

PEARSON EDEXCEL A-LEVEL BIOLOGY B • 9B10

BIOLOGY



EXAM QUESTION PACK

TOPIC 7: MODERN GENETICS
GENE TECHNOLOGY

SCORE

/110

PERCENTAGE

%

STEMUP

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Q1.

In July 2014, scientists announced that '*Tp12*-KO' knockout mice were resistant to inflammation of the spinal cord.

Describe what is meant by '*Tp12*-KO' knockout mice.

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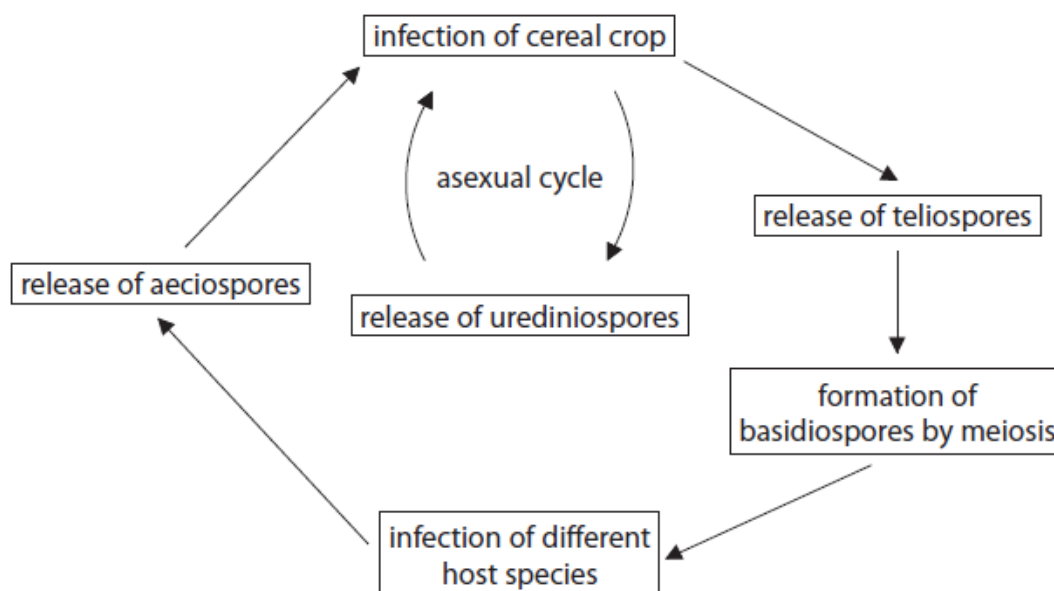
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Q2.

The stem rust fungus is responsible for destroying cereal crops and reducing grain yield.

The diagram shows some stages in the life cycle of the stem rust fungus.



Cereal crops have been genetically modified (GM) to produce plants that are resistant to stem rust fungus.

Analyse the diagram to deduce why the formation of basidiospores and urediniospores can produce a stem rust fungus to which these GM plants are no longer resistant.

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(Total for question = 3 marks)

Q3.

In July 2014, scientists announced that '*Trp12*-KO' knockout mice were resistant to inflammation of the spinal cord.

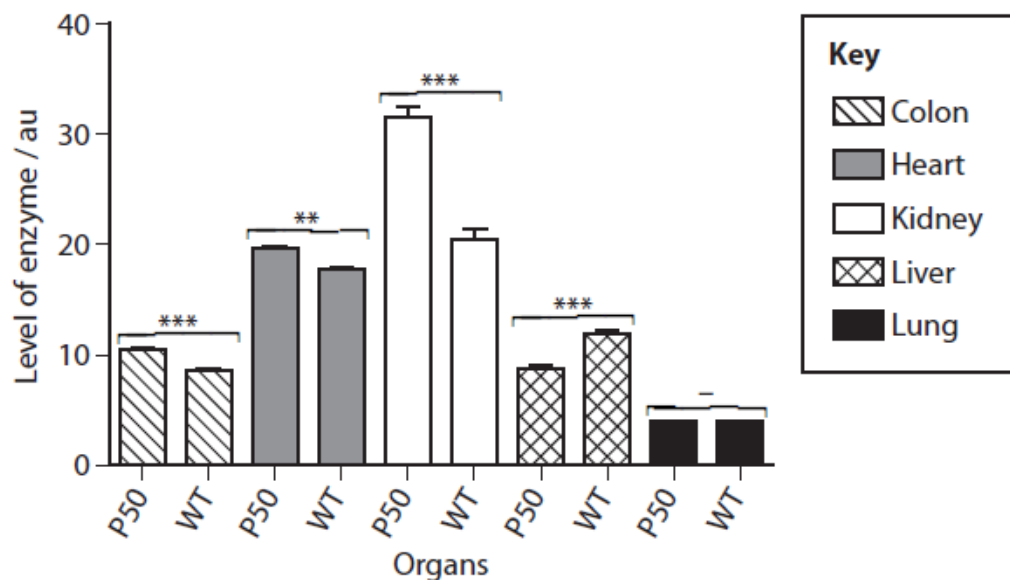
A different knockout mouse strain, called P50, has also been developed.

Premature ageing can be caused by overactive NAD dehydrogenase. This enzyme is found in mitochondria.

This enzyme can cause a build-up of superoxides that damage the mitochondria.

The graph shows the levels of NAD dehydrogenase in different tissues of P50 mice and in wild type (WT) mice. Significance levels for p are also shown.

*** $-p < 0.001$; ** $-p < 0.01$



Use the information in the graph to predict the probability of damage occurring to the mitochondria in the organs shown.

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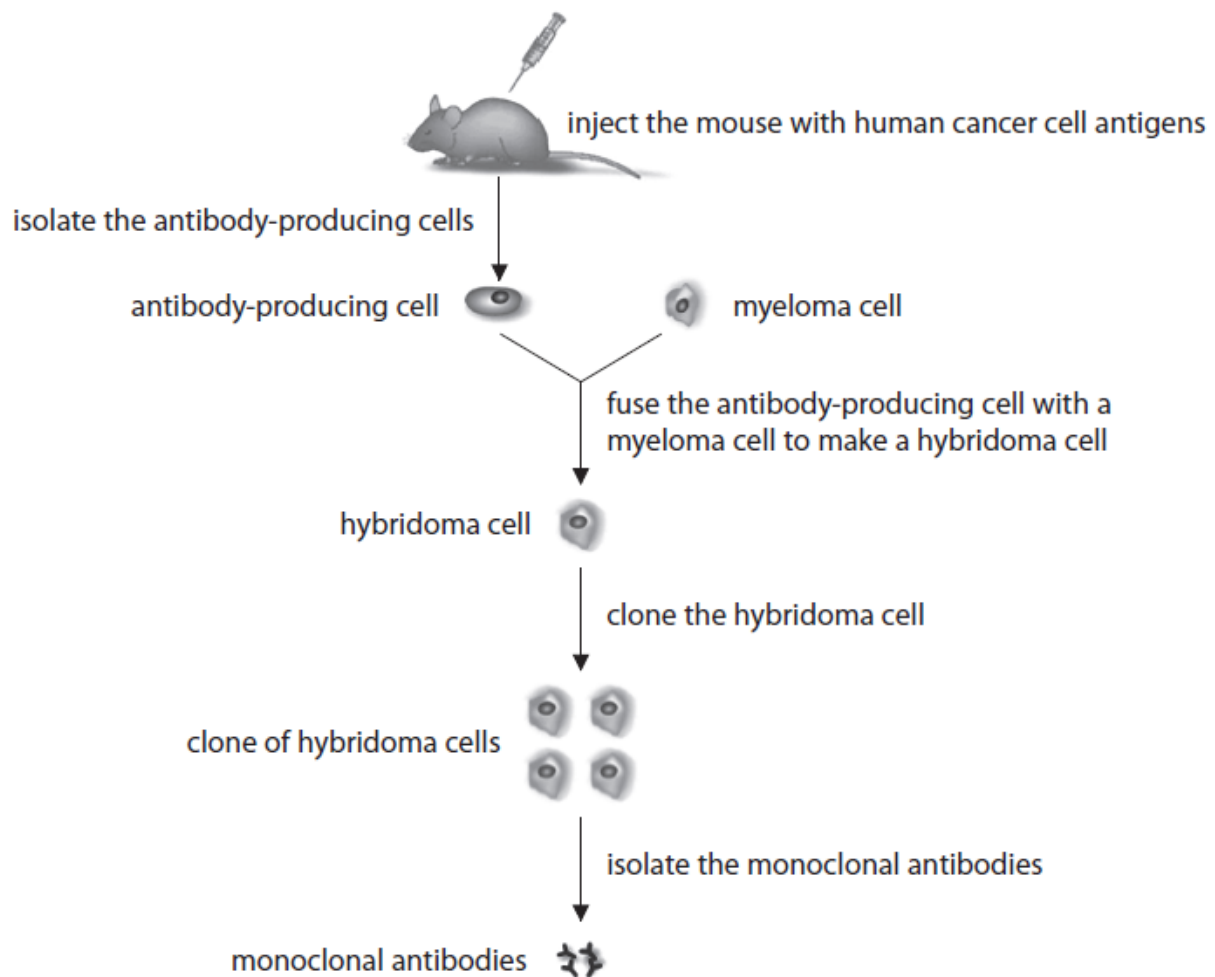
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Q4.

Monoclonal antibodies can be made against a wide range of different antigens. They are used in research and medicine.

Monoclonal antibodies are made by fusing an antibody-producing cell with a myeloma cell.

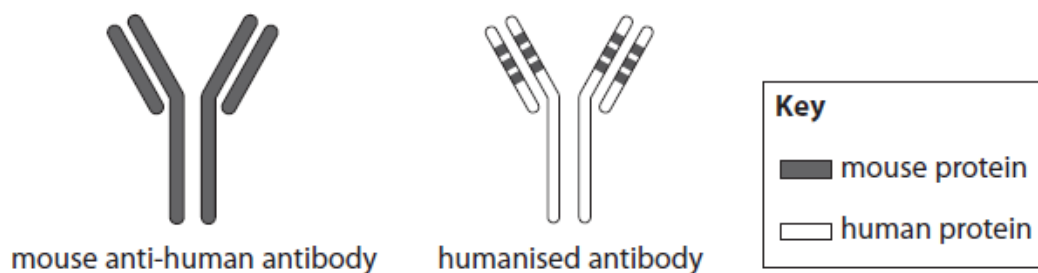
The diagram shows some of the steps involved in making monoclonal antibodies against human cancer cell antigens.



The antibodies made by this method are called 'mouse anti-human antibodies'. These antibodies are made by a mouse but are specific to human antigens.

Mouse anti-human antibodies are humanised using recombinant DNA methods.

The diagram shows a mouse anti-human antibody and a humanised antibody.



(i) Explain the advantages of using humanised antibodies in the treatment of cancer.

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* (ii) Explain why mouse anti-human antibodies need to be humanised in order to treat cancer.

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(Total for question = 9 marks)

Q5.

Plasmids with genes for resistance to antibiotics are widely used in gene technology. These plasmids are used to create recombinant bacteria.

Explain how culturing could be used to obtain recombinant bacteria.

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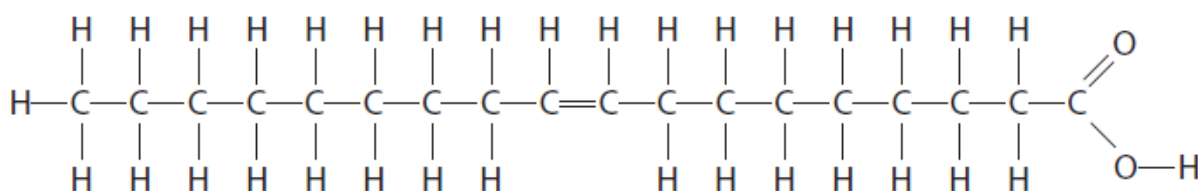
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(Total for question = 5 marks)

Q6.

Soya bean plants have been genetically modified (GM) to increase the concentration of certain organic molecules.

The diagram shows one of these molecules.



Describe how soya bean plants can be genetically modified to produce large numbers of GM soya bean plants.

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(Total for question = 4 marks)

Q7.

Malaria is a serious and sometimes fatal disease.

Scientists are constantly looking for new ways of controlling this disease.

One group of scientists has genetically modified a fungus to produce a spider toxin that kills mosquitoes.

Describe how a fungus could be genetically modified to produce spider toxin.

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(Total for question = 3 marks)

Q8.

Malaria is a serious and sometimes fatal disease.

Scientists are constantly looking for new ways of controlling this disease.

One group of scientists has genetically modified a fungus to produce a spider toxin that kills mosquitoes.

Another group of scientists has discovered a type of fungus that completely protects mosquitoes from infection by the pathogen that causes malaria.

This fungus does not kill the mosquitoes.

Explain why this approach is less controversial than the approach used by the scientists who are developing the genetically-modified fungus.

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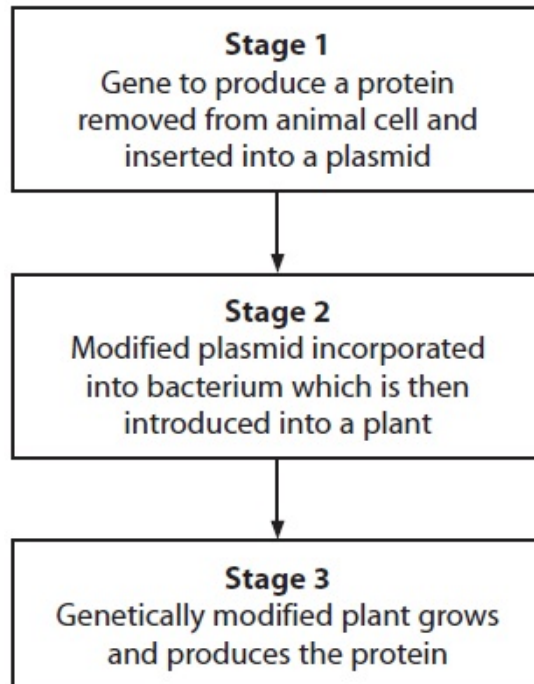
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Q9.

Some organisms have been genetically modified to produce proteins including hormones and vaccines.

The flow diagram below shows part of a process to produce a protein, using genetically modified plants.



(a) Describe and explain the role of the enzymes involved in stage 1.

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(b) Describe the structure of the modified plasmid used in stage 2.

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(c) Suggest why plants rather than bacteria are used to produce the protein in stage 3.

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(d) Describe **two** risks associated with the use of genetically modified organisms.

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(Total for question = 11 marks)

Q10. The scientific article you have studied is adapted from several sources.

Use the information from the article and your own knowledge to answer the following questions.

(a) The sweet potato eaten by naked mole rats (paragraph 3) is very rich in starch. Starch can be a combination of amylose and amylopectin.

Give **two** structural differences between amylose and amylopectin.

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(b) Explain why a colony of naked mole rats is considered 'a eusocial society' (paragraph 4).

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(c) Naked mole rats show evidence of poikilothermy (paragraph 5).

(i) Explain what is meant by the term **poikilothermic**.

(1)

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(ii) Suggest how each of the following 'contribute to poikilothermic responses to changing temperature of this mammal'.

(2)

'Lack of an insulating layer'

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'A marked reduction in sweat glands'

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Touching something hot, which could lead to a burn, can cause nerve impulses to travel along myelinated sensory neurones very rapidly.

Explain how myelination increases the speed of transmission of nerve impulses in a sensory neurone.

[illegible]

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(f) Explain how a heart attack can temporarily reduce the oxygen concentration in brain tissue (paragraph 36).

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(g) Using the information in paragraph 48, name **one** hormone **and** state its function.

(1)

Hormone:

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Function:

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(h) Suggest how a change in the mid region of the sperm may make it non-motile (paragraph 48).

(2)

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(i) Disperser naked mole rats 'are laden with fat' (paragraph 50).

Suggest why it may be advantageous for disperser naked mole rats to have high levels of fat.

(3)

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(j) Explain the statement that 'a preference by reproductively active females for unfamiliar males is interpreted as inbreeding avoidance' (paragraph 52).

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(k) 'The naked mole rat hasn't yet had its genome sequenced' (paragraph 53).

Explain what is meant by the term **genome sequenced**.

(1)

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(l) 'With so much to offer science, it is no surprise that naked mole rats are becoming more common in labs' (paragraph 53).

Using information from the article, describe **two** adaptations of naked mole rats. For each adaptation, explain why it could be of interest in a medical research laboratory.

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(Total for Question = 30 marks)

Q11.

Soya beans are an important crop for the production of food and oil.

A study of the nutritional content of soya beans from non-transgenic soya bean plants and from transgenic soya beans plants was carried out in two regions of Brazil.

The regions were Ponta Grossa and Londrina.

Tables 1 and 2 show the results of this study.

Table 1

Type of plant	Region	Mean mineral content / mg per 100 g dried soya beans		
		Iron	Copper	Manganese
Non-transgenic	Ponta Grossa	3.34	0.76	1.38
Transgenic	Ponta Grossa	3.44	0.86	1.40
Non-transgenic	Londrina	4.59	1.35	2.20
Transgenic	Londrina	4.15	1.25	2.02

Table 2

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(iii) Explain why this study also analysed the types of fatty acid found in soya beans from transgenic plants and from non-transgenic plants.

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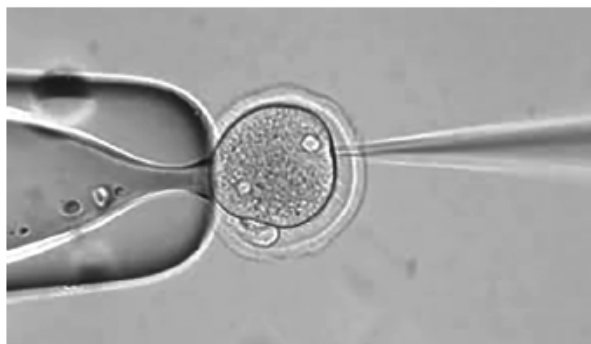
(Total for question = 13 marks)

Q12.

In July 2014, scientists announced that '*Tp12-KO*' knockout mice were resistant to inflammation of the spinal cord.

Genetic modification of mammals can be carried out using microinjection of recombinant DNA. Microinjection of DNA has a low success rate.

The photograph shows this technique being carried out using a micropipette.



In an investigation, 275 eggs were microinjected with DNA. Eight of these resulted in the birth of a live mammal, one of which was transgenic.

(i) Calculate the percentage success rate for producing transgenic offspring.

Give your answer to two significant figures.

(2)

Answer %

(ii) The success rate of DNA microinjection is lower in plants.

Plant cells have a cell wall and an internal turgor pressure. The micropipette used for DNA microinjection can cause a drastic loss of pressure and the plant cell dies.

An alternative technique is to place protoplasts into polyethylene glycol (PEG) containing the DNA. A protoplast is a plant cell with its cell wall removed.

PEG stimulates endocytosis.

This alternative technique had a success rate of up to 20% for producing genetically modified plants.

Analyse this information to explain why this alternative technique has increased the success rate of genetic modification.

(3)

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This image shows a full page of white paper with horizontal dashed lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

Q13.

Prothrombin is involved in the blood clotting process.

The *F2* gene codes for the synthesis of prothrombin.

A mutation of the *F2* gene causes thrombophilia, a condition that results in the production of excess prothrombin.

A genetic test can be used to find out if a person has thrombophilia.

The test involves using a restriction endonuclease to obtain genetic material from white blood cells.

This genetic material is then used in the polymerase chain reaction (PCR).

(i) State the role of a restriction endonuclease.

(1)

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(ii) Describe the process of PCR.

(3)

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(Total for question = 4 marks)

Q14.

The scientific article you have studied is adapted from articles in *Nature* and *Scientific American*.

Use the information from the article and your own knowledge to answer the question.

* Suggest how researchers had genetically modified the pathogen to 'provoke an effective immune response' (paragraph 12).

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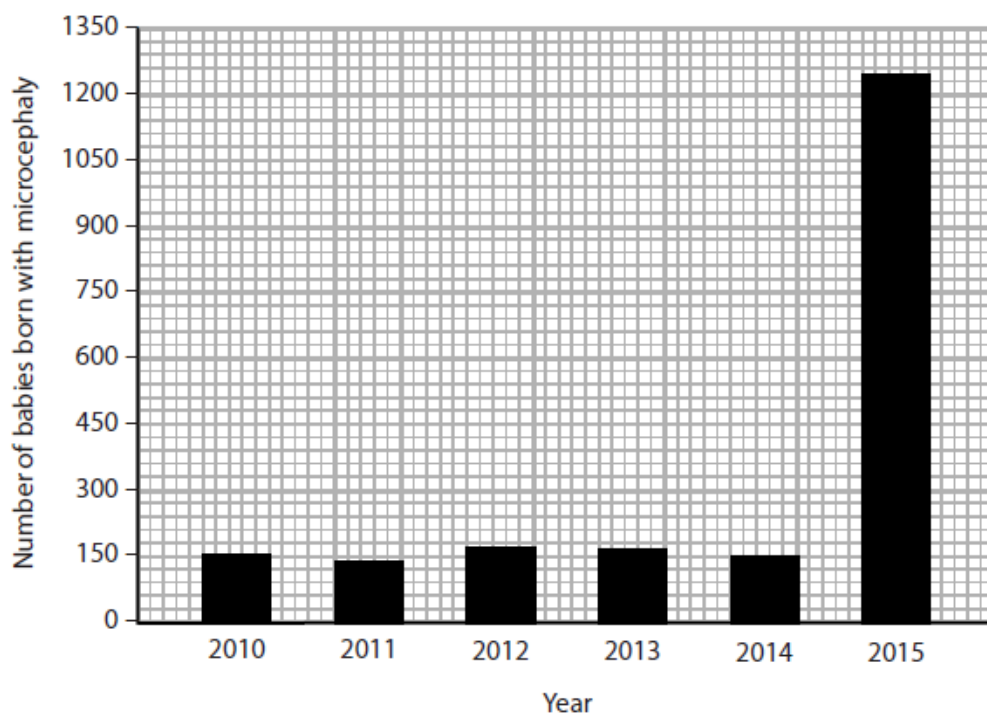
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Q15.

In February 2016, the World Health Organisation (WHO) declared a public health emergency because of the spread of the Zika virus.

The mild symptoms, such as joint pains, headaches and a slight temperature increase lasted only a few days. However, Zika virus has been linked to a birth defect called microcephaly.

The graph shows the number of babies born with microcephaly in Brazil from 2010 to 2015.



Zika virus is transmitted to humans by infected mosquitoes.

(i) Explain why another type of drug, rather than antibiotics, has to be used to treat Zika virus infections.

(2)

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(ii) Scientists have suggested that genetically modified (GM) mosquitoes could be used to help combat the spread of the Zika virus.

Mosquito eggs are injected with DNA, from GM mosquitoes. This DNA contains a gene for fluorescence. However, only one in a few thousand injected eggs results in a GM mosquito.

Explain how this procedure could help in the production of large numbers of GM mosquitoes.

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(iii) Explain why the Brazilian government has advised people to use mosquito nets, even if they have already contracted the Zika virus.

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Mark Scheme

Q1.

Question Number	Acceptable Answer	Additional guidance	Mark
	A description that makes reference to the following: - they are mice which have been genetically modified (1) <i>Tp12</i>-KO refers to a gene involved with inflammation of the spinal cord (1)		(2)

Q2.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to three of the following: - because {meiosis / sexual reproduction / basidiospore production} results in {genetically different fungi / variation} (1) - because of {crossing over / random assortment / independent assortment} (1) - because of mutation (in the DNA) (1) - the {asexual cycle / production of uredospore} results in more stem rust fungus that plants are not resistant to (1)	ACCEPT recombinants ACCEPT only in the context of causing variation DO NOT ACCEPT meiosis causes mutation ACCEPT clones of stem rust fungus that plants are not resistant to	

Q3.

Question Number	Acceptable Answer	Additional guidance	Mark
	An answer that makes reference to the following: • no significant difference in the damage to lung tissue between the two mice (1) • liver tissue in wild type mice is more likely to be damaged (1) • colon and kidney have the highest probability of damage in the knockout mice (1) • significant effect on heart tissue but lower probability than colon or kidney in the knockout mice (1)		(4)

Q4.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to the following: - humanised antibodies will not trigger an immune response / mouse antibodies could trigger an immune response (1) - antibodies would {bind to cancer cells so that macrophages could destroy the cancer cells / opsonise the cancer cells} (1) - the antibodies are target specific (1) - reducing the need for other {treatments / named treatment} (1)	Accept humanised antibodies will not be recognised as {foreign / as an antigen} / mouse antibodies could be recognised as {foreign / as an antigen} Accept antibodies will bind only to cancer cells Accept have less {side effects / named side effects}	(3)

Question Number	Indicative content
* (ii)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. Description: - mouse antibody is made of all mouse components - humanised antibody consists mostly of human components - mouse antibody recognised by the patient's immune system (rejection) - mouse protein acts as an antigen Consequence: - mouse antibody could be destroyed - mouse antibodies would not persist in the body - macrophages may not bind to mouse antibody - so phagocytosis of the cancer cells would not be enhanced - humoral / B cell immune response could be initiated - macrophages may phagocytose the mouse antibody Immunology: - details of how macrophage destroys antibody - macrophage becomes an antigen-presenting cell - T helper cells become activated - antibodies against the mouse antibodies could be produced (by plasma cells) Accept converse for humanised antibody throughout

Level 0	0	No awardable content
Level 1	1-2	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context. Description of mouse antibody resulting in rejection (Accept converse for humanised antibody throughout)
Level 2	3-4	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts to provide the explanation being presented. Lines of argument occasionally supported through the application of relevant evidence (scientific ideas, processes, techniques and procedures). The explanation shows some linkages and lines of reasoning with some structure. Details given on why the mouse antibodies may not be effective in treating the cancer (Accept converse for humanised antibody throughout)
Level 3	5-6	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts to provide the explanation being presented. Line(s) of argument supported throughout by sustained application of relevant evidence (scientific ideas, processes, techniques and procedures). The explanation shows a well-developed and sustained line of reasoning which is clear, coherent and logically structured. Explanation of how the mouse antibody could be destroyed by the immune system (Accept converse for humanised antibody throughout)

Q5.

Question Number	Acceptable Answer	Additional guidance	Mark
	An explanation that makes reference to five of the following: - the gene of interest is inserted into plasmids (1) - this plasmid has a marker gene for antibiotic resistance (1) - the recombinant bacteria will be resistant to this antibiotic (1) - the bacteria are grown on agar containing that antibiotic (1) - only the recombinant bacteria will grow (1) - use of replica plating to transfer recombinant bacteria to fresh medium (1)		(5)

Q6.

Question Number	Answer	Additional Guidance	Mark
	A description that makes reference to four of the following: • use of restriction enzyme to cut {gene / DNA / allele / plasmid} (1) • use of ligase to insert / join {gene / DNA / allele} (1) • use of vector (1) • use of plasmid / <i>Agrobacterium</i> / gene gun / virus / electroporation / microinjection (1) • use of cloning (1)	ACCEPT remove cell wall / produce a protoplast	(4)

Q7.

Question Number	Answer	Additional Guidance	Mark
	A description that makes reference to three of the following: • {gene / DNA / genetic material} coding for toxin isolated (from the spiders) (1) • using {restriction enzymes / (restriction) endonucleases} (1) • (spider) gene inserted into fungus using a {vector / named vector} (1) • genetically-modified fungi {identified / cloned / cultured} (1)	IGNORE references to fungi as plants throughout ACCEPT mRNA isolated and used to synthesise the gene / base sequence of gene determined and used to synthesise a gene ACCEPT in context of vector DNA e.g. virus / plasmid / gene gun / injection ACCEPT replicate / reproduce	(3) EXP

Q8.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to three of the following: • not unethical as mosquitoes not killed (1) • risk of other organisms being affected by the genetically-modified fungus is avoided (1) • organisms that feed on mosquitoes will not lose their food supply (1) • some people believe that modifying DNA is {wrong / unethical} (1)	ACCEPT converse for other approach e.g. toxins could harm other organisms, transfer of genes into other organisms ACCEPT unknown risks ACCEPT biodiversity maintained / ecosystems not disrupted / food chain not disrupted	(3) EXP

Q9.

Question Number	Answer	Mark
(a)	1. reference to {restriction enzyme / endonuclease} ; 2. to cut gene out of animal DNA ; 3. idea of amplification using DNA polymerase (in PCR) ; 4. (enzymes) open plasmid ; 5. (same endonuclease) to produce 'sticky ends' /description / at selected base sequence ; 6. H bonds formed between bases at 'sticky ends' ; 7. ligase ; 8. to join gene to plasmid / eq ; 9. reference to {phosphodiester / eq} bond ;	(5)

Question Number	Answer	Mark
(b)	1. (small) {circle /eq} of DNA ; 2. containing bacterial (survival) genes and {protein / animal} gene ; 3. marker gene / description given ;	(2)

Question Number	Answer	Mark
(c)	1. idea of easier to manage growth e.g. do not need sterile conditions ; 2. idea that it is safer (than bacteria) ; 3. idea of more protein can be made /eq ; 4. bacteria may not have correct amino acids to make protein / eq ; 5. idea that it could produce edible drugs ; 6. idea that plants have introns/bacteria do not so gene does not need modifying ; 7. idea that it is cheaper ;	(2)

Question Number	Answer	Mark
(d)	1. idea of gene transfer to other {species / eq} ; 2. idea of consequence of transfer e.g. resistance to pesticide / antibiotics, superweeds ; 3. idea of possible harmful effects from genes e.g. biochemical changes to substances that could act as allergens, long term effects of consuming ; 4. idea that benefit focused on developed countries / converse ; 5. idea of risk related to use of viral vectors ; 6. idea of effect on organic farmers ;	(2)

Q10.

Question Number	Answer	Additional Comments	Mark
(a)	1. only (alpha) 1-4 glycosidic bonds in amylose / (alpha) 1-6 only found in amylopectin ; 2. only amylopectin has side branches / only amylose is {coiled / eq} ; 3. Amylopectin is a {larger / eq} molecule than amylose ;	1. ACCEPT 1-6 and 1-4 in amylopectin	(2)

Question Number	Answer	Additional Comments	Mark
(b)	1. Different individuals in the {colony / eq} take on specific {roles / jobs / eq} ; 2. Example given e.g. queen produces offspring ;	1. Accept division of labour 2. Accept dominance by queen, {few of the males / kings} involved in breeding	(2)

Question Number	Answer	Additional Comments	Mark
(c) (i)	Idea that body temperature of animal mimics the ambient temperature ;	Accept body temp follows environmental temperature	(1)

Question Number	Answer	Additional Comments	Mark
(c) (ii)	1. Lack of insulating layer: Idea that does not impede transfer of heat energy / allows exchange of heat energy more easily ; 2. A marked reduction in sweat glands: Idea that they do not need to cool down OR less water lost ;	1. Accept enables heat transfer between environment and NMR	(2)

Question Number	Answer	Additional Comments	Mark
(d)	1. (Cancer causing) gene identified / eq ; 2. Gene {cut / isolated / eq} from DNA / eq ; 3. Using a {restriction / eq} enzyme / eq ; 4. Gene in {vector / named vector} ; 5. Mechanism for getting {gene/vector} into host cells (of mice) / eq ;	1. Accept screen for the gene 2. Accept extracted 3. Accept correctly named restriction enzyme e.g. EcoR1 4. Accept Named <u>egs</u> – retrovirus, virus, liposome, plasmid, bacteria 5. Accept reference to (micro)injection, <u>microprojectiles</u> , electroporation, gene gun, inhaler, transduction	(3)

Question Number	Answer	Additional Comments	Mark
* (e)	QWC – Spelling of technical terms (<i>shown in italics</i>) must be correct and the answer must be organised in a logical sequence 1. {<i>neurone</i> (cell) surface membrane exposed / no <i>myelination</i> / eq} at nodes of <i>Ranvier</i> ; 2. Nodes are the site of clusters of {<i>sodium-gated channel proteins</i> / <i>potassium channels</i>} ; 3. Which {open / close} when <i>impulse</i> arrives / eq ; 4. Allowing <i>depolarisation</i> at nodes / eq ; 5. idea that <i>myelin</i>/eq acts as an (electrical) <i>insulator</i> (on <i>neurone</i> surface between nodes) ; 6. reference to <i>Schwann</i> cell ; 7. idea that <i>impulse/depolarisation</i> 'jumps' to next node ; 8. Reference to this being <i>saltatory conduction</i> ; 9. idea that this happens between the <i>myelin</i> layers of the <i>Schwann</i> cell ;	QWC emphasis on spelling 3. Accept influx of sodium ions	(5)

Question Number	Answer	Additional Comments	Mark
(f)	1. idea of heart working less efficiently ; 2. idea of less oxygen absorbed at lungs / eq ; 3. less blood pumped to brain ; 4. concentration gradient (for oxygen) at brain reduced / eq ; 5. less oxygen in blood (in brain) diffuses into brain tissue / eq ; 6. idea of less oxygen in brain tissue due to continual (aerobic) respiration ;		(3)

Question Number	Answer	Additional Comments	Mark
(g)	~~gonadotrophin~~-releasing (hormone) stimulates ~~gonadotrophin~~ release / ~~gonadotrophin~~ stimulates ovulation / testosterone stimulates {sperm production / (male) secondary sexual characteristics / other named example} ;		(1)

Question Number	Answer	Additional Comments	Mark
(h)	1. Idea of effect on mitochondria ; 2. (therefore) reduced {energy / ATP / eq} for flagellum movement ;	1. Accept less efficient/fewer/ none 2. Accept tail for flagellum	(2)

Question Number	Answer	Additional Comments	Mark
(i)	1. idea that fat is an energy store ; 2. reduces dependence on external food source / eq ; 3. enables disperser to travel / eq ; 4. (metabolic) water is released (on oxidation) / eq ; 5. acts as a thermal insulator / eq ;	Accept energy-rich	(3)

Question Number	Answer	Additional Comments	Mark
(j)	1. idea that unfamiliar males are likely to be genetically different ; 2. idea that this is outbreeding ; 3. idea that this increases genetic diversity ;	3. Accept producing offspring that are genetically different	(2)

Question Number	Answer	Additional Comments	Mark
(k)	the order of the {bases / genes and non-coding sequences / eq} in the DNA (of the naked mole rats) is found / eq ;	Accept exons and introns Ignore genes unqualified	(1)

Question Number	Answer	Additional Comments	Mark
(l)	Paired responses: 1. reduced sensitivity to chemical pain / disconnection of 'pain nerves' ; 2. Idea of pain relief e.g. dealing with post traumatic pain, post surgical pain, joint pain after a knee operation ; 3. haemoglobin has higher affinity for oxygen ; 4. Idea of dealing with reduced oxygen situations such as due to a heart attack or stroke ; 5. Naked mole rat {incisors / eq} grow through skin (of lip) without damage ; 6. Idea of better prosthesis e.g. new {coatings / permanent seal} at {skin / bone / metal} interface, soft tissue not damaged, avoid infection ; 7. High protein stability / does not (easily) lose 3D shape ; 8. (so) reduced effect of oxidative {damage / stress} / reduced effect of oxygen-containing free radicals / live healthily into old age ; 9. Cell overcrowding early warning gene / ref. to two tiered contact inhibition / presence of gene p16 ; 10. Idea of cancer prevention e.g. cancer resistance, future cancer therapy ; 11. Naked mole rat neurones display immature {characteristics / physiological properties} / brain cells that cope with {low oxygen / hypoxia} ; 12. To treat people with temporary loss of oxygen to brain e.g. heart attack, stroke, drowning / to prevent permanent brain damage ; 13. High levels of oxytocin receptors in {brain / nucleus <u>accumbens</u> } ; 14. Idea of links to autism ; 15. Naked mole rats do not experience menopause ; 16. Ref to osteoporosis {treatment / prevention} (without side effects) ; 17. circadian rhythms / sleep patterns of naked mole rats ; 18. Idea that may help with sleep disorders ;	9. Accept anticancer mechanism	

Q11.

Question Number	Indicative content
* (i)	Answers will be credited according to candidates' deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. <u>Indicative content</u> Table 1 • Ponta Grossa: transgenic plants have higher mineral content than non-transgenic plants • Londrina: transgenic plants have lower mineral content than non-transgenic plants • Transgenic plants: plants grown in Ponta Grossa have lower mineral content than plants grown in Londrina • Non-transgenic plants: plants grown in Ponta Grossa have lower mineral content than plants grown in Londrina • Londrina: both types of soybean have more mineral content than both types in Ponta Grossa

	Table 2 • Ponta Grossa: transgenic plants have higher protein and lipid but lower carbohydrate content than non-transgenic plants • Londrina: transgenic plants have higher lipid but lower protein and carbohydrate content than non-transgenic plants • Transgenic plants: plants grown in Ponta Grossa have higher lipid but lower protein and carbohydrate content than plants grown in Londrina • Non-transgenic plants: plants grown in Ponta Grossa have higher lipid but lower protein and carbohydrate content than plants grown in Londrina • Londrina: both types of soybean have more protein and carbohydrate but lower lipid than both types in Ponta Grossa Examples of Conclusions • Londrina soybeans are (generally) the most nutritious • In Londrina, non-transgenic soybeans are more nutritious
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		• In Ponta Grossa, transgenic soybeans are more nutritious • Very little difference in nutritional content overall
Level 0	Marks	No awardable content
Level 1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one piece of scientific information. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context. 2 / 3 comparisons / conclusions
Level 2	3-4	An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows some linkages and lines of scientific reasoning with some structure. 4 / 5 comparisons / conclusions
Level 3	5-6	An explanation is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured. 6 / more comparisons and conclusions

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to five of the following: - Londrina (has a more fertile soil therefore the) soya beans will have a higher {mineral / mineral ion / ion / named mineral ion} content (1) - Londrina (has a more fertile soil therefore the) soya beans will have a higher protein content as there will be more nitrates (1) - Londrina has a higher temperature so {photosynthesis / Calvin cycle / carbon fixation} will be faster (1) - as {enzymes / RUBISCO} will {increase rate of reactions / have more kinetic energy} (1) - therefore making more {organic molecules / carbohydrate / named carbohydrate / protein} (1) - Londrina has a higher rainfall therefore more water for {photolysis / transport of minerals} (1)	ACCEPT {photosynthesise faster as more magnesium ions for chlorophyll / be stronger as more calcium ions for cell walls / more phosphate for ATP or nucleic acid synthesis} ACCEPT greater activity / work faster ACCEPT light-dependent reactions	(5)

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to the following: - to compare the fatty acids in the two types of soya bean (1) - so that {the (transgenic) soybeans will be less likely to increase the risk of heart disease / oxidation is less likely} (1)	ACCEPT to see if there were less saturated fatty acids / less linoleic acid / more oleic acid ACCEPT converse less likely to go rancid oleic acid less likely to oxidise than linoleic acid	(2)

Q12.

Question Number	Acceptable Answer	Additional guidance	Mark
(i)	An answer that makes reference to the following: - percentage calculated (1) - answer given to two significant figures (1)	<u>Example of calculation</u> $(1 \div 275) \times 100$ $= 0.36\%$	(2)

Question Number	Acceptable Answer	Additional guidance	Mark
(ii)	An answer that makes reference to the following: - PEG can stimulate the cell membrane because cell wall has been removed (1) - therefore recombinant DNA can be taken up by endocytosis (1) - and therefore microinjection is not needed so the cell does not die (1)		(3)

Q13.

Question Number	Answer	Additional Guidance	Mark
(i)	cut DNA to produce {short sections of DNA / short tandem repeats / mini satellites} (1)	Accept cut DNA into fragments / cut DNA to give sticky ends	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	A description that makes reference to three of the following: • use (DNA) primers / nucleotides (1) • use {high temperature / 95 °C} for 30 seconds (to separate DNA strands) (1) • use {lower temperature / 55 °C} for 20 seconds (to bind primers) (1) • heat to 72°C with polymerase (to replicate DNA) (1) • repeat process (to obtain many copies of DNA) (1)		(3)

Q14.

Question Number	Answer	Additional Guidance	Mark
*	(QWC – Spelling of technical terms must be correct and the answer must be organised in a logical sequence) 1. identify a gene that {provokes an effective immune response / codes for {antigen / eq} / inhibits <i>T. gondii</i> entering {brain/muscle}}	QWC with emphasis on clarity of expression	

	cells} ; 2. gene removed using a {restriction enzyme / endonuclease} ; 3. {same / this / eq} restriction enzyme used to open {<i>T. gondii</i> genome / eq} / eq ; 4. sticky ends {formed / eq} ; 5. ligase used to bind gene / eq ; 6. by forming phosphodiester bonds / eq ; 7. idea of method of introducing gene into pathogen ; 8. idea that gene needs to be expressed e.g. protein synthesised ; 9. idea of this protein in provoking an immune response ; 10. detail of immune response ;	3. NOT plasmid cut open 7. IGNORE plasmid 8. ACCEPT synthesises antigen	
			(6)

Q15.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to the following: - because viruses are {not living / not cells / have no metabolism / have no protein synthesis organelles / lack a cell wall / lack peptidoglycan} (1) - antiviral drugs used because they inhibit replication (1)		(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to four of the following: • identify mosquitoes that fluoresce (1) • because these mosquitoes are {genetically modified / contain the gene} (1) • allow {those that fluoresce / GM mosquitoes} to interbreed (1) • repeat for several generations (1) • offspring with the gene for fluorescence are selected to produce a population of GM mosquitoes (1)	Do not accept eggs	(4)

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to two of the following: • to prevent (people with Zika) being bitten (1) • therefore preventing {spread of Zika / biting uninfected people / increase in infected mosquitoes} (1) • mosquitoes spread other diseases (1)		(2)