

**Year 12 Human Biology**

**Test 3: Biotechnology**

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| Name: |
| Teacher: |

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|  | Marks Available | Marks Achieved |
| Multiple Choice | 20 |  |
| Short Answer | 22 |  |
| Extended Answer | 13 |  |
| Total | 55 |  |

Assessment Time: 50 minutes

Weighting: 5%

**MULTIPLE CHOICE SECTION Total 20 Marks**

1. Which of the statements about gel electrophoresis is **false**?

A. The process requires an electric current

B. This technique can be used to separate charged molecules

C. Large molecules migrate more slowly in the agarose gel than small molecules

D. None of them.

2. In recombinant DNA technology, plasmids may be used to:

A. introduce foreign DNA into human cells

B. cut DNA at a specific location

C. activate restriction enzymes

D. introduce foreign DNA into bacteria

Questions 3 and 4 refer to the diagram below



3. Structure A contains a

A. gene

B. messenger RNA molecule

C. single nucleotide only

D. plasmid

4. Structure B represents

A. a ribosome

B. recombinant DNA

C. transfer RNA

D. a vector

5. Which of the following tools of recombinant DNA technology is INCORRECTLY paired with one of its uses?

A. restriction enzymes - production of DNA fragments for gene cloning.

B. DNA ligase - enzyme that cuts DNA, creating sticky ends.

C. DNA polymerase - copies DNA sequences in the polymerase chain reaction.

D. vector - often a bacteriophage to host a plasmid

6. What is the main difference between embryonic and adult stem cells?

A. Embryonic stems cells are undifferentiated; adult stem cells are partially differentiated.

B. It is easier to induce dedifferentiation in adult stem cells.

C. Embryonic stem cells are easier to isolate than are adult stem cells.

D. Both A and C

7. What is the "polymerase chain reaction" (PCR) technique?

A. An elegant chemical technique that utilizes the body’s own DNA polymerase to synthesize DNA that is complementary to the parent DNA fragments

B. A technique that allows investigators to determine the nucleotide sequence of a given gene

C. A technique that has led to the development of genetic screening tests of newborns for genetic disease (e.g., cystic fibrosis) once the nucleotide sequence of disease-causing gene is known

D. A technique that incorporates repeated cycles of heating and cooling of DNA segments in the presence of primers and heat-resistant DNA polymerase

8. Which of the following would you expect to be a drawback to PCR techniques?

A. PCR has the potential to create positive results from very low levels of contamination.

B. PCR can be used with very small samples such as single sperm cells.

C. PCR is very rapid; in some cases results can be available in a few hours

D. All of these

9. What benefit does administration of genetically engineered human insulin provide to patients that pig/bovine insulin does not?

A. There was no benefit; the nucleotide sequence that determines the structure of insulin is the same in all three species.

B. Allergic reactions were avoided by using the recombinant human insulin.

C. It could be produced in large quantities using bacteria/yeast genetically engineered to carry the human insulin gene.

D. B and C

10. What key feature of Taq polymerase allows PCR to be conveniently performed?

A. Taq polymerase does not require primers

B. Taq polymerase does not require a template.

C. Taq polymerase is not damaged by heating

D. Taq polymerase can work at very low temperatures

11. Recombinant DNA techniques

A. utilise restriction enzymes that help to join segments of DNA back together.

B. rely on DNA ligase that cuts DNA to form sticky ends.

C. have been used to produce insulin, growth hormone and the flu vaccine

D. often use bacteria as they only have one long strand of DNA to manipulate.

12. Some of the steps involved in Gene Cloning (in vivo gene cloning) are given below:

i) Insertion of isolated gene to the vector

ii) Introduction of recombinant vector to the host

iii) Isolation of desired gene

iv) Expression of recombinant gene in host

v) Extraction of recombinant gene product

Which of the following shows these steps in correct order?

A. iii, i, iv, ii, v

B. iii, i, ii, iv, v

C. i, ii, iii, iv, v

D. ii, i, iii, iv, v

13. To treat cystic fibrosis (CF) through gene therapy, a healthy gene that codes for the proper amino acid sequence is placed into the cells of the patient’s lung tissue. Which statement applies to this technology?

A. Airborne bacteria with the healthy gene are injected into lung cells.

B. CF patients are infected with a virus this is inhaled.

C. Healthy genes are inhaled as free DNA fragments in an air sample.

D. Healthy genes are injected into lung cells through microsurgery

14. Imagine you are looking at a DNA fingerprint that shows the pattern of a mother's DNA and her child's DNA. Will all of the bands on the electrophoresis gel showing the child's DNA match those of the mother?

A. No, because a person’s DNA pattern changes with age.

B. Yes, because the DNA of mothers and children are identical.

C. Yes, because the child developed from an egg produced by the mother.

D. No, because the father contributed half of the child's DNA

15. The immediate goal of the Human Genome Project was to

A. develop new technologies for studying DNA

B. compare the genomes of a large number of individuals from different parts of the world

C. map all the human genes and determine the nucleotide sequence of the entire human genome

D. find cures for human genetic disorders

16. Which of the following is NOT a step taken to produce recombinant DNA using human DNA?

A. use of yeasts to circularize DNA

B. seal human DNA fragments into plasmids with DNA ligase

C. cut both human and plasmid DNA with the same restriction enzymes

D. isolate and purify DNA from tissues and from plasmids

17. DNA fingerprints used as evidence in a murder trial look something like supermarket bar codes. The pattern of bars in a DNA fingerprint shows the

A order of genes along particular chromosomes

B presence of various-sized fragments of DNA

C exact location of a specific gene in a genomic library

D presence of dominant or recessive genes

18. Electrophoresis separates DNA fragments of different sizes, with \_\_\_\_ fragments moving closer to the \_\_\_\_ pole.

A. shorter, negative

B. shorter, positive

C. longer, negative

D. longer, positive

19. Which of the following is **not** a purpose of genetic modification?

A. To create proteins used in vaccines (e.g. hepatitis B vaccine).

B. To modify the characteristics of an organism.

C. To create hormones such as insulin or human growth hormone.

D. To create antibiotics

20. Gene therapy can be made highly effective by conducting

A. gene therapy using tissues from a donor.

B. gene therapy through injecting modified cells from the same individual

C. fingerprinting

D. transplantation of cells from a family member

**SHORT ANSWER SECTION Total 22 marks**

21. In 1991, nine skeletons were found in Russia. They were believed to be those of Tsar Nicholas II, his family and staff who were killed in 1917 during the Russian revolution. Very small amounts of DNA were isolated from these skeletons. This DNA was used in the polymerase chain reaction (PCR). Genetic fingerprinting was then carried out on this DNA to identify the skeletons.

The chart shows some of the results obtained from the genetic fingerprinting of seven of the skeletons, three children and four adults.



Figure 1.

1. Explain why the polymerase chain reaction was used in this investigation.

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| Only small samples of DNA are available – PCR amplifies the DNA to be tested |
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(1 mark)

(b) In the polymerase chain reaction, DNA is heated to 95 °C and nucleotides, enzymes and DNA primers are added to the mixture.

(i)  Explain why the DNA is heated to 95 °C.

Separates double strand of DNA to form 2 single strands

(1 mark)

(ii)  What are DNA primers and what do they do?

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| What are they: |
| • Short single stranded sections of DNA |
| What do they do: |
| • Attach/bond to template strand of DNA on either side of the target sequence **OR**  • Provide a starting point for DNA extension/elongation |

(2 marks)

(iii) Which **two** of the adults (1, 2, 3 or 4) are the parents of the children?

Adult 3 (1) and Adult 4/1 (1)

(2 marks)

22. The Human Genome Project has provided more supporting evidence for the theory of evolution by providing a better comparison between the DNA of modern humans and extinct hominin species. Explain how the project could also help treat genetically inherited diseases.

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| • Allows faulty/mutated genes to be identified |
| • Once identified, the reason for the dysfunction can potentially be identified |
| • Genetic counselling of individuals |
| • Potentially allows gene therapy – replace faulty genes |
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(2 marks)

23. (a) What is nuclear transfer?

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| • Nucleus removed from somatic cell |
| • Transferred into an empty egg |

(2 marks)

1. How could nuclear transfer be used therapeutically?

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| • Can create embryonic stem cells (1) |
| • Which can be used in cell replacement therapy to replace damaged cells **OR** |
| • Which can be used in tissue engineering to create replacement tissues |

(2 marks)

24. To engineer (grow) tissues for implantation into human, what **three** things are required?

1. Cells from the patient, a donor or stem cells

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| 1. A matrix or scaffold to grow the tissue on |
|  |
| 1. Chemicals to stimulate cell division/growth |
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1. marks)

25. Gene therapy has had varied success over the years. Describe two reasons why some gene therapy treatments have been unsuccessful in the past.

**Any two points**

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| • Body’s immune system detects the virus vector and destroys it along with the beneficial gene |
| • Gene is inserted into the wrong part of the patient’s DNA |
| • Gene therapy has not affected the stem cells therefore, the cure is short-lived |

(2 marks)

26. Medical research into vaccine development is a growing field. Explain why modern vaccines are now seen as preferential over traditional vaccines previously used.

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| • Pathogen has the potential to cause infection in traditional vaccines  • Using rDNA reduces the risks of infection |
| • Fewer possible side effects as animal products are not included in the production of modern vaccine  • But are used to produce traditional vaccines |
| • More vaccines can be produced over a shorter period of time |

(2 marks)

27. (a) Describe two factors which control the speed at which DNA fragments pass through the gel when performing gel electrophoresis.

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| 1. Size of the DNA fragments – larger fragments travel slower than smaller fragments |
| 1. Strength of the electric field – stronger electrically current results in faster movement of DNA |
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(2 marks)

1. What is the function of the buffer solution when running a gel electrophoresis?

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| • Allows the electrical current to pass through the gel |
|  |

(1 mark)

**EXTENDED REPSONSE SECTION Total 13 marks**

1. Researchers are hoping to start human clinical trials for Tay-Sachs disease using gene therapy. They hope to achieve this by using modified viruses that are infused into cerebrospinal fluid.

Describe the process of how the viruses would be genetically engineered and then how it could lead to a treatment for Tay-Sachs.

(13 marks)

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| **Description** | **Marks** |
| * The normal (HEXA) gene is removed | 1-11 |
| * by cutting it at a recognition site |
| * With a restriction enzyme |
| * Creating sticky ends from (overhanging) unpaired nucleotides / staggered cut |
| * DNA / genetic material removed from virus |
| * Viral DNA cut with same restriction enzyme |
| * To create sticky ends that are complementary to gene |
| * DNA ligase is an enzyme |
| * That joins sticky ends of gene and viral DNA |
| * This amalgamation is called recombinant DNA |
| * Which is inserted back into virus |
| * Virus is now termed a vector |
| * Once inserted in the body, the virus would insert correct gene into body cells / replace faulty gene | 1-2 |
| * Gene could then function to produce the correct protein / enzyme |
|  | **Total 13** |