8.4 The control of gene expression (A-Level Only) - Gene technologies 2 – Mark schemes

Q1.

(a) (i) transfer / carry genes from one organism to another / into bacteria / cells;

1

(ii) cut open plasmid;
cut donor DNA, to remove gene / length of DNA;
cut donor DNA and plasmid with the same enzyme / enzyme that cuts at the same base sequence;
sticky ends / (overhanging) ends with, single strand / bases exposed;
association / attachment / pairing of complementary strand;

2 max

(iii) annealing / splicing / backbones joined / phosphodiester bonds;

1

(b) (i) L and M;

1

(ii) fragments 64 and 36(kilobases obtained)

1

[6]

Q2.

1 DNA heated to 90 to 95°C;
2 strands separate;
3 cooled / to temperature below 70°C
4 primers bind;
5 nucleotides attach;
6 by complementary base pairing;
7 temperature 70 - 75°C;
8 DNA polymerase joins nucleotides together;
9 cycle repeated;

6 max

[6]

Q3.

(a) (i) restriction (endonuclease) enzyme;

cuts DNA at specific / restriction points / after specific base sequence;

2

(ii) PCR / polymerase chain reaction;

1

(b) isolated cells divide by mitosis;
can get many plants (producing toxin) / rapid production of (toxin producing) plants;

all cells (in the new plant / clone) will produce the toxin;

3

[6]

Q4.

(a) (i) to separate polynucleotide strands / form single strands;

1

(ii) not denatured (at 95°C);

1

(iii) for binding of primers / nucleotides (to DNA strands);

1

(b) (i) doubling (of DNA) each cycle;
but very low numbers to start with, so appears flat then exponential growth;

2

(ii) suggestion; with explanation e.g.:

nucleotides being used up;
so less / nothing to make complementary chains;

primers used up;
so cannot start complementary chains;

enzymes losing activity / denatured;
so no polymerisation of complementary strands;

2 max

[7]

Q5.

(a) to separate the two strands / break hydrogen bonds;

1

(b) (i) enables replication / sequencing to start (*allow keeps strands separate*);

1

(ii) joins DNA nucleotides (*not complementary bases*);

1

(c) (i) 64;

1

(ii) replication of DNA from crime scene / tissue sample / for DNA sequencing / gene cloning;

1

(d) (transcription uses) RNA polymerase;
RNA nucleotides / uracil;
one (template) strand / PCR both strands;
start / stop codons;
(*accept enzyme separates strands*)

2 max

[7]

Q6.

(a) (cut out gene using an) endonuclease / restriction enzyme;
reference to specificity / recognition site;
sticky ends;
use the same enzyme to cut;
plasmid / virus / potato DNA;
fixed by ligase;
method of introducing vector e.g. micropipette / virus injects DNA / remove plant cell wall;

6 max

(b) different genes are expressed;
producing different enzymes / proteins;

2

[8]

Q7.

(a) Presence of resistant and non-resistant varieties / mutation produces resistant variety;
Resistant ones survive / non-resistant ones killed by treatment;
These will reproduce and produce more resistant parasites / pass on resistance allele;

3

(b) Likelihood of being infected (by strain resistant to both drugs) is less;
1/500 × 1/500/1/250 000;
Drug has longer effective life;

max 2

(c) (i) As comparison / to show that nothing else in the treatment was responsible;

1

(ii) Given injections of saline / injection without SPf66;
(otherwise) treated the same as experimental group;

2

(d) (i) 100%;

1

(ii) 10%;

1

(e) (i) Different lengths of DNA have different base sequences / cut at specific sequence;
Results in different shape / different shape of active site;
Therefore (specific sequence) will only fit active site of enzyme;

3

(ii) Recognition sites contain only AT pairs;
Which would occur very frequently;

2

[15]

Q8.

(a) 1 macrophages present antigens to B lymphocytes;
2 antigen binds to / is complementary to receptors on lymphocyte;
3 binds to a specific lymphocyte;
4 lymphocytes become competent / sensitised;
5 (B) lymphocytes reproduce by mitosis / (B) lymphocytes cloned;
6 plasma cells secrete antibodies;

4 max

(b) 1 restriction enzyme / endonuclease;
2 to cut plasmid / to form sticky ends in plasmid;
3 (use) ligase(to join) gene to plasmid;
4 culture bacteria with (in medium containing) plasmids
5 to allow uptake of plasmids / transformation;
6 use of cold shock / chemical treatment (to enhance uptake) / heat shock;
(ignore bullets / electroporation / microinjection)

3 max

[7]

Q9.

(a) probe will attach (to mutant allele);
attaches to one DNA strand;
as a result of complementary base pairing;
radioactivity detected on film / X-ray / by autoradiography (if mutant allele present);

4

(b) *for*
gene is only active in mammary cells / only affects milk / easy to obtain product / product produced in large amounts / gene passed to offspring;

1

against
long term effects not known / qualified reference to animal exploitation e.g. use of embryos / effect of inserted gene on other sheep tissues / genes;

1

[6]

Q10.

(a) introduction of healthy gene / 'replacement' of defective gene;

1

(b) can enter cells / infect cells / inject DNA into cells;
targets specific cells;
replicates (in cells);

2

(c) reproductive cells / gamete cells do not contain ADA allele / gene;

1

(d) (i) to 'prevent' rejection / immune response;

1

(ii) T lymphocytes have a limited life span / die off / do not reproduce;
bone marrow provides continual supply of T lymphocytes /
(ADA) gene enzyme;

2

[7]

Q11.

(a) isolate wanted gene / DNA from another organism / mRNA from cell / organism;
using restriction endonuclease / restriction enzyme / reverse transcriptase to get DNA and produce sticky ends;
use ligase to join wanted gene to plasmid;
also include marker gene e.g. antibiotic resistance;
add plasmid to bacteria to grow (colonies)then (replica) plate onto medium where the marker gene is expressed;
bacteria / colonies not killed have antibiotic resistance gene and (probably) the wanted gene;

6

(b) (i) injection, rapid rise and fall;
virus, slower rise and longer in effective / harmful range;
capsule slowest rise, longest in effective / harmful range;
injection and virus give harmful concentrations but capsule does
not;

3 max

(ii) advantage e.g.:
substance never reaches harmful levels / no side effect / less likely to harm the organism, longer relief from symptoms / less frequent treatment needed / longer effective range / longer but without harmful side effects;

1 max

disadvantage e.g.:
takes longer to take effect;

1

[11]

Q12.

(a) use restriction enzyme / endonuclease / named, e.g. Bam / Eco;
to cut DNA in specific place / base sequence;

2

(b) heat DNA to 90 – 95 °C;
strands separate;
add primers;
and nucleotides;

cool so that primers bind to DNA;
(DNA) polymerase forms new strands / joins nucleotides;

4 max

(c) (i) virus is inhaled / sprayed into the lungs;
gets into cells, inserting the healthy gene;

2

(ii) makes DNA from RNA
rather than other way round

1

[9]

Q13.

(a) (i) Amount of mRNA > amount of DNA / multiple copies of mRNA;

Insulin mRNA/the specific mRNA is found in pancreas cells;

Introns / non-coding information present in DNA / these removed in mRNA / corr. ref. post-transcriptional modification;

2 max

(ii) Enzyme 1 = reverse transcriptase;

Enzyme 2 = (DNA)-polymerase;

2

(iii) Hydrogen (bonds) / H-(bonds);

1

(b) (i) Primers;

1

(ii) To allow H-bond re-formation / to allow joining of primers/P (and Q) to (single-stranded) DNA / converse re. high temp. breaks H-bonds / prevents joining;

1

(iii) To mark region of DNA to be 'copied' / to show enzyme where to start;

(Enzyme) needs starting strand onto which to attach nucleotides;
Allow idea of extending pre-existing chain

2

(iv) 32;

1

[10]

Q14.

(a) Correct answer: 1.25;
Ignore working

OR (if wrong answer)

$$\frac{\text{measurement in } \mu m}{40000} \; / \; \frac{\text{measurement in mm}}{40} = 1 \text{ mark}$$

125 but wrong order of magnitude = 1 mark

2

(ii) **C** has myosin / thick (and actin / thin) filaments;

OR

A has only actin / thin (/ no myosin / no thick) filaments;

1 max

(b) When contracted:

Thick & thin filaments/myosin & actin overlap more;

Interaction between myosin heads & actin / cross-links form;

Movement of myosin head;

Thin filaments / actin moved along thick filaments / myosin;

Movement of thin filaments / actin pulls Z-lines closer together;

Displacement of tropomyosin to allow interaction;

Role of Ca^{2+};

Role of ATP;

Allow ref. to 'sliding filament mechanism' / described if no other marks awarded

4 max

(c) (i) 8 has DMD but 3 and 4 do not / 12 has DMD but 6 and 7 do not / neither parent has the condition but their child has;

Allow parents 3 and 4 give 8, parents 6 and 7 give 12

1

(ii) 4 ***AND*** 7;

1

(iii) Parental genotypes: 6 = $\mathbf{X^DY}$ AND 7 = $\mathbf{X^DX^d}$

AND

Gametes correct for candidate's P genotypes – e.g.

$\mathbf{X^D}$ and $\mathbf{Y}$ + $\mathbf{X^D}$ and $\mathbf{X^d}$;

Offspring genotypes correctly derived from gametes e.g.

$X^DX^D + X^DX^d + X^DY + X^dY$;

Male offspring with MD correctly identified: X^dY;

Probability = 0.25 / correct for candidates offsprings genotypes;

Accept ¼ / 1 in 4 / 1:3 / 25%

NOT '3:1' / '1:4'

4

(d) (i) No gene fragment **G**;

1

(ii) Only one copy of gene fragment **F**;

Male has only one X-chromosome / is XY
(c.f. female has two / is XX);

2

(iii) 10 has only one copy of gene fragment **G**;

10 has only one normal X-chromosome / has one abnormal / has only one normal allele / has one X^d / is X^DX^d / is heterozygous;

11 has two normal X-chromosomes / has 2 normal alleles / is X^DX^D / has not got X^d / has 2 copies of (F and) G;

3

(e) (i) To prevent rejection / prevent antibody production vs. injected cells / injected cells have (foreign) antigen (on surface);

1

(ii) Shows effect of <u>cells</u> / not just effect of injection / not just effect of salt solution;

1

(iii) Only one person tested so far – need more to see if similar results / need more to see if reliable;

Need to assess if new (dystrophin positive) muscle fibres are functional / if muscle becomes functional;

Can't tell how widespread effect is in the muscle / sample taken near injection site;

Need to test for harmful side effects;

Need to test if successful for other mutations of dystrophin gene;

Need to assess permanence / longevity of result/insufficient time allowed in investigation;

(In this patient) only small response / %;

Further sensible suggestion;

4 max

[25]

Q15.

(a) Restriction enzyme / restriction endonuclease;

1

(b) (i) A-G-C-T / T-C-G-A;

Allow A-G-C-T-T / T-T-C-G-A

1

(ii) Joining two pieces of DNA;

By complementary binding/complementary base-pairing;

2

(c) (i) 4943;

1

(ii) 3;

1

(iii) 2 bands disappear / only 3 bands;

New band formed at heavier position/nearer to origin/higher up;

2

[8]

Q16.

(a) Cocaine (binding) changes shape of transporter/prevents dopamine binding;

Reject references to active site

Transporter cannot move (bound) dopamine (through membrane / protein / into cell);
Dopamine remains / builds up in synapses (leading to feelings of pleasure);

3

(b) (i) Polymerase chain reaction / PCR;

1

(ii) Single-stranded DNA;

Reject reference to a single strand of DNA

Bases / sequence complementary to DNA / gene to be identified;

(Radioactively / fluorescent) labelled so that it can be detected;

2 max

(c) Mutation changes base sequence of gene / DNA;

Accept references to active site

(Thus) changing amino acid sequence;
Changes tertiary structure / shape of protein/transporter;
Cocaine binding site changes/cocaine cannot bind;
Dopamine can still bind (and be transported);

3 max