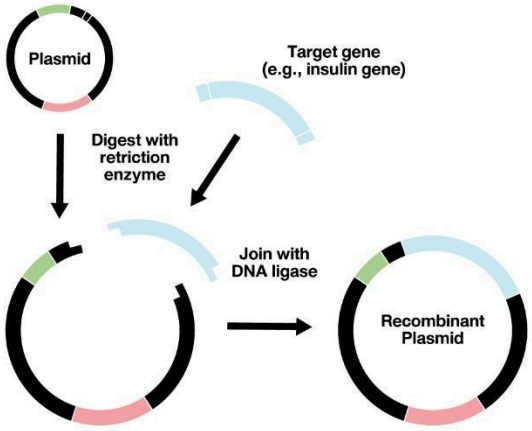
Year 12 HL

IB BIOLOGY

3.5 Genetic Modification and Biotechnology



Name:

Teacher: Mr Trent

3.5 Genetic Modification and Biotechnology

Understandings:

- Gel electrophoresis is used to separate proteins or fragments of DNA according to size.
- PCR can be used to amplify small amounts of DNA.
- DNA profiling involves comparison of DNA.
- Genetic modification is carried out by gene transfer between species
- Clones are groups of genetically identical organisms, derived from a single original parent cell.
- Many plant species and some animal species have natural methods of cloning.
- Animals can be cloned at the embryo stage by breaking up the embryo into more than one group of cells.
- Methods have been developed for cloning adult animals using differentiated cells.

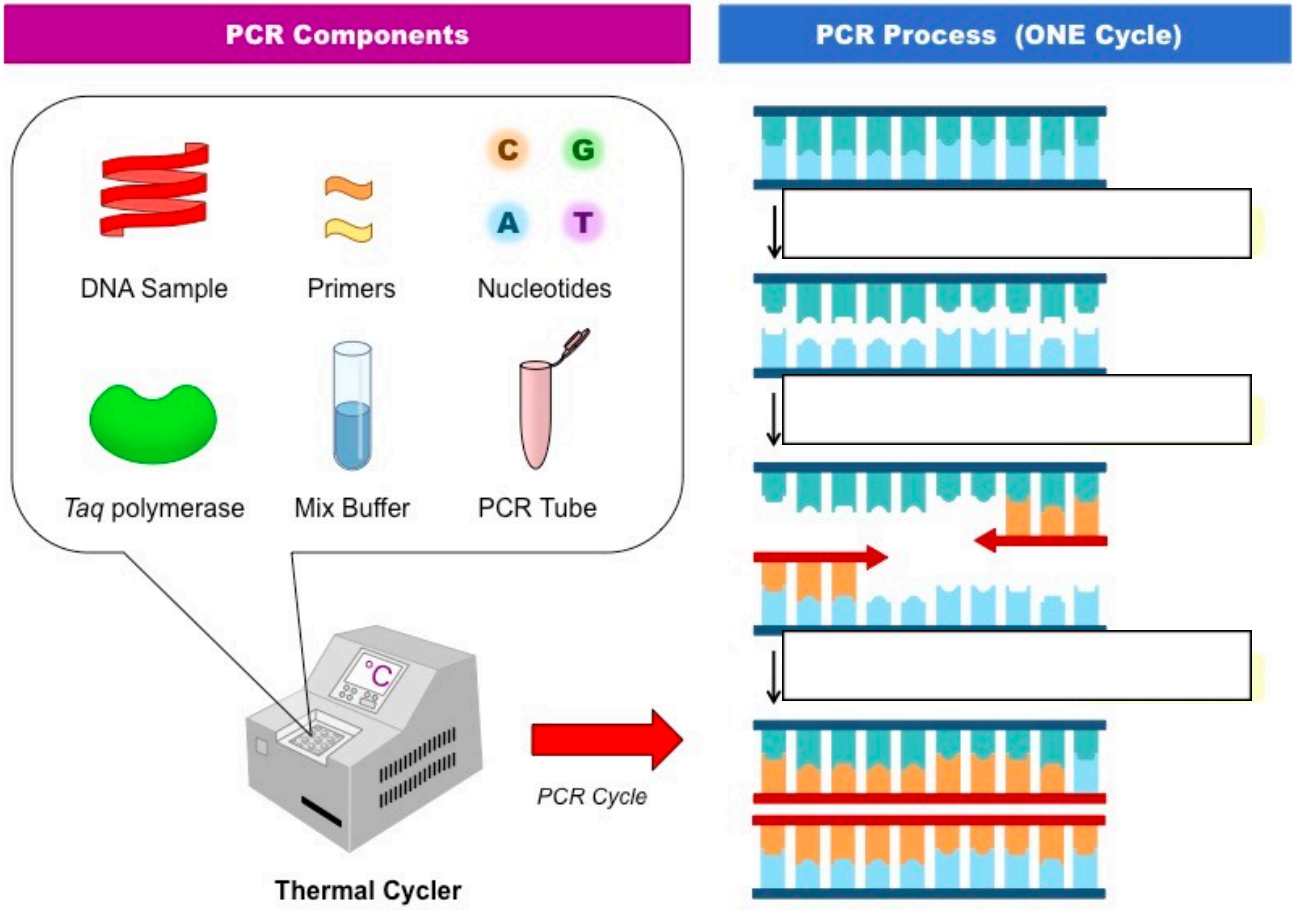
Applications:

- Use of DNA profiling in paternity and forensic investigations.
- Gene transfer to bacteria using plasmids makes use of restriction endonucleases and DNA ligase.
- Assessment of the potential risks and benefits associated with genetic modification of crops.
- Production of cloned embryos produced by somatic-cell nuclear transfer.

Skills:

- Design of an experiment to assess one factor affecting the rooting of stem-cuttings.
- Analysis of examples of DNA profiles.
- Analysis of data on risks to monarch butterflies of Bt crops.

PCR (Polymerase Chain Reaction)



The **polymerase chain reaction** *(PCR)* is used where DNA samples are too small to be useful.

State the purpose of PCR in labs and investigations.

Identify the cellular process which PCR mimics.

State the role of high temperatures in PCR.

State the role of complementary base pairing in PCR.

Describe why it is called a **chain reaction**.

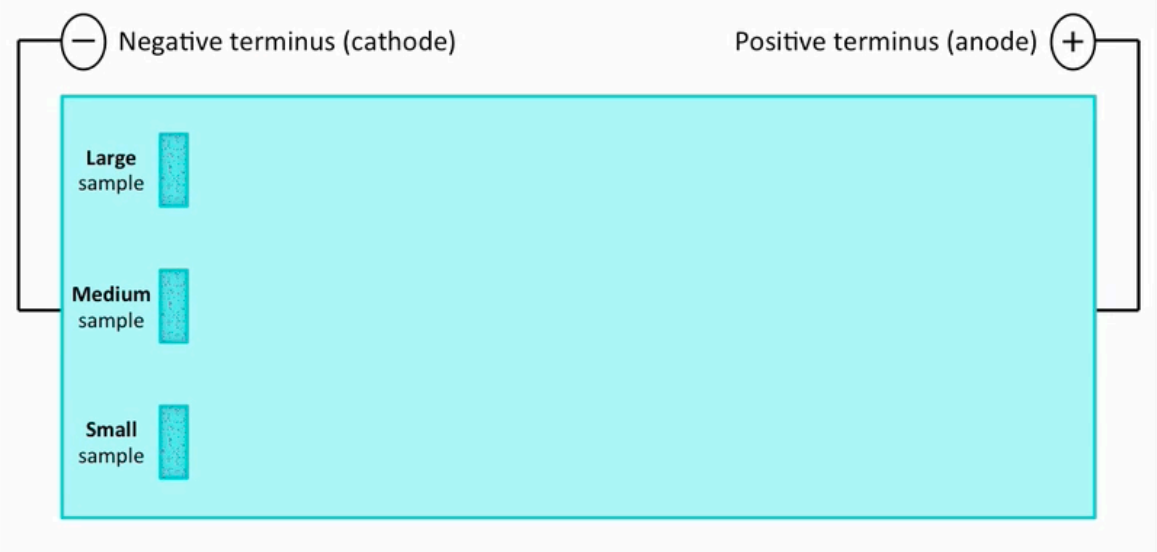
Gel Electrophoresis

Try the Electrophoresis lab here: http://learn.genetics.utah.edu/content/labs/gel/

State the roles of the following components of gel electrophoresis:

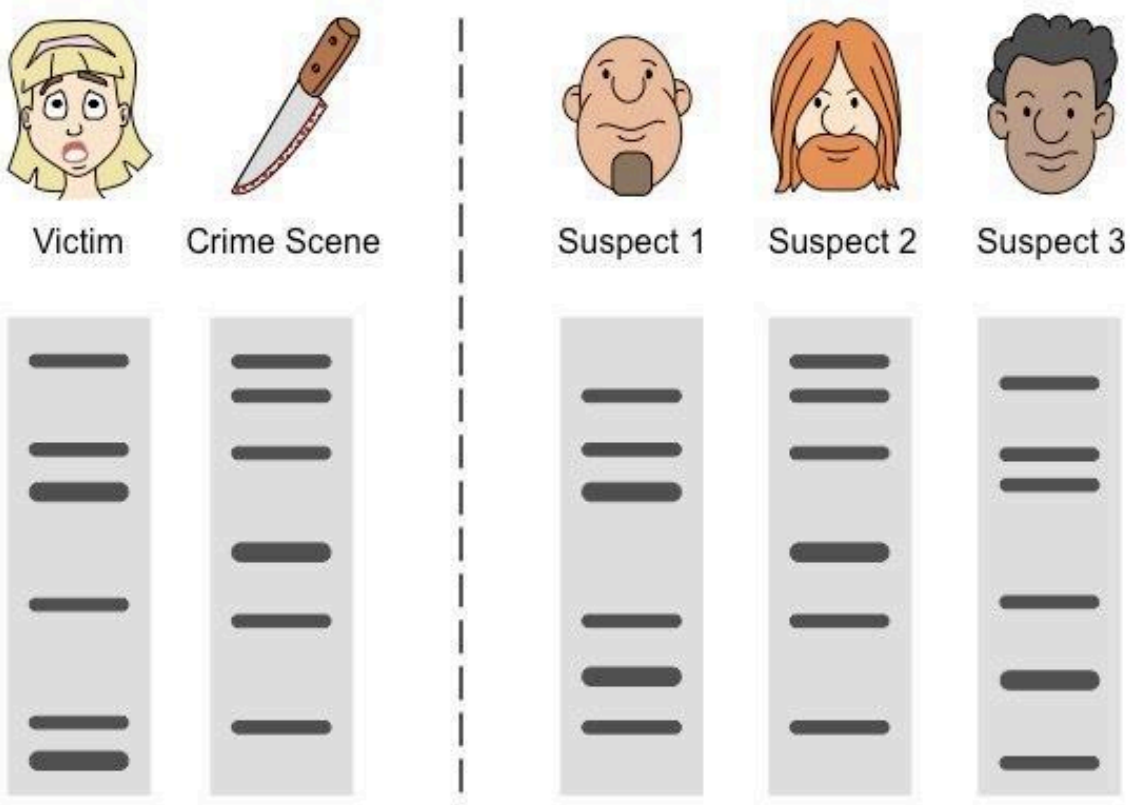
Restriction enzymes	
Gel	
Electric current	
Fluorescent DNA markers	

Annotate the image below to outline briefly how gel electrophoresis works, including how the size of fragments affects their position on the final gel.

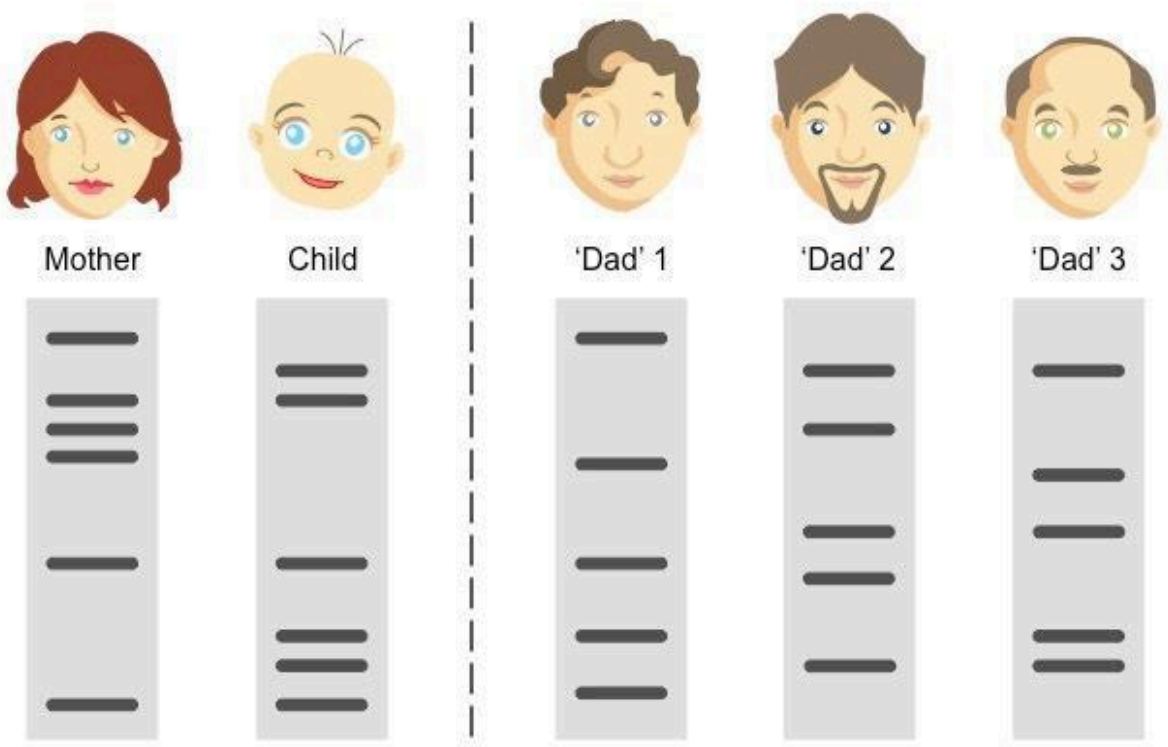


State two main uses of **DNA profiling** *by electrophoresis.*

State some other names for DNA profiling.

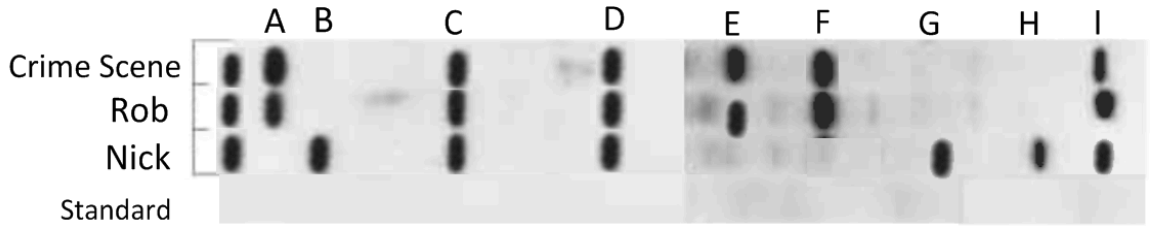


What can you conclude from the DNA profile?



What can you conclude from the DNA profile?

Use the gel electrophoresis results below to answer these questions.
In this case, a DNA sample was taken from a cigarette found at a crime scene (smoking in a no-smoking zone):



State the process used to amplify the small amounts of DNA collected at the crime scene to an amount big enough to be used in DNA profiling.

Deduce which criminal, Rob McCarr or Nick Allott, left their dribbly cigarette-end at the crime scene. Explain your answer.

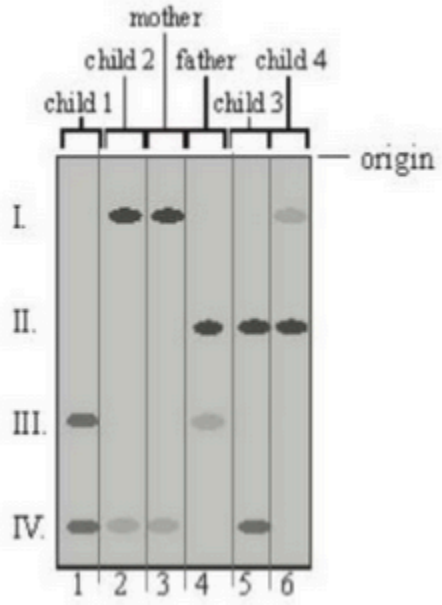
- Criminal:

- Explanation:

Draw bands to show where the **standard fragments** would be observed. State the role of the standard fragment.

Outline the evidence in the DNA profile that suggests Nick and Rob are related.

Sample Questions



1. Identify the smallest DNA fragment.

   I. II. III. IV.

2. State the number of bands that would appear in the 'standard' lane.

   2 3 4 5 6

3. Identify the child which is most likely to be from the mother's previous marriage.

   1 2 3 4

[Source: *The Biology Project*, University of Arizona]

What are Short tandem repeats (STRs) ?

Genetically Modified Organisms

Genetically modified organisms (GMOs) are created using gene transfer.

Outline **gene transfer**

Draw the process of genetic modification to produce insulin

Explain how gene transfer is used in *industrial production of insulin*.

Explain how the *universality of the genetic code* is central to gene transfer applications.

Define **transgenic organism.**

State the role of the following in gene transfer:

Restriction enzymes

E. coli plasmids

Ligase

Vector

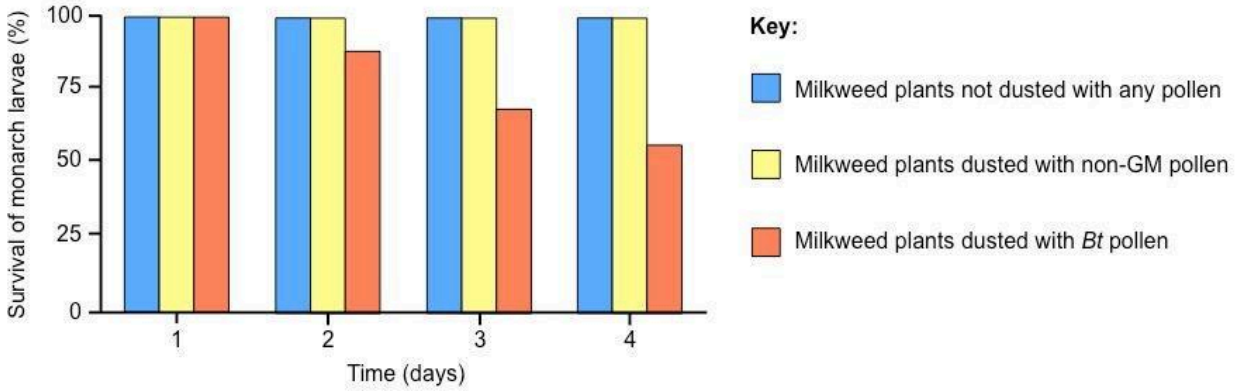
Watch this clip and portray your findings in a table below

https://www.youtube.com/watch?v=7TmcXYp8xu4

Benefits of GMOs	Risks of GMOs
Nutritional value of foods could be improved (e.g. by introducing proteins, vitamins or vaccines)	New traits could cause adverse health reactions (e.g. new proteins may cause allergic responses)
Crops can be produced that lack known allergens	Removal of traits could have unknown effects
Crops can grow in arid conditions for better yield (e.g. by introducing drought resistant genes)	Crops may limit biodiversity of local environment (increased competition with native species)
GM crops can produce herbicides to kill pests	Cross pollination could lead to 'super weeds'
Improve food supply / agriculture in poor countries (GM crops can be engineered for improved yields)	Patents restrict farmers from accessing GM seeds (biotech companies hold monopolies over crop use)
GM crops may have longer shelf lives (less spoil)	Foods with GM components may not be labeled
Reduces economic costs and carbon footprint – less need for land clearing and pesticide usage	Different governments may have conflicting regulatory standards concerning safe usage

Watch this and evaluate the usage of GMO https://youtu.be/DK5kRGs0HX0

What is the effect of Bt Pollen on Survival Rates of Monarch Butterflies (Laboratory Conditions)



What can be concluded from this experiment?

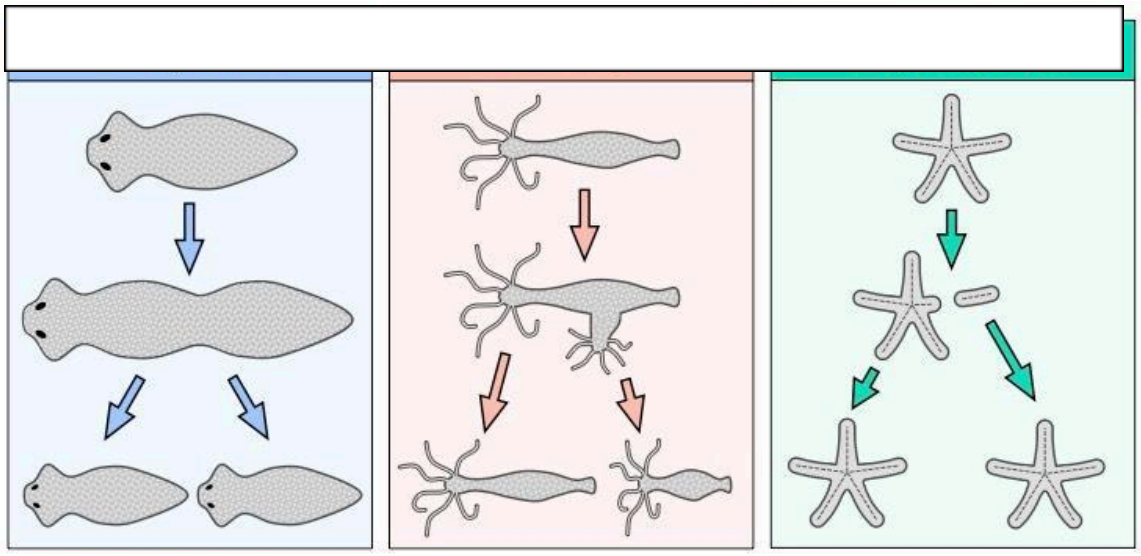
What happened in this experiment that made the results void?

Cloning

https://www.youtube.com/watch?v=tELZEPcgKkE
https://quizlet.com/71174853/bio-genetics-flash-cards/#:~:text=Define%20differentiated%20nucleus%3A,to%20suit%20a%20different%20function

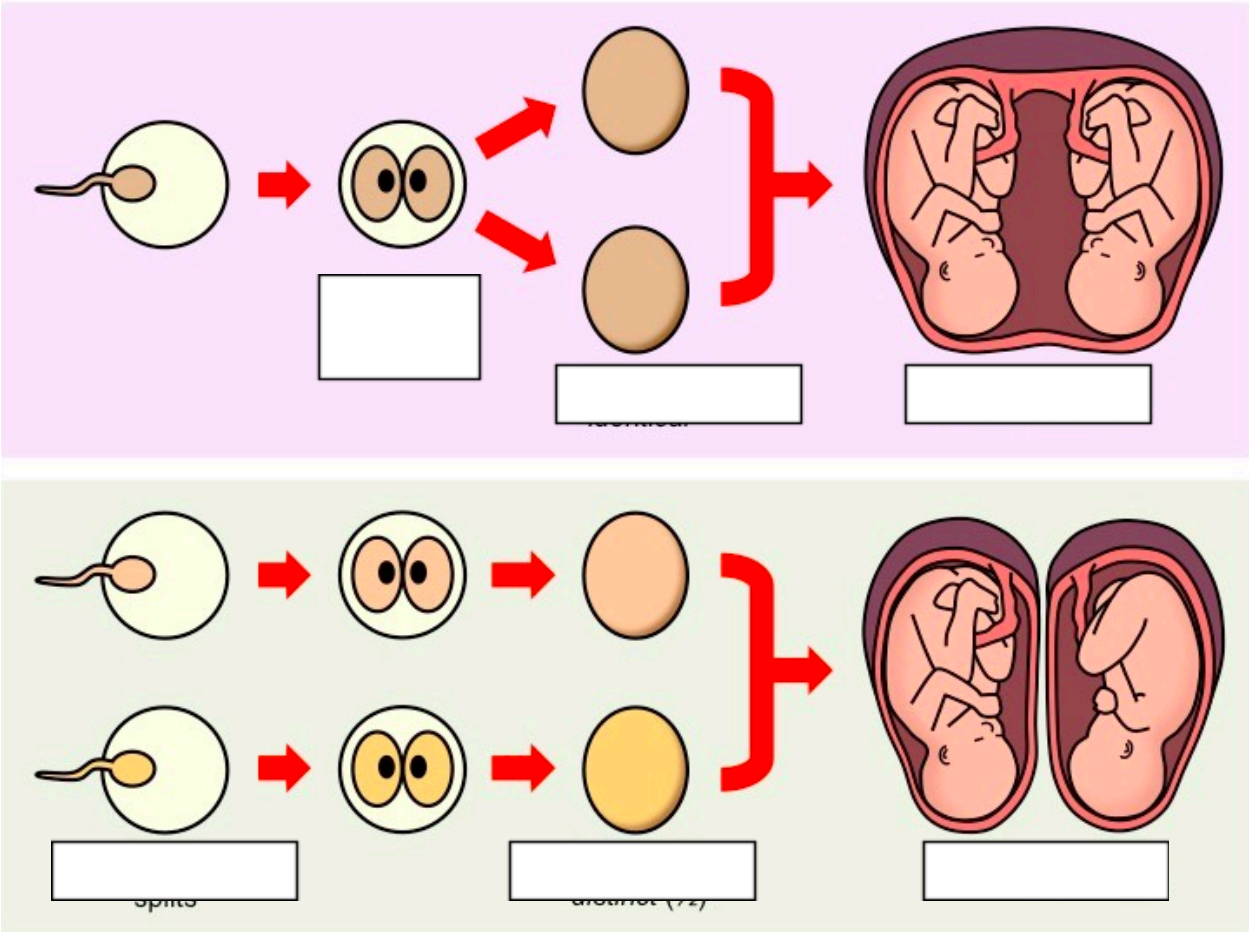
Define **clone.**

Give three examples of **naturally occurring clones.**



Plant Cloning Methods

Human Cloning Methods



Dolly the Sheep was produced by cloning using a differentiated nucleus.

Define **differentiated nucleus**.

Suggest why the differentiated nucleus was taken from an udder cell.

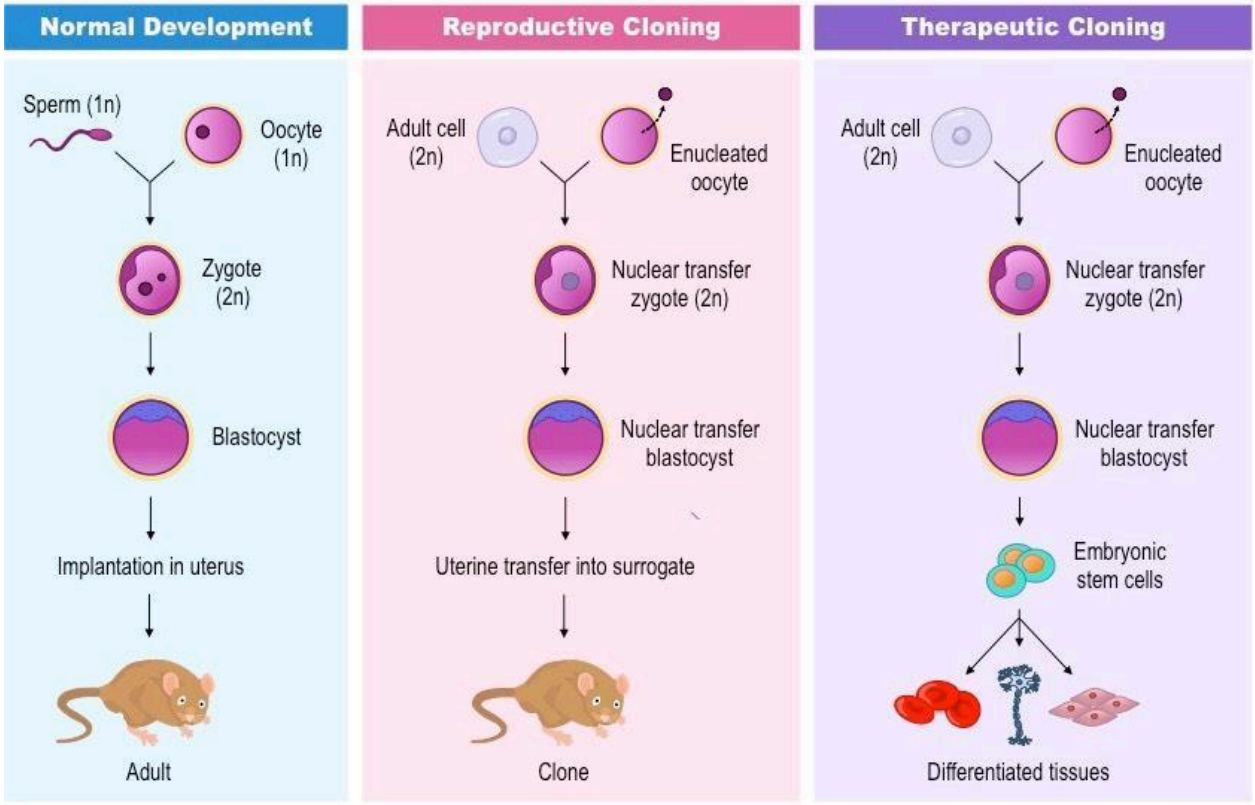
Suggest one reason why Dolly died younger than normal, but of age-related illnesses.

Outline the method used to clone Dolly the Sheep.

Distinguish between reproductive cloning and therapeutic cloning.
Reproductive =

Therapeutic =

State some of the medical applications and benefits of therapeutic cloning.



Discuss the ethical considerations of therapeutic cloning in humans:

Advantages	
Disadvantages	

Suggest why stem-cell reprogramming (IPS cells) might mitigate the negative opinions of human therapeutic cloning.

Source: http://www.nature.com/nature/journal/v451/n7180/full/451858a.html

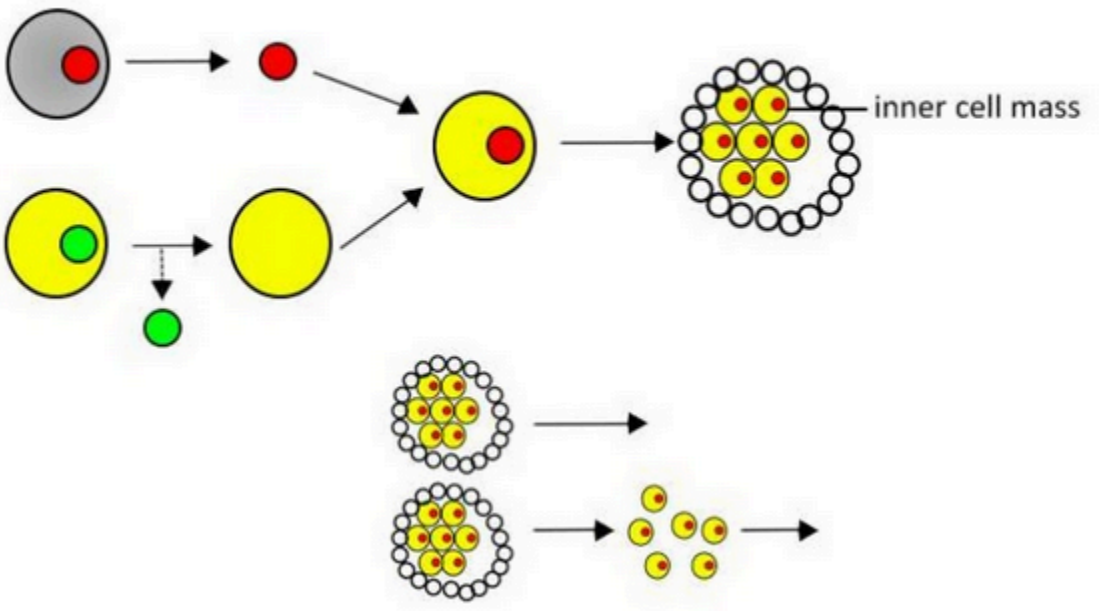
Define iPS stem cells.

Outline the process for reprogramming the cells.

Explain the benefits of using iPS cells in medicine and research.

Reproductive vs Therapeutic Cloning

Annotate this flow chart to compare reproductive and therapeutic cloning.



Design a stem cuttings experiment below

1. Why can DNA profiling be used to determine paternity?

A. Genes of children are exactly the same as their father's.

B. Half the genes of children are the same as their father's.

C. The father passes on all of his genes to each of his children.

D. The father passes on a fraction of his genes equal to the number of his children.

(Total 1 mark)

2. A small amount of a suspect's DNA is obtained from a crime scene. What techniques would be used to carry out DNA profiling?

A. Gel electrophoresis and paternity testing

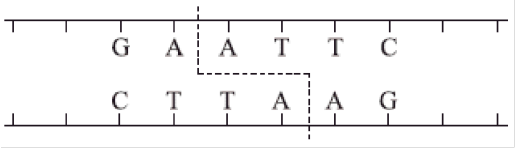
B. Paternity testing and the polymerase chain reaction (PCR)

C. Polymerase chain reaction (PCR) and gel electrophoresis

D. Test crossing and pedigree analysis

(Total 1 mark)

3. What type of enzyme could be used to cut a DNA molecule as indicated by the dotted line on the diagram below?



A. DNA ligase

B. DNA polymerase

C. Helicase

D. Restriction enzyme

(Total 1 mark)

4. Which process is used in polymerase chain reaction (PCR)?

A. Transcription

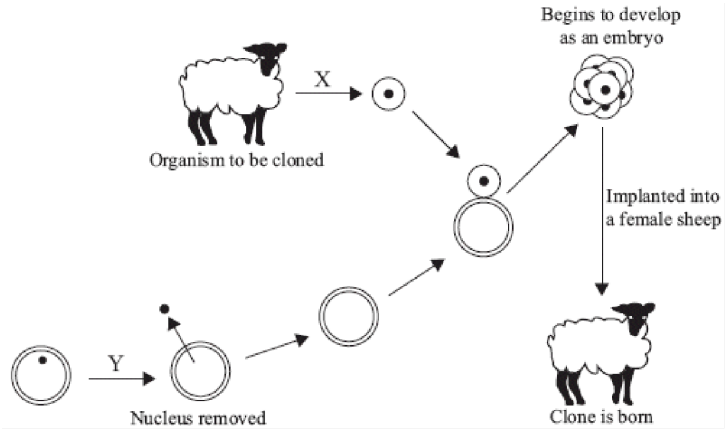
B. Translation

C. Replication

D. Mutation

(Total 1 mark)

5. Which processes involved in cloning an animal are indicated by the letters X and Y?



	X	Y
A.	differentiated cell removed from animal	nucleus removed from unfertilized egg cell
B.	sex cell removed from animal	nucleus removed from differentiated animal cell
C.	sex cell removed from animal	nucleus removed from unfertilized egg cell
D.	differentiated cell removed from animal	nucleus removed from differentiated animal cell

(Total 1 mark)

6. (a) State the name of the technique that is used to separate fragments of DNA according to their size, during DNA profiling.

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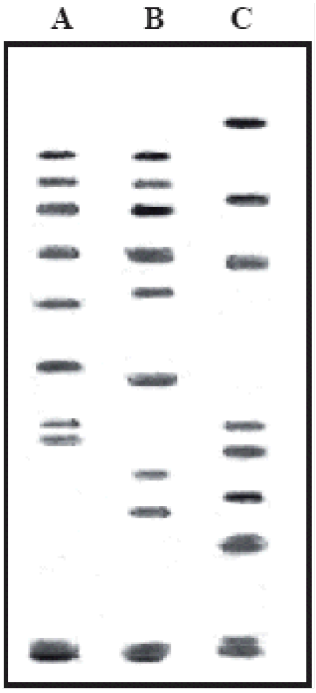
(1)

(b) The diagram below represents the results of a paternity investigation. Track A is the profile of the mother of a child, track B is the profile of the child and track C is the profile of a man who might be the father.



Explain, using evidence from the diagram, whether this man is the father or not.

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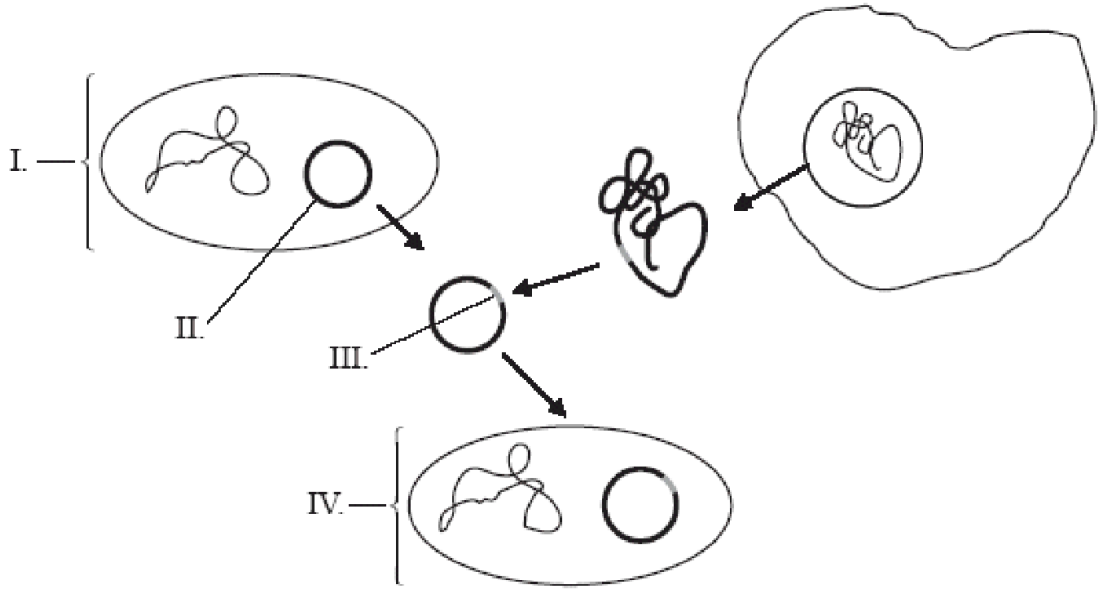
(3)

7. (a) Label the diagram below which shows a basic gene transfer.



I. .....

II. .....

III. .....

IV. .....

(2)

(b) State **two** general types of enzymes used in gene transfer.

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(1)

9. Using a **named** example, discuss the benefits and harmful effects of genetic modification.

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(8)

1. **B**
[1]

2. C
[1]

3. D
[1]

4. C
[1]

5. A
[1]

6. (a) (gel) electrophoresis 1

(b) (track C is) not (DNA from) the father;
some bands on track B do not occur on A or C;
these bands must be DNA inherited from the real father;
band in track B that does not occur on A or C identified;
Annotations to the gel illustrating the above points may be used. 3 max

7. (a) *Award **[1]** for every two correct answers.*
I. bacterial cell/bacterium/prokaryote;
II. plasmid;
III. inserted/engineered/cloned/desired DNA/DNA from donor cell;
IV. genetically modified/transformed/GM/recombinant organism/ cell/bacterium/host cell containing recombinant plasmid; 2 max

(b) restriction enzymes / endonucleases;
ligases;
reverse transcriptase;
*Award **[1]** for two correct responses.* 1 max

8. genetic modification is when the DNA/genotype of an organism is artificially changed;
genetic modification alters some characteristic/phenotype of the organism;
named example with modification (*e.g.* salt tolerance in tomato plants);

*benefits: **[5 max]***
allows crops to be grown where they would not grow naturally;
provides more food;
economic benefits;

expands world's productive farmland;
reduces the need to clear rainforests to grow crops;
lowers cost of production;
less pesticides/fertilizers/chemicals needed so better for environment;
*Award marks for any valid benefit consistent with a **named** example.*

*harmful effects: **[5 max]***
may be released into natural environment;
may affect food chains / unintended effects on other organisms;
may affect consumers *e.g.* allergies/health risks;
unfair to smaller farmers who cannot compete;
long-term effects are unknown;
risk of cross-pollination;
risk of long-term contamination of soil;
*Award marks for any harmful effect consistent with the **named** example.* 8 max