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VCE Biology ¾
Introduction to DNA Manipulation Techniques [1.5]
Homework

Homework Outline:

Compulsory Questions	Pg 2 – Pg 21

Section A: Compulsory Questions (46 Marks)

Sub-Section [1.5.1]: Identify and Describe the Function of Polymerases, Endonucleases, and Ligases in DNA Manipulation

Question 1

Definitions:

a. Endonuclease

_____

_____

b. Recognition site

_____

_____

c. Sticky end

_____

_____

d. Blunt end

_____

_____

e. Polymerase

_____

_____

f. Ligase

_____

_____

Question 2 (1 mark)

A scientist is attempting to combine a gene of interest into a plasmid. Which pair of enzymes would they most likely use?

A. Polymerase and ligase.

B. Helicase and polymerase.

C. Endonuclease and ligase.

D. Endonuclease and polymerase.

Question 3 (1 mark)

During a DNA repair process, which enzyme is likely involved in sealing the gap between adjacent nucleotides?

A. Endonuclease

B. Polymerase

C. Ligase

D. Restriction enzyme

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Question 4 (1 mark)

A student observes that after cutting a DNA sample, the fragments have "sticky ends." Which enzyme likely produced these fragments?

A. Ligase

B. DNA Polymerase

C. Endonuclease

D. Helicase

Question 5 (1 mark)

In a PCR experiment, which enzyme replicates the DNA template by adding nucleotides?

A. Restriction enzyme

B. Taq Polymerase

C. DNA Ligase

D. Topoisomerase

Question 6 (1 mark)

If an endonuclease cuts DNA into fragments and a ligase enzyme fails to function, what would be the consequence?

A. DNA will replicate incorrectly.

B. DNA fragments will remain unattached.

C. The DNA will form sticky ends.

D. The fragments will rejoin naturally.

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Question 7 (1 mark)

Which enzyme would be most useful for amplifying a specific DNA sequence from a small sample?

A. DNA Ligase

B. DNA Polymerase

C. Endonuclease

D. Helicase

Question 8 (2 marks)

Explain why sticky ends are preferred over blunt ends when cutting DNA from manipulation using an endonuclease.

_____

_____

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Sub-Section [1.5.2]: Identify the Ingredients Required, Describe the Process, and Recall Key Applications of PCR

Question 9

Definitions:

a. Primer

_____

_____

b. PCR

_____

_____

c. Denaturation

_____

_____

d. Elongation

_____

_____

e. Annealing

_____

_____

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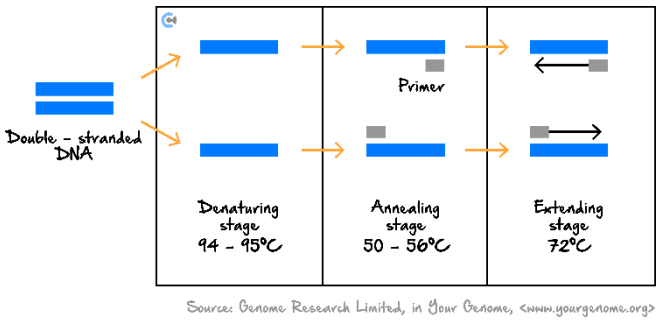
Question 10 (1 mark)

The diagram below represents a method of DNA manipulation.



Source: Genome Research Limited, in Your Genome, <www.yourgenome.org>

The method represented is:

A. Gel electrophoresis.

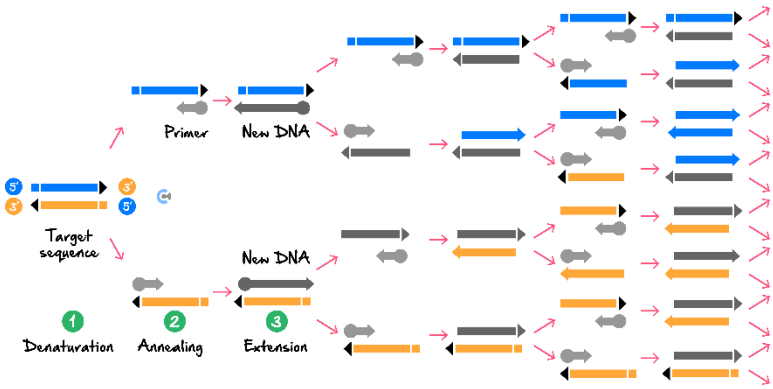
B. DNA transformation.

C. Bacterial transformation.

D. Polymerase chain reaction.

The following information applies to the two questions that follow.

Question 11 (1 mark)



During the extension stage, the most ideal temperature is typically:

A. 72 degrees.

B. 50 degrees.

C. 82 degrees.

D. 95 degrees.

Question 12 (1 mark)

The purpose of a primer in this reaction is

A. to act as a short sequence of nucleotides that provides a starting point for DNA synthesis.

B. to move along the original DNA strand and add complementary nucleotides.

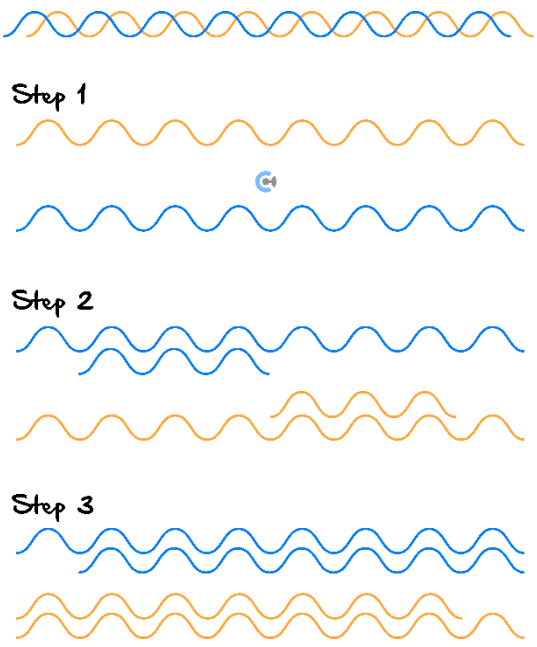
C. to act as the 'glue' to join complementary nucleotides together.

D. to separate the DNA and prime it, ready for a copy to be made.

The following information applies to the two questions that follow.

Polymerase chain reaction (PCR) has been used to primarily amplify specific sections of DNA from small samples. It has uses in DNA sequencing, forensic analysis and genetic testing for diseases.

The diagram below illustrates the steps involved in each replication cycle.



Question 13 (1 mark)

A temperature of 50°C is needed for step:

A. 1 only.

B. 2 only.

C. 3 only.

D. 2 and 3 only.

Question 14 (1 mark)

At the beginning of the first PCR cycle there was 1 DNA strand.

After 5 cycles, there would be:

A. 5 strands.

B. 16 strands.

C. 32 strands.

D. 64 strands.

Question 15 (6 marks)

Scientists investigating a transgenic strain of the *Arabidopsis* plant called kojak carried out a gel electrophoresis to find the root hair gene that had been transferred into the kojak strain from a species of barley.

The root hair gene was removed along with some other DNA using restriction enzymes, and underwent PCR prior to the gel electrophoresis being run.

a. Why was PCR performed on the DNA sample prior to the gel electrophoresis being carried out? (1 mark)

_____

_____

b. Outline the three major steps in PCR. (3 marks)

_____

_____

_____

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_____

c. Describe the role of primers in PCR. (2 marks)

_____

_____

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Sub-Section [1.5.3]: Describe the Process of Gel Electrophoresis, and Describe How it May be Used to Differentiate DNA Samples or to Obtain a "DNA Profile"

Question 16

Definitions:

a. Gel Electrophoresis

_____

_____

b. Well

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_____

c. Standard Ladder

_____

_____

d. Buffer

_____

_____

e. Electrode

_____

_____

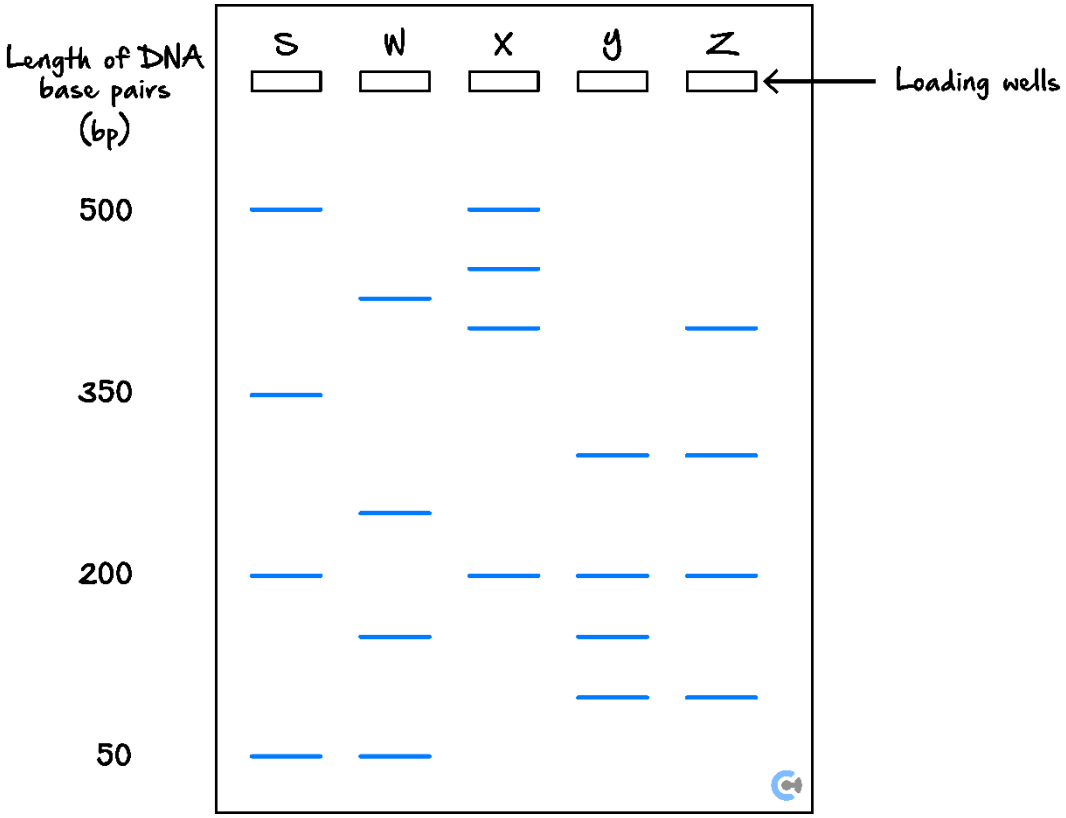
f. Band

_____

_____

The following information applies to the two questions that follow.

Four samples of DNA were loaded into four different wells in lanes W, X, Y and Z. A standard ladder was loaded into the well in lane S. The results of gel electrophoresis are shown below.



Question 17 (1 mark)

Which lane represents a sample that was loaded with DNA fragments of four different lengths: 100 bp, 150 bp, 200 bp and 300 bp?

A. *W*

B. *X*

C. *Y*

D. *Z*

Question 18 (1 mark)

Which lane contains the band that is closest to the negative electrode?

A. *W*

B. *X*

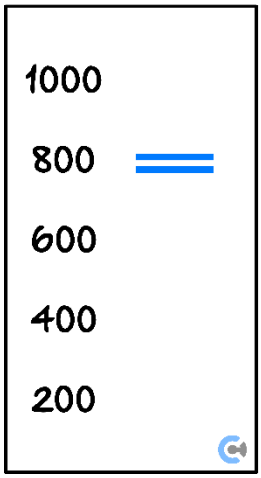
C. *Y*

D. *Z*

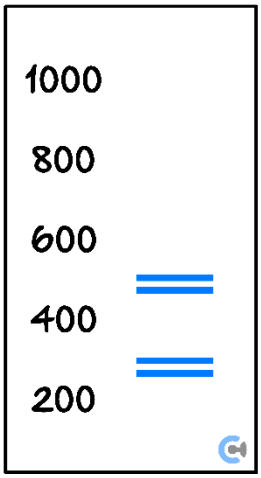
Question 19 (1 mark)

Beta thalassemia is an autosomal recessive genetic disorder. Genetic screening is now available that can test for one common genetic mutation that causes this disorder. A restriction enzyme is used which cuts the defective gene into two strands of length 280 base pairs and 520 base pairs respectively. Which of the following results would indicate the person tested was a carrier of beta thalassemia?

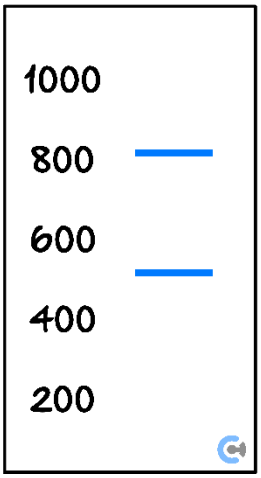
A.



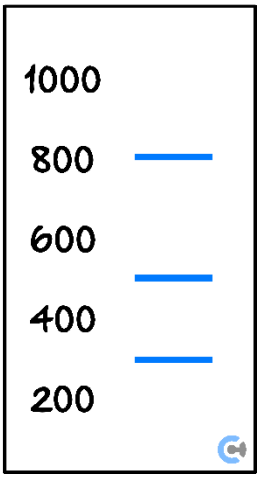
B.



C.



D.



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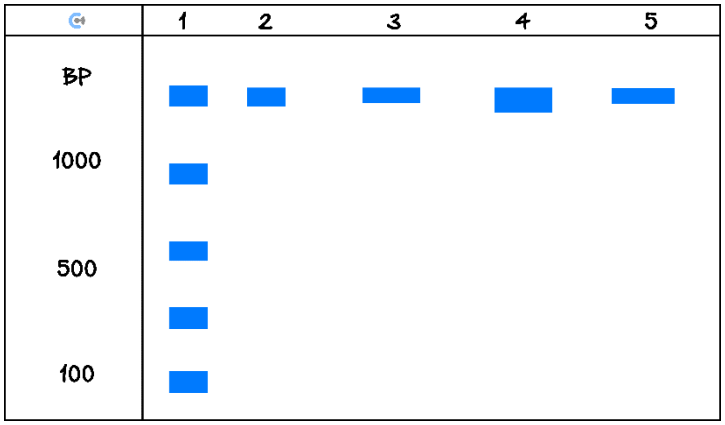
Question 20 (4 marks)

The table below gives the sizes of the various DNA fragments (genes) used in the genetic engineering of the *Arabidopsis* plant.

Gene	Size (base pairs)	Well (gel electrophoresis)
Normal *Arabidopsis* root hair gene	520	2
Mutant kojak *Arabidopsis* gene	450	3
Barley root hair gene	600	4
Recombined mutant *Arabidopsis* + barley genes	1050	5

a. On the diagram below, indicate where each of the DNA fragments would be positioned after the gel electrophoresis has been run. (2 marks)



b. What is placed in well 1? (1 mark)

_____

_____

c. What is the purpose of the standard ladders? (1 mark)

_____

_____

Sub-Section [1.5.4]: Explain the Factors That Affect the Movement of Fragments in Gel Electrophoresis

Question 21 (1 mark)

If a gel electrophoresis was left to run for 24 hours longer than normal, what would be expected to happen to the DNA fragments?

A. They would get darker.

B. They would all collect at the positive terminal.

C. They would all collect at the negative terminal.

D. There would be no apparent difference.

Question 22 (1 mark)

A particular DNA marker used in DNA profiling has four possible variations of length, namely 8, 10, 16 and 21. If this marker was used as part of a DNA profile, which of the following results is least likely?

A. 8, 14

B. 10, 10

C. 8, 16, 21

D. 21, 10

Question 23 (4 marks)

List and explain the factors that affect the movement of fragments in a gel electrophoresis experiment.

Sub-Section [1.5.5]: Define Satellite DNA and STRs, and Explain Their Use in Identifying People Through DNA Profiling for Crimes and Paternity Testing

Question 24

Definitions:

a. DNA Profiling

_____

_____

b. Genetic testing

_____

_____

c. STRs

_____

_____

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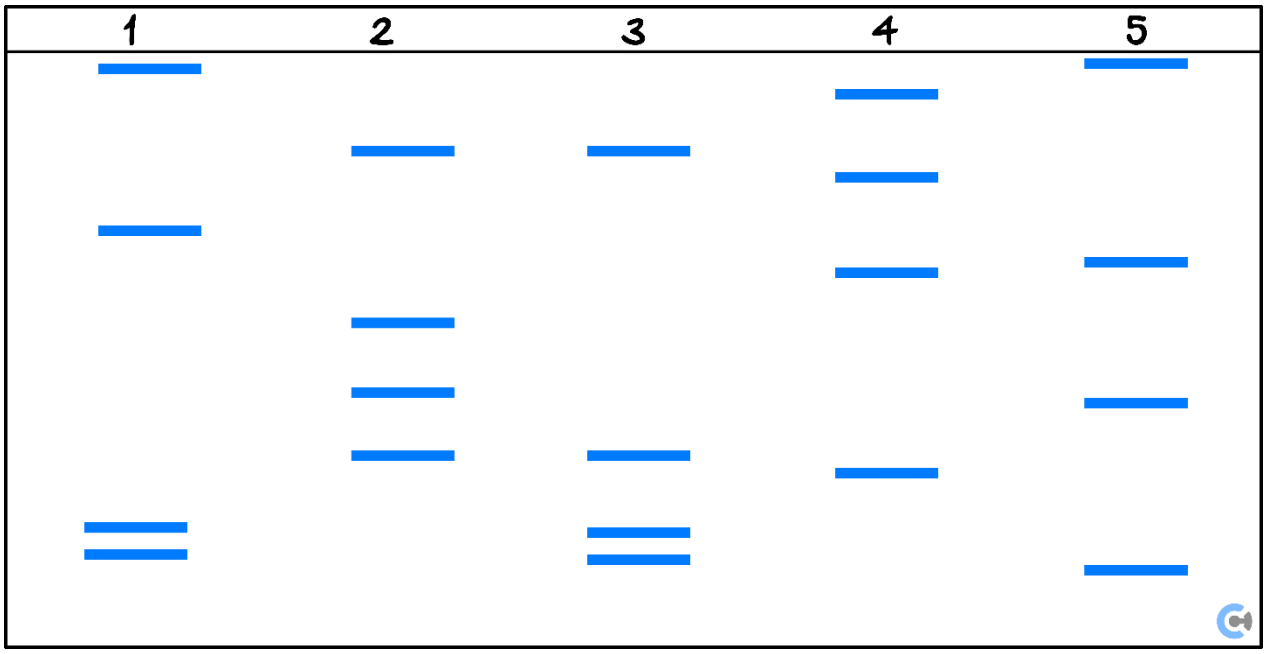
Question 25 (1 mark)

A woman with a child marries a man. The couple then have a child of their own, after which they adopt a third child. Genetic fingerprinting was carried out and the results are shown below. Lane 1 contains the woman's DNA; lane 2 contains the man's DNA; and lanes 3, 4 and 5 contain the children's DNA.



Use the information provided to identify each of the children as being the woman's child, the couple's child or the adopted child.

	Lane 3	Lane 4	Lane 5
A.	Woman's child	Couple's child	Adopted child
B.	Adopted child	Couple's child	Woman's child
C.	Couple's child	Woman's child	Adopted child
D.	Couple's child	Adopted child	Woman's child

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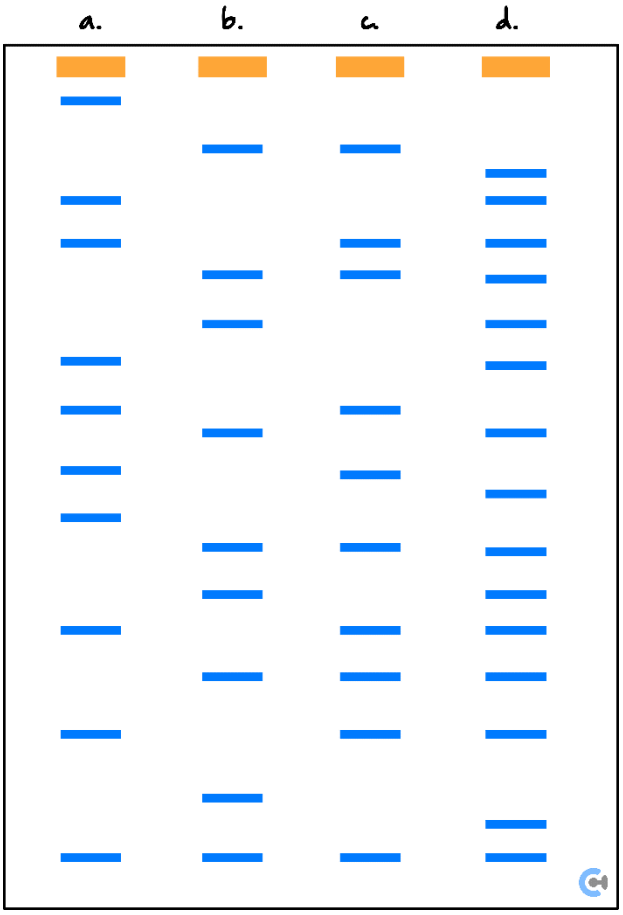
Question 26 (1 mark)

The image below depicts a gel electrophoresis run from a husband (a) and wife (b).



From the information above, which of the following statements is correct?

A. Neither lane *c* or *d* is likely to be a child of the husband or wife.

B. Lane *d* is likely the child of the husband and wife.

C. Lane *c* is likely the child of the husband and wife.

D. Lane *c* and *d* are identical twins.

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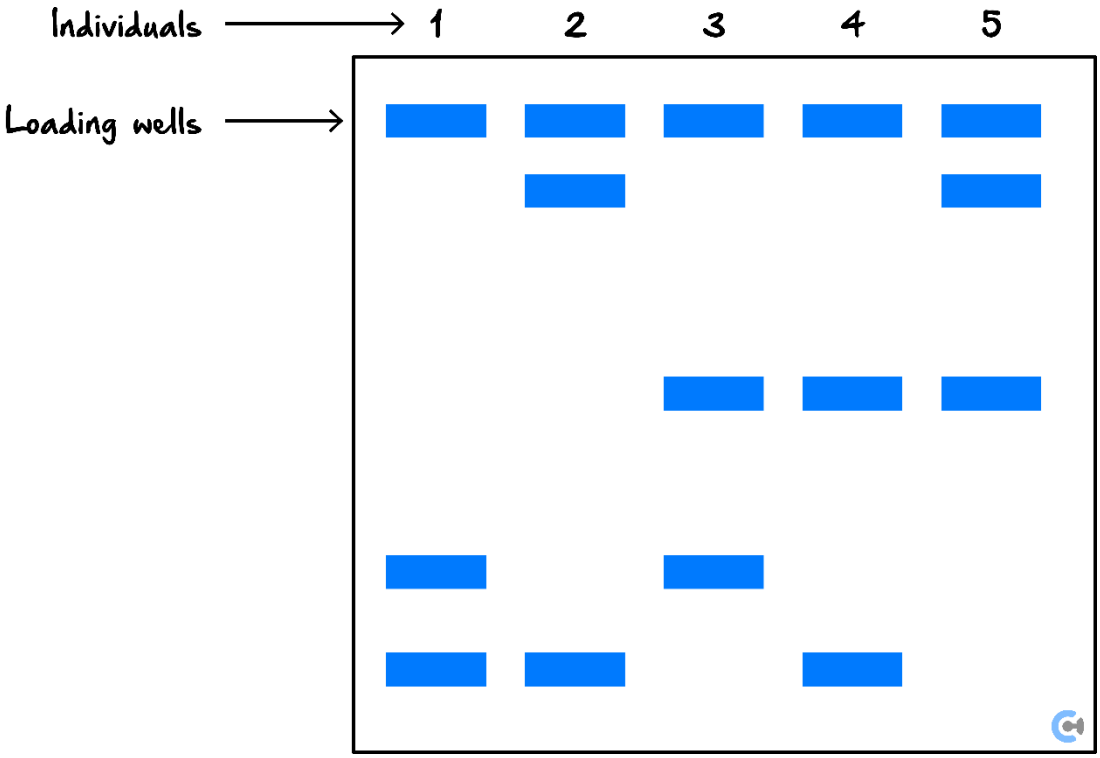
The following information applies to the two questions that follow.

The electrophoresis gel shown below shows the results of a restriction enzyme digest of five individuals, a mother and father and their three children.



Question 27 (1 mark)

The pattern shown by the fragments on the gel is a result of the:

A. Heaviest fragments moving the furthest towards the negative pole of the gel.

B. Lightest fragments moving the furthest towards the negative pole of the gel.

C. Lightest fragments moving the furthest towards the positive pole of the gel.

D. Heaviest fragments moving the furthest towards the positive pole of the gel.

Question 28 (1 mark)

From the results, it can be stated that:

A. Individuals 2 and 3 are the parents and 1,4 and 5 are the children.

B. Individuals 4 and 5 are the parents and 1,2 and 3 are the children.

C. Individuals 1 and 5 are the parents and 2,3 and 4 are the children.

D. Individuals 2 and 4 are the parents and 1,3 and 5 are the children.

Question 29 (10 marks)

Beginning in 1996 the FBI launched a national DNA database known as CODIS. The database stores information relating to 13 specific loci which have variable numbers of short tandem repeat sequences (STRs). One of these is the CSF1PO locus which has between six and fifteen repeats of the AGAT tetranucleotide.

a. Prior to analysis, genetic samples are amplified using PCR. Briefly identify the three stages of PCR and explain what occurs during each stage. (3 marks)

b. Why is PCR carried out prior to analysing a DNA sample? (1 mark)

c. Identify an enzyme which carries out a function in DNA replication, but is not used in a PCR mix. Explain why this enzyme is not used during PCR. (2 marks)

d. Explain how the size of a DNA fragment affects its movement through an electrophoresis gel and why DNA moves towards the positive terminal. (2 marks)

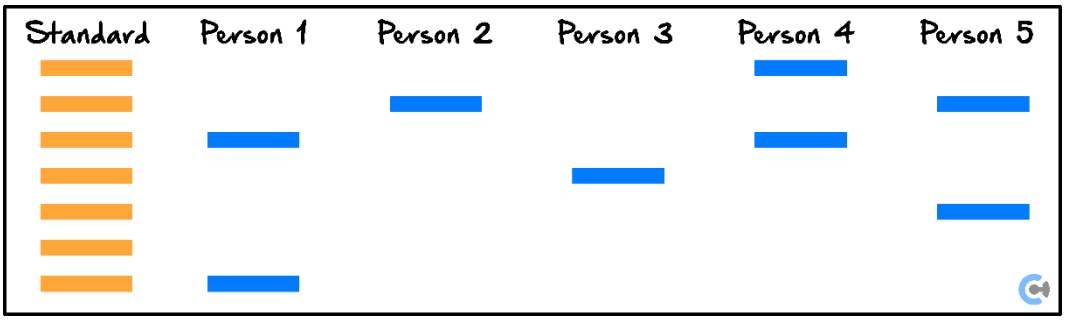
_____

_____

_____

_____

The following diagram shows an example of an electrophoresis gel containing samples from five different people. The DNA of each person would have been inserted into a well at the top of the diagram.



e. Which individual has the variation with the most STR regions? Provide a reason to support your answer. (2 marks)

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