such animals — R correctly explains A.

Explanation

Both statements are factually correct as per the textbook: in some reptiles, incubation temperature determines sex, and in animals like snails, sex is not genetically determined. R directly explains *why* A is true, making option (a) the correct choice. Students must check whether R *correctly explains* A, not just whether both are true.

Q31. § 8.2.4 Sex Determination **[4]**

> The mechanism by which the sex of an individual is determined is called sex-determination. In human beings, sex of a newborn is genetically determined, whereas in some others it is not. There are 46 (23 pairs) chromosomes in human beings. Out of these, 44 (22 pairs) control the body characters and 2 (one pair) are known as sex chromosomes. The sex chromosomes are of two types — X chromosome and Y chromosome. At the time of fertilisation, depending upon which type of male gamete fuses with the female gamete, the sex of the newborn child is decided.

Read the passage and answer the following questions:

(a) Why is a pair of sex chromosomes in human beings called a mismatched pair in terms of type and size ? [1]

(b) Out of male or female, which of them has a perfect pair of sex chromosomes ? In case of a perfect pair, will the gametes produced be of the same kind or of a different kind ? [1]

(c) Choose one of the following alternatives: [2]

Previously asked in: 2022 31/1/1 Q14

◆ **Heredity** | Gamete Formation and Sex Chromosomes | Sex Chromosomes – X and Y Chromosomes | Sex determination in human beings

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Model Answer

(a) In males, the pair of sex chromosomes consists of one X chromosome and one Y chromosome, which differ in both type and size (Y is much smaller than X). Hence, it is called a mismatched pair.

(b) Female has a perfect pair of sex chromosomes (XX). Since both chromosomes are identical, all eggs produced will carry one X chromosome — so gametes will be of the **same kind**.

(c) *(Note: The alternatives for part (c) are not printed in the question. Based on the passage, the standard answer is:)*
The sex of a child is determined by the father, not the mother. All eggs from the mother carry X chromosome. The father produces two types of sperms — 50% carrying X and 50% carrying Y. If a sperm with X fertilises the egg → girl (XX); if a sperm with Y fertilises the egg → boy (XY). Thus, the father's sperm determines the sex of the child.

Source: Chapter 8 – How do Organisms Reproduce?, Sex Determination

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Explanation

- For **(a)**, the key point is that X and Y differ in both **type and size** — examiners expect both words.
- For **(b)**, remember females are **XX** (homogametic) → one type of gamete; males are **XY** (heterogametic) → two types. This directly follows from the passage.
- For **(c)**, since the alternatives were missing, the standard NCERT-based answer about father determining sex is used. If alternatives are printed, choose the one stating the **father/male parent** is responsible for the child's sex.

Q32. § Introduction § 8.2 HEREDITY § 8.2.4 Sex Determination **[1]**

When a sperm carrying the Y chromosome fertilises an egg, the resulting zygote would have the following combination of chromosomes :

(a) 44 + XX
(b) 44 + XY
(c) 22 + XX
(d) 22 + XY

Previously asked in: 2023 31/2/1 Q12

◆ **Heredity** Sex Determination – Chromosomal Combination in Zygote

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Model Answer

(b) 44 + XY

When a Y-carrying sperm fertilises an egg (which carries X), the zygote has 44 autosomes + XY sex chromosomes.

Source: What you have learnt, Chapter 8

Explanation

- Every human egg carries **22 autosomes + X**; every sperm carries **22 autosomes + X or Y**.
- At fertilisation, both sets combine: 22 + 22 = 44 autosomes, and X (egg) + Y (sperm) = XY.
- Total = **44 + XY** → male offspring.
- Common mistake: choosing 22 + XY (forgetting that fertilisation doubles the chromosome number from each gamete).

Q33. § 8.2.4 Sex Determination **[1]**

Assertion (A) : Sex of the children will be determined by what they inherit from their mother.
Reason (R) : Women have XX sex chromosomes.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(C) Assertion (A) is true, but Reason (R) is false.
(D) Assertion (A) is false, but Reason (R) is true.

Previously asked in: 2024 31/5/1 Q18

◆ **Heredity** Sex Determination and Sex Chromosomes

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Model Answer

(D) Assertion (A) is false, but Reason (R) is true.

A is false because sex is determined by what children inherit from their **father** (X gives girl, Y gives boy), not the mother. R is true — women are XX.

Explanation

The passage clearly states: *"the sex of the children will be determined by what they inherit from their father."* Since mothers are always XX, they can only pass an X chromosome — so the mother's contribution does not determine sex. The father's X or Y does. Reason (R) is a true fact but it actually explains *why* the Assertion is false (mother only contributes X, so she cannot determine sex).

Q34. § 8.2.4 Sex Determination **[3]**

Answer the following :

(a) Giving two examples, justify the statement that the sex of the offspring in all animals is not always genetically determined.

(b) Differentiate between the sex chromosomes of male and female human beings.

Previously asked in: 2026 31/2/1 Q14

◆ **Heredity** | Environmental determination of sex in animals | Sex chromosomes in human beings (XX and XY)

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Model Answer

(a) Sex of offspring is not always genetically determined in all animals. In some animals, environmental factors decide sex:

- **Snails** – social factors can determine sex.
- **Lizards/Turtles** – temperature during incubation of eggs determines the sex of offspring.

Thus, factors other than sex chromosomes can determine sex in certain animals.

(b)

Feature	Female	Male
Sex chromosomes	XX (two X chromosomes)	XY (one X, one Y chromosome)
Gametes produced	All eggs carry X	50% sperms carry X, 50% carry Y

The Y chromosome in males is smaller and carries fewer genes than the X chromosome.

Explanation

- Part (a) is 2 marks — give **two distinct examples** with a brief explanation each. Snails (social/environmental), lizards/turtles (temperature) are standard NCERT examples. The key point is that environmental factors, not genes, determine sex here.
- Part (b) is 1 mark — a simple comparison: Female = XX, Male = XY. One crisp differentiating point is sufficient. Don't over-explain.
- The source passages provided are unrelated (Chemistry/Physics), so this answer is based on NCERT Class 10 Biology (Chapter: Heredity and Evolution), as required by the question.

Q35. § Introduction § 8.2.4 Sex Determination **[1]**

When a human egg is fertilized by a sperm having 'Y' chromosome, the zygote has the following combination of chromosomes :

(A) 44 + XX
(B) 22 + XX
(C) 44 + XY
(D) 22 + XY

Previously asked in: 2026 31/5/1 Q5

◆ **Heredity** Sex Determination and Chromosomal Combination in Zygote

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Model Answer

(C) 44 + XY

When the egg (22 + X) is fertilized by a sperm carrying Y chromosome (22 + Y), the zygote formed has 44 + XY chromosomes, developing into a male child.

Explanation

The human egg always carries an X chromosome along with 22 autosomes (total 23). A sperm carrying Y has 22 + Y. On fertilization: (22 + X) + (22 + Y) = 44 + XY. Remember, sex is determined by the father's sperm, not the mother's egg.

Q36. § 8.2.4 Sex Determination **[1]**

Sex is determined by different factors in various species. However, in human beings, it is determined genetically. Which amongst the following option(s) is/are correct for human beings ?
(i) Gamete carrying X chromosome from female parent.
(ii) Gamete carrying X chromosome from male parent.
(iii) Gamete carrying Y chromosome from male parent.

A (ii) and (iii)
B (i) only
C (i) and (iii)
D (iii) only

Previously asked in: 2026 31/1/1 Q6

◆ **Heredity** Sex determination in human beings

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Model Answer

Answer: A — (ii) and (iii)

In human beings, females are XX and males are XY. The female parent always gives an X chromosome to all children. The male parent gives either X (producing a girl) or Y (producing a boy) through his gametes. So statements (ii) and (iii) are correct — it is the father's gamete (carrying X or Y) that determines sex, not the mother's.

Source: Chapter 8, Section 8.2.4 – Sex Determination

Explanation

- Statement (i) is **incorrect** because the female (mother) *always* contributes an X chromosome — this does not determine sex, as it is constant.
- Statements (ii) and (iii) are **correct** because the male contributes either X or Y, making sex determination entirely dependent on the **paternal gamete**.
- Key exam point: **Sex is determined by the father, not the mother** in human beings.

Q37. § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions **[4]**

> 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.

Read the case and answer the following questions:

(a) What do the F1 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 F2 progeny along with their ratio, if F1 progeny was allowed to self pollinate. (1+1+2 = 4)

Previously asked in: 2022 31/2/1 Q14 (OR-1)

◆ **Heredity** | Dihybrid Cross and F2 progeny ratios | Dominant and Recessive Traits | Mendel's Laws of Inheritance

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Model Answer

(a) The F1 progeny will all be **tall plants with round seeds**, as tall and round are the dominant traits over short and wrinkled respectively.

(b) The recessive traits in the above cross are:

- **Short height** (dwarf)
- **Wrinkled seeds**

(c) When F1 progeny (tall, round) is allowed to self-pollinate, the F2 generation shows **two new combinations** along with parental types in the ratio **9:3:3:1**:

Phenotype	Ratio
Tall Round	9
Tall Wrinkled *(new)*	3
Short Round *(new)*	3
Short Wrinkled	1

The two **new combinations** are: **Tall Wrinkled** and **Short Round**.

Source: Chapter – Heredity and Evolution, Dihybrid Cross / Laws of Inheritance

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Explanation

- **(a)** Always state that F1 shows only dominant traits — the answer must name both dominant characters (tall + round).
- **(b)** Examiners want both recessive traits named clearly; one mark each, so don't miss either.
- **(c)** This is a 2-mark part — you must name the **two new combinations** AND give the **9:3:3:1 ratio**. Missing either loses a mark. The table format is neat but a list is equally acceptable.

Q38. § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions **[4]**

> In order to trace the inheritance of traits Mendel crossed pea plants having one contrasting character or a pair of contrasting characters. When he crossed pea plants having round and yellow seeds with pea plants having wrinkled and green seeds, he observed that no plants with wrinkled and green seeds were obtained in the F_1 generation. When the F_1 generation pea plants were cross-bred by self-pollination, the F_2 generation had seeds with different combinations of shape and colour also.

Read the passage and answer the following:

(a) Write any two pairs of contrasting characteristics of pea plant used by Mendel other than those mentioned above. [1]

(b) Differentiate between dominant and recessive traits. [1]

(c) State the ratio of the combinations observed in the seeds of F_2 generation (in the above case). What do you interpret from this result ? [2]

Previously asked in: 2023 31/1/1 Q38

◆ **Heredity** | Dihybrid cross and F2 generation phenotypic ratio (9:3:3:1) | Dominant and Recessive Traits | Mendel's experiments and contrasting characters in pea plants

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Model Answer

(a) Two pairs of contrasting characters used by Mendel (other than seed shape and colour):

- Tall plant vs. Dwarf plant
- Inflated pod vs. Constricted pod

(b) A **dominant trait** is the one that expresses itself in the F_1 generation (e.g., round, yellow seeds). A **recessive trait** is the one that remains hidden in F_1 but reappears in F_2 (e.g., wrinkled, green seeds).

(c) The F_2 generation shows seeds in the ratio **9 : 3 : 3 : 1**
(9 Round Yellow : 3 Round Green : 3 Wrinkled Yellow : 1 Wrinkled Green).

Interpretation: The traits of seed shape and seed colour are **independently inherited**; they segregate independently during gamete formation and recombine freely. This is Mendel's **Law of Independent Assortment**.

Source: Heredity and Evolution, Mendel's Contribution

Explanation

- **(a)** Any two of the seven pairs Mendel used are acceptable; tall/dwarf and inflated/constricted pod are safe choices.
- **(b)** The key distinction is *expression in F_1 vs. hidden in F_1 but visible in F_2*. Use the words "expresses" and "remains hidden/suppressed."
- **(c)** The 9:3:3:1 ratio is the standard dihybrid ratio — must be stated with the full description of each class. The interpretation must mention independent assortment; examiners look for this conclusion explicitly.

Q39. § 8.2 HEREDITY **[1]**

The statement that correctly describes the characteristic(s) of a gene is :

(a) In individuals of a given species, a specific gene is located on a particular chromosome.
(b) A gene is not the information source for making proteins in the cell.
(c) Each chromosome has only one gene located all along its length.
(d) All the inherited traits in human beings are not controlled by genes.

Previously asked in: 2023 31/1/1 Q10

◆ Heredity | Characteristics of a Gene

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Model Answer

(a) In individuals of a given species, a specific gene is located on a particular chromosome.

Source: Chapter 8, Heredity

Explanation

- Option (b) is wrong — DNA **is** the information source for making proteins (Chapter 7).
- Option (c) is wrong — each chromosome carries **many** genes, not just one.
- Option (d) is wrong — in humans, inherited traits **are** controlled by genes.
- Option (a) is correct: genes have fixed loci on specific chromosomes within a species, which is a fundamental characteristic of genes covered in the heredity chapter.

Q40. § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions **[1]**

A cross between two tall pea plants resulted in offsprings having a few dwarf plants. The gene-combination of the parental plants must be

A Tt and Tt
B Tt and tt
C TT and tt
D TT and Tt

Previously asked in: 2024 31/3/1 Q12

◆ Heredity | Monohybrid Cross and Genotype Determination

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Model Answer

Option A: Tt and Tt

When two tall plants with genotype Tt are crossed, offspring are TT : Tt : tt in ratio 1:2:1, producing 25% dwarf (tt) plants along with tall plants.

Explanation

Key logic: dwarf plants appear in offspring only if both parents carry the recessive allele 't'. A Tt × Tt cross gives ¼ tt (dwarf). Option B (Tt × tt) gives 50% dwarf — too many. Options C and D cannot produce dwarf offspring at all (TT is present). Examiners expect you to recall the Tt × Tt cross from Mendel's F1 self-pollination experiment.

Q41. § Introduction § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions **[1]**

A cross made between two pea plants produces 50% tall and 50% short pea plants. The gene combination of the parental pea plants must be

(A) Tt and Tt
(B) TT and Tt
(C) Tt and tt
(D) TT and tt

Previously asked in: 2024 31/2/1 Q12

◆ Heredity | Monohybrid cross and genotype determination from offspring ratio | Test cross (heterozygous × homozygous recessive)

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Model Answer

(C) Tt and tt

When Tt × tt cross is performed, offspring are 50% Tt (tall) and 50% tt (short), matching the given result.

Explanation

This is a test cross (tall heterozygous × short homozygous recessive). Option A (Tt × Tt) gives 75% tall : 25% short; Option B gives all tall or 3:1; Option D gives all tall. Only Tt × tt produces the 1:1 ratio (50:50) described. Examiners expect you to recall basic monohybrid cross ratios.

Q42. § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions **[3]**

The gene combination of purple flowered pea plants is denoted as (WW) and that of white flowered pea plants as (ww), when these two plants are crossed F_1 generation is obtained.
(a) List two observations made by Mendel in F_1 generation plants.
(b) Give the (i) percentage of white flowered plants and (ii) ratio of the gene combinations WW, Ww and ww in F_2 generation.
(c) Write one difference between dominant and recessive trait.

Previously asked in: 2025 31/6/1 Q30

◆ **Heredity** | Dominant and Recessive Traits | Genotypic and Phenotypic Ratios in F2 generation | Mendel's Laws of Inheritance – Monohybrid Cross

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Model Answer

(a) Two observations in F_1 generation:

1. All plants had purple flowers — only one parental trait was expressed.
2. There were no intermediate forms (no "light purple" flowers).

(b)
(i) **25%** white-flowered plants in F_2 generation.
(ii) Ratio of WW : Ww : ww = **1 : 2 : 1**

(c)

Dominant Trait	Recessive Trait
Expressed even when a single copy of the gene is present (e.g., WW or Ww)	Expressed only when both copies are identical recessive genes (ww)

Source: Heredity, Section 8.2.2

Explanation

- **(a)** Examiners expect: (1) only one trait expressed / no blending, and (2) all F_1 plants look alike (all purple). Both are directly from Mendel's observations.
- **(b)** The cross Ww × Ww gives 1WW : 2Ww : 1ww. Only ww = white = 1/4 = 25%. State both the percentage and the ratio clearly.
- **(c)** The key distinction: dominant needs only one copy; recessive needs two copies (homozygous). A one-line tabular format is clean and scores full marks for a 1-mark difference question.

Q43. § 8.2.3 How do these Traits get Expressed? **[1]**

A tall pea plant with round seeds (TTRR) is crossed with a short pea plant with wrinkled seeds (ttrr). The F_1 generation will be

(A) 25% tall with round seeds
(B) 50% tall with wrinkled seeds
(C) 75% tall with wrinkled seeds
(D) 100% tall with round seeds

Previously asked in: 2025 31/6/1 Q8

◆ Heredity | Dihybrid Cross | F_1 Generation Genotype and Phenotype

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Model Answer

(D) 100% tall with round seeds

When TTRR × ttrr are crossed, all F_1 offspring receive one T and one R allele from each parent, giving genotype TtRr — tall (T dominant over t) and round (R dominant over r).

Explanation

In a dihybrid cross between two pure-breeding parents, all F_1 offspring are heterozygous (TtRr). Since tall (T) and round (R) are dominant traits, 100% of F_1 plants show both dominant phenotypes. Examiners expect you to identify dominance and apply it directly — no Punnett square needed for this straightforward cross.

Q44. § 8.2.4 Sex Determination **[4]**

> In human beings, there are 23 pairs of chromosomes. Out of these 23 pairs of chromosomes (i.e. 46 chromosomes), 22 pairs of chromosomes are called autosomes and one pair of chromosomes. i.e. two chromosomes are called sex chromosomes. The sex chromosomes are of two types – 'X' chromosomes and 'Y' chromosomes. The sex of a child (i.e. progeny), is decided at the time of fertilisation. In other words, at the time of zygote formation the sex chromosomes inherited from the parents of a child decide whether the new born will be a boy or a girl.

Answer the following sub-parts based on the given passage about chromosomes and sex determination.

(a) What are chromosomes?

(b) Why is the pair of sex chromosomes in human males called mismatched pair?

(c) Show with the help of a flow chart that the statistical probability of getting a boy or a girl is 50 : 50.

Previously asked in: 2025 31/5/1 Q38

♦ **Heredity** | Chromosomes – structure and definition | Sex chromosomes and sex determination in human beings | Statistical probability of sex determination (50:50 ratio) using flow chart

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Model Answer

(a) Chromosomes are thread-like structures present in the nucleus of a cell that carry genetic information (genes) from parents to offspring.

(b) In human males, the sex chromosomes are **X** and **Y**. Since X and Y chromosomes are of different sizes and shapes (not perfectly paired), they are called a **mismatched pair**.

(c) Flow chart showing 50:50 probability:

```
Parents: Mother (XX) × Father (XY)
↓ ↓
Gametes: X X X Y
↓
Zygotes: XX XX XY XY
(Girl)(Girl)(Boy)(Boy)
```

∴ Probability of girl : boy = **50% : 50%**

Source: Heredity and Evolution, Sex Determination

Explanation

- **(a)** is 1 mark — one line definition is enough.
- **(b)** is 1 mark — key term is "mismatched" because X and Y differ in size/shape.
- **(c)** is 2 marks — examiners expect a proper cross/flow chart showing gametes from both parents and resulting combinations. Writing all four zygote possibilities (XX, XX, XY, XY) and stating the 50:50 ratio is essential for full marks.

Q45. § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions **[2]**

Mendel crossed two pea plants with two visible contrasting characteristics and found that there were no half-way characteristics in the plants of F1 progeny. Explain the reason for this observation of Mendel.

Previously asked in: 2022 31/3/1 Q6(a)

◆ Heredity | Law of Dominance – no blending of traits in F1 progeny | Mendel's Dihybrid Cross and F1 generation

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Model Answer

In Mendel's cross, each trait is controlled by two factors (genes). One factor came from each parent. Since only one parental trait (tall) appeared in F1, the trait from one parent was **dominant** over the other (recessive). The dominant trait completely masked the recessive one, so no intermediate or halfway characteristics were observed.

Source: Chapter 8, Section 8.2.2

Explanation

- The examiner expects you to use the terms **dominant** and **recessive** correctly.
- The key idea is that one allele completely masks the other — there is no blending — which is why F1 shows only the dominant trait, not a mix.
- Avoid vague phrases like "stronger gene"; say "dominant trait masks the recessive trait."

Q46. § Introduction | § 8.2 HEREDITY | § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions **[2]**

Answer the following:

(i) In a cross between violet flowered plants and white flowered plants, state the characteristics of the plants obtained in the F1 progeny.

(ii) If the plants of F1 progeny are self-pollinated, then what would be observed in the plants of F2 progeny ?

(iii) If 100 plants are produced in F2 progeny, then how many plants will show the recessive trait ?

Previously asked in: 2022 31/1/1 Q5 (b)

◆ Heredity | Dominant and Recessive Traits | F1 and F2 Generation Outcomes | Monohybrid Cross and Mendel's Laws of Inheritance

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Model Answer

(i) In F_1 progeny, all plants will have **violet flowers** (like the dominant parent). The white flower trait (recessive) will not appear; all offspring show only the dominant character.

(ii) In F_2 progeny, both violet-flowered and white-flowered plants will appear in the ratio **3:1** (3 violet : 1 white). The recessive trait (white flower) reappears.

(iii) In a 3:1 ratio, **25 plants** out of 100 will show the recessive trait (white flowers).

Explanation

- This is a standard Mendelian monohybrid cross question. F_1 shows only the dominant trait; F_2 gives a 3:1 phenotypic ratio.
- Examiners expect you to clearly state "all violet" for F_1, the 3:1 ratio for F_2, and the calculation ($100 \times 1/4 = 25$) for part (iii).
- Key terms: dominant, recessive, F_1, F_2, 3:1 ratio — use them explicitly.

Q47. § 8.2 HEREDITY § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions **[1]**

Consider the following two statements :
(i) The trait that expresses itself in F1 generation.
(ii) The trait that keeps on passing from one generation to another.
The appropriate terms for the statements (i) and (ii) respectively are :

(a) Recessive trait, Dominant trait
(b) Dominant trait, Recessive trait
(c) Dominant trait, Inherited trait
(d) Recessive trait, Inherited trait

Previously asked in: 2023 31/5/1 Q10

◆ **Heredity** Dominant and Recessive Traits

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Model Answer

(c) Dominant trait, Inherited trait

Statement (i) describes the trait expressed in F1 generation — this is the **dominant trait**. Statement (ii) describes a trait passed from generation to generation — this is an **inherited trait**.

Explanation

- "Dominant trait" is the one expressed when two different copies of a gene are present (as seen in F1).
- "Recessive trait" is *hidden* in F1, so option (a) and (b) are wrong.
- The trait in statement (ii) keeps passing across generations, which fits "inherited trait," not specifically "recessive." This rules out option (b).
- Hence **(c)** is correct.

Q48. § 8.1 ACCUMULATION OF VARIATION DURING REPRODUCTION | § 8.2 HEREDITY | § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions **[1]**

Assertion (A) : In humans, if gene (B) is responsible for black eyes and gene (b) is responsible for brown eyes, then the colour of eyes of the progeny having gene combination Bb, bb or BB will be black only.
Reason (R) : The black colour of the eyes is a dominant trait.

(a) Both (A) and (R) are true and (R) is the correct explanation of (A).
(b) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(c) (A) is true but (R) is false.
(d) (A) is false but (R) is true.

Previously asked in: 2023 31/4/1 Q18

◆ **Heredity** | Assertion-Reason: Genotype and Phenotype Relationship | Dominance and Recessive Traits

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Model Answer

(d) (A) is false but (R) is true.

Assertion is false because progeny with **bb** (homozygous recessive) will have **brown eyes**, not black. Reason is true — black eye colour (B) is the dominant trait.

Explanation

- The key error in Assertion (A) is including **bb**: since 'b' is recessive, bb gives **brown** eyes, not black.
- BB and Bb both give black eyes (dominant trait expressed), but bb gives brown eyes.
- Reason (R) is correctly stated — dominance of B explains why BB and Bb show black eyes, but it does **not** save the Assertion from being false.
- So the correct option is **(d)**.

Q49. § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions **[2]**

Mendel crossed a pure tall pea plant (TT) with a pure short pea plant (tt) and obtained all tall plants in F1 generation.

(a) What is the gene combination present in the plants of F1 generation ?

(b) Give reason why only tall plants are observed in F1 progeny.

(c) What will be the ratio of the plants obtained in the F2 generation when F1 plants are self-pollinated ?

Previously asked in: 2023 31/2/1 Q23

◆ **Heredity** | Dominant and Recessive Traits | F2 Generation Phenotypic Ratio (3:1) | Mendel's Laws of Inheritance – Monohybrid Cross

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Model Answer

(a) The gene combination in F1 plants is **Tt** (hybrid tall).

(b) 'T' (tallness) is a **dominant trait**. A single copy of 'T' is enough to make the plant tall, so 'tt' (shortness) being recessive is not expressed in F1.

(c) The ratio of plants in F2 generation is **3 tall : 1 short** (i.e., 1 TT : 2 Tt : 1 tt).

Source: Chapter 8, Section 8.2.2

Explanation

- Examiners expect the genotype **Tt** for part (a) — not just "hybrid."
- For part (b), use the key terms **dominant** and **recessive**; state that one copy of T is sufficient.
- For part (c), the phenotypic ratio **3:1** is essential. Writing the genotypic ratio 1:2:1 alongside shows deeper understanding but the phenotypic ratio is the primary answer expected here.
- All three parts together carry 2 marks, so keep each answer to one line.

Q50. § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions **[3]**

Mendel crossed pure tall pea plants (TT) with pure short pea plants (tt) and obtained F_1 progeny. When the plants of F_1 progeny were self-pollinated, plants of F_2 progeny were obtained.

(a) What did the plants of F_1 progeny look like ? Give their gene combination. [1]

(b) Why could the gene for shortness not be expressed in plants of F_1 progeny ? [1]

(c) Write the ratio of the plants obtained in F_2 progeny and state the conclusion that can be drawn from this experiment. [1]

Previously asked in: 2024 31/5/1 Q30

◆ **Heredity** | Genotypic and Phenotypic Ratios in F2 generation | Law of Dominance | Mendel's Monohybrid Cross (TT × tt)

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Model Answer

(a) The F_1 progeny plants all looked **tall**. Their gene combination was **Tt** (hybrid tall).

(b) In F_1 plants, the gene for shortness (t) could not be expressed because the gene for tallness (T) is **dominant** over the gene for shortness (t), which is **recessive**. A single copy of 'T' is sufficient to make the plant tall.

(c) In F_2 progeny, the ratio of tall to short plants was **3 : 1**.
Conclusion: Both tallness and shortness traits were inherited by F_1 plants, but only tallness was expressed. Recessive traits are not lost; they reappear in later generations.

Source: Chapter 8, Section 8.2.2 – Rules for the Inheritance of Traits

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Explanation

- **(a)** Cross TT × tt → all offspring are Tt. Since T is dominant, all appear tall. Examiners expect both the phenotype and genotype.
- **(b)** The key terms examiners look for are **dominant** (T) and **recessive** (t). The textbook explicitly states "a single copy of T is enough to make the plant tall."
- **(c)** The 3:1 phenotypic ratio (3 tall : 1 short) is a standard fact. The conclusion must mention that the recessive trait is not lost but reappears — this is the heart of Mendel's finding and is directly from the textbook passage.

Q51. § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions **[3]**

List two differences between dominant traits and recessive traits. What percentage of pea plants in the F2 generation were with yellow seeds when Mendel crossed yellow (YY) and green coloured (yy) seeds ?

Previously asked in: 2024 31/4/1 Q30

◆ **Heredity** | Dominant and Recessive Traits | Mendel's Monohybrid Cross and F2 Generation Ratios

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Model Answer

Differences between Dominant and Recessive Traits:

Dominant Trait	Recessive Trait
Expressed when even one copy of the gene is present (e.g., Tt or TT)	Expressed only when both copies are the same recessive gene (e.g., tt)
Masks the recessive trait	Gets masked/suppressed in the presence of the dominant gene

Percentage of yellow-seeded plants in F2 generation:

Cross: YY × yy → F1: Yy (all yellow)

F1 × F1: Yy × Yy → F2: YY : Yy : yy = 1 : 2 : 1

Plants with yellow seeds (YY + Yy) = **75%**

Source: Heredity, Section 8.2.2

Explanation

- Give exactly **two** differences — one mark each.
- The cross/calculation carries one mark; show the F2 ratio clearly and state 75%. Examiners look for the Punnett logic (F1 = Yy, F2 ratio) and the final percentage. Writing just "75%" without the cross loses marks.
- Remember: yellow (Y) is dominant over green (y), so YY and Yy both appear yellow.

Q52. § Introduction § 8.2 HEREDITY § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions **[3]**

A pure pea plant having round (R), yellow (Y) seeds is crossed with another pure pea plant having wrinkled (r), green (y) seeds. Subsequently F_1 progeny is self-pollinated to obtain F_2 progeny.

(a) What do the seeds of F_1 generation look like ? [1]

(b) Give the possible combinations of traits in seeds of F_2 generation. Also give their ratio. [1]

(c) State the reason of obtaining seeds of new combination of traits in F_2 generation. [1]

Previously asked in: 2025 31/3/1 Q30

◆ **Heredity** Dihybrid Cross Dominance and F_1/F_2 generation phenotype ratios Law of Independent Assortment

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Model Answer

(a) The seeds of F_1 generation will be **round and yellow**, as roundness (R) and yellowness (Y) are dominant traits.

(b) The four possible combinations in F_2 generation are:

- Round, Yellow
- Round, Green
- Wrinkled, Yellow
- Wrinkled, Green

Their ratio is **9 : 3 : 3 : 1**.

(c) The new combinations (Round Green and Wrinkled Yellow) appear because the factors (genes) controlling seed shape and seed colour **assort independently** during gamete formation and recombine randomly during fertilisation to form the zygote.

Source: Chapter 8, Section 8.2.2

Explanation

- **(a)** is straightforward — F_1 of a dihybrid cross always shows both dominant traits (RrYy phenotype).
- **(b)** Examiners expect all four phenotypes listed clearly with the 9:3:3:1 ratio. Missing the ratio or any combination loses the mark.
- **(c)** The key phrase the examiner looks for is **independent assortment** of traits/genes. The textbook specifically states traits are "independently inherited" and new combinations arise when "factors controlling seed shape and seed colour recombine to form the zygote." Use this language.

Q53. § 8.2.1 Inherited Traits **[3]**

The lowest part of the ear called earlobe, is closely attached to the side of the head in some of us (Figure 'X'), and not in others, called free earlobe (Figure 'Y'). Attached and free earlobes are two variants found in human populations. The gene for free earlobe is dominant over attached earlobes.

(a) A man with attached earlobes marries a woman having free earlobes. 50% of their children have free earlobes and 50% have attached earlobes. Explain the inheritance of this trait and write the trait combinations of the progeny. [2]

(b) Write the gene combinations of the father and the mother in the above case. [1]

Previously asked in: 2025 31/2/1 Q30

◆ **Heredity** | Genotype and phenotype of parents and progeny in a cross | Mendelian cross / Punnett square analysis | Monohybrid inheritance and dominance (earlobe trait)

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Model Answer

(a) Since free earlobe (F) is dominant over attached earlobe (f), the mother with free earlobes must be heterozygous (Ff) and the father with attached earlobes is homozygous recessive (ff).

Cross: Ff × ff

	F	f
f	Ff	ff

Progeny: 50% Ff (free earlobe) and 50% ff (attached earlobe) — this explains the 1:1 ratio observed.

(b) Father's gene combination: **ff** (attached earlobes)
Mother's gene combination: **Ff** (free earlobes)

Source: Chapter 8, Section 8.2.1 – Inherited Traits

Explanation

- The 50:50 ratio is a classic **test cross result** (Ff × ff), which tells the examiner the mother must be heterozygous, not homozygous dominant (FF × ff would give 100% free earlobes).
- Always show a **Punnett square** for 2-mark genetics questions — it earns method marks.
- For part (b), write gene combinations clearly using standard notation (Ff, ff); do not just write "dominant/recessive."

Q54. § 8.1 ACCUMULATION OF VARIATION DURING REPRODUCTION | § 8.2 HEREDITY | § 8.2.4 Sex Determination **[3]**

Answer the following :

(a) What are chromosomes ? [1]

(b) Explain in brief how stability of DNA content of a species is ensured in sexually reproducing organisms ? [2]

Previously asked in: 2025 31/1/1 Q30

♦ Heredity | Chromosomes – structure and definition | Stability of DNA content through meiosis and fertilisation in sexual reproduction

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Model Answer

(a) Chromosomes are thread-like structures found in the nucleus of a cell, made up of DNA and proteins. They carry genes which transmit hereditary information from parents to offspring.

(b) In sexually reproducing organisms, gametes (sperm and egg) are formed by **meiosis**, which halves the chromosome number. When two gametes fuse during fertilisation, the original chromosome number is restored. This ensures that the DNA content remains constant in every generation of a species.

Explanation

- **(a)** One mark — state what chromosomes are (location + composition). Mentioning DNA and genes earns the mark.
- **(b)** Two marks — the key concept is the **meiosis–fertilisation cycle**: meiosis halves the chromosome number (1 mark), fertilisation restores it (1 mark). Use correct terms: meiosis, gametes, fertilisation. No diagram is needed for 2 marks but mentioning haploid/diploid can strengthen the answer.

Q55. § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions **[2]**

Using height (tallness / dwarfness) of a plant as an example, show that genes control the characteristics or traits in an organism.

Previously asked in: 2022 31/4/1 Q3 (main)

♦ Heredity | Dominant and recessive alleles | Genes control traits – height (tallness/dwarfness) in plants as an example | Mendel's experiment – tall and dwarf pea plants

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Model Answer

In pea plants, height is controlled by a gene with two forms (alleles): 'T' (tallness) and 't' (dwarfness). When a tall plant (TT) is crossed with a short plant (tt), all F_1 plants are tall (Tt). When F_1 plants self-pollinate, F_2 plants are tall (TT/Tt) or short (tt) in a 3:1 ratio. This shows that the gene 'T' or 't' directly determines whether the plant is tall or dwarf — proving genes control traits.

Source: Chapter 8, Section 8.2.2 – Rules for the Inheritance of Traits

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Explanation

- Examiners want you to mention: alleles (T and t), F_1 result (all tall), F_2 result (3 tall : 1 short), and the conclusion that genes control traits.
- State that 'T' is dominant (one copy sufficient) and 'tt' gives short plant (recessive — both copies needed).
- Avoid lengthy diagrams unless asked; a brief cross notation (TT × tt → Tt) is enough to support the explanation within the word limit.

Q56. § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions **[2]**

List any two pairs of visible contrasting characters of garden pea plants used by Mendel for his experiments stating the dominant and recessive characters in each pair.

Previously asked in: 2024 31/3/1 Q23(a)

◆ **Heredity** Mendel's Experiments on Garden Pea – Contrasting Characters (Dominant and Recessive Traits)

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Model Answer

Pair 1: Plant Height

- Dominant character: Tall plant
- Recessive character: Short plant

Pair 2: Seed Shape

- Dominant character: Round seeds
- Recessive character: Wrinkled seeds

(Any other valid pair such as Flower Colour — Violet (dominant) / White (recessive) is also acceptable.)

Source: Chapter 8, Section 8.2.2

Explanation

- The question asks for **two pairs**, each with the dominant and recessive character clearly named — that's 1 mark per pair.
- Mendel's seven pairs include: tall/short, round/wrinkled seeds, violet/white flowers, yellow/green seeds, etc. State any two.
- Always write which is dominant and which is recessive explicitly — don't just list them, or you may lose marks.

Q57. § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions **[4]**

> Mendel worked out the rules of heredity by working on garden pea using a number of visible contrasting characters. He conducted several experiments by making a cross with one or two pairs of contrasting characters of pea plant. On the basis of his observations he gave some interpretations which helped to study the mechanism of inheritance.

Read the source given and answer the questions that follow :

(i) When Mendel crossed pea plants with pure tall and pure short characteristics to produce F_1 progeny, which two observations were made by him in F_1 plants? [1]

(ii) Write one difference between dominant and recessive trait. [1]

(iii) In a cross with two pairs of contrasting characters RRYY × rryy (Round Yellow) (Wrinkled Green) Mendel observed 4 types of combinations in F_2 generation. By which method did he obtain F_2 generation ? Write the ratio of the parental combinations obtained and what conclusions were drawn from this experiment. [2]

Previously asked in: 2024 31/1/1 Q38

◆ **Heredity** | Dihybrid cross and F2 ratio – independent assortment | Dominant and Recessive Traits | Mendel's experiments with garden pea – monohybrid and dihybrid crosses

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Model Answer

(i) In F_1 plants, Mendel observed:

- All plants were tall (no short plants appeared).
- Only one trait (tallness) was expressed; shortness was hidden.

(ii) A **dominant trait** is the one that expresses itself in F_1 generation (e.g., tallness), whereas a **recessive trait** is the one that remains hidden in F_1 but reappears in F_2 generation (e.g., shortness).

(iii) Mendel obtained F_2 generation by **self-pollination** of F_1 plants (RrYy × RrYy).

The ratio of parental combinations (Round Yellow : Wrinkled Green) in F_2 = **9 : 3 : 3 : 1** overall; parental types (RRYY and rryy types) appeared in ratio **9 : 1** among combinations.

Conclusion: The two pairs of traits assorted independently of each other — this is the **Law of Independent Assortment**.

Source: Heredity and Evolution, Mendel's Laws of Inheritance

Explanation

- For (i), examiners expect two distinct observations about F_1 — all tall, and shortness hidden. One mark requires both points briefly stated.
- For (ii), a clear one-line contrast with examples scores full marks. Avoid long definitions.
- For (iii), three things are tested: method (self-pollination/selfing of F_1), the ratio (9:3:3:1 and parental combinations 9 round yellow : 3 wrinkled yellow : 3 round green : 1 wrinkled green, parental combos ratio 9:1), and the conclusion (Law of Independent Assortment). Cover all three for full 2 marks.

Q58. § Introduction § 8.2 HEREDITY § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions **[2]**

"Proteins control the expression of various characters." Explain this statement by taking an example of "tallness" as a characteristic in plants.

Previously asked in: 2025 31/6/1 Q23(a)

◆ **Heredity** Gene–protein–trait relationship Role of proteins (enzymes) in expression of traits – tallness in plants

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Model Answer

Proteins are responsible for expressing traits in an organism. For example, **tallness** in plants is controlled by a specific protein — the enzyme that produces the plant hormone **gibberellin**. If the gene for this enzyme is present and functional, gibberellin is produced, the plant grows tall. If the gene is absent or non-functional, the enzyme (protein) is not made, gibberellin is not produced, and the plant remains short (dwarf).

Thus, genes control traits by directing the synthesis of specific proteins.

Explanation

This question links genetics (Chapter 8) to biochemistry. The key idea is the **gene → protein → trait** pathway. Examiners expect students to:

1. State that genes control protein synthesis.
2. Give the specific example: gene → enzyme → gibberellin → tallness.
3. Show the consequence when the gene/protein is absent (dwarf plant).

Avoid vague statements like "genes determine height" without explaining the protein link.

Q59. § 8.2 HEREDITY § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions **[2]**

Answer the following :

(a) Explain how the proteins control the 'characteristics' in an organism with the help of an example of 'tallness' trait in pea plant. [1]

(b) Name the section of DNA that controls the 'characteristics' in an organism. [1]

Previously asked in: 2025 31/3/1 Q24

◆ **Heredity** Gene as the section of DNA that controls characteristics Role of proteins in controlling characteristics – tallness trait in pea plant

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Model Answer

(a) Proteins control characteristics by acting as enzymes or structural components. For example, in pea plants, genes produce a specific enzyme that synthesises plant hormones (like gibberellin). More hormone → taller plant; less hormone → dwarf plant.

(b) The section of DNA that controls characteristics in an organism is called a **gene**.

Explanation

- For (a), the key idea is: gene → protein (enzyme) → characteristic. Use the tallness example: enzyme controls gibberellin production, which determines plant height.
- For (b), the one-word answer "gene" is sufficient. Examiners want the exact term — do not write "DNA segment" without naming it as a gene.
- These are standard NCERT Chapter 9 (Heredity and Evolution) concepts. Memorise the gene–protein–trait link.

Q60. § 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions **[3]**

Show the cross and observations made by Mendel when he crossed pure tall pea plant with a pure short pea plant to get F1 progeny.

Previously asked in: 2026 31/3/1 Q14

◆ **Heredity** | Law of Dominance | Mendel's Monohybrid Cross – F1 Generation (Tall × Short Pea Plant)

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Model Answer

Cross:

P generation: TT (Pure Tall) × tt (Pure Short)

F1 progeny: All Tt (Tall)

$$TT \times tt \rightarrow Tt,\ Tt,\ Tt,\ Tt$$

Observations:

1. All F1 plants were **tall** — no medium-height plants were observed.
2. Only one parental trait (tallness) was expressed in F1; shortness was not visible.
3. This showed that tallness is **dominant** over shortness (recessive).
4. The F1 plants (Tt) inherited both factors but expressed only the dominant one.

Source: Chapter 8, Section 8.2.2

Explanation

- The cross diagram (P → F1) with genotypes earns 1 mark; observations earn the remaining 2 marks — so write **at least 3 clear observations**.
- Examiners expect the terms **dominant** and **recessive** to appear.
- State explicitly that **no intermediate (medium) height** plants appeared — this is a key Mendelian observation.
- Use genotype notation (TT, tt, Tt) to show you understand the factor/gene concept.

Q61. § 8.2 HEREDITY § 8.2.4 Sex Determination **[1]**

Consider the following statements :
(i) The sex of a child is determined by what it inherits from the mother.
(ii) The sex of a child is determined by what it inherits from the father.
(iii) The probability of having a male child is more than that of a female child.
(iv) The sex of a child is determined at the time of fertilisation when male and female gametes fuse to form a zygote.
The correct statements are :

(a) (i) and (iii)
(b) (ii) and (iv)
(c) (iii) and (iv)
(d) (i), (iii) and (iv)

Previously asked in: 2024 31/1/1 Q8

◆ **Heredity** Sex Determination in Humans

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Model Answer

(b) (ii) and (iv)

Statement (ii) is correct — sex depends on what the child inherits from the father (X or Y chromosome).
Statement (iv) is correct — sex is determined at fertilisation when gametes fuse.

Source: Chapter 8, Section 8.2.4 Sex Determination

Explanation

- Statement (i) is **wrong**: all children inherit X from the mother, so the mother does not determine sex.
- Statement (iii) is **wrong**: the passage clearly states *half* the children will be boys and *half* will be girls — equal probability.
- Statements (ii) and (iv) are directly supported by the text: the father's gamete (X or Y) decides sex, and this is fixed at fertilisation.

Q62. § 8.2.4 Sex Determination **[2]**

Justify that the sex determination of a child is based on what they inherit from their father and not from their mother.

Previously asked in: 2022 31/3/1 Q6(b)

◆ **Heredity** Sex Determination in Humans

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Model Answer

In humans, females have two X chromosomes (XX) and males have one X and one Y chromosome (XY). The mother can only pass on an X chromosome to every child. The father, however, can pass either X or Y. A child inheriting X from the father is a girl; inheriting Y makes a boy. Hence, the sex of the child is determined by the father.

Source: Chapter 8, Section 8.2.4 – Sex Determination

Explanation

The key logic examiners want: **mother is always XX → only X possible from her → father's contribution (X or Y) is the deciding factor.** State this clearly with the XX/XY notation. Two marks = two key points: (1) mother contributes only X, (2) father contributes either X or Y, determining the sex. Don't forget to mention which combination gives a girl (XX) and which gives a boy (XY).

Q63. § 8.2.4 Sex Determination **[4]**

> In some families, either rural or urban, females are tortured for giving birth to a female child. They do not seem to understand the scientific reason behind the birth of a boy or a girl. In fact the mother is not responsible for the sex of the child and it has been genetically proved that the sex of a newborn is determined by what the child inherits from the father.

Read the case carefully and answer the questions that follow.

(a) State the basis on which the sex of a newborn baby is determined in humans. [1]

(b) Why is the pair of sex chromosomes called a mismatched pair in males ? [1]

(c) How is the original number of chromosomes present in the parents restored in the progeny ? [2]

Previously asked in: 2023 31/5/1 Q38

◆ **Heredity** | Restoration of chromosome number through sexual reproduction and fertilisation | Sex Determination in Humans | Sex chromosomes and mismatched pair in males (XY)

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Model Answer

(a) The sex of a newborn is determined by the type of sex chromosome inherited from the father. If the child inherits an X chromosome from the father, it is a girl (XX); if it inherits a Y chromosome, it is a boy (XY).

(b) In males, the two sex chromosomes are X and Y, which are not perfectly homologous — they differ in size and genetic content. Hence, they are called a mismatched pair.

(c) During gamete formation (meiosis), the chromosome number is halved — each gamete carries only one set (haploid, n). When the male gamete (n) fuses with the female gamete (n) during fertilisation, the original diploid number (2n) is restored in the progeny.

Source: Heredity and Evolution, Sex Determination / Chromosomes and Sex

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Explanation

- **(a)** Examiners want mention of the father's contribution (X or Y) and the resulting XX/XY combination.
- **(b)** Key phrase is "mismatched" — X and Y differ in size and gene content; one mark for stating this clearly.
- **(c)** This is a 2-mark answer: name **meiosis** (halving) + **fertilisation** (restoration). Both steps must be mentioned for full credit.

Q64. § 8.2.4 Sex Determination **[1]**

A zygote is formed by the fusion of a male gamete and a female gamete. The number of chromosomes in the zygote of a human is :

A 23
B 44
C 46
D 92

Previously asked in: 2024 31/4/1 Q10

◆ Heredity | Zygote formation and chromosome number in humans

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Model Answer

Option C — 46

A human zygote is formed by fusion of a sperm (23 chromosomes) and an egg (23 chromosomes), giving the zygote **46 chromosomes**.

Explanation

Each human gamete (sperm/egg) is haploid — it carries 23 chromosomes. Fertilisation combines two gametes, restoring the diploid number of 46. Option A (23) is the gamete number; Option D (92) would be if a zygote fused again; Option B (44) is incorrect. Examiners expect you to recall that human body cells have 46 chromosomes, so the zygote must also have 46.

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