

1(a). Ali and Mary do not have cystic fibrosis, but their baby does.

Ali and Mary consider whether or not to have another child.

These are some of the questions that they could consider before making their decision.

A	How much will it cost to have another child with cystic fibrosis?
B	What is the chance of another child of ours having cystic fibrosis?
C	If we find that the foetus has cystic fibrosis should we have a termination?
D	Do we want to have a boy or a girl?
E	What will other people think?
F	Should we discuss this with the grandparents?

(i) Which question, A, B, C, D, E or F, is an **ethical** issue?

question = [1]

(ii) Which question, A, B, C, D, E or F, can be answered by **science**?

question = [1]

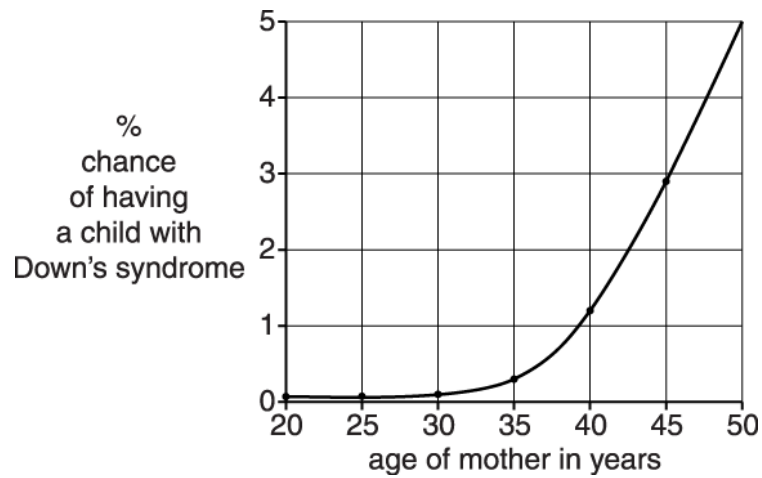
(b). Another couple, Rajesh and Sangeeta, are thinking of having a baby.

They talk to a genetic counsellor.

They are told that because of Sangeeta's age they have a 1% chance of having a child with Down's syndrome.

This would mean that the child could have some physical and mental issues.

Look at the graph.



(i) What is Sangeeta's age?

----- years [1]

(ii) Describe the trend shown by the graph.

----- [2]

(iii) It is possible to increase confidence in the trend shown by the graph.

Put ticks (✓) in the boxes next to the **two** best methods.

ask patients how they feel

collect data for other ages

use a larger sample size

use smaller graph paper

collect data for other genetic conditions

collect data from just one hospital

(iv) Explain how the information supplied by the graph and the genetic counsellor could affect any decision taken by Rajesh and Sangeeta about whether or not to have a baby.

----- [2]

(c). Rajesh and Sangeeta decide to have a baby.
They decide that if Sangeeta becomes pregnant, the foetus will be tested for genetic disorders.

Describe the implications that need to be considered of having the foetus tested.



The quality of written communication will be assessed in your answer.

----- [6]

2(a). Bacteria can be grown on a large scale in fermenters to produce medicines.

A single bacterium can reproduce in the fermenter by dividing into two every twenty minutes.

- (i) Starting with **ten** bacteria, how long will it take for the fermenter to contain **640** bacteria?
Show your working.

----- min [1]

- (ii) Suggest **one** reason why it is not possible to calculate accurately the number of bacteria in the fermenter after 48 hours.

----- [1]

- (iii) Some medicines can be made by growing plants and then extracting the medicine.
Scientists often prefer to use bacteria to make medicines.

Use your answer from (i) to suggest why bacteria are used instead of plants.

----- [1]

(b). Bacteria can be genetically modified to produce different medicines.

(i) Explain what is meant by genetic modification.

[2]

(ii) Some crop plants can grow only in hot conditions.

Scientists want to genetically modify some crops so that they can also grow in colder conditions.

Suggest why this might be a useful application of genetic modification.

[1]

3(a). Genetic modification is where a gene from one organism is transferred to another organism.

The gene continues to work.

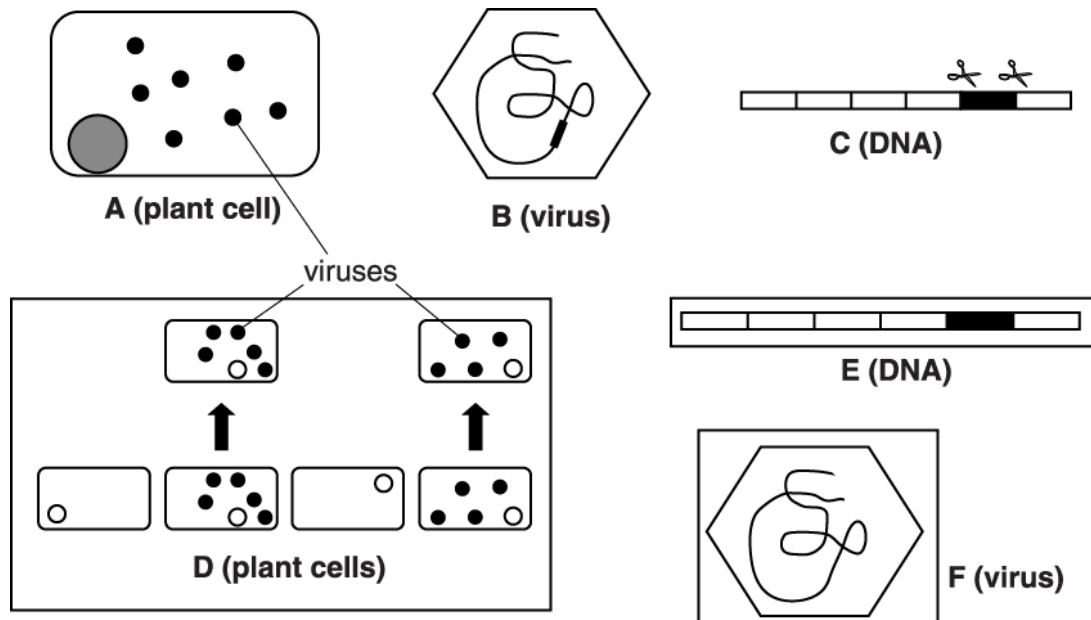
Genetic modification can be used to make crop plants resistant to herbicides.

The stages in this process are listed in the correct order.

1	Find the herbicide resistant gene.
2	Isolate and remove the gene from the original DNA.
3	Find a suitable virus vector.
4	Insert the gene into the vector.
5	Replicate the vector in a plant cell.
6	Select cells with the herbicide resistant gene.

The diagrams show the stages in this process. They are not drawn to scale.

They are not in the correct order.



Write down the correct order of the diagrams.

The first one has been done for you.

E -----

[4]

(b). Suggest why scientists would want to make a crop plant resistant to a herbicide.

[3]

4.

(i) A doctor can prescribe drugs to treat heart disease.

It is now possible to genetically test people before prescribing drugs.

What are the benefits of this type of genetic testing?

Put ticks (✓) in the boxes next to the **three** correct answers.

Each drug works in the same way in every person.

Less money is wasted prescribing drugs that don't work.

Doctors don't have to learn about so many drugs.

People won't have to visit the doctor any more.

The drugs will always cure the patient from the disease.

It may reduce the number of people who suffer dangerous side effects.

The doctor can adjust the dose of the drug to suit the patient.

[3]

(ii) Some people believe that this type of genetic testing should be compulsory for everyone.

Which of the following are **ethical** reasons why people might object to compulsory testing?

Put ticks (✓) in the boxes next to the **two** best **ethical** reasons.

Some people might be discriminated against when the test result is known.

Some people might find the test painful.

It will cost too much money to test everyone.

The results of the test might be inaccurate.

Everyone should have the right to choose whether they are tested or not.

[2]

5. Some people do not agree with fetal testing.

Suggest why.

[1]

7. Genetic testing can be used for screening adults, children and embryos for genetic disorders.

There are different reasons for genetic testing and the results can lead to different decisions.

Draw a straight line from each result of the test to a possible decision the person makes.

result of the test	possible decision
embryos are tested and one has a single allele for cystic fibrosis	to tell her children as soon as possible
a fetus has two alleles for cystic fibrosis	which embryo to implant
a fifty-year-old woman has one copy of the allele for Huntington's disorder	to have a termination
a twenty-year-old woman has one allele for Huntington's disorder	not to have any children

[3]

8. Two different sets of parents get the results of a genetic test.

Steve and Val are told their fetus has a type of genetic disease that causes brain damage and death during early childhood.

Mel and Jo are told their fetus has polydactyly.

Polydactyly is when a person has an extra finger or toe.

One consequence of genetic testing is to decide whether or not to have the pregnancy terminated.

Based on this information, each set of parents may make a different decision about terminating the pregnancy.

Suggest why.

[2]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1	a	i	C;	1	<p>Examiner's Comments</p> <p>Was often well answered, but an appreciable number of responses gave a list of letters rather than choosing one option.</p>
		ii	B;	1	<p>Examiner's Comments</p> <p>Was much better answered than 2bi, suggesting that candidates were clearer on the idea of what was a scientific question than they were on what was an ethical question.</p>
	b	i	38 or 39;	1	<p>accept 38 – 39 / 38 to 39</p> <p>Examiner's Comments</p> <p>Looked for candidates to read an age of 38 or 39 from the graph. A majority of candidates were able to do this. The most frequent incorrect response was 40, which suggests that some need more practice in this skill in data handling.</p>
		ii	<p><i>any two from:</i> the older the mother; the more likely to have a child with Down's; Or the rate of risk increases with age;</p> <p>little or no risk at 20–25 years of age; there is a higher risk after 35;</p>	2	<p>accept a positive correlation between age and risk</p> <p>Examiner's Comments</p> <p>Was well answered; it was encouraging to see so many candidates link both factors in the correlation.</p>
		iii	<p>ask patients how they feel use a larger sample size collect data for other genetic conditions collect data for other ages use smaller graph paper collect data from just one hospital</p> <div style="display: flex; align-items: center;"> <div style="margin-right: 10px;"> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> </div> </div>	2	<p>Deduct 1 mark for each additional incorrect response if more than 2 boxes are ticked. Minimum mark = 0</p> <p>Examiner's Comments</p> <p>More commonly yielded one mark rather than two. A notably frequent wrong answer was “collect data for other genetic conditions”. It was pleasing to see virtually all candidates place the correct number of ticks in the boxes even when they were selecting wrong options.</p>

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	iv	there is only a small chance of having Down's syndrome; but consequence is large / any qualification of consequence;	2	<p>accept "there is a 1% chance" for the first marking point consequences include cost, stress, challenging to parent, affects other family members, is a long term commitment.</p> <p>Examiner's Comments</p> <p>Asked for a comment about the small chance of having a Down's syndrome and also a comment about the large consequence of having such a child. Very few candidates seemed to realise that this was a question about risk and consequence.</p>

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	c	<p>Level 3 (5–6 marks) Includes several indicative scientific points from at least two or three areas. Quality of written communication does not impede communication of science at this level</p> <p>Level 2 (3–4 marks) Includes an indicative scientific point or points from at least two areas. Quality of written communication partly impedes communication of the science at this level.</p> <p>Level 1 (1–2 marks) Includes an indicative scientific point or points from at least one area. Quality of written communication impedes communication of the science at this level.</p> <p>Level 0 (0 marks) Insufficient or irrelevant science. Answer not worthy of credit.</p>	6	<p>This question is targeted at grades up to C.</p> <p>Indicative scientific points about implications of test may include:</p> <ul style="list-style-type: none"> • risk of miscarriage as a result of having the test • results may not be accurate • false positives and false negatives • risk of infection or harm to the foetus <p>Indicative scientific points about decisions may include:</p> <ul style="list-style-type: none"> • whether or not to have children • whether or not they would terminate a pregnancy • who to inform of their decision <p>Indicative scientific points about implications of not or after testing may include:</p> <ul style="list-style-type: none"> • financial implications of having a disabled child • stress on family if they have a disabled child • care issues / quality of life • test result could reveal other information eg paternity issues and other disorders • problems re employment • problems re insurance <p>Use the L1, L2, L3 annotations in SCORIS; do not use ticks.</p> <p>Examiner's Comments</p> <p>Was common to the higher tier paper. Many responses were limited to references to risks of the procedure such as the chances of miscarriage. The most common route to Level 2 was mention of a decision to terminate. Level 3 responses were few, and were again characterised by being clear and detailed.</p>
		Total	15	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
2	a	i	120 mins	1	Accept 2 hours
		ii	Any one from... Some will die idea of availability of resources idea that conditions throughout will vary	1	
		iii	(Bacteria) Quicker / cheaper	1	ORA
	b	i	A gene / genetic material / DNA Is transferred from one organism to another	2	Accept ref to 'vector' for transfer
		ii	Idea of providing more food / growing in a wider range of conditions / places / can grow all year round	1	Ignore ref to being able to grow in cold conditions (in stem) Examiner's Comments The calculation caused problems for many candidates, however, the parts concerning genetic modification were much answered more successfully.
			Total	6	
3	a		C before F; F before B; B before A; A before D;	4	(Correct order C F B A D) Examiner's Comments This was well answered indicating that many candidates knowledge of genetic modification was good.
	b		Can use herbicide on crop; to kill weeds; Crop not damaged;	3	Examiner's Comments There was a large problem in this question with candidates not knowing what a herbicide does. A number knew that it killed something but many were under the misapprehension that it killed insects.
			Total	7	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance														
4		i	<table border="1"> <tr> <td>Each drug works in the same way in every person.</td> <td></td> </tr> <tr> <td>Less money is wasted prescribing drugs that don't work.</td> <td style="text-align: center;">✓</td> </tr> <tr> <td>Doctors don't have to learn about so many drugs.</td> <td></td> </tr> <tr> <td>People won't have to visit the doctor anymore.</td> <td></td> </tr> <tr> <td>The drugs will always cure the patient from the disease.</td> <td></td> </tr> <tr> <td>It may reduce the number of people who suffer dangerous side effects.</td> <td style="text-align: center;">✓</td> </tr> <tr> <td>The doctor can adjust the dose of the drug to suit the patient.</td> <td style="text-align: center;">✓</td> </tr> </table>	Each drug works in the same way in every person.		Less money is wasted prescribing drugs that don't work.	✓	Doctors don't have to learn about so many drugs.		People won't have to visit the doctor anymore.		The drugs will always cure the patient from the disease.		It may reduce the number of people who suffer dangerous side effects.	✓	The doctor can adjust the dose of the drug to suit the patient.	✓	3	<p>All three correct for three marks Two correct for two marks One correct for one mark</p> <p>More than 3 boxes ticked, negate 1 mark for each additional tick.</p> <p>Examiner's Comments</p> <p>Candidates were asked to apply their knowledge of genetic testing to identify three benefits of genetically testing people before prescribing drugs. This question was answered well with most candidates gaining at least one mark and over half of all candidates correctly identifying all three benefits.</p>
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		ii	<table border="1"> <tr> <td>Some people might be discriminated against the test result is known.</td> <td style="text-align: center;">✓</td> </tr> <tr> <td>Some people might find the test painful.</td> <td></td> </tr> <tr> <td>It will cost too much to test everyone.</td> <td></td> </tr> <tr> <td>The results of the test might be inaccurate.</td> <td></td> </tr> <tr> <td>We all have the right to choose whether they are tested or not.</td> <td style="text-align: center;">✓</td> </tr> </table>	Some people might be discriminated against the test result is known.	✓	Some people might find the test painful.		It will cost too much to test everyone.		The results of the test might be inaccurate.		We all have the right to choose whether they are tested or not.	✓	2	<p>More than 2 boxes ticked, negate 1 mark for each additional tick.</p> <p>Examiner's Comments</p> <p>This question asked candidates to consider the ethical reasons why people might object to compulsory testing. Again this question was answered well with very few candidates failing to gain any marks on this question. Candidates scoring one mark on this question often did so for the response 'everyone should have the right to choose whether they are tested or not'.</p>				
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Some people might find the test painful.																			
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The results of the test might be inaccurate.																			
We all have the right to choose whether they are tested or not.	✓																		
			Total	5															
5			<p>unethical / fetus is a living things with rights / should not interfere with nature / may harm the fetus / baby / may cause a miscarriage (1)</p>	1	<p>allow religious argument do not allow vague references to harm ignore harm to mother / ideas about results being unreliable</p> <p>Examiner's Comments</p> <p>Generally this question was answered well. Common incorrect answers made reference to potential harm to the mother or the inaccuracy of the test.</p>														
			Total	1															

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
6	<p>[Level 3] Includes reference to getting the gene AND transferring the gene AND expressing the gene. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks)</p> <p>[Level 2] Includes reference to getting the gene AND transferring the gene OR getting the gene AND expressing the gene. OR transferring the gene AND expressing the gene. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks)</p> <p>[Level 1] Includes reference to getting the gene OR transferring the gene OR expressing the gene. Quality of written communication impedes communication of the science at this level. (1 – 2 marks)</p> <p>[Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	6	<p>This question is targeted at grades D to C</p> <p>Indicative scientific points may include:</p> <p>Getting the gene</p> <ul style="list-style-type: none"> • identify gene • isolate gene • replicate gene <p>Transferring the gene</p> <ul style="list-style-type: none"> • put gene into vector • example of vector eg virus / aerosol / plasmid / phage • explanation of how insertion occurs <p>Expressing the gene</p> <ul style="list-style-type: none"> • idea that DNA is common in all organisms <p><i>in humans</i></p> <ul style="list-style-type: none"> • transferred gene makes Factor 8 <p><i>in bacteria</i></p> <ul style="list-style-type: none"> • transferred gene makes Factor 8 • bacteria reproduce • isolate / purify Factor 8 / give people Factor 8 <p>If they inject bacteria into human, then max L2</p> <p>Use the L1, L2, L3 annotations in Scoris; do not use ticks.</p> <p>Examiner's Comments</p> <p>This six-mark extended-writing question produced a very disappointing response from the majority of the candidates. The key indicative science points about how the gene is obtained, transferred or expressed were either missing totally or explained in a very confused way.</p>

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
		Total	6	
7			3	<p>4 lines correct = 3 marks 2 or 3 lines correct = 2 marks 1 line correct = 1 mark</p> <p>2 lines from one box negates that mark</p> <p>Examiner's Comments</p> <p>This question tested candidates' ability to link up different results of tests with possible decisions. It was encouraging to see that candidates were able to link most of these correctly.</p>
		Total	3	
8		<p>idea that genetic disease / Steve & Val is much more serious / dangerous than polydactyly / Mel & Jo (1)</p> <p>(Steve & Val) May be more likely to have termination (1)</p>	2	<p>accept more life-threatening</p> <p>O.R.A.</p> <p>Examiner's Comments</p> <p>In this question, candidates were asked to explain why parents may make different choices regarding the termination of a foetus. Few candidates were able to explain the general idea that polydactyly was not as serious as brain damage and to therefore explain which couple may terminate the pregnancy.</p>
		Total	2	