IG.B9 Monohybrid Inheritance and Genetic Diagrams

Total Marks

EDEXCEL 4BI1 · Calculator allowed · about 50 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Define the term genotype in the context of inheritance of a single gene in humans.

(Total for Question 1 is 1 mark)

2 Define the term phenotype as used when discussing a single inherited characteristic in humans.

(Total for Question 2 is 1 mark)

3 Define what is meant by homozygous for a particular gene in human genetics.

(Total for Question 3 is 1 mark)

4 Define heterozygous for a single gene in human inheritance.

(Total for Question 4 is 1 mark)

5 State what is meant by a dominant allele when discussing a single gene trait in humans.

(Total for Question 5 is 1 mark)

6 State what is meant by a recessive allele when discussing a single gene trait in humans.

(Total for Question 6 is 1 mark)

7 Construct a genetic diagram to show the result of a cross between a carrier parent for cystic fibrosis (genotype Cc, where c is the recessive cystic fibrosis allele) and an affected parent with cystic fibrosis (genotype cc). Label the gametes, the Punnett square, and give the genotypes of the offspring.

(Total for Question 7 is 3 marks)

---

8 Construct a fully labelled genetic diagram (Punnett square) for cystic fibrosis showing the cross between two carrier parents, each genotype Cc. Label gametes, fill the four offspring boxes, and state the genotype ratio.

(Total for Question 8 is 4 marks)

---

9 Predict the percentage of children expected to have cystic fibrosis when two carrier parents (both genotype Cc) have a child. Show your working and give the answer as a percentage.

(Total for Question 9 is 2 marks)

---

10 Explain briefly why two parents who are both carriers of a recessive allele can be unaffected themselves but have an offspring with the recessive disorder. Refer to genotypes in your explanation.

(Total for Question 10 is 2 marks)

11 Construct a genetic diagram to show how sex is determined in humans when the mother is XX and the father is XY. Label the gametes, complete the Punnett square and state the genotypes of male and female offspring.

(Total for Question 11 is 3 marks)

---

12 Predict the probability, as a percentage, that a child of an XX mother and XY father will be male. Show your working.

(Total for Question 12 is 2 marks)

---

13 Thalassaemia is also an inherited recessive disorder. Construct a genetic diagram for a cross between two carrier parents for thalassaemia, both genotype Tt. Label gametes, complete the Punnett square and state the phenotype ratio assuming T is normal dominant and t is recessive disease allele.

(Total for Question 13 is 3 marks)

---

14 Give one similarity and one difference between the inheritance of cystic fibrosis and thalassaemia as recessive human disorders.

(Total for Question 14 is 2 marks)

15 Explain, using a labelled Punnett square and genotypes, how two unaffected carrier parents can have an affected child with a recessive disorder such as cystic fibrosis. In your answer, include the terms carrier, homozygous recessive and probability, and explain the difference between genotype and phenotype.

(Total for Question 15 is 6 marks)

Mark scheme · IG.B9 Monohybrid Inheritance and Genetic Diagrams

Question 1

- **B1** the genetic constitution of an organism for a particular gene, the alleles an organism has
- **Answer: The genetic constitution for a particular gene; the alleles an organism has**

Question 2

- **B1** the observable characteristics or traits of an organism resulting from genotype and environment
- **Answer: The observable characteristic resulting from genotype and environment**

Question 3

- **B1** having two identical alleles for a particular gene (e.g. AA or aa)
- **Answer: Having two identical alleles for a gene, e.g. AA or aa**

Question 4

- **B1** having two different alleles for a particular gene (e.g. Aa)
- **Answer: Having two different alleles for a gene, e.g. Aa**

Question 5

- **B1** an allele that is expressed in the phenotype when at least one copy is present
- **Answer: An allele expressed in the phenotype when at least one copy is present**

Question 6

- **B1** an allele that is only expressed in the phenotype when two copies are present (homozygous recessive)
- **Answer: An allele expressed only when two copies are present, i.e. homozygous recessive**

Question 7

- **M1** correct gametes shown: C and c for the carrier parent, c and c for the affected parent
- **M1** Punnett square completed with four boxes showing genotypes: Cc, Cc, cc, cc or equivalent placement
- **A1** final statement of offspring genotypes: 2 Cc and 2 cc, or 50% Cc and 50% cc cao
- **Answer: Gametes: C and c, and c and c. Punnett square yields 2 Cc and 2 cc, so 50% carriers and 50% affected**

Question 8

- **M1** correct gametes shown for each parent: C and c on both sides
- **M1** Punnett square completed correctly with genotypes in boxes: CC, Cc, Cc, cc
- **A1** states genotype ratio as 1 CC : 2 Cc : 1 cc
- **B1** labels one of the offspring boxes as homozygous recessive (cc) and identifies it as affected by cystic fibrosis
- **Answer: Gametes C and c vs C and c. Offspring CC, Cc, Cc, cc. Genotype ratio 1:2:1 with cc affected**

Question 9

- **M1** uses genotype ratio from Punnett square, e.g. 1 CC : 2 Cc : 1 cc and identifies 1 out of 4 are cc
- **A1** gives 25% cao
- **Answer: 25%**

Question 10

- **B1** states that carriers have one dominant and one recessive allele (heterozygous, e.g. Cc) so they show the dominant phenotype
- **B1** explains that if both parents pass the recessive allele the child is homozygous recessive (cc) and shows the disorder
- **Answer: Carriers are Cc so show the normal dominant phenotype. If both pass c the child is cc and affected**

Question 11

- **M1** correct gametes shown: mother X and X, father X and Y
- **M1** Punnett square completed with boxes: XX, XX, XY, XY or equivalent placement
- **A1** states genotypes: XX = female, XY = male and implies 50% each
- **Answer: Gametes X and X from mother, X and Y from father. Offspring XX and XY; female = XX, male = XY, 50% each**

Question 12

- **M1** uses Punnett square result that 2 out of 4 boxes are XY
- **A1** gives 50% cao
- **Answer: 50%**

Question 13

- **M1** correct gametes shown: T and t for both parents
- **M1** Punnett square completed with genotypes: TT, Tt, Tt, tt
- **A1** gives phenotype ratio: 3 normal : 1 affected, or 75% normal : 25% affected cao
- **Answer: Gametes T and t each. Offspring TT, Tt, Tt, tt. Phenotype ratio 3 normal : 1 affected (75% : 25%)**

Question 14

- **B1** valid similarity: both are inherited as recessive alleles, so affected individuals are homozygous recessive
- **B1** valid difference: they affect different systems or have different symptoms, e.g. cystic fibrosis affects lungs and digestion, thalassaemia affects haemoglobin and causes anaemia
- **Answer: Similarity: both recessive so affected are homozygous recessive. Difference: CF affects lungs and digestion, thalassaemia affects haemoglobin causing anaemia**

Question 15

- **Level 1** (1-2): Basic description of carriers or a simple statement about how two carriers might produce an affected child with minimal reference to genotypes or probabilities.
- **Level 2** (3-4): Clear explanation including a correct Punnett square for Cc x Cc, statement of genotype ratio and probability, and a brief mention of why carriers are unaffected.
- **Level 3** (5-6): Detailed explanation that includes a labelled Punnett square, correct genotypic and phenotypic ratios, calculation of probability as a percentage, clear definitions of carrier, homozygous recessive, genotype and phenotype, and an explicit link showing how genotype determines phenotype for the disorder.
- **Indicative content:**
  - Draws and labels gametes C and c for both parents and completes Punnett square showing CC, Cc, Cc, cc
  - States genotypic ratio 1 CC : 2 Cc : 1 cc and phenotypic ratio 3 unaffected : 1 affected
  - Calculates probability of affected child as 1 in 4 or 25%
  - Defines carrier as a heterozygote (Cc) who has the recessive allele but shows the dominant phenotype
  - Defines homozygous recessive (cc) as having two recessive alleles and showing the disorder
  - Explains difference between genotype (the alleles present) and phenotype (the observable trait or disorder) and links cc genotype to affected phenotype