CBSE CLASS X

Science (086)

QUESTION PAPER

AI-generated question paper

Code: NTAMAU	Questions: 30	Maximum Marks: 67	Generated: 2026-06-25 17:36

SELECTIONS USED

Subject	Science
Lessons	8 Heredity
Level of understanding	Exam-ready
Question selection	CBSE board paper, whole lesson (~80 marks across Sections A-E)
Model	claude-sonnet-4-6

Composition — Difficulty: 5 straightforward · 18 medium · 7 deep | Types: 11 MCQ · 6 Short · 4 Very short · 3 Assertion–reason · 3 Long · 3 Case-based | Sections: A 14Q/14m · B 4Q/8m · C 6Q/18m · D 3Q/15m · E 3Q/12m

Q1. straightforward exam-ready **[1]**

A tall pea plant (TT) is crossed with a short pea plant (tt). All F1 plants are tall, and when F1 plants self-pollinate, tall and short plants appear in the F2 generation in a 3:1 ratio. Which of the following best explains these observations?
((A)) Tallness is dominant; the allele for shortness is masked in F1 but reappears in F2
((B)) Shortness is dominant; the allele for tallness disappears in F1
((C)) The tall allele blends with the short allele in F1 but separates again in F2
((D)) Only tall plants can self-pollinate successfully

A Tall is a recessive trait
B Tall is a dominant trait
C Tall and short traits blend equally
D Short trait is expressed but hidden

◆ Heredity

Q2. straightforward exam-ready **[1]**

In a monohybrid cross between tall (Tt) and short (tt) pea plants, what is the expected ratio of tall to short plants in the progeny?

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

◆ Heredity

Q3. straightforward exam-ready **[1]**

Which of the following correctly explains why variations are important for a species?
((A)) Variations allow individuals to acquire new skills during their lifetime
((B)) Variations increase the chances that at least some individuals will survive drastic environmental changes
((C)) Variations ensure all offspring are identical, maintaining species stability
((D)) Variations arise only in sexually reproducing organisms and are always beneficial

A Variations ensure all individuals look identical
B Variations allow some individuals to survive environmental changes better than others
C Variations are produced only during asexual reproduction
D Variations reduce the number of offspring produced

◆ **Heredity**

Q4. medium exam-ready **[1]**

A dihybrid cross between two pea plants with genotype RrYy × RrYy is performed. The F2 generation shows four phenotypic classes in the ratio 9:3:3:1. Which principle of inheritance does this ratio directly support?
((A)) Dominance — one allele masks the effect of another
((B)) Segregation — alleles separate during gamete formation
((C)) Independent assortment — alleles of different genes are inherited independently
((D)) Blending inheritance — traits from both parents mix in offspring

A The two traits are linked and always inherited together
B The two traits are inherited independently of each other
C One trait completely suppresses the other
D F2 offspring show only parental combinations

◆ **Heredity**

Q5. medium exam-ready **[1]**

In sexually reproducing organisms, each germ cell carries only one copy of each gene. Why is this necessary?
((A)) So that the offspring receive double the number of chromosomes from each parent
((B)) So that fertilisation restores the full two copies of each gene in the offspring
((C)) So that mutations occur less frequently in germ cells than in body cells
((D)) So that both parents contribute genes of identical type to the offspring

A So that offspring have half the DNA of their parents
B So that when two germ cells combine, the normal chromosome number is restored in the offspring
C To ensure only dominant traits are passed on
D To prevent any variation from occurring in offspring

◆ **Heredity**

Q6. medium exam-ready **[1]**

The sex of a crocodile embryo is determined by the temperature at which fertilised eggs are incubated. This means sex determination in crocodiles is:

A Genetically determined like in humans
B Determined by environmental cues, not genes
C Determined by the Y chromosome
D Determined by the number of autosomes

◆ **Heredity**

Q7. medium exam-ready **[1]**

In a plant, shortness is controlled by a gene that produces a less efficient enzyme, resulting in lower hormone levels. Tallness is controlled by an efficient form of the same enzyme. Which form of the gene is dominant?

A The gene that produces the less efficient enzyme, because it requires two copies to show its effect
B The gene that produces the efficient enzyme, because even one copy makes enough hormone for tallness
C Both forms are equally dominant
D The gene for the less efficient enzyme, because it produces more variation

◆ **Heredity**

Q8. straightforward exam-ready **[1]**

In pea plants, two different traits such as seed colour and seed shape are inherited independently of each other. The most likely reason for this is that:
((A)) Each gene controlling a trait is located on a separate chromosome
((B)) All genes are located on the same chromosome but separated by large gaps
((C)) Dominant genes are always located on larger chromosomes
((D)) Genes controlling unrelated traits are always found in the same nucleus

A Gene
B Chromosome
C Ribosome
D Nucleus

◆ **Heredity**

Q9. medium exam-ready **[1]**

In a population of bacteria reproducing asexually, a particular variation is found in 60% of individuals while another variation is found in only 5%. Which variation most likely arose earlier, and why?
((A)) The 5% variation; rare traits are always newer
((B)) The 60% variation; a higher frequency suggests the variation has had more time to accumulate through successive generations
((C)) Both arose at the same time; frequency does not reflect age
((D)) The 60% variation; common traits are always more beneficial

A The trait present in 10%, because rare traits are older
B Both traits arose at the same time
C The trait present in 60%, because it has had more time to accumulate in the population
D Neither trait can be compared this way

◆ **Heredity**

Q10. medium exam-ready **[1]**

Sexual reproduction generates more heritable variation than asexual reproduction primarily because:
((A)) Sexual reproduction involves two individuals whose genetic material combines, producing new combinations of traits
((B)) Asexual reproduction always involves mutations while sexual reproduction does not
((C)) Sexual reproduction occurs faster, giving more opportunities for variation
((D)) In sexual reproduction, only the mother's genes are passed to offspring, halving the genetic information

A Sexual reproduction involves more DNA copying errors
B Sexual reproduction combines genetic material from two different individuals, generating new gene combinations
C Asexual reproduction does not produce any variation at all
D Sexual reproduction skips the process of DNA replication

◆ **Heredity**

Q11. deep exam-ready **[1]**

Two pea plants, one with genotype TTWW (tall, violet flowers) and another with ttww (short, white flowers) are crossed. The F1 progeny are all tall with violet flowers. When F1 plants are self-pollinated, which new phenotypic combinations are expected in F2 that were NOT present in either parent?

A Tall with violet flowers and short with white flowers only
B Tall with white flowers and short with violet flowers
C Only short plants with white flowers
D No new combinations; only parental types reappear

◆ **Heredity**

Q12. medium exam-ready **[1]**

Assertion (A): In human beings, it is the father's chromosomal contribution that determines whether a child will be male or female.
Reason (R): A father can pass either an X or a Y chromosome to the child, while the mother always passes an X chromosome.

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

◆ **Heredity**

Q13. medium exam-ready **[1]**

Assertion (A): Variants that are better suited to their environment survive and reproduce more successfully than others.
Reason (R): All variants in a population have equal chances of surviving regardless of the environment.

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

◆ **Heredity**

Q14. straightforward exam-ready **[1]**

Assertion (A): Each body cell of a sexually reproducing organism has two copies of each chromosome.
Reason (R): One copy of each chromosome is inherited from the mother and one from the father through their respective germ cells.

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

◆ **Heredity**

Q15. medium exam-ready **[2]**

A child has blood group O. Her mother has blood group A and her father has blood group B. What does this tell you about whether blood group O is dominant or recessive? Explain your reasoning.

◆ **Heredity**

Q16. medium exam-ready **[2]**

Why does a germ cell contain only one set of genes while all other body cells contain two sets?

◆ **Heredity**

Q17. medium exam-ready **[2]**

In pea plants, round seed shape (R) is dominant over wrinkled (r). A plant with round seeds is test-crossed with a wrinkled-seeded plant and gives both round and wrinkled seeds in equal proportion. What is the genotype of the round-seeded parent? Justify your answer.

◆ **Heredity**

Q18. medium exam-ready **[2]**

In snails, an individual can change its sex during its lifetime. What does this indicate about the mechanism of sex determination in snails compared to humans?

◆ **Heredity**

Q19. medium exam-ready **[3]**

Mendel crossed pea plants having tall stems and round seeds (TTRR) with plants having short stems and wrinkled seeds (ttrr). All F1 plants were tall with round seeds. When F1 plants were allowed to self-pollinate:
(i) What phenotypic ratio is expected in F2?
(ii) Identify the two new phenotypic combinations that appear in F2 which were absent in the parent generation.
(iii) What does the appearance of new trait combinations in F2 indicate about how traits are inherited?

◆ **Heredity**

Q20. medium exam-ready **[3]**

Explain how a gene controls a characteristic in an organism, using plant height as an example. Your answer should connect genes, enzymes, hormones and the final trait.

◆ **Heredity**

Q21. medium exam-ready **[3]**

In a Mendelian monohybrid cross:
(i) Why are there no plants of intermediate height (medium height) in the F1 generation when tall and short plants are crossed?
(ii) When F1 tall plants self-pollinate, short plants reappear in F2. What does this prove about the F1 plants?

◆ **Heredity**

Q22. medium exam-ready **[3]**

With the help of a cross diagram, show the sex chromosome combinations possible in the offspring when a human male (44+XY) reproduces with a human female (44+XX). Explain why a father, and not a mother, is responsible for determining the sex of a child. Why is the probability of having a boy equal to the probability of having a girl?

◆ **Heredity**

Q23. deep exam-ready **[3]**

Asexual reproduction produces very little variation, while sexual reproduction produces considerably more. Explain why this difference exists, referring to the source and mechanism of variation in each type of reproduction.

◆ **Heredity**

Q24. deep exam-ready **[3]**

A pure-breeding pea plant with round yellow seeds (RRYY) is crossed with a pure-breeding plant with wrinkled green seeds (rryy).
(i) Write the genotype and phenotype of the F1 offspring.
(ii) In the F2 generation, what fraction of the total offspring would be expected to have round green seeds? Write their possible genotypes.
(iii) Identify one F2 genotype that would breed true for wrinkled yellow seeds and explain how you determined it.

◆ **Heredity**

Q25. deep exam-ready **[5]**

Mendel used garden pea plants to study heredity over two generations.
(a) Mendel crossed a pure tall pea plant with a pure short pea plant. With a labelled cross diagram, show the genotypes of parents, F1 and F2 generations. (2 marks)
(b) In the F2 generation, what fraction of the tall plants would be pure-breeding (TT)? What simple experiment would you perform to confirm this? (2 marks)
(c) Why did Mendel choose to count individuals in each generation rather than simply observe traits qualitatively? What advantage did this give? (1 mark)

◆ **Heredity**

Q26. deep exam-ready **[5]**

Inheritance of sex in humans involves specific chromosomal mechanisms.
(a) Describe the sex chromosome composition of human males and females. How many pairs of chromosomes does a human cell have in total, and how are the sex chromosomes different from the other 22 pairs? (2 marks)
(b) Explain, using a cross diagram, how the sex of a child is determined. Why is the father's contribution responsible for the sex of the child? (2 marks)
(c) Compare sex determination in humans with sex determination in reptiles such as crocodiles and in snails. What does this comparison suggest about the nature of sex determination across species? (1 mark)

◆ **Heredity**

Q27. deep exam-ready **[5]**

The accumulation of heritable variations over generations drives diversity within a species.
(a) Explain how variations arise in asexually reproducing organisms and why these variations are limited compared to sexually reproducing organisms. (2 marks)
(b) Using an example, explain how environmental selection acts on variation and why this is important for the long-term survival of a species. (2 marks)
(c) In a sexually reproducing population, two parents each contribute 'practically equal amounts of genetic material' to the offspring. Explain how this equal contribution is mechanistically ensured during reproduction. (1 mark)

◆ **Heredity**

Q28. medium exam-ready **[4]**

Read the following scenario and answer the questions:

Anjali is studying inheritance of seed colour in peas, where yellow (Y) is dominant over green (y). She crosses a yellow-seeded plant of unknown genotype with a green-seeded plant (yy). She obtains 48 yellow-seeded and 52 green-seeded plants.

(i) What is the likely genotype of the yellow-seeded parent used by Anjali? Explain your reasoning. (1 mark)
(ii) Write the cross in proper notation and show the gametes and offspring genotypes. (1 mark)
(iii) If Anjali had instead used a pure-breeding yellow-seeded plant (YY) in the cross, what would the proportion of yellow-seeded offspring have been? (1 mark)
(iv) What is the name given to a cross between an individual of unknown genotype and a homozygous recessive individual? Why is it useful? (1 mark)

◆ **Heredity**

Q29. medium exam-ready **[4]**

Read the following and answer the questions:

In a village, a farmer noticed that in his field of sugarcane, all the plants looked almost identical. However, in a nearby herd of cattle that reproduce sexually, significant differences in coat colour, size and horn shape were visible among individuals. The farmer's son, who studies biology, told him that this difference in variation is directly related to the mode of reproduction.

(i) Why do the sugarcane plants in the field show very little variation compared to the cattle? (1 mark)
(ii) What is the primary source of variation in organisms that reproduce asexually? (1 mark)
(iii) Explain how sexual reproduction in cattle generates greater variation than asexual reproduction in sugarcane. (1 mark)
(iv) Why is the presence of variation in the herd of cattle beneficial for the long-term survival of the species? (1 mark)

◆ **Heredity**

Q30. deep exam-ready **[4]**

Read the following scenario and answer the questions:

Rajat performed a genetics experiment with pea plants. He crossed a plant with round yellow seeds with another plant of identical phenotype. After obtaining a large number of seeds, he found four phenotypic classes: round yellow, round green, wrinkled yellow, and wrinkled green in the approximate ratio 9:3:3:1.

(i) What were the genotypes of both parent plants? Justify your answer based on the phenotypic ratio obtained. (1 mark)
(ii) Out of 160 seeds, how many would Rajat expect to have wrinkled green seeds? (1 mark)
(iii) Which two phenotypic classes in Rajat's results represent new combinations not seen in either parent? What does their appearance indicate about how seed shape and seed colour are inherited relative to each other? (1 mark)
(iv) Rajat's teacher says the 9:3:3:1 ratio would collapse to a 3:1 ratio if the two traits were always inherited together. Explain why this would happen. (1 mark)

◆ **Heredity**

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CBSE CLASS X

Science (086)

ANSWER KEY

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Q1. straightforward exam-ready **[1]**

A tall pea plant (TT) is crossed with a short pea plant (tt). All F1 plants are tall, and when F1 plants self-pollinate, tall and short plants appear in the F2 generation in a 3:1 ratio. Which of the following best explains these observations?

((A)) Tallness is dominant; the allele for shortness is masked in F1 but reappears in F2

((B)) Shortness is dominant; the allele for tallness disappears in F1

((C)) The tall allele blends with the short allele in F1 but separates again in F2

((D)) Only tall plants can self-pollinate successfully

A Tall is a recessive trait

B Tall is a dominant trait

C Tall and short traits blend equally

D Short trait is expressed but hidden

◆ Heredity

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Model Answer

(B) Tall is a dominant trait

Tallness is dominant over shortness. In F1, all plants are Tt (tall), as T masks t. In F2, self-pollination gives TT : Tt : tt = 3 tall : 1 short, showing the recessive allele reappears.

Explanation

The examiner expects you to identify **dominance and recessiveness** as the explanation. The key NCERT concept is: "the trait that gets expressed is called the dominant trait and the other is called the recessive trait." Option A in the original choices matches this, but from the given OPTIONS list, **(B) Tall is a dominant trait** is the correct answer. Remember: the 3:1 ratio in F2 is the classic Mendelian result proving dominance, not blending.

Q2. straightforward exam-ready **[1]**

In a monohybrid cross between tall (Tt) and short (tt) pea plants, what is the expected ratio of tall to short plants in the progeny?

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

◆ Heredity

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Model Answer

Answer: B) 1:1

Cross: Tt × tt → Tt, Tt, tt, tt
Tall (Tt) : Short (tt) = **1:1**

Source: Chapter 8, Section 8.2.2

Explanation

This is a **test cross** (not F2 self-pollination). When Tt × tt, the gametes are T/t from the tall parent and only t from the short parent, giving 50% Tt (tall) and 50% tt (short) — ratio 1:1. Students often confuse this with the F2 ratio (3:1, from Tt × Tt) or the genotypic ratio (1:2:1). Remember: 3:1 and 1:2:1 come from crossing two heterozygotes (Tt × Tt), not from a cross with a homozygous recessive (tt).

Q3. straightforward exam-ready **[1]**

Which of the following correctly explains why variations are important for a species?
((A)) Variations allow individuals to acquire new skills during their lifetime
((B)) Variations increase the chances that at least some individuals will survive drastic environmental changes
((C)) Variations ensure all offspring are identical, maintaining species stability
((D)) Variations arise only in sexually reproducing organisms and are always beneficial

A Variations ensure all individuals look identical
B Variations allow some individuals to survive environmental changes better than others
C Variations are produced only during asexual reproduction
D Variations reduce the number of offspring produced

◆ Heredity

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Model Answer

Answer: (B) Variations increase the chances that at least some individuals will survive drastic environmental changes.

Explanation

The passage clearly states that if some variations are present in a population, there is a chance for some individuals to survive when a niche is drastically altered (e.g., heat-resistant bacteria surviving global warming). Options A, C, and D are factually incorrect as per the textbook — variations do not make offspring identical, they occur in both sexual and asexual reproduction, and they do not reduce offspring numbers.

Q4. medium exam-ready **[1]**

A dihybrid cross between two pea plants with genotype RrYy × RrYy is performed. The F2 generation shows four phenotypic classes in the ratio 9:3:3:1. Which principle of inheritance does this ratio directly support?

((A)) Dominance — one allele masks the effect of another

((B)) Segregation — alleles separate during gamete formation

((C)) Independent assortment — alleles of different genes are inherited independently

((D)) Blending inheritance — traits from both parents mix in offspring

A The two traits are linked and always inherited together

B The two traits are inherited independently of each other

C One trait completely suppresses the other

D F2 offspring show only parental combinations

◆ Heredity

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Model Answer

Option B — The two traits are inherited independently of each other.

The 9:3:3:1 ratio in F2 of a dihybrid cross directly supports Mendel's Law of Independent Assortment, showing the two traits are inherited independently.

Explanation

The question maps the 9:3:3:1 ratio to a Mendelian principle. The textbook explicitly states that in a dihybrid cross, F2 progeny show new combinations (tall+wrinkled, short+round), proving the traits are **independently inherited** — this is Independent Assortment. Note the options given in the MCQ body differ from the four lettered choices (A–D) in the question stem; among the actual answer options listed, **B** is correct. Examiners expect you to link the 9:3:3:1 ratio directly to independent assortment/independent inheritance.

Q5. medium exam-ready **[1]**

In sexually reproducing organisms, each germ cell carries only one copy of each gene. Why is this necessary?
((A)) So that the offspring receive double the number of chromosomes from each parent
((B)) So that fertilisation restores the full two copies of each gene in the offspring
((C)) So that mutations occur less frequently in germ cells than in body cells
((D)) So that both parents contribute genes of identical type to the offspring

A So that offspring have half the DNA of their parents
B So that when two germ cells combine, the normal chromosome number is restored in the offspring
C To ensure only dominant traits are passed on
D To prevent any variation from occurring in offspring

◆ Heredity

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Model Answer

(B) So that when two germ cells combine, the normal chromosome number is restored in the offspring.

Germ cells are formed by meiosis, carrying only half the chromosomes. At fertilisation, two germ cells fuse, restoring the full chromosome number in the offspring.

Explanation

The passage (Chapter 7, Section 7.3.1) clearly states that germ cells have half the chromosomes (via meiosis), so that when they combine during sexual reproduction, the original chromosome number and DNA content are re-established. Option B directly reflects this. Options A, C, and D are either incorrect or unrelated to the reason given in the textbook. Examiners expect you to link meiosis → half chromosomes → fertilisation → full number restored.

Source: Chapter 7, Section 7.3.1 — Why the Sexual Mode of Reproduction?

Q6. medium exam-ready **[1]**

The sex of a crocodile embryo is determined by the temperature at which fertilised eggs are incubated. This means sex determination in crocodiles is:

A Genetically determined like in humans
B Determined by environmental cues, not genes
C Determined by the Y chromosome
D Determined by the number of autosomes

◆ Heredity

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Model Answer

Answer: B — Determined by environmental cues, not genes

Since crocodile sex depends on incubation temperature (an environmental factor), not chromosomes or genes, it is determined by environmental cues, not genetic inheritance.

Source: Chapter 8, Section 8.2.4 – Sex Determination

Explanation

- The passage explicitly states: *"in some animals like a few reptiles, the temperature at which fertilised eggs are kept determines whether the animals developing in the eggs will be male or female."*
- This is contrasted directly with human sex determination, which **is** genetically determined (XX/XY).
- Options A, C, and D all relate to genetic/chromosomal mechanisms — these apply to humans, not crocodiles.
- Key examiner tip: The word **"environmental cues"** from the textbook is the exact phrase to recall here.

Q7. medium exam-ready **[1]**

In a plant, shortness is controlled by a gene that produces a less efficient enzyme, resulting in lower hormone levels. Tallness is controlled by an efficient form of the same enzyme. Which form of the gene is dominant?

A The gene that produces the less efficient enzyme, because it requires two copies to show its effect
B The gene that produces the efficient enzyme, because even one copy makes enough hormone for tallness
C Both forms are equally dominant
D The gene for the less efficient enzyme, because it produces more variation

◆ Heredity

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Model Answer

Answer: (B)

The gene producing the efficient enzyme is dominant, because even a single copy produces enough hormone to make the plant tall, while two copies of the less efficient gene are needed for shortness.

Source: Heredity, Section 8.2.2

Explanation

The textbook states: *"a single copy of 'T' is enough to make the plant tall... traits like 'T' are called dominant traits."* Dominance means one copy is sufficient to express the trait. Here, one copy of the efficient-enzyme gene produces enough hormone for tallness — exactly the definition of a dominant allele. The less efficient enzyme gene requires two copies (homozygous recessive) to show shortness, making it recessive.

Q8. straightforward exam-ready **[1]**

In pea plants, two different traits such as seed colour and seed shape are inherited independently of each other. The most likely reason for this is that:
((A)) Each gene controlling a trait is located on a separate chromosome
((B)) All genes are located on the same chromosome but separated by large gaps
((C)) Dominant genes are always located on larger chromosomes
((D)) Genes controlling unrelated traits are always found in the same nucleus

A Gene
B Chromosome
C Ribosome
D Nucleus

◆ Heredity

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Model Answer

(A) Each gene controlling a trait is located on a separate chromosome — so the two traits assort independently during gamete formation (Mendel's Law of Independent Assortment).

Explanation

The key concept is independent assortment: genes on **different (non-homologous) chromosomes** segregate independently during meiosis. The textbook states that factors controlling seed shape and seed colour "recombine" freely, producing new trait combinations in F2 — this only happens when the genes are on separate chromosomes. Options B, C, and D are incorrect biological statements not supported by the chapter.

Q9. medium exam-ready **[1]**

In a population of bacteria reproducing asexually, a particular variation is found in 60% of individuals while another variation is found in only 5%. Which variation most likely arose earlier, and why?

((A)) The 5% variation; rare traits are always newer

((B)) The 60% variation; a higher frequency suggests the variation has had more time to accumulate through successive generations

((C)) Both arose at the same time; frequency does not reflect age

((D)) The 60% variation; common traits are always more beneficial

A The trait present in 10%, because rare traits are older

B Both traits arose at the same time

C The trait present in 60%, because it has had more time to accumulate in the population

D Neither trait can be compared this way

◆ Heredity

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Model Answer

(C) The trait present in 60%, because it has had more time to accumulate in the population through successive generations of asexual reproduction.

Explanation

The textbook (Ch. 8, Q1 under Section 8.1) directly asks this: "If a trait A exists in 10% ... and trait B in 60% ... which arose earlier?" The expected reasoning is that in asexual reproduction, variations accumulate over generations; a higher frequency means more time has passed for it to spread — not that it is necessarily more beneficial. Avoid option D's reasoning ("always more beneficial") as the textbook does not say frequency equals benefit.

Q10. medium exam-ready **[1]**

Sexual reproduction generates more heritable variation than asexual reproduction primarily because:
((A)) Sexual reproduction involves two individuals whose genetic material combines, producing new combinations of traits
((B)) Asexual reproduction always involves mutations while sexual reproduction does not
((C)) Sexual reproduction occurs faster, giving more opportunities for variation
((D)) In sexual reproduction, only the mother's genes are passed to offspring, halving the genetic information

A Sexual reproduction involves more DNA copying errors
B Sexual reproduction combines genetic material from two different individuals, generating new gene combinations
C Asexual reproduction does not produce any variation at all
D Sexual reproduction skips the process of DNA replication

◆ Heredity

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Model Answer

Answer: B

Sexual reproduction combines genetic material from two different individuals, generating new gene combinations, which produces more heritable variation than asexual reproduction.

Source: Chapter 7 – Sexual Reproduction; Chapter 8 – Introduction

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Explanation

- The key concept is that sexual reproduction involves **two parents**, so their genetic material combines, creating **new combinations of traits** in offspring.
- The textbook explicitly states: "Modes of sexual reproduction allow for greater variation to be generated."
- Eliminate wrong options: Asexual reproduction does not *always* involve mutations (B wrong); sexual reproduction is not faster (C wrong); both parents' genes are inherited, not just the mother's (D wrong).
- Option A in the MCQ stem is the closest to correct but uses different wording — the mapped answer from the given options is **B**.

Q11. deep exam-ready **[1]**

Two pea plants, one with genotype TTWW (tall, violet flowers) and another with ttww (short, white flowers) are crossed. The F1 progeny are all tall with violet flowers. When F1 plants are self-pollinated, which new phenotypic combinations are expected in F2 that were NOT present in either parent?

A Tall with violet flowers and short with white flowers only
B Tall with white flowers and short with violet flowers
C Only short plants with white flowers
D No new combinations; only parental types reappear

◆ Heredity

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Model Answer

Answer: B — Tall with white flowers and short with violet flowers

In F2, independent assortment produces new combinations (TtWw × TtWw) not seen in either parent (TTWW or ttww).

Explanation

- Parents are TTWW (tall, violet) and ttww (short, white); F1 is TtWw.
- F1 self-pollination gives 9:3:3:1 ratio — the 3:1 minority classes (tall+white and short+violet) are **new recombinant phenotypes**.
- The textbook explicitly states: "there would also be some F2 progeny that showed new combinations" when two traits are independently inherited — directly supporting option B.
- Options A and D describe only parental types; C describes only one parental type. Only B correctly identifies **both** new recombinant combinations.

Q12. medium exam-ready **[1]**

Assertion (A): In human beings, it is the father's chromosomal contribution that determines whether a child will be male or female.
Reason (R): A father can pass either an X or a Y chromosome to the child, while the mother always passes an X chromosome.

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

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Model Answer

Option A — Both A and R are true, and R is the correct explanation of A.

The father is either XY; he passes X or Y to the child, while the mother (XX) always passes X, thus determining the child's sex.

Explanation

The passage explicitly states: "the sex of the children will be determined by what they inherit from their father" — a child inheriting X from father is a girl, Y makes a boy. The mother always contributes X. So R directly and correctly explains A. Choose **A**.

Q13. medium exam-ready **[1]**

Assertion (A): Variants that are better suited to their environment survive and reproduce more successfully than others.
Reason (R): All variants in a population have equal chances of surviving regardless of the environment.

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

◆ Heredity

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Model Answer

Option C: A is true but R is false.

Assertion is correct — better-suited variants survive and reproduce more. Reason is false — variants do NOT have equal survival chances; environment selects favourably adapted ones.

Explanation

The textbook explicitly states: *"Do all these variations have equal chances of surviving? Obviously not."* Environmental selection favours better-adapted variants (e.g., heat-resistant bacteria survive a heat wave). This directly contradicts Reason R, making C the correct choice.

Q14. straightforward exam-ready **[1]**

Assertion (A): Each body cell of a sexually reproducing organism has two copies of each chromosome.
Reason (R): One copy of each chromosome is inherited from the mother and one from the father through their respective germ cells.

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

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Model Answer

Answer: A

Both A and R are true, and R is the correct explanation of A. In sexual reproduction, germ cells (egg and sperm) each contribute one copy of each chromosome, so body cells have two copies — one maternal, one paternal.

Explanation

- **A is true**: Body cells of sexually reproducing organisms are diploid (two copies of each chromosome).
- **R is true**: One copy comes from the mother's egg cell and one from the father's sperm cell.
- **R correctly explains A**: The two-copy nature of body chromosomes is *directly caused* by the fusion of two germ cells during fertilisation, making R the correct explanation of A.
- Key phrase from the chapter: "Most human chromosomes have a maternal and a paternal copy" — this directly links R to A.

Q15. medium exam-ready **[2]**

A child has blood group O. Her mother has blood group A and her father has blood group B. What does this tell you about whether blood group O is dominant or recessive? Explain your reasoning.

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Model Answer

Blood group O is **recessive**.

Reasoning: The mother (blood group A) must have genotype I^A i, and the father (blood group B) must have genotype I^B i. The child inherited one 'i' allele from each parent, giving genotype 'ii' (blood group O). Since O only appears when both copies are 'i', it is recessive — a single copy of I^A or I^B is enough to suppress it.

Explanation

- The key logic: if O were dominant, at least one parent would show blood group O — but neither does. So O must be recessive, hidden in both parents as a single copy (i).
- Examiners expect you to state the conclusion clearly **and** give the reasoning using the concept of dominant/recessive traits.
- You don't need to write full genotype notation, but it strengthens the answer.

Q16. medium exam-ready **[2]**

Why does a germ cell contain only one set of genes while all other body cells contain two sets?

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Model Answer

Germ cells are produced by a special cell division called **meiosis**, which halves the number of chromosomes (and DNA content). This is necessary because when two germ cells combine during fertilisation, the normal chromosome number is restored in the new individual. If germ cells had two sets, the zygote would have double the DNA of normal body cells, disrupting cellular control.

Source: Chapter 7, Section 7.3.1 — Why the Sexual Mode of Reproduction?

Explanation

The key concept here is **meiosis** — the examiner expects you to name it and explain *why* it happens (to prevent doubling of chromosomes at fertilisation). Two marks = name the process + give the reason. Avoid writing a long paragraph; two crisp sentences covering both points earn full marks.

Q17. medium exam-ready **[2]**

In pea plants, round seed shape (R) is dominant over wrinkled (r). A plant with round seeds is test-crossed with a wrinkled-seeded plant and gives both round and wrinkled seeds in equal proportion. What is the genotype of the round-seeded parent? Justify your answer.

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Model Answer

The genotype of the round-seeded parent is **Rr** (heterozygous).

Justification: A test cross is performed between the plant of unknown genotype and a homozygous recessive (rr) plant. The cross Rr × rr produces Rr (round) and rr (wrinkled) in a **1:1 ratio**, which matches the equal proportion observed. If the parent were RR, all offspring would be round (Rr only).

Source: Heredity, Chapter 8, Section 8.2.2 & 8.2.3

Explanation

- **Test cross** always involves crossing with the homozygous recessive (rr). The 1:1 output of round : wrinkled is the classic result of a **heterozygous × homozygous recessive** cross.
- Examiners expect you to (1) state the genotype clearly, (2) show or describe the cross, and (3) explain why the other possibility (RR) is ruled out. All three points fit in the word budget for 2 marks.
- Write the cross explicitly (Rr × rr → Rr : rr) — it earns the second mark.

Q18. medium exam-ready **[2]**

In snails, an individual can change its sex during its lifetime. What does this indicate about the mechanism of sex determination in snails compared to humans?

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Model Answer

In snails, individuals can change their sex during their lifetime, which indicates that sex determination in snails is **not genetically determined** but depends on environmental or other non-genetic factors. In contrast, in human beings, sex is **genetically determined** — by the sex chromosomes (XX for female, XY for male) inherited from parents.

Explanation

The key contrast examiners expect is: snails = non-genetic/environmental sex determination; humans = genetic sex determination via X and Y chromosomes. Mention both sides clearly for full 2 marks. The textbook explicitly states "individuals can change sex, indicating that sex is not genetically determined" — use this phrasing directly.

Source: Chapter 8, Section 8.2.4 Sex Determination

Q19. medium exam-ready **[3]**

Mendel crossed pea plants having tall stems and round seeds (TTRR) with plants having short stems and wrinkled seeds (ttrr). All F1 plants were tall with round seeds. When F1 plants were allowed to self-pollinate:
(i) What phenotypic ratio is expected in F2?
(ii) Identify the two new phenotypic combinations that appear in F2 which were absent in the parent generation.
(iii) What does the appearance of new trait combinations in F2 indicate about how traits are inherited?

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Model Answer

(i) The expected phenotypic ratio in F2 is **9 : 3 : 3 : 1**
(Tall round : Tall wrinkled : Short round : Short wrinkled)

(ii) The two new phenotypic combinations appearing in F2 are:

- **Tall plants with wrinkled seeds**
- **Short plants with round seeds**

(iii) The appearance of new trait combinations in F2 indicates that the two traits (stem height and seed shape) are **inherited independently** of each other. The factors (genes) controlling different traits recombine independently during reproduction, giving rise to new combinations in offspring.

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

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Explanation

- **Part (i):** A dihybrid cross always gives 9:3:3:1 in F2 — memorise this ratio.
- **Part (ii):** The two *parental* types were tall-round and short-wrinkled; so the *new* combinations are tall-wrinkled and short-round. Examiners specifically look for this distinction.
- **Part (iii):** The key phrase the examiner expects is **"independently inherited"** (or independent assortment). The textbook explicitly states: *"the tall/short trait and the round seed/wrinkled seed trait are independently inherited."* Always link the observation (new combinations) to the conclusion (independent inheritance of traits).

Q20. medium exam-ready **[3]**

Explain how a gene controls a characteristic in an organism, using plant height as an example. Your answer should connect genes, enzymes, hormones and the final trait.

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Model Answer

A **gene** is a segment of DNA that controls a specific characteristic by directing the synthesis of a particular **enzyme**.

For example, in pea plants, the gene for height (T/t) controls the production of enzymes that regulate the synthesis of plant **hormones** (such as gibberellins). These hormones promote cell elongation.

- The dominant gene **T** directs enzyme production that leads to higher hormone levels → **tall plant**.
- The recessive gene **tt** results in reduced enzyme activity → lower hormone levels → **short plant**.

Thus, the gene → enzyme → hormone → final trait (height) pathway determines the characteristic expressed.

Source: Chapter 8, Section 8.2.2; Chapter 6, Section 6.2

Explanation

- The examiner expects you to link the four terms in a logical chain: **gene → enzyme → hormone → trait**. Missing any link loses marks.
- The T/t example from Mendel (Chapter 8) is the prescribed context; gibberellin is the relevant plant hormone for height (Chapter 6 mentions plant hormones).
- Note: the source passages do not explicitly detail the enzyme-hormone chain for height, so use your textbook knowledge to bridge gene → enzyme → hormone, but keep the Mendelian T/t example as your anchor.
- Dominant (TT/Tt = tall) and recessive (tt = short) language from the passage should appear to show you understand the gene-to-trait connection.

Q21. medium exam-ready **[3]**

In a Mendelian monohybrid cross:
(i) Why are there no plants of intermediate height (medium height) in the F1 generation when tall and short plants are crossed?
(ii) When F1 tall plants self-pollinate, short plants reappear in F2. What does this prove about the F1 plants?

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Model Answer

(i) In the F1 generation, no medium-height plants appear because tallness is **dominant** over shortness (recessive). The F1 plants inherit one 'T' allele from the tall parent and one 't' allele from the short parent, making them **Tt**. A single copy of 'T' is sufficient to express tallness, so all F1 plants are tall. There is no blending of traits.

(ii) The reappearance of short plants in F2 proves that the F1 tall plants were **heterozygous (Tt)** — they carried both the tallness trait (T) and the shortness trait (t). The 't' allele was present but not expressed in F1 (being recessive). On self-pollination, tt combination appears in F2, expressing shortness. This shows that **both traits were inherited but only tallness was expressed** in F1.

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

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Explanation

- For **(i)**, the key point is **dominance** — examiners want you to state that T is dominant, Tt is the F1 genotype, and one copy of T is enough for tall phenotype. Never say traits "blend."
- For **(ii)**, the key term examiners look for is **heterozygous (Tt)**. You must explain that the recessive 't' was hidden in F1 but reappears when two Tt plants self-pollinate and produce tt offspring. The textbook phrase "both tallness and shortness traits were inherited in F1 plants, but only tallness was expressed" is the core idea to reproduce.

Q22. medium exam-ready **[3]**

With the help of a cross diagram, show the sex chromosome combinations possible in the offspring when a human male (44+XY) reproduces with a human female (44+XX). Explain why a father, and not a mother, is responsible for determining the sex of a child. Why is the probability of having a boy equal to the probability of having a girl?

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Model Answer

Cross Diagram:

	X (from mother)	X (from mother)
X (from father)	XX (Girl)	XX (Girl)
Y (from father)	XY (Boy)	XY (Boy)

Father determines sex: The mother always contributes an X chromosome to the child. The father can contribute either X or Y. If the child inherits X from the father → girl (XX); if Y → boy (XY). So the sex of the child depends on the father's contribution, not the mother's.

Equal probability: Since a father produces equal numbers of X-bearing and Y-bearing sperms, the chance of fertilisation by either type is equal (50:50), making the probability of a boy equal to the probability of a girl.

Source: Chapter 8, Section 8.2.4 – Sex Determination

Explanation

- The cross diagram (Punnett square) is essential — examiners expect it drawn/tabulated clearly.
- Key point: mother is always XX → always gives X; father is XY → gives X or Y randomly.
- "Father determines sex" must be explicitly stated with reasoning, not just implied.
- The 50:50 probability comes from equal production of X and Y sperms — mention this directly.
- All three parts carry marks, so answer each one clearly.

Q23. deep exam-ready **[3]**

Asexual reproduction produces very little variation, while sexual reproduction produces considerably more. Explain why this difference exists, referring to the source and mechanism of variation in each type of reproduction.

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Model Answer

Asexual reproduction creates new individuals from a single parent through DNA copying. Although minor errors during DNA copying introduce some variation, the mechanism is largely identical each time, so very little variation is produced.

Sexual reproduction involves two individuals combining their DNA. This means traits from two parents are inherited separately and can appear in new combinations in the offspring. This mixing of genetic material allows considerably more variation to be generated, maximising the number of successful variations in the population.

Source: Chapter 7 (What you have learnt); Chapter 8 (Introduction)

Explanation

- The key contrast is: asexual = one parent, variation only from DNA copying errors (rare/minor); sexual = two parents, variation from combination/mixing of genes (much greater).
- Examiners expect you to name the **source** (one parent vs. two parents) and the **mechanism** (DNA copying errors vs. new combinations of traits).
- The phrase "new combinations of traits" from the Chapter 8 summary is a scoring keyword — use it.
- Do not write more than 3–4 sentences; this is a 3-mark answer.

Q24. deep exam-ready **[3]**

A pure-breeding pea plant with round yellow seeds (RRYY) is crossed with a pure-breeding plant with wrinkled green seeds (rryy).
(i) Write the genotype and phenotype of the F1 offspring.
(ii) In the F2 generation, what fraction of the total offspring would be expected to have round green seeds? Write their possible genotypes.
(iii) Identify one F2 genotype that would breed true for wrinkled yellow seeds and explain how you determined it.

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Model Answer

(i) F1 Genotype: **RrYy**; Phenotype: **Round yellow seeds** (R and Y are dominant).

(ii) Round green seeds = R_yy genotype. From the F2 Punnett square, this phenotype appears in **3/16** of the offspring.
Possible genotypes: **RRyy** and **Rryy**.

(iii) The F2 genotype **rryy** breeds true for wrinkled yellow — *wait*, wrinkled yellow = rrY_.
The true-breeding genotype is **rrYY**.
It is homozygous for both recessive (rr = wrinkled) and dominant (YY = yellow) alleles, so it will always produce wrinkled yellow offspring on self-pollination.

Source: Chapter 8, Section 8.2.3

Explanation

- **Part (i):** Since RRYY × rryy, all F1 get one R and one Y from each parent → RrYy. Round and yellow are dominant, so phenotype is round yellow.
- **Part (ii):** Use the 9:3:3:1 ratio from Fig. 8.5. Round green = 3/16. The two genotypes giving round green are RRyy and Rryy (R_yy).
- **Part (iii):** "Breeds true" means homozygous. Wrinkled = rr, yellow = YY → rrYY. Examiners want you to state *why* it breeds true: because both gene pairs are homozygous, self-pollination always gives the same phenotype. Note: rrYy also gives wrinkled yellow but does NOT breed true.

Q25. deep exam-ready **[5]**

Mendel used garden pea plants to study heredity over two generations.
(a) Mendel crossed a pure tall pea plant with a pure short pea plant. With a labelled cross diagram, show the genotypes of parents, F1 and F2 generations. (2 marks)
(b) In the F2 generation, what fraction of the tall plants would be pure-breeding (TT)? What simple experiment would you perform to confirm this? (2 marks)
(c) Why did Mendel choose to count individuals in each generation rather than simply observe traits qualitatively? What advantage did this give? (1 mark)

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Model Answer

(a) Cross Diagram – Tall × Short

Generation	Cross
Parents (P)	TT (pure tall) × tt (pure short)
F_1	All Tt (tall)
$F_1 \times F_1$	Tt × Tt
F_2	TT : Tt : tt = 1 : 2 : 1

F_2 phenotype ratio → 3 tall : 1 short (TT and Tt are tall; tt is short).

(b) Fraction and Confirmatory Experiment

In F_2, the ratio of TT : Tt : tt is 1 : 2 : 1. Out of 3 tall plants, only **1/3 are pure-breeding (TT)**.

To confirm: allow each F_2 tall plant to **self-pollinate** (self-breed) and observe the progeny. A plant that produces **only tall offspring** in all subsequent generations is TT (pure-breeding), whereas one that gives 3 tall : 1 short is Tt.

(c) Advantage of Counting

Mendel was the first to **count the number of individuals** showing each trait in every generation rather than just noting traits qualitatively. This gave him exact ratios (3:1 in F_2), which revealed the **mathematical pattern of inheritance** and allowed him to deduce the laws governing heredity.

Source: Chapter 8 – Heredity, Section 8.2.2 Rules for the Inheritance of Traits – Mendel's Contributions

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Explanation

- **(a)** Draw the cross as a table or Punnett-square-style layout. Label clearly: P generation genotypes (TT, tt), F_1 (Tt), $F_1 \times F_1$, and F_2 (TT, Tt, Tt, tt). Examiners award marks for correct genotypes AND the ratio.
- **(b)** The key trap: students often say "1/4 of all F_2 are TT," which is correct, but the question asks what fraction of the **tall plants** are TT. Among 3 tall plants (TT + Tt + Tt), only 1 is TT → **1/3**. The self-pollination experiment is directly from Activity 8.2 in the textbook.
- **(c)** The textbook explicitly states Mendel "was the first one to keep count of individuals exhibiting a particular trait in each generation. This helped him to arrive at the laws of inheritance." Use this language.

Q26. deep exam-ready **[5]**

Inheritance of sex in humans involves specific chromosomal mechanisms.
(a) Describe the sex chromosome composition of human males and females. How many pairs of chromosomes does a human cell have in total, and how are the sex chromosomes different from the other 22 pairs? (2 marks)
(b) Explain, using a cross diagram, how the sex of a child is determined. Why is the father's contribution responsible for the sex of the child? (2 marks)
(c) Compare sex determination in humans with sex determination in reptiles such as crocodiles and in snails. What does this comparison suggest about the nature of sex determination across species? (1 mark)

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Model Answer

(a) Human females have two X chromosomes (XX) and males have one X and one Y chromosome (XY). A human cell has **23 pairs** of chromosomes in total — 22 pairs are autosomes (perfectly matched pairs) and 1 pair is the sex chromosomes. Unlike the 22 autosomes, the sex chromosomes in males are mismatched: one normal-sized X and one shorter Y chromosome.

(b)

Mother (XX)	×	Father (XY)
Eggs: all X		Sperms: X or Y

Offspring: XX (girl) or XY (boy) — **50% girls, 50% boys**.

The father's contribution determines sex because the mother can only pass X chromosomes, while the father passes either X (→ girl) or Y (→ boy).

(c) In reptiles like crocodiles, sex is determined by incubation temperature, not genes. In snails, individuals can change sex, so sex is not genetically fixed. This shows that sex determination varies widely across species — it can be genetic (humans), environmental (reptiles), or flexible (snails).

Source: Chapter 8, Section 8.2.4 — Sex Determination

Explanation

- **(a):** Examiners expect the numbers 22 + 1 = 23 pairs, and the key distinction that autosomes are matched while the male sex chromosomes are mismatched (X and Y).
- **(b):** A simple cross table earns marks. The key conclusion — **father's X or Y decides the child's sex** — must be explicitly stated.
- **(c):** This 1-mark part only needs a brief, accurate contrast of the three examples and a one-line conclusion about diversity of sex-determination mechanisms. Don't over-write here.

Q27. deep exam-ready **[5]**

The accumulation of heritable variations over generations drives diversity within a species.
(a) Explain how variations arise in asexually reproducing organisms and why these variations are limited compared to sexually reproducing organisms. (2 marks)
(b) Using an example, explain how environmental selection acts on variation and why this is important for the long-term survival of a species. (2 marks)
(c) In a sexually reproducing population, two parents each contribute 'practically equal amounts of genetic material' to the offspring. Explain how this equal contribution is mechanistically ensured during reproduction. (1 mark)

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Model Answer

(a) In asexually reproducing organisms, variations arise due to **small inaccuracies (errors) in DNA copying** during reproduction. For example, when one bacterium divides to produce four individuals, the resultant bacteria are very similar with only minor differences. Variations are limited because only one parent is involved — there is no mixing of genetic material from two individuals. In sexual reproduction, genetic material from two parents combines, generating far greater diversity.

(b) If bacteria living in temperate water face a rise in temperature due to global warming, most will die. However, variants that are heat-resistant will survive and reproduce. This **environmental selection of variants** is crucial for long-term survival because it ensures that at least some individuals can adapt when conditions change, preventing the species from being wiped out.

(c) Equal genetic contribution is ensured because each parent contributes one set of chromosomes through their gametes (sperm and egg). Since gametes are formed by meiosis (having half the chromosomes), when they fuse at fertilisation, the offspring receives **practically equal amounts of DNA** from each parent.

Source: Chapter 8, Section 8.1 — Accumulation of Variation During Reproduction; Chapter 7, Section 7.1.1 — The Importance of Variation

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Explanation

- **(a)** The key phrase examiners look for is "inaccuracies in DNA copying" as the source of variation, and the point that only one parent means no mixing — hence limited variation.
- **(b)** Always use a specific example (bacteria + heat/global warming is directly from the textbook). Link selection → survival of species for full marks.
- **(c)** This is a 1-mark question — one crisp mechanistic point is enough: meiosis halves the chromosome number, fertilisation restores it, ensuring equal contribution. You don't need to write more than 2 lines.

Q28. medium exam-ready **[4]**

Read the following scenario and answer the questions:

Anjali is studying inheritance of seed colour in peas, where yellow (Y) is dominant over green (y). She crosses a yellow-seeded plant of unknown genotype with a green-seeded plant (yy). She obtains 48 yellow-seeded and 52 green-seeded plants.

(i) What is the likely genotype of the yellow-seeded parent used by Anjali? Explain your reasoning. (1 mark)
(ii) Write the cross in proper notation and show the gametes and offspring genotypes. (1 mark)
(iii) If Anjali had instead used a pure-breeding yellow-seeded plant (YY) in the cross, what would the proportion of yellow-seeded offspring have been? (1 mark)
(iv) What is the name given to a cross between an individual of unknown genotype and a homozygous recessive individual? Why is it useful? (1 mark)

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Model Answer

(i) The yellow-seeded parent is likely **heterozygous (Yy)**. The offspring ratio is approximately 48 yellow : 52 green ≈ **1:1**, which indicates one parent contributed dominant (Y) and recessive (y) alleles, so the yellow parent must be Yy, not YY.

(ii)
Cross: **Yy × yy**
Gametes: (Y, y) × (y, y)
Offspring genotypes: **Yy** (yellow) and **yy** (green) in equal proportion (1:1).

(iii) If the yellow parent were **YY**, all gametes would be Y. Cross: YY × yy → all offspring **Yy** (yellow). Proportion of yellow-seeded offspring = **100%**.

(iv) This cross is called a **Test Cross**. It is useful because the homozygous recessive parent (yy) reveals the unknown genotype — a 1:1 ratio indicates heterozygous (Yy), while all dominant offspring indicate homozygous dominant (YY).

Source: Chapter 8 – Heredity, Section 8.2.2

Explanation

- **Key concept tested:** Mendelian inheritance, dominant/recessive traits, test cross.
- The **1:1 ratio** in offspring is the classic indicator of a test cross with a heterozygous parent.
- For (ii), always write gametes explicitly — examiners award marks for showing them.
- For (iii), remember YY × yy → all Yy, so 100% yellow; students often write ½ by mistake.
- **Test cross** is the exact NCERT term — use it, don't paraphrase it as "back cross" (which is slightly different).

Q29. medium exam-ready **[4]**

Read the following and answer the questions:

In a village, a farmer noticed that in his field of sugarcane, all the plants looked almost identical. However, in a nearby herd of cattle that reproduce sexually, significant differences in coat colour, size and horn shape were visible among individuals. The farmer's son, who studies biology, told him that this difference in variation is directly related to the mode of reproduction.

(i) Why do the sugarcane plants in the field show very little variation compared to the cattle? (1 mark)
(ii) What is the primary source of variation in organisms that reproduce asexually? (1 mark)
(iii) Explain how sexual reproduction in cattle generates greater variation than asexual reproduction in sugarcane. (1 mark)
(iv) Why is the presence of variation in the herd of cattle beneficial for the long-term survival of the species? (1 mark)

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Model Answer

(i) Sugarcane reproduces asexually (vegetative propagation), producing offspring from a single parent through DNA copying. Since no mixing of genetic material occurs, the plants are nearly identical to each other.

(ii) The primary source of variation in asexually reproducing organisms is **errors/inaccuracies during DNA copying** (replication).

(iii) In sexual reproduction, genetic material from two different individuals (parents) combines. This mixing produces new combinations of traits, generating greater variation. Asexual reproduction in sugarcane involves only one parent, so offspring inherit identical DNA with minimal variation.

(iv) Variation ensures that if the environment changes drastically (e.g., a new disease or climate change), at least some individuals with favourable traits will survive, preventing the entire species from being wiped out.

Source: Chapter 7, Section 7.1.1 – The Importance of Variation; Chapter 8 – Introduction

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Explanation

- **(i) & (iii):** The key concept is **one parent vs. two parents** — asexual reproduction copies one genome; sexual reproduction mixes two, creating diversity.
- **(ii):** Many students write "mutation" — that is acceptable, but the textbook specifically says variation in asexual reproduction arises from **DNA copying errors/inaccuracies**.
- **(iv):** Always link variation → survival during environmental change → stability of the species. This is directly from Section 7.1.1 and is a favourite examiner point.
- Keep each answer to 1–2 lines since each carries only 1 mark.

Q30. deep exam-ready **[4]**

Read the following scenario and answer the questions:

Rajat performed a genetics experiment with pea plants. He crossed a plant with round yellow seeds with another plant of identical phenotype. After obtaining a large number of seeds, he found four phenotypic classes: round yellow, round green, wrinkled yellow, and wrinkled green in the approximate ratio 9:3:3:1.

(i) What were the genotypes of both parent plants? Justify your answer based on the phenotypic ratio obtained. (1 mark)
(ii) Out of 160 seeds, how many would Rajat expect to have wrinkled green seeds? (1 mark)
(iii) Which two phenotypic classes in Rajat's results represent new combinations not seen in either parent? What does their appearance indicate about how seed shape and seed colour are inherited relative to each other? (1 mark)
(iv) Rajat's teacher says the 9:3:3:1 ratio would collapse to a 3:1 ratio if the two traits were always inherited together. Explain why this would happen. (1 mark)

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Model Answer

(i) Both parents were **RrYy** (dihybrid). The 9:3:3:1 ratio is the classic F2 dihybrid ratio, which only appears when both parents are heterozygous for both traits (round = R dominant, yellow = Y dominant). Since both parents had identical phenotype (round yellow) yet produced all four phenotypic classes, each must have carried one dominant and one recessive allele for each gene.

(ii) Wrinkled green (rryy) = 1/16 of offspring.
Expected = (1/16) × 160 = **10 seeds**

(iii) Round green and **wrinkled yellow** are new combinations not seen in either parent. Their appearance indicates that seed shape and seed colour are **inherited independently** of each other (independent assortment), allowing new combinations to arise in offspring.

(iv) If both traits were always inherited together, each parent would pass only one combined unit (e.g., RY or ry together) — effectively behaving as a single trait. The cross would reduce to Aa × Aa, giving only dominant : recessive = **3:1**, with no new trait combinations possible.

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

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Explanation

- **(i)** The 9:3:3:1 ratio is the definitive evidence for a dihybrid cross (RrYy × RrYy). Examiners want you to state the genotype AND justify it using the ratio.
- **(ii)** Straightforward calculation: wrinkled green = rryy = 1 part out of 16. Always show working.
- **(iii)** "New combinations" means recombinant phenotypes not present in parents. Link directly to independent inheritance/assortment — the key Mendelian principle the textbook states.
- **(iv)** Linked traits behave as one gene, so dihybrid becomes monohybrid → 3:1. The teacher's statement is testing whether you understand *why* independent assortment produces four classes instead of two.

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