1.15 DNA, Genetics and Inheritance: Test Pack

AQA 8464 · Calculator allowed · about 40 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 The nucleus of a cell contains DNA arranged into structures called chromosomes.

(a) Name the molecule made from DNA that codes for a single protein. **(1)**

(b) Give the names of two of the four nitrogenous bases found in DNA. **(2)**

(Total for Question 1 is 3 marks)

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2 In humans, blood type O is recessive. A parent with blood type O has a child with blood type A. The other parent must have at least one A allele.

(a) Give the genotype of the parent with blood type O. **(1)**

(b) State one possible genotype of the other parent if the child is type A and one parent is type O. **(1)**

(Total for Question 2 is 2 marks)

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3 A gene mutation changes one base in a DNA coding sequence, causing a different amino acid in the protein. This is called a missense mutation.

(a) State what is meant by the term 'mutation'. **(1)**

(b) Explain why a missense mutation can affect the function of a protein. **(1)**

(Total for Question 3 is 2 marks)

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4 Genetic engineering is used to produce GM (genetically modified) crops with useful characteristics, such as resistance to insect pests or improved nutrient content.

(a) Give two potential benefits of growing genetically modified crops. **(2)**

(b) Give one concern some people have about growing GM crops. **(1)**

(Total for Question 4 is 3 marks)

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5 Crossing over during meiosis increases genetic variation. A student sketches homologous chromosomes swapping sections.

(a) Describe when during meiosis crossing over occurs and what structures are involved. **(2)**

(b) Explain how crossing over contributes to genetic variation in gametes. **(2)**

(Total for Question 5 is 4 marks)

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6 A pedigree shows a disorder that appears in every generation and affects both males and females equally. A student suggests the disorder is autosomal dominant.

(a) Give two features of the pedigree data that support an autosomal dominant inheritance. **(2)**

(b) State one additional observation that would further confirm autosomal dominant inheritance. **(1)**

(Total for Question 6 is 3 marks)

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7 During a required practical, students investigate variation in seed mass. They collect 30 seeds from Plant A and 30 seeds from Plant B and measure mass in mg. The class mean mass for Plant A seeds is 12.4 mg and for Plant B seeds is 10.2 mg.

(a) State one control variable the students should use when measuring seed mass and why it should be controlled. **(1)**

(b) A student claims the difference in mean seed mass shows Plant A is genetically different from Plant B. Give two reasons why the data might not be sufficient to support this claim. **(2)**

(Total for Question 7 is 3 marks)

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8 Cystic fibrosis is caused by a recessive allele (f). Both parents in a family are unaffected carriers of the cystic fibrosis allele, with genotype Ff.

(a) Complete a genetic cross to calculate the probability that a child of these two parents has cystic fibrosis (ff). **(2)**

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(b) The couple go on to have two children. Calculate the probability that both children have cystic fibrosis. Give your answer as a fraction. **(2)**

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(Total for Question 8 is 4 marks)

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9 Genetic engineering can be used to make bacteria produce a useful human protein, such as insulin.

(a) Describe how bacteria can be genetically engineered to produce human insulin. Your answer should include the roles of a restriction enzyme, a vector and a host cell. **(4)**

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(Total for Question 9 is 4 marks)

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10 Sickle cell anaemia is caused by a single base substitution in the β globin gene. This affects haemoglobin and red blood cells.

(a) Explain how a single base substitution can lead to red blood cells having a sickle shape. **(3)**

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(Total for Question 10 is 3 marks)

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Mark scheme · 1.15 DNA, Genetics and Inheritance: Test Pack

Question 1

(a) mRNA (messenger RNA), or gene (the section of DNA that codes for a single protein) cao **B1**

(a) Answer: mRNA (a gene is also correct)

(b) one correct base: adenine, thymine, cytosine or guanine **B1**

(b) a second correct base (a second distinct base from the list) cao **B1**

(b) Answer: Any two of: adenine, thymine, cytosine, guanine.

Question 2

(a) ii or OO (either notation acceptable) cao **B1**

(a) Answer: ii (or OO)

(b) IAi, IAIA or IAIB (IA is A allele), oe **B1**

(b) Answer: IAi (or IAIA, or IAIB)

Question 3

(a) a change in the DNA sequence (one or more bases) cao **B1**

(a) Answer: A change in the DNA base sequence.

(b) different amino acid may change the protein folding or active site so function is altered, oe **B1**

(b) Answer: Because the different amino acid can change the protein's shape or active site, altering its function.

Question 4

(a) higher yields or pest/disease resistance, which can reduce the need for pesticides, oe **B1**

(a) can be engineered to have improved nutritional content, helping to address malnutrition (for example, extra vitamins), oe **B1**

(a) Answer: Any two: higher yields or pest resistance, reducing the need for pesticides; improved nutritional content, which can help address malnutrition.

(b) GM genes could spread to wild plant populations and reduce biodiversity, or uncertainty about long-term effects on human health/the environment, oe **B1**

(b) Answer: Some people worry that GM genes could spread to wild plant populations, reducing biodiversity, or about possible long-term effects on health or the environment.

Question 5

(a) occurs in prophase I of meiosis **B1**

(a) involves homologous chromosomes/pairs of chromatids forming chiasmata and exchanging sections, oe **B1**

(a) Answer: Crossing over occurs in prophase I when homologous chromosomes form chiasmata and exchange sections between chromatids.

(b) states that exchanging sections creates new combinations of alleles on a chromosome **M1**

(b) links this to producing genetically different gametes and increased variation in offspring, oe **A1**

(b) Answer: Because crossing over creates new combinations of alleles on chromosomes, gametes have novel allele combinations leading to greater genetic variation in offspring.

Question 6

(a) appears in every generation (affected parents have affected children), oe **B1**

(a) affects males and females equally (not sex-linked) oe **B1**

(a) Answer: Any two: appears in every generation; affects males and females equally.

(b) any one of: two unaffected parents never have an affected child; every affected individual has at least one affected parent; an affected (heterozygous) parent crossed with an unaffected parent gives about 50% affected children, oe **B1**

(b) Answer: Two unaffected parents never have an affected child (or an affected parent crossed with an unaffected parent has about 50% affected children).

Question 7

(a) e.g. use seeds dried to the same moisture content or measured at same temperature, to ensure mass differences are due to genetic variation not water content or temperature, oe **B1**

(a) Answer: Ensure all seeds are dried to the same moisture content so differences in mass are not caused by water content.

(b) sample size or sampling method may not be representative (e.g. only 30 seeds, may be from limited plants) oe **B1**

(b) environmental factors or measurement error could have affected mass (e.g. humidity, not controlled) or no statistical test done, oe **B1**

(b) Answer: Any two reasons: sample may not be representative; environmental effects or measurement error could explain difference; no statistical test done.

Question 8

(a) shows correct cross Ff x Ff giving genotypes FF, Ff, Ff, ff **M1**

(a) 1/4 (or 25%) cao **A1**

(a) Answer: 1/4 (25%)

(b) recognises the two births are independent events and multiplies the probabilities: 1/4 x 1/4 **M1**

(b) 1/16 cao **A1**

(b) Answer: 1/16

Question 9

(a) a restriction enzyme is used to cut the gene for insulin out of human DNA, and to cut open a vector such as a plasmid, oe **M1**

(a) the insulin gene is inserted into the vector (plasmid) and joined using ligase, oe **M1**

(a) the vector carrying the gene is inserted into a host cell, such as a bacterium, oe **A1**

(a) the genetically modified bacterium expresses the inserted gene and produces human insulin, which can be collected and purified, oe **A1**

(a) Answer: A restriction enzyme cuts the insulin gene out of human DNA and cuts open a plasmid vector; the gene is inserted into the plasmid and joined using ligase; the plasmid is inserted into a bacterium (host cell), which expresses the gene and produces human insulin.

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Question 10

(a) states base substitution changes codon and so a different amino acid is inserted **M1**

(a) explains different amino acid alters the structure (folding) of haemoglobin or its properties **M1**

(a) states altered haemoglobin molecules stick together or form fibres, changing red blood cell shape to sickle, oe **A1**

(a) Answer: The base substitution changes a codon so a different amino acid is in haemoglobin; this alters folding and causes haemoglobin molecules to stick together forming fibres, which distort red blood cells into a sickle shape.

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