1.15 DNA, Genetics and Inheritance: 30-minute Pack

AQA 8464 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 In fruit flies a gene for red eye (R) is dominant to white eye (r). Two heterozygous red-eyed flies are crossed.

Gametes	R	r
R	?	?
r	?	?

(a) Complete the Punnett square and give the genotypic ratio of offspring. **(2)**

.....

(b) Give the expected phenotypic ratio for eye colour. **(1)**

(Total for Question 1 is 3 marks)

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2 Deoxyribonucleic acid (DNA) is the molecule that carries genetic information in almost every living cell.

(a) State the shape formed by a molecule of DNA. **(1)**

(b) Define the term 'genome'. **(1)**

(c) Define the term 'gene'. **(1)**

(d) State the name of the structures, found in the nucleus of a cell, on which genes are located. **(1)**

(Total for Question 2 is 4 marks)

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3 Required practical: A student extracts DNA from kiwi fruit. The method is: (1) mash the kiwi fruit with a pestle and mortar; (2) mix the pulp with a detergent and salt solution; (3) filter the mixture through muslin into a clean test tube; (4) gently pour ice-cold ethanol down the side of the tube, so that it forms a layer on top of the filtered extract.

(a) State the purpose of adding detergent to the fruit pulp. **(1)**

(b) State the purpose of adding salt to the mixture. **(1)**

(c) State the purpose of filtering the mixture through muslin. **(1)**

(d) Explain why the ethanol used in this practical should be ice-cold. **(2)**

(e) Name the general group of enzymes that could break down DNA if the extract is not kept cold. **(1)**

(f) Describe what the student should observe at the boundary between the ethanol layer and the filtered extract. **(1)**

(g) Explain why the extracted DNA appears as a stringy, clumped precipitate, rather than as separate, individual DNA molecules. **(2)**

(h) Suggest one variable that should be kept the same to fairly compare the amount of DNA extracted from different fruits. **(1)**

(i) Suggest one reason why kiwi fruit is often chosen for this practical. **(1)**

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(j) State one safety precaution that should be taken when carrying out this practical. **(1)**

(k) The student repeats the practical using strawberry instead of kiwi fruit, and finds that a smaller mass of DNA precipitate is produced from the same mass of fruit. Suggest one reason for this difference. **(1)**

(l) The student weighs 5 g of mashed kiwi fruit and extracts a DNA precipitate with a mass of 0.004 g. Calculate the percentage of the fruit's mass, by mass, that was extracted as DNA precipitate. **(2)**

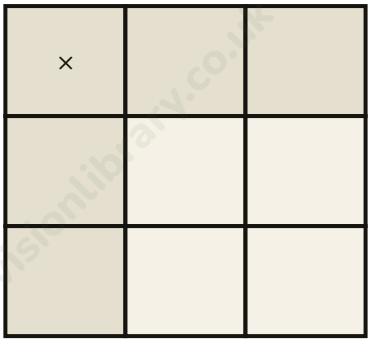
(Total for Question 3 is 15 marks)

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4 Phenylketonuria (PKU) is an inherited metabolic disorder caused by a recessive allele, p. The dominant allele, P, does not cause PKU. Josh and Chloe are both known carriers (Pp) of the PKU allele.

(a) Complete a genetic cross diagram to find the possible genotypes of their children, and state the probability, as a fraction, that a child will have PKU. **(2)**

Cross: Pp × Pp



(b) Josh and Chloe's first child does not have PKU. State the probability that their second child will have PKU, and explain your answer. **(1)**

(c) Higher tier only. Calculate the probability, as a percentage, that if Josh and Chloe have three children in total, none of the three will have PKU. **(2)**

(Total for Question 4 is 5 marks)

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Mark scheme · 1.15 DNA, Genetics and Inheritance: 30-minute Pack

Question 1

(a) shows correct Punnett square entries: RR, Rr, Rr, rr or equivalent **M1**

(a) genotypic ratio 1 RR : 2 Rr : 1 rr cao **A1**

(a) Answer: 1 RR : 2 Rr : 1 rr

(b) 3 red : 1 white (or 3:1) cao **B1**

(b) Answer: 3 red : 1 white

Question 2

(a) double helix **B1**

(a) Answer: A double helix.

(b) the entire genetic material (all of the DNA) of an organism, oe **B1**

(b) Answer: The entire genetic material of an organism.

(c) a short section of DNA (found on a chromosome) that codes for a particular protein, and so controls a specific characteristic, oe **B1**

(c) Answer: A short section of DNA that codes for a particular protein and controls a characteristic.

(d) chromosomes **B1**

(d) Answer: Chromosomes.

Question 3

(a) breaks down the cell membranes (and nuclear membrane) of the cells, releasing the DNA into solution, oe **B1**

(a) Answer: It breaks down the cell membranes, releasing the DNA into solution.

(b) causes the DNA molecules to clump/stick together, helping the DNA to precipitate out of solution later, oe **B1**

(b) Answer: It causes the DNA molecules to clump together, helping the DNA to precipitate later.

(c) removes/separates solid pieces of fruit debris (cell wall/pulp fragments) from the liquid extract containing the dissolved DNA, oe **B1**

(c) Answer: It removes solid fruit debris, leaving the liquid extract containing the DNA.

(d) DNA is not soluble in cold ethanol (unlike in water), so keeping the ethanol ice-cold ensures the DNA precipitates out of solution rather than dissolving, oe **B1**

(d) the cold temperature also slows/reduces the activity of any enzymes present that could break down the DNA, oe **B1**

(d) Answer: DNA is insoluble in cold ethanol, so it precipitates rather than dissolving; the cold temperature also slows enzymes that could break the DNA down.

(e) DNases (DNA-degrading enzymes) **B1**

(e) Answer: DNases.

(f) a white, cloudy/stringy precipitate of DNA forms at the boundary between the two layers, oe **B1**

(f) Answer: A white, stringy precipitate of DNA forms at the boundary between the two layers.

(g) each cell contains a very large number of DNA molecules, and the salt and ethanol cause many of these molecules to stick/clump together **B1**

(g) a single DNA molecule is far too thin to be seen without a microscope, so only the large clump of many strands together is visible to the naked eye, oe **B1**

(g) Answer: Many thousands of DNA molecules clump together due to the salt and ethanol; a single DNA molecule is far too thin to see, but the clump of many strands is visible.

(h) any one of: mass of fruit used, volume/concentration of the detergent-salt solution, temperature, or time allowed for each step, oe **B1**

(h) Answer: For example, the mass of fruit used should be kept the same for each sample.

(i) it is soft and easy to mash, so its cells are broken open quickly and easily, releasing DNA efficiently, oe **B1**

(i) Answer: It is soft and easy to mash, so its cells release DNA easily.

(j) e.g. wear eye protection, and keep the ethanol away from any naked flame, as it is flammable, oe **B1**

(j) Answer: Wear eye protection and keep the flammable ethanol away from any naked flame.

(k) e.g. different fruits contain different amounts of DNA per gram, or their cells are broken open with different efficiency during mashing, oe **B1**

(k) Answer: Different fruits can contain different amounts of DNA per gram, or their cells may break open less easily when mashed.

(l) (0.004 / 5) x 100, oe **M1**

(l) 0.08% cao **A1**

(l) Answer: 0.08%

Question 4

(a) correct offspring genotypes shown: PP, Pp, Pp, pp **M1**

(a) 1/4 cao **A1**

(a) Answer: 1/4

(b) still 1/4, ft from (a); because each pregnancy is an independent event, so the genotype of an earlier child does not affect the probability for a later child, oe **B1**

(b) Answer: Still 1/4, because each pregnancy is an independent event and is not affected by the outcome of an earlier pregnancy.

(c) 3/4 x 3/4 x 3/4, ft from (a) **M1**

(c) awrt 42.2% (27/64) cao **A1**

(c) Answer: 27/64 (approximately 42.2%)

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