Application of Reproduction and Genetics (2.7): Eduqas A Level Biology Exam Questions by Topic

23 questions · 49 marks · about 59 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · A level Component 2 · June 2024 · Q2(a)(i) · 2 marks

2. The Human Genome Project set out to sequence the 3 billion base pairs that make up human DNA and to identify all the genes in the human chromosomes. The project was set up in 1990 and involved scientists working in 18 different countries.

DNA samples were collected from a group of volunteers. The samples had their identification removed.

(a) (i) Suggest why it was important to the **volunteers** that the DNA samples had their identification removed. [2]

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Question 2 · A level Component 2 · June 2024 · Q2(a)(ii) · 2 marks

(ii) Suggest **two** ways in which the Human Genome Project may lead to improved treatments for genetic medical conditions. [2]

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Question 3 · A level Component 2 · Autumn 2021 · Q4(b)(i) · 2 marks

The presence or absence of the RhD protein is controlled by a gene with two alleles:
D – the presence of RhD, and **d** – the absence of RhD.

If a woman who is rhesus negative (genotype **dd**) becomes pregnant with a child who carries a dominant allele for RhD, the mother will develop an immune response against the RhD protein from the foetus. Antibodies against RhD can cross the placenta and potentially kill the foetus.

Pre-natal testing of the foetus to determine its blood group can now be carried out by analysing the mother's blood. Some foetal DNA passes into the mother's blood and if the allele for RhD is detected doctors know that the foetus is at risk.

(b) (i) Explain why a blood test is preferable to either sampling the amniotic fluid surrounding the foetus or sampling tissue from the placenta (chorionic villus sampling). [2]

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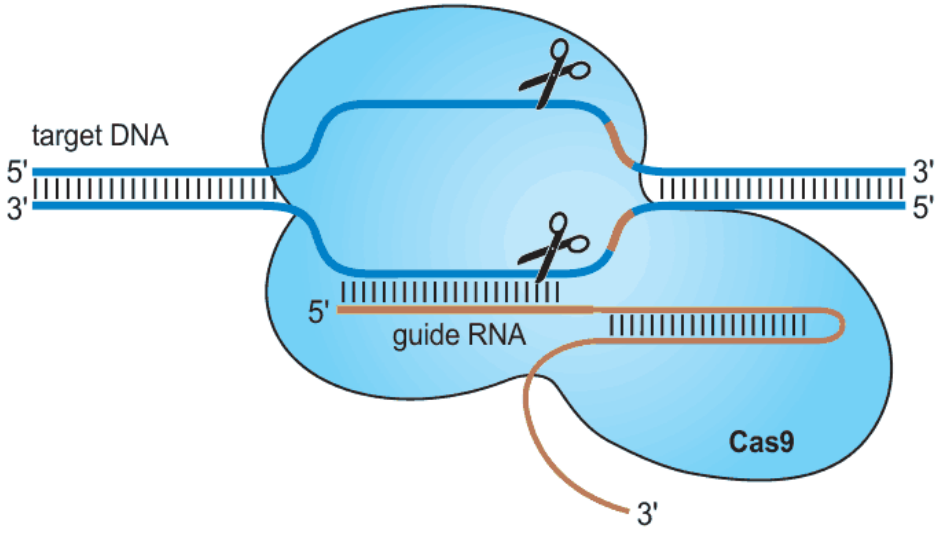
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Question 4 · information from earlier in the question

The CRISPR technique can be used to remove a target gene.
In this technique:

- Guide RNA is made.
- The guide RNA and Cas9 endonuclease combine to form a CRISPR/Cas9 complex.
- The complex is then inserted into a cell.
- The guide RNA attaches to the target gene as shown in Figure 2.1.

Figure 2.1



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Genetic engineers have discovered that by synthesising guide RNA with particular nucleotide sequences they can target any gene in any organism, if they know its nucleotide sequence. Using this technique it is possible to remove a target gene.

Question 4 · A level Component 2 · June 2019 · Q2(d) · 3 marks

(d) Explain how releasing these sterilised mosquitoes into the wild might benefit humankind and suggest an ethical reason for not doing so. [3]

Question 5 · A level Component 2 · Autumn 2020 · Q3(c) · 3 marks

(c) In medicine, DNA samples can be taken from a developing foetus as part of pre-natal testing for genetic disorders. The quantity of DNA extracted is very small.
Identify and describe a method that can be used to increase the quantity of DNA available for analysis. [3]

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Question 6 · A level Component 2 · June 2025 · Q3(a)(ii) · 4 marks

Samples of meat products are tested for the presence of different types of meat. Small quantities of DNA are extracted and copied using the polymerase chain reaction (PCR). Genetic fingerprinting is then carried out on the samples to check for the presence of different types of meat.

(ii) DNA replication takes place in both human cells and in PCR.

State **two** similarities and **two** differences between DNA replication in PCR and DNA replication in cells. [4]

Similarities

I. .....

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II. .....

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Differences

I. .....

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II. .....

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Question 7 · A level Component 2 · June 2025 · Q3(a)(iv) · 1 mark

(iv) When the PCR cycle is repeated it is theoretically possible to produce over 3.35×10^7 copies of the target sequence from just one piece of DNA.

Suggest **one** reason why the actual number of copies is likely to be less than this theoretical number. [1]

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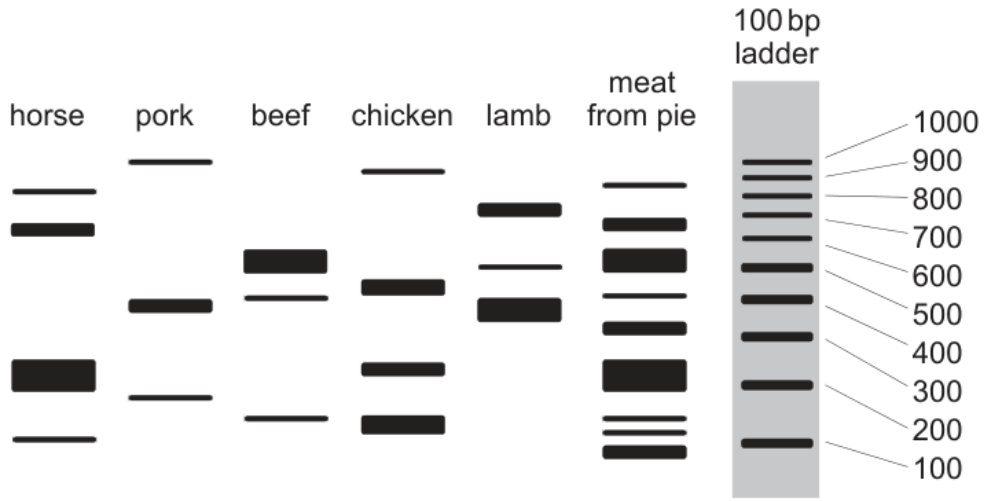
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Question 8 · A level Component 2 · June 2025 · Q3(b)(i) · 2 marks

(b) Genetic fingerprinting was used to identify the types of meat present in a sample of a meat pie. **Image 3.2** shows the gel electrophoresis results for the meat from this pie. It also shows the results for pure samples from horse, pork, beef, chicken and lamb.

Image 3.2



Key: bp = DNA base pairs

(i) **Draw** an **arrow** on **Image 3.2** to show the direction in which the fragments moved during electrophoresis.

Explain why you have drawn the arrow in that direction. [2]

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Question 9 · A level Component 2 · June 2025 · Q3(b)(ii) · 1 mark

(ii) Explain why a DNA ladder is run alongside fragments in gel electrophoresis. [1]

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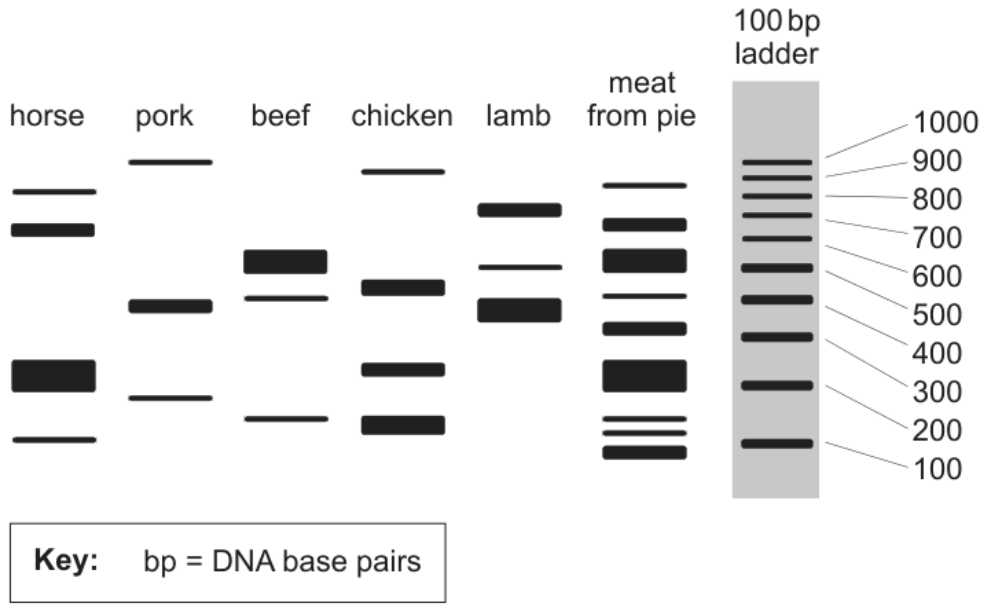
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Question 10 · information from earlier in the question

(b) Genetic fingerprinting was used to identify the types of meat present in a sample of a meat pie. **Image 3.2** shows the gel electrophoresis results for the meat from this pie. It also shows the results for pure samples from horse, pork, beef, chicken and lamb.

Image 3.2



Key: bp = DNA base pairs

Question 10 · A level Component 2 · June 2025 · Q3(b)(iv) · 2 marks

(iv) Conclude what the results in **Image 3.2** show about the contents of the meat in the pie. [2]

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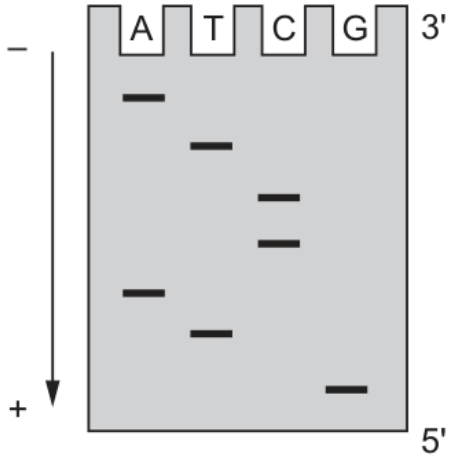
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(c) Using DNA polymerase, a short fragment of DNA was copied in four separate experiments including a mixture of unlabelled A, T, C and G deoxyribonucleotides and one of radio-labelled A, T, C or G dideoxyribonucleotides.

The DNA chains produced in each experiment were then separated using gel electrophoresis as shown in **Image 5.3**.

Image 5.3

DNA samples from experiments with radiolabelled dideoxyribonucleotides



(i) The arrow shows the direction of movement of the DNA fragments in the electrophoresis gel. Explain why the fragments have separated as shown in **Image 5.3**. [3]

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Question 12 · A level Component 2 · June 2022 · Q5(c)(iii) · 1 mark

(iii) Sanger sequencing took several months to sequence a genome but Next Generation Sequencing (NGS) can sequence a whole genome in less than five hours. State **one** medical advantage of using NGS rather than Sanger sequencing. [1]

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Question 13 · A level Component 2 · June 2017 · Q5(a) · 3 marks

5. Currently, a million tons of wild fish are harvested from the oceans annually. Of these, 80% are used to feed fish reared in farms.
Fish do not make their own omega-3 fatty acids, they get these by eating algae. For farmed fish to be as nutritious as wild fish, they need to be fed a diet rich in omega-3 fatty acids. Algae are hard to culture on a large scale, so wild fish provide a more convenient source.

Scientists have identified and spliced genes from algae that code for producing high levels of omega-3 fatty acids into *Camelina* plants. The genetically modified *Camelina* plants now produce seeds that contain 26% omega-3 fatty acids, so are useful for fish farm feed.

(a) Explain how named enzymes would be used to cut genes from algae and splice them into *Camelina* plants. [3]

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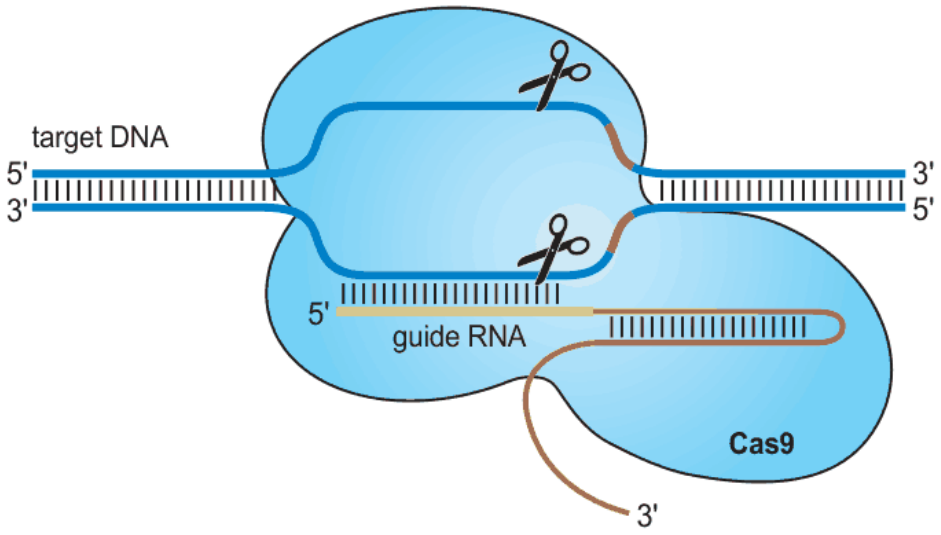
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Question 14 · A level Component 2 · June 2019 · Q2(b) · 2 marks

The CRISPR technique can be used to remove a target gene.
In this technique:

- Guide RNA is made.
- The guide RNA and Cas9 endonuclease combine to form a CRISPR / Cas9 complex.
- The complex is then inserted into a cell.
- The guide RNA attaches to the target gene as shown in Figure 2.1.

Figure 2.1



(b) Cas9 enzyme is a restriction endonuclease. State what is meant by a restriction endonuclease. [2]

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Question 15 · A level Component 2 · Autumn 2020 · Q4(c)(iv) · 3 marks

(iv) Outline the process by which a synthetic daffodil gene could be prepared from mRNA. [3]

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Question 16 · A level Component 2 · Autumn 2020 · Q4(d) · 2 marks

(d) The production of 'golden rice' is still in progress despite trials showing that humans can utilise the beta carotene contained in 'golden rice' to produce vitamin A. Suggest why people may still be opposed to the wide-scale growing and use of 'golden rice'. [2]

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Question 17 · A level Component 2 · June 2025 · Q2(b)(v) · 2 marks

The genetically modified wheat may be used for wheat crops in the future.

(v) Give **one** benefit and **one** concern over the use of this genetically modified wheat crop. [2]

Benefit:

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Concern:

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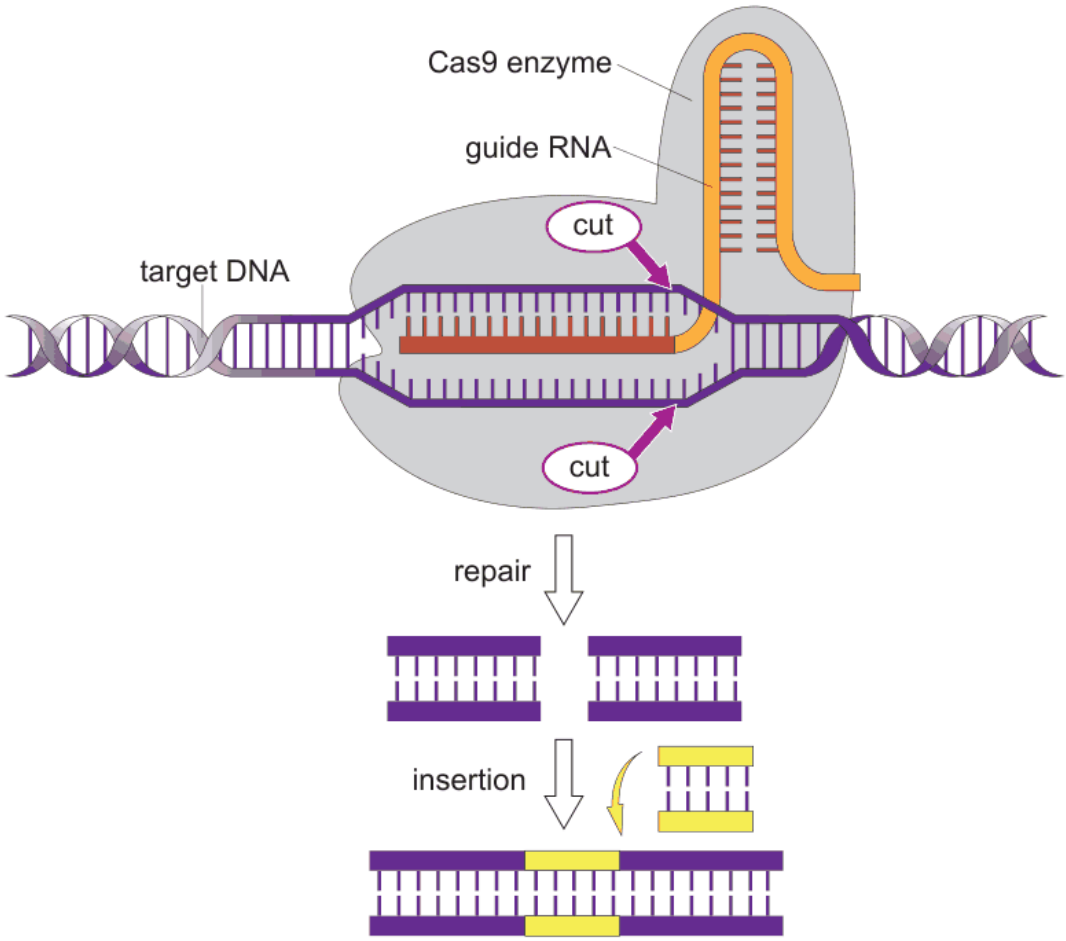
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Question 18 · information from earlier in the question

5. Cas9 is a DNA endonuclease that is associated with a strand of guide RNA (gRNA). The enzyme unwinds DNA and breaks the hydrogen bonds between the DNA strands. The base sequence on part of the gRNA then aligns next to a specific target sequence on the DNA. The endonuclease then makes a double stranded cut at this target sequence. During the repair of the DNA molecule a double-stranded length of DNA can be inserted. This is shown in **Image 5**.

Image 5



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Question 18 · A level Component 2 · June 2023 · Q5(a)(iii) · 3 marks

(iii) Artificial gRNA molecules can be made that have specific base sequences. Double stranded DNA containing functional alleles of genes associated with recessive genetic disorders can also be produced. These functional alleles can be inserted into human DNA as shown in **Image 5** using an enzyme.

It has been suggested that the Duchenne Muscular Dystrophy (DMD) allele could be replaced with a functioning allele in germ-line therapy.

Suggest how Cas9 and these functional alleles could be used to alter an embryo's genotype so that it no longer has DMD. [3]

Question 19 · A level Component 2 · June 2023 · Q5(a)(iv) · 2 marks

(iv) Suggest **two** advantages of germ-line therapy. [2]

Question 20 · A level Component 2 · Autumn 2020 · Q3(e) · 2 marks

(e) Gene therapy for beta thalassaemia has been trialled.
Suggest **one** advantage and **one** possible disadvantage of using a non-pathogenic virus as the vector for the beta-globin gene. [2]

Questions, mark schemes and examiners' report extracts © WJEC CBAC Ltd (Eduqas).

Question 21 · A level Component 2 · Autumn 2020 · Q3(d)(i) · 2 marks

One genetic disorder that can be detected through analysis of foetal DNA is beta thalassaemia. This disorder is caused by a mutation to the gene coding for the beta-globin chain of adult haemoglobin. To date the only possible cures that have been trialled are stem cell therapy and gene therapy.

(d) In 2008, a child was born from an embryo produced by *in vitro* fertilisation. Before implantation the embryo was screened to ensure that it did not carry the gene for beta thalassaemia. Following the birth of the child, stem cells from the baby's umbilical cord were saved and transplanted to his brother who suffered from beta thalassaemia. These replaced the stem cells in his brother's bone marrow and red blood cells were then produced that had normal haemoglobin.

(i) Suggest why the treated child should still receive genetic counselling in the future before trying to become a parent. [2]

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Question 22 · A level Component 2 · Autumn 2020 · Q3(d)(ii) · 1 mark

(ii) Suggest why there is opposition to producing one child specifically to treat a genetic disorder in another child. [1]

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Question 23 · A level Component 2 · June 2024 · Q1(e) · 1 mark

(e) After the baby is born, the placenta and the umbilical cord can be used as a source of stem cells. These may be used for replacing damaged tissues and organs when the baby grows older.
It is better to take the baby's stem cells from the umbilical cord rather than the placenta.
Suggest the reason for this. [1]

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Mark schemes

Question 1 · A level Component 2 · June 2024 · Q2(a)(i) · 2 marks

2	(a)	(i)	**Any two (×1) from** • Cannot match samples and individuals (1) • volunteers wouldn't know if they had {problem / owtte} genes (1) • they will not be discriminated against / refused {life insurance / job opportunities} (1)	2		2	2

Question 2 · A level Component 2 · June 2024 · Q2(a)(ii) · 2 marks

(ii)	**Any two (×1) from** • Locates "problem" genes (1) • it will allow greater use of gene therapy (1) • {Tailoring / targeting} treatment to an {individual / specific condition} (genomic medicine) (1)	2	2

Question 3 · A level Component 2 · Autumn 2021 · Q4(b)(i) · 2 marks

	(b)	(i)		non-invasive / does not involve taking tissue from the {uterus / amnion / placenta} (1) no risk of test causing {miscarriage / loss of foetus / harm to foetus} / no risk of infection (1) Accept reverse arguments	2	2

Question 4 · A level Component 2 · June 2019 · Q2(d) · 3 marks

(d)	• Reference to reduced fertility in mosquitoes (1) • Less mosquitoes = less malaria (1) • Any **one** (×1) from Reference to right of humans to make another species extinct / Effect on {removal from food chain/ ecosystems/ biodiversity} Unknown effects of GM mosquitoes in the environment (1)	2	1 3

Question 5 · A level Component 2 · Autumn 2020 · Q3(c) · 3 marks

	(c)			PCR (1) **Any two (×1) from:** heating the DNA to 95°C to separate the two strands of DNA (1) cooled to 50-60°C **+** to allow primers to {bind / anneal} to DNA (1) Heating to 70°C **+** allow {thermally stable DNA polymerase /*Taq polymerase}* to add (complementary) nucleotides (1)	3			3	3

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Question 6 · A level Component 2 · June 2025 · Q3(a)(ii) · 4 marks

(ii)	**Similarities** **Any two (x1) from** • Use (DNA) polymerase (1) • Complementary base pairing (1) • Semi conservative replication / owtte(1) • Requires the breaking of hydrogen bonds (1) **Differences** **Any two (x1) from** • uses {higher temperature / or given temperatures higher than 37°C} / temperatures vary / {DNA/ taq} polymerase is thermostable in PCR (1) • PCR uses Taq polymerase rather than the polymerase in the cell (1) • Heat used to {separate strands / break hydrogen bonds} instead of enzymes (1) • (DNA) primers are added (to start replication) but not in cell (1) • PCR replicates small pieces of DNA not whole chromosomes (1)			4	4

Question 7 · A level Component 2 · June 2025 · Q3(a)(iv) · 1 mark

(iv)	Not all primers bind / run out of {primers / nucleotides} / some non target sections present / DNA strands rejoin rather than with primer (1) Accept enzymes start to denature after numerous cycles			1	1 1

Question 8 · A level Component 2 · June 2025 · Q3(b)(i) · 2 marks

(b)	(i)	Arrow drawn down (1) {Smallest molecules / fragments with the smallest number of base pairs } move {furthest / fastest} / {Largest / fragments with the largest number of base pairs} move {less / slower} (1)		1	1	2

Question 9 · A level Component 2 · June 2025 · Q3(b)(ii) · 1 mark

	(ii)	{Identify / estimate} the {number of base pairs / fragment size} / Fragment size can be compared against known sizes (1)		1	1	1

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Question 10 · A level Component 2 · June 2025 · Q3(b)(iv) · 2 marks

(iv)	Pie meat contains horse **and** beef. (1) Another {unidentified meat / source of DNA / contamination present / organism} (1)		2	2

Question 11 · A level Component 2 · June 2022 · Q5(c)(i) · 3 marks

(c)	(i)	**Any three (x1) from:** Fragments are negatively charged (1) So move towards the positive (electrode) (1) Smaller fragments move {further / faster} ORA (1) (Because they) can move through the pores in the gel more easily/ ORA (1)	3		3	3

Question 12 · A level Component 2 · June 2022 · Q5(c)(iii) · 1 mark

(iii)	{Faster / better} + {diagnosis / treatment} / treatment can be tailored to the individual patient (1)	1	1

Question 13 · A level Component 2 · June 2017 · Q5(a) · 3 marks

5	(a)	Any 3 from: {Restriction (endonuclease) enzyme/ named enzyme e.g. EcoR1} used to cut out {gene/ DNA} (1) Sticky ends/ or description of (1) Same restriction enzyme used to open DNA in {vector/ plasmid/ virus/ *Camelina*} (1) Ligase used to {insert / anneal / splice} gene into {vector/ plasmid/ viral/ *Camelina}*(1)	3	3

Question 14 · A level Component 2 · June 2019 · Q2(b) · 2 marks

(b)		It cuts DNA/ or description (1) Ignore reference to RNA At a specific (base) sequence(1)	2		2	

Question 15 · A level Component 2 · Autumn 2020 · Q4(c)(iv) · 3 marks

(iv)	**Any 3 (x1) from:** extract mRNA from a cell actively synthesising the required protein (1) mRNA used as a template to make DNA (1) reverse transcriptase (1) to form a single stranded DNA (1) DNA polymerase to produce a double stranded cDNA (1)	3	3	3

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Question 16 · A level Component 2 · Autumn 2020 · Q4(d) · 2 marks

(d)	**Any 2 (x1) from** unknown {side effects/ health issues of eating GM crop (1) concerns over use of pathogenic bacterium in gene transfer (1) unknown effect on environment (1) Relevant economic concern / religious opposition (1)	2	2

Question 17 · A level Component 2 · June 2025 · Q2(b)(v) · 2 marks

(v)	Benefit: higher yield / more produced/ produced faster / owtte (1) Concern: may be spread to other plants causing them to grow faster / reduction {in biodiversity / or description of} / outcompete other plants / unknown effects of eating (new protein produced in) crop (1)	2	2

Question 18 · A level Component 2 · June 2023 · Q5(a)(iii) · 3 marks

(iii)	**Any three (x1) from** • gRNA with sequence complementary to recessive allele used (1) • Cuts recessive allele. (1) Reject cuts <u>out</u> • Functional allele is placed into {defective / faulty} allele (1) • Using ligase (1)		

	3	3		

Question 19 · A level Component 2 · June 2023 · Q5(a)(iv) · 2 marks

(iv)	**Any two (x1) from** Can be passed on to future generations/ inherited (1) Present in all cells of the body (1) Does not need to be repeated (1)	2		2		

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Question 20 · A level Component 2 · Autumn 2020 · Q3(e) · 2 marks

	(e)			**advantage**: a virus would transfer the gene directly into the {blood/ host} stem <u>cells</u> (1) **disadvantage**: non-pathogenic virus could mutate and become {pathogenic/ cause harm} insertion of gene could activate oncogene / insertion of gene into another gene could inactivate that gene OWTTE/ immune response (1)			2		

Question 21 · A level Component 2 · Autumn 2020 · Q3(d)(i) · 2 marks

	(d)	(i)		Mutation / allele for beta thalassaemia still present in germ-line cells / sperm / individual would still be a carrier (1) somatic stem cell therapy not germ-line therapy / does not replace germ line cells / treats symptoms not heritable (1)			2	2		

Question 22 · A level Component 2 · Autumn 2020 · Q3(d)(ii) · 1 mark

		(ii)		the child has no choice / lack of consent/ suitable ethical concern (1) NOT unethical unjustified			1	1	

Question 23 · A level Component 2 · June 2024 · Q1(e) · 1 mark

	(e)	Umbilical cord only contains cells from baby / placenta is mother and baby's cells.	1	1		

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