PEARSON EDEXCEL A-LEVEL BIOLOGY B · 9BI0

BIOLOGY



MARK SCHEME

TOPIC 7: MODERN GENETICS

GENE TECHNOLOGY

SCORE	PERCENTAGE
/110	%

STEMUP

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(Total for question = 8 marks)

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) • *Tpl2*-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 / *Agrobacterium* / 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 egs – retrovirus, virus, liposome, plasmid, bacteria **5. Accept** reference to (micro)injection, microprojectiles, electroporation, gene gun, inhaler, transduction	**(3)**

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

	• 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 ÷ 275) × 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 *T. gondii* 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 {*T. gondii* 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)**