# Mark scheme

## Biotechnology and genetic modification

Biology 0610 · Questions from Paper 3 and Paper 4

Total marks

**97**

**MARKS FOR EACH QUESTION**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 8 | 8 | 9 | 10 | 10 | 10 | 11 | 12 | 14 | **97** |

## Question 1 [5]

| | | |
|---|---|---|
| 1 | organism ;<br>removing ;<br>bacteria ;<br>weeds ;<br>vitamin ; | 5 |

## Question 2 [8]

| | | | |
|---|---|---|---|
| 2 (a) | rapid reproduction ;<br>can make complex molecules ;<br>cheaper to produce ; | [max 2] | |
| (b) (i) | (contain ) enzymes;<br>break down / digests food molecules (in stain); | [2] | |
| (ii) | at high temperature enzymes, do not function / inactive / destroyed ;<br>enzymes more active at 30°C ;<br>AVP ; | [max 2] | **A** denatured<br>**R** enzymes die / killed<br>**A** optimum temperature is 30°C<br>e.g. 60°C uses more energy than 30°C |
| (iii) | enzymes are catalysts / not used up in the reaction ; | [1] | |
| (c) | lipase ; | [1] | |
| | | **[Total: 8]** | |

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## Question 3 [8]

| | | | |
|---|---|---|---|
| 3(a) | yeast ; | 1 | |
| 3(b)(i) | flour / starch / sugar / glucose / sucrose / carbohydrate ; | 1 | |
| 3(b)(ii) | respiration ; | 1 | |
| 3(b)(iii) | carbon dioxide ; | 1 | |
| 3(c) | *step 3 / 35 °C / low(er) temperature:*<br>optimum / best / suitable / AW, temperature for,<br>respiration / enzymes / gas production ;<br>to allow the dough to, rise / expand / AW ;<br><br>*step 5 / 200 °C / high(er) temperature*<br>organism **A** / microorganisms / yeast, killed / enzymes denature ;<br>to cook the dough ;<br>to allow ethanol to evaporate ; | 2 | |
| 3(d) | biofuels ;<br>wine / beer, making ;<br>penicillin / antibiotic (production) ;<br>AVP ;; | 2 | |

## Question 4 [9]

| | | | |
|---|---|---|---|
| 4(a)(i) | *any two from:*<br>rapid reproduction rate ;<br>ability to make complex molecules ;<br>**AVP** ; | 2 | e.g.no / low, ethical concerns |
| 4(a)(ii) | *any three from:*<br>to confer resistance to herbicides ;<br>confer resistance to, insect / pests ;<br>to increase, yield / product ;<br>to improve nutritional qualities ;<br>**AVP** ;; | 3 | e.g. confer resistance to pathogens / stress tolerance (drought or extreme temperatures) / increase shelf life |

**4(b)(i)**

| | |
|---|---|
| At pH 10, enzyme **B** is more active than enzyme **A.** | ✓ ; |
| Enzyme **A** and enzyme **B** are **not** active at pH 4. | |
| Enzyme **B** has a greater maximum activity than enzyme **A.** | |
| Enzyme **A** has a maximum activity of 33 arbitrary units. | ✓ ; |
| Enzyme **A** shows activity over a pH range of 6 to 10. | |
| The largest difference in activity between enzyme **A** and enzyme **B** is at pH 5. | ✓ ; |

3 — **R** each additional tick

| | | | |
|---|---|---|---|
| 4(b)(ii) | (enzyme) B ***and***<br>*idea of* only enzyme **B** is active at pH 9 / optimum of enzyme **B** is closer to pH 9 / AW ; | 1 | |

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## Question 5 [10]

| | | | |
|---|---|---|---|
| 5 (a) | Change the genetic material (of an organism) ;<br>By removing / changing / inserting (individual) genes ;<br>From one organism / species to another ; | [max 2] | |
| (b) (i) | rapid reproduction ;<br>can make complex molecules ;<br>cheaper to produce ;<br>ref. to no ethical issues ; | [max 2] | |
| (ii) | <table><tr><th>statement</th><th>uses genetic engineering?</th></tr><tr><td>producing fruit juice using pectinase</td><td></td></tr><tr><td>introducing genes into crop plants to provide additional vitamins</td><td>✓ ;</td></tr><tr><td>selective breeding to produce organisms with desirable features</td><td></td></tr><tr><td>placing a section of DNA into bacteria to produce human insulin</td><td>✓ ;</td></tr><tr><td>using yeast to produce ethanol</td><td></td></tr><tr><td>the use of contraceptive implants in birth control</td><td></td></tr></table> | [2] | 3 ticks–deduct 1 mark<br>4, 5 or 6 ticks = 0 marks |
| (c) (i) | to kill weeds;<br>to reduce competition, with weeds / for resources;<br>to increase crop yield; | [max 2] | |
| (ii) | (the weeds) kills them AW ;<br>(the crop plants)no effect / does not kill them ; | [2] | |
| | | **[Total: 10]** | |

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## Question 6 [10]

| | | | | |
|---|---|---|---|---|
| 6 | (a) (i) | amylase ; | [1] | |
| | (ii) | pH is a factor that influences / affects enzyme activity / AW;<br>to give the optimum pH ;<br>extreme pH could denature enzyme / **AW** ; | [max 1] | **ORA** |
| | (b) | *idea that* protease , would break down, enzymes / enzyme 2 ; | [1] | |
| | (c) | stable at high temperatures / does not denature at 60 °C / optimum temperature near 60 °C ; | [1] | **I** bears / tolerates hot temperatures<br>**I** heat resistant **I** ref to denatures > 60 °C |
| | (d) | **1** (bacteria grown in) fermenters ;<br>**2** (bacteria provided with) substrate / food (substances) / glucose / minerals / whey / waste substances / nutrients / culture medium / AW ;<br>**3** oxygen / aerobic conditions ; **A** air bubbled through<br>**4** (bacteria) grow / reproduce / increase in number ;<br>**5** enzymes, secreted / released / AW ;<br>**6** enzymes separated from, bacteria / mixture ; **A** ref to filtration<br>**7** AVP ; e.g. conditions – 26 °C / pH 5–6 | [max 3] | **A** extracted by crushing bacteria |
| | (e) | extracts more juice / speeds up juice extraction ;<br>pectin converted to sugars ;<br>so juice is sweeter ;<br>cell wall material is removed from juice / pectin digested to soluble product(s) ;<br>so the juice is clearer ;<br>AVP; humans don't produce pectinase i.e. humans can digest the juice. | [max 3] | **I** easier……. |
| | | | [Total:10] | |

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## Question 7 [10]

| | | | |
|---|---|---|---|
| 7 **(a)** | taking a, gene / DNA / allele, from one species ;<br>inserting it into another organism ;<br><br>OR<br><br>changing the, genetic material / chromosome of, an organism / cell ;<br>by removing / changing / inserting, genes / DNA / alleles ; | max [2] | |
| **(b)** | <table><tr><th>Letter from fig</th><th>Name</th><th>Description</th></tr><tr><td>**M**</td><td>chromosomes</td><td>threads of DNA found in the nucleus</td></tr><tr><td>**N**</td><td>gene / allele ;</td><td>section of DNA removed from human cell</td></tr><tr><td>**Q**</td><td>plasmid</td><td>vector / loop / circle, of DNA (that can carry a foreign section of DNA) / separate piece of DNA (from chromosome) ;</td></tr><tr><td>**R**</td><td>bacterial (cell) ;<br>**A** yeast</td><td>type of cell that is genetically engineered</td></tr><tr><td>**O**</td><td>insulin / protein ;</td><td>specific chain of amino acids coded by the section of DNA removed from the human cell</td></tr><tr><td>**P**</td><td>fermenter</td><td>(container in which) bacteria / microorganisms / cells, reproduce / grow / produce insulin ;</td></tr></table> | [5] | |

| | | | |
|---|---|---|---|
| **(c)** | clone / (genetically) identical ;<br>rapid / less energy to reproduce (asexually) / only one parent / no gametes ;<br>large quantity of insulin produced ;<br>all bacteria, have the insulin gene / produce insulin ;<br>same insulin produced ;<br>once cells are engineered does not have to be repeated ;<br>AVP ; e.g. cheap / ethical *or* religious reasons / less allergic reaction / no immune rejection / more efficient / no risk of disease (transmission) | max [3] | **A** no variation<br><br>only accept in context of comparisons with animal insulin extraction methods |
| | | **[Total: 10]** | |

## Question 8 [11]

| | | | |
|---|---|---|---|
| **8**(a) | **1** nucleus / chromosome(s) **;**<br>**2** bases **;**<br>**3** protein **;**<br><br>**4** genes / alleles **;**<br>**5** same **;**<br>**6** sticky **;**<br><br>**7** recombinant **;**<br>**8** bacteria / vectors / viruses / yeast / (prokaryotic / host) cells **;**<br>**9** insulin **;** | **9** | |
| **8**(b) | washing powders **;**<br>(pectinase) for (fruit) juice production **;**<br>(lactase) for lactose-free milk **;**<br>AVP **;** | **2** | |

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## Question 9 [12]

| | | | |
|---|---|---|---|
| **9**(a)(i) | restriction (enzyme) ; | **1** | |
| **9**(a)(ii) | sticky ends ; | **1** | |
| **9**(a)(iii) | plasmid is cut with the same (restriction) enzyme (as DNA) ;<br>to form, sticky ends / region **A**, that are complementary to sticky ends of, gene / *cry* ;<br>*reference to* base sequences (being complementary / AW) ;<br>(DNA) ligase used to join plasmid and, *cry* / gene ;<br>AVP ; e.g. formation of recombinant DNA / plasmid | **3** | |
| **9**(b) | gene / *cry*, codes for the sequence of amino acids in, (toxic) protein ;<br>DNA / gene / *cry*, is copied / transcribed, to form mRNA ;<br>*cry* / gene / DNA, remains in nucleus ;<br>mRNA moves from nucleus to, cytoplasm / ribosome ;<br>mRNA passes through ribosomes / AW ;<br>ribosomes assemble amino acids (into protein molecules) ;<br>ribosomes make proteins ;<br>AVP ; e.g. order of amino acids determined by base sequence of, mRNA / DNA / gene | **4** | |
| **9**(c) | to kill / harm / deter, caterpillars / insects / pests ;<br>higher yield / reduce losses due to, (certain) caterpillars / insects / pests ;<br>higher quality of cotton ;<br>use less insecticide ;<br>(so) less pollution ;<br>(so) less money spent on, insecticides / spraying ;<br>(so) less risk to workers' health (from using insecticides) ;<br>(so) less chance of insecticide resistance ;<br>AVP ; | **3** | |

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## Question 10 [14]

| | | | |
|---|---|---|---|
| **10**(a)(i) | bacteria ; | **1** | |
| **10**(a)(ii) | antibiotic ; | **1** | |
| **10**(b)(i) | *any two from:*<br>nucleus ;<br>mitochondria ;<br>(r)ER ;<br>vacuole ;<br>AVP ; | **2** | e.g., hyphae / structure of cell wall |
| **10**(b)(ii) | *Penicillium* ; | **1** | |
| **10**(b)(iii) | *any two from:*<br>glucose ;<br>ammonia / amino acids ;<br>(named mineral) salts / ions ;;<br>water ; | **2** | |
| **10**(b)(iv) | stops the growth of microorganisms / AW ; | **1** | **A** prevent contamination |
| **10**(b)(v) | *any two from:*<br>release of, waste gas / carbon dioxide ;<br>(carbon dioxide / gas) is produced during fermentation / respiration ;<br>to prevent fermenter exploding / to reduce pressure ;<br>carbon dioxide is toxic (to fungus if it builds up) ; | **2** | |
| **10**(b)(vi) | *any four from:*<br>1 (step 4) is reproduction (of **A** before adding to fermenter) ;<br>2 (step 5) inoculation in a fermenter / AW ;<br>3 (step 6) exponential growth (of organism **A** in fermenter) ;<br>4 sampling to check when penicillin is ready ;<br>5 penicillin is, a byproduct of maximum growth / a toxin / fermentation ;<br>6 (step 7) cells / product / penicillin, are removed ;<br>7 (step 8) purification / filtering / described ;<br>8 idea of packaging of penicillin ;<br>9 AVP ; | **4** | **A** idea of adapting to environment<br><br>**A** drying / AW<br><br>e.g., batch cultures (described) / limited resources / stationary phase triggers production of penicillin |

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