

PEARSON EDEXCEL A-LEVEL BIOLOGY B • 9B10

BIOLOGY



EXAM QUESTION PACK

TOPIC 7: MODERN GENETICS
USING GENE SEQUENCING

SCORE

/32

PERCENTAGE

%

STEMUP

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Q1.

Tapirs are nocturnal mammals that are found in South America.

In 2013, the Journal of Mammalogy published an article describing the discovery of a new species of tapir, *Tapirus kabomani*.

Scientists already knew about the animal but thought that it was the same species as *Tapirus terrestris*.



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(a) Give **one** reason why scientists thought that *Tapirus kabomani* was the same species as *Tapirus terrestris*.

(1)

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(b) These two species of tapir can be distinguished using gene sequencing.

Describe how sufficient amounts of DNA could be obtained in preparation for gene sequencing.

(4)

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(c) Explain how distinguishing *Tapirus kabomani* as a separate species could affect the index of

diversity of the area.

(2)

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(Total for question = 7 marks)

Q2.

Chester Zoo has 12 000 animals from 400 different species.

Chester Zoo aims "to be a major force in conserving biodiversity worldwide".

Chester Zoo supports an *in-situ* rhinoceros conservation and monitoring project in Chyulu Hills National Park in Kenya.

It is difficult to find and count the black rhinoceros because they roam freely across a large area.

However, the DNA of a black rhinoceros can be obtained from its dung (faeces).

(i) Devise a method by which black rhinoceros dung could be used to estimate the number of black rhinoceros living in Chyulu Hills National Park.

(5)

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(ii) DNA from dung indicated that 14 black rhinoceros were present in the park.

Explain why 14 black rhinoceros could be an underestimate of the population.

(2)

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Q3.

The polar bear, *Ursus maritimus*, preys on seals and fish. Polar bears are adapted to live in cold Arctic regions.



Polar bear
Magnification $\times 0.04$

A recent study has shown that all polar bears are descended from populations that diverged from the Irish brown bear, *Ursus arctos*, approximately 120 000 years ago.

In this study, DNA from modern polar bears, the remains of historic polar bears and the remains of Irish brown bears was analysed.

(a) The first part of the study involved the amplification of DNA to give large enough samples for analysis.

(i) Describe how small samples of DNA can be amplified.

(4)

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(ii) Name **one** technique that could be used to analyse the amplified DNA samples.

(1)

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(b) Suggest how the scientists who conducted the study had their results accepted by other

scientists.

(2)

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(c) Suggest how each of the following may have contributed towards the divergence of polar bears and Irish brown bears into two separate species.

(i) Separation of the Arctic and Irish regions by sea

(2)

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(ii) Genetic mutation

(2)

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(Total for question = 11 marks)

Q4.

Prothrombin is involved in the blood clotting process.

The *F2* gene codes for the synthesis of prothrombin.

A mutation of the *F2* gene causes thrombophilia, a condition that results in the production of excess prothrombin.

A genetic test can be used to find out if a person has thrombophilia.

The test involves using a restriction endonuclease to obtain genetic material from white blood cells.

This genetic material is then used in the polymerase chain reaction (PCR).

(i) State the role of a restriction endonuclease.

(1)

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(ii) Describe the process of PCR.

(3)

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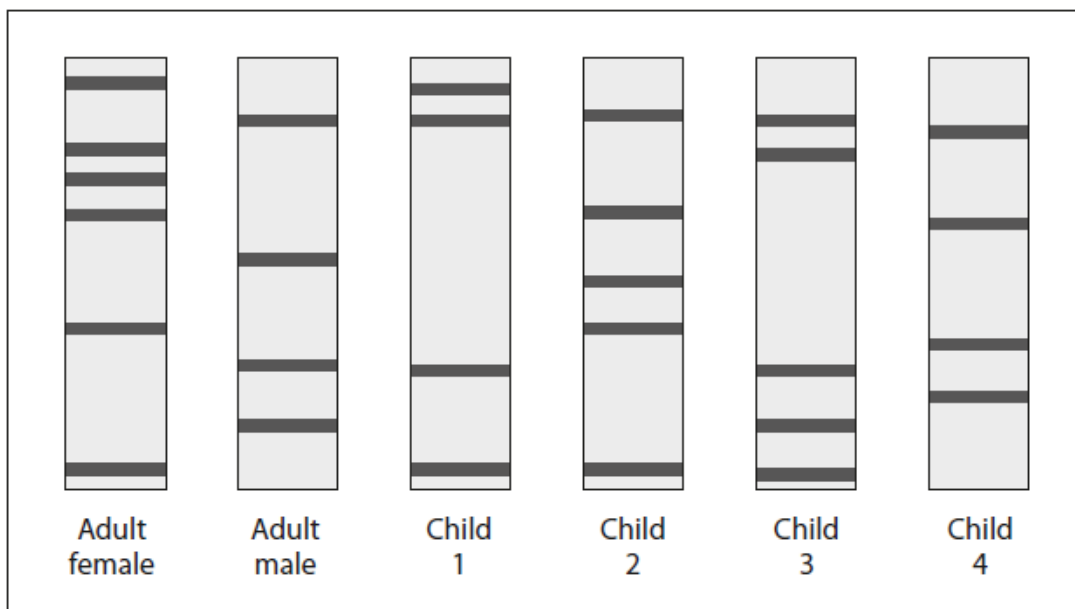
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(Total for question = 4 marks)

Q5.

The polymerase chain reaction (PCR) and gel electrophoresis are used to produce DNA profiles.
The diagram shows DNA profiles, from an adult female, an adult male and each of four children.



Explain why PCR is used before gel electrophoresis to produce these DNA profiles.

(2)

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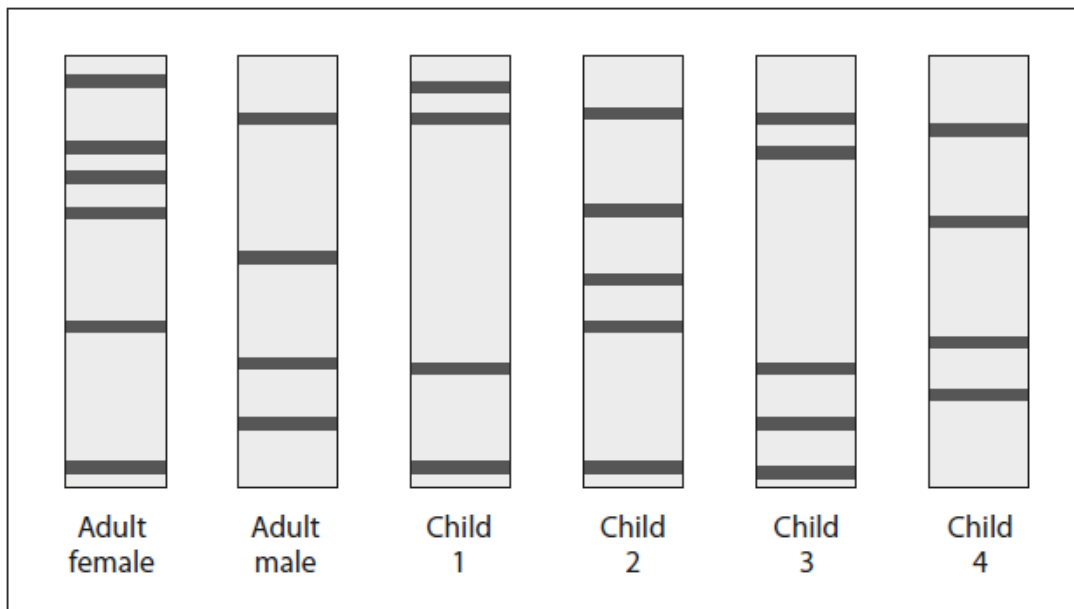
(Total for question = 2 marks)

Q6.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

The polymerase chain reaction (PCR) and gel electrophoresis are used to produce DNA profiles.

The diagram shows DNA profiles, from an adult female, an adult male and each of four children.



Which of the children have both of these adults as their parents?

- ☐ **A** child **1** and child **2**
- ☐ **B** child **1** and child **3**
- ☐ **C** child **2** and child **3**
- ☐ **D** child **2** and child **4**

Mark Scheme

Question Number	Correct Answer	Additional guidance	Mark
(a)	both species look alike and are active at night (1)	morphologically and behaviourally similar	(1)

Question Number	Correct Answer	Additional guidance	Mark
(b)	A description that makes reference to the following: - sample of {cells / DNA} (1) - DNA polymerase chain reaction (1) - procedure repeated several times (1) - temperature requirements (1)	e.g. 55 °C, 72 °C, 95 °C	(4)

Question Number	Correct Answer	Additional guidance	Mark
(c)	An explanation that makes reference to the following points: - increases biodiversity / index of diversity increases (1) - as the value for {N / numerator} increases in the index of diversity (1)	Accept justification consistent with formula Correct answer gains full marks	(2)

Q2.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	An experimental method that makes reference to five of the following steps: - use of experts to identify and collect many samples of rhinoceros dung from all areas of the park (1) - DNA extracted from rhinoceros cells and amplified using PCR (1) - use of { restriction endonucleases / appropriate primers } to obtain short tandem repeat sequences from DNA (1) - use of gel electrophoresis to separate DNA fragments (1) - description of method used to visualise fragments (1) - each different pattern of bands represents one individual rhinoceros (1)	e.g. radioactive probe / fluorescent probe / Southern blotting / UV light / autoradiography / X- rays	

Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: - no dung found from some rhinoceros, so they were not counted (1) - closely related individuals have similar DNA profiles, so they may not be distinguished as separate individuals (1)		(2)

Q3.

Question Number	Answer	Additional guidance	Mark
(a)(i)	- reference to {polymerase chain reaction / PCR} ; - polymerase (enzyme) {added / eq} ; - idea of need for primers and nucleotides ; {90-98} (°C) → {50-65} (°C) → {70-75} (°C) ; - idea that cycle needs to be repeated {several times / to make several copies of DNA / eq} ;	1. Accept as a ref to PCR machine	(4)

Question Number	Answer	Additional guidance	Mark
(a)(ii)	(DNA) {profiling / fingerprinting / (gel) electrophoresis} ;	Ignore Southern blotting, PCR Accept DNA profile / DNA fingerprint	(1)

Question Number	Answer	Additional guidance	Mark
(b)	1. idea of work appearing in a (Scientific) journal or being presented at a conference ; 2. idea that validity or reliability is considered ; 3. by other scientists / ref to peer review ;	1. Accept publishing a paper, scientific meeting	(2)

Question Number	Answer	Additional guidance	Mark
(c)(i)	1. reference to different {conditions / environments / eq} (in each region) ; 2. idea of different selection pressures ; 3. idea of {restricted gene flow / separate gene pools} ; 4. reference to reproductive isolation;	1. Accept appropriate named factor e.g. temperature 3. Ignore different allele frequency	(2)

Question Number	Answer	Additional guidance	Mark
(c)(ii)	1. idea of different {alleles/ gene pool} ; 2. idea that this leads to {new / different} phenotypes ; 3. idea of new {allele / gene} can be {advantage / disadvantage} ; 4. reference to (advantageous) {(mutated) gene / (new) allele} passed onto offspring ;	1. Ignore allele frequency 2. Accept traits / characteristics / features	(2)

Q4.

Question Number	Answer	Additional Guidance	Mark
(i)	cut DNA to produce {short sections of DNA / short tandem repeats / mini satellites} (1)	Accept cut DNA into fragments / cut DNA to give sticky ends	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	A description that makes reference to three of the following: • use (DNA) primers / nucleotides (1) • use {high temperature / 95 °C} for 30 seconds (to separate DNA strands) (1) • use {lower temperature / 55 °C} for 20 seconds (to bind primers) (1) • heat to 72°C with polymerase (to replicate DNA) (1) • repeat process (to obtain many copies of DNA) (1)		(3)

Q5.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to two of the following: • because DNA needs to be {amplified / replicated} (1) • as only small samples are taken / to produce enough DNA (1) • all copies of the DNA need to be identical (to the original sample)(1)		(2)

Q6.

Question Number	Answer	Additional Guidance	Mark
	The only correct answer is B A is incorrect because child 2 has no matching bands with the father C is incorrect because child 2 has no matching bands with the father D is incorrect because child 4 has no matching bands with either adult		(1)

