A-Level Biology

Gene Technologies

Mark Scheme

Time available: 74 minutes
Marks available: 53 marks

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1.

(a) 1. (Requires DNA fragment) DNA polymerase, (DNA) nucleotides and primers;

2. Heat to 95 °C to break hydrogen bonds (and separate strands);
Accept temperature in range 90 to 95 °C.

3. Reduce temperature so primers bind to DNA/strands;
Accept temperature in range 40 to 65 °C.

4. Increase temperature, DNA polymerase joins nucleotides (and repeat method);
Accept Taq polymerase for DNA polymerase.
Accept temperature in range 70 to 75 °C.

4

(b) 1. (Initially) number (of molecules) doubling is low

OR

Doubles each cycle to produce exponential increase;
First alternative relates to idea of low numbers i.e., 2, 4, 8, 16, 32 etc.

2. Plateaus as no more nucleotides/primers;
Accept 'levels out' or 'flattens' for plateaus.
Accept enzyme/polymerase (eventually) denatures.

2

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2.

(a) 1. Extract DNA and add restriction endonucleases/restriction enzymes;

2. Separate fragments using electrophoresis;

3. (Treat DNA to) form single strands

OR

(Treat DNA to) expose bases;
Ignore method used to separate strands

4. The probe will bind to/hybridise/base pair with the *SUT1*/gene;

5. Use autoradiography (to show the bound probe);
Accept use photographic or X ray film (to show the bound probe)
X rays alone is not sufficient

4 max

(b) 1. Antisense mRNA is <u>complementary</u> to 'sense' mRNA;

2. Antisense mRNA would bind/base pair to (sense) mRNA;

OR

Double stranded (m)RNA forms;

3. Ribosomes would not be able to bind;

4. Preventing/less translation (of mRNA)

OR

Preventing/less production of SUT1 (protein);

Accept descriptions of translation

4

(c) $0.4\ (3\dot{1}\dot{8})$**:1;**

Accept any suitable rounding

1

(d) 1. Some ($^{14}CO_2$) used to make cellulose/cell walls;

Accept some becomes lipids/ proteins/DNA/RNA/ nucleotides

2. Some ($^{14}CO_2$) converted into starch (which remains in the leaf);

Accept some ($^{14}CO_2$) converted into glucose

3. Not all ($^{14}CO_2$) fixed/used in photosynthesis;

OR

Not enough RuBP (to combine with all of the $^{14}CO_2$);

Accept descriptions of this

4. Some used to reform RuBP

OR

Some (is still) in glycerate 3-phosphate/GP/triose phosphate/in the Calvin cycle;

2 max

(e) 1. Reduced *SUT1* expression/less SUT 1 (protein) means less sucrose exported (so concentration increases in leaves);

2. (Increased sucrose in leaves) inhibits rubisco, so less $^{14}CO_2$ fixed into GP;

OR

(Increased sucrose in leaves) inhibits rubisco, so less $^{14}CO_2$ combines with RuBP;

OR

(Increased sucrose in leaves) inhibits rubisco, so less Calvin cycle/light independent reaction/s;

Accept less rubisco or less active rubisco for 'inhibits rubisco'

3. Less sucrose transported to roots, so roots do not develop/grow (as shown by larger shoot to root dry mass ratio);

4. Roots less developed so fewer minerals available for growth

Accept: roots less developed so less water available for photosynthesis

5. Less growth means less dry mass;

Accept: less photosynthesis/light <u>in</u>dependent reaction/s means less dry mass;

4 max

[15]

3. (a) 1. (Short) single strand of DNA;

2. <u>Bases</u> complementary (with DNA/allele/gene);

2

(b) 1. <u>Restriction</u> endonuclease/enzyme;

2. (Cuts DNA at specific) base sequence
OR
(Breaks) phosphodiester <u>bonds</u>
OR
(Cuts DNA) at recognition/restriction site;

Accept palindromic sequence.

2

(c) (So DNA) probe binds/attaches/anneals;

1

(d) 1. (Lane 1 has DNA fragments) of known sizes/lengths;

2. Compare (position of viral fragment/s);

2

(e) 3, 4, 5 with these numbers in any sequence;

All three numbers required.

Reject if more than three numbers given.

1

[8]

4.

(a) 1. (If injected into egg), gene gets into all / most of cells of silkworm;
2. So gets into cells that make silk.

2

(b) 1. Not all eggs will successfully take up the plasmid;
2. Silkworms that have taken up gene will glow.

2

(c) Promoter (region / gene).

1

(d) 1. So that protein can be harvested;
2. Fibres in other cells might cause harm.

2

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5.

(a) (i) Restriction endonuclease;

1

(ii) (DNA) ligase;

1

(b) (For those plants that contained the desired gene in the nucleus/plant DNA)

1. (DNA of desired gene) copied/replicated with host DNA/inside nucleus;
2. Passed on by mitosis/plant grows by mitosis;
3. Produces genetically identical cells/clones;

Ignore references to protein synthesis or plasmids not taking up the gene

1. Accept DNA replication during mitosis

1. and 2. Accept converse for plants with the gene in the cytoplasm

3. Neutral 'identical unqualified'

3. Accept description, e.g., DNA is the same

3

(c) 1. Genetic code is universal/triplets in DNA always code for same amino acid;
2. It/insect DNA can be transcribed;
3. Can be translated (process/mechanism same in all organisms/cells);

2. Accept (basic) transcription (process/mechanism) same in all organisms/cells;

2. Accept descriptions of process

3. Accept descriptions of process

3

[8]

6.

(a) Produces (c)DNA using (m)RNA;

Accept: 'converts' (m)RNA to (c)DNA.

Reject: tRNA

1

(b) Joins nucleotides to produce (complementary strand/s of) DNA;

Accept: 'joins DNA nucleotides'.

1

(c) 1. To remove any DNA present;
2. As this DNA would be amplified / replicated;

1. Must be idea of removal / destruction.

2. Accept: idea of DNA not being used as template.

2

(d) 1. Ratio in range of 1.4 :1 to 1.5 :1 = **2 marks**;
2. One mark for answers which shows incorrect ratio but
Shows 0.24 as a number or line on the graph
OR
Ratio in correct range, but the wrong way round
OR
Ratio in correct range but not expressed to 1
OR
Ratio shown the other way round in range
1: 0.67 to 1:0.71;

Note: ratio not expressed to 1 in correct range may be shown in different ways, for example as:

3:2 or simply as 1.5 for one mark.

2

(e) Limited number of primers / nucleotides;

Accept: DNA polymerase (eventually) denatures

Accept: primers / nucleotides 'used up'.

1

(f) 1. Base sequences differ;
2. (Different) complementary primers required;

1. Accept: reference to either RNA or DNA base sequences but reject reference to DNA base sequence in viruses.

2

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