Mark schemes

**1**

(a) 1. Cut (DNA) at same (base) sequence / (recognition) sequence;

*Accept: cut DNA at same place*

2. (So) get (fragments with gene) **R** / required gene.

*Accept: 'allele' for 'gene' / same gene*

**2**

(b) 1. Each has / they have a specific base sequence;
2. That is complementary (to allele r or R). *Accept description of 'complementary'*

**2**

(c) 1. Fragments L from parent rr, because all longer fragments / 195 base pair fragments;

*Ignore: references to fragments that move further / less, require identification of longer / shorter or 195 / 135 Accept: (homozygous) recessive*

2. Fragments N from parent RR, because all shorter fragments / 135 base pairfragments;

*1 and 2 Accept: A3 for 195 and A4 for 135*

*2. Accept: (homozygous) dominant*

*3.* (M from) offspring heterozygous / Rr / have both 195 and 135 base pairfragments.

*Accept: have both bands / strips*

*Reject: primer longer / shorter*

**3**

(d) 1. (Cells in mitosis) chromosomes visible;
2. (So) can see which chromosome DNA probe attached to.

**2**

(e) (i) 1. For comparison with resistant flies / other (two) experiments / groups;

*Ignore: compare results / data / no other factors*

2. To see death rate (in non-resistant) / to see effect of insecticide in non-resistant / normal flies. *Accept: 'pesticide' as 'insecticide'*

*Accept to see that insecticide worked / to see effect of enzyme*

**2**

(ii) (PM must be involved because)
1. Few resistant flies die (without inhibitor);
2. More inhibited flies die than resistant flies;
3. (PM) inhibited flies die faster (than resistant flies);

(Other factors must be involved because)
4. Some resistant flies die;

5. But (with inhibitor) still have greater resistance / die slower thannon-resistant flies.

*Accept: (with inhibitor) die slower than non-resistant flies*

**4 max**

**[15]** (a) Reverse transcriptase;

**2** **1**

(b) 1. Probe (base sequence) complementary (to DNA of allele A / where A is (and) binds by forming base pairs / hydrogen bonds; *Accept gene A*

2. So (only) this DNA labelled / has green dye / gives out (green) light;

*Accept glows for green light*

**2**

(c) (i) 1. More probe binding / more cDNA / mRNA / more allele / gene A means more light;

2. DNA (with **A**) doubles each (PCR) cycle;

3. So light (approximately) doubles / curve steepens more and more (eachcycle) / curve goes up exponentially / increases even faster;

**3**

(ii) (**G** because)

1. (Heterozygous) only has half the amount of probe for **A** attaching / only half the amount of DNA / allele A (to bind to); *Accept only one A to bind to*

2. (So,) only produced (about) half the light / glow / intensity (of **H**) (per cycle of PCR);

*If reference to 'half' for point 1, allow 'less light' in 2.*

**2**

**[8]**

**Essay Using DNA in science and technology**

**3**

**DNA and classification**

2.2 Structure of DNA

2.3 Differences in DNA lead to genetic diversity

2.9 Comparison of DNA base sequences

**Genetic engineering and making useful substances**

2.5 Plasmids

5.8 The use of recombinant DNA to produce transformed organisms that benefit humans

**Other uses of DNA**

2.5 Cell cycle and treatment of cancer

5.8 Gene therapy;

Medical diagnosis and the treatment of human disease;

The use of DNA probes to screen patients for clinically important genes.

**4**

(a) (i) 1. Negative correlation;

*Accept: description for 'negative correlation'*
*Neutral: 'correlation'*
*Reject: positive correlation*

2. Wide range;

3. Overlap;

4. (Graph suggests that) other factors may be involved (in age of onset);

*2 / 3 Accept the use of figures from the graph*

*2 / 3 Can refer to age of onset or number of CAG repeats*

*Ignore references to methodology*

*3* **max**

(ii) 1. Age of onset can be high / symptoms appear later in life;
*Accept: 'gene' for 'allele'*

2. (So) individuals have already had children / allele has been passed on;

***OR***

3. Individuals have passed on the allele / already had children;

4. Before symptoms occur;

**2 max**

(b) (i) 1. Person **K**;

2. (As has) high(est) band / band that travelled a short(est) distance / (er) so has large(st) fragment / number of CAG repeats; *Must correctly link distance moved and fragment size*

**2**

(ii) Run fragments of known length / CAG repeats (at the same time);
*Accept: references to a DNA ladder / DNA markers*
*Do not accept DNA sequencing*

**1**

(iii) Homozygous / (CAG) fragments are the same length / size / mass;

*Accept: small fragment has run off gel / travelled further*

1

**[9]**

**5** (a) (i) To cut the DNA;

*Reject breakdown, cutting out*

1

(ii) To separate the (pieces of) DNA;

1

(c) Complimentary base sequence / complementary DNA; binds to both (haplotypes);

Label would show up in both;

*Idea of complimentarity required*

2

(d) (i) Y chromosome inherited / comes from male parents / only found in males;

1

(ii) Mitochondria in egg / female gamete / no mitochondria come from sperm / malegamete;

1

(e) (i) Allows comparison;

Different (sized) areas covered;

2

(ii) Wolves do not eat all of prey animal / do not eat (large) bones / skin;

Inedible parts make up different proportions / wolf eats different proportions;

2

(f) Limited by food / prey; as prey increases so do wolf numbers / positive correlation;

Large range so other factors involved;

2

**[12]**

**6** (a) a length of DNA;

that codes for a single protein / polypeptide;

2

(b) by heating;to break the H-bonds (between complementary bases);

2

(c) (i) to allow the DNA polymerase to attach / start addition ofnucleotides / mark start and end of sequence to be copied / prevents strands re-joining;

1

(ii) because the sequences at the ends of the target sequenceare different / one is at the beginning and one at the end;

**1**

(d) 8;

*accept 7*

**1**

**[7]** (a) 1 DNA is cut;

**7**

2 Using restriction enzyme;

3 Use electrophoresis;

4 Separates according to length / mass;

5 Southern blotting / transfer to (nylon) membrane;

6 Make single-stranded;

7 Apply probe;

8 Radioactive / fluorescent;

9 Reference to tandem repeats / VNTRs / minisatellites;

10 Autoradiography / eq;8 and 10 should be consistent

**max 6**

(c) (i) All bands in cub which don't come from mother;

Must be in father's DNA fingerprint;

*Principle that all bands in cub must come from mother and father = 1*

**2**

(ii) Select pairs with dissimilar DNA fingerprints;

**1**

(d) (i) Cells (from panda) in faeces / gut cells / blood cells;

**1**

(ii) To increase amount of DNA / only small amount present;

**1**

(iii) DNA / primer has specific base-sequence;
Reference to specific / complementary base-pairing;

**2**

(e) Taking samples from animals causes stress / injury to animal;

Difficult to find animals;

Pandas are dangerous / threat to human;

**max 2**

**[15]** (a) 1. DNA is cut;

**8**

2. using restriction enzyme;
3. electrophoresis;
4. separates according to length / mass / size;
5. DNA made single-stranded;
6. transfer to membrane / Southern blotting;
7. apply probe;
8. radioactive / single stranded / detected on film / fluorescent;
9. reference to tandem repeats / VNTRs / minisatellites;
10. pattern unique to every individual;

**6 max**

(b) cells on toothbrush;
DNA present in cell;

**2**

(c) (i) toothbrush gives small sample of DNA / need more DNAfor analysis;
PCR gives many copies;

**2**

(ii) uses heat;to separate strands;
*OR*
PCR replicates pieces of DNA;
because DNA has been cut;
*OR*
primer added in PCR;
to initiate replication

**2 max**

(d) (i) PCR / amplification needed;

**1**

(ii) other DNA present; need to identify 'required' DNA from rest;

**2**

**[15]** (a) Mother and father both heterozygotes / Tt / carriers;

**9**

Probability of thalassaemia 1/4 and female 1/2;
Probability of both 1/8;

**3**

(b) (i) Cut at same base sequence as same enzyme used;
Fragments are same length / size / have same charge;

**2**

(ii) Single base occurs many times;
Sequence of 20 unlikely to occur elsewhere;

*Allow one mark for establishing the principle where neither marking point clearly made.*

**2**

**[7]** (a) (i) Different genes / characteristics / features;

**10**

Reference to mutations;
Or
Base sequence determines protein;
Different species have different protein sequences;

**max 2**

(ii) Primer has different DNA sequence;
DNA specific / complementary base-pairing;

**2**

(iii) Electrophoresis separates DNA;
(So they can be) identified by position on gel;
Smaller / shortest fragments travel furthest / quicker / or reverse argument;

**3**

(b) (*conventional*) Many lengths / all DNA / (*new*) one length;
Each rung is DNA of one / specific length;

**2**

(c) 1 Heat DNA;
2 Breaks hydrogen bonds / separates strands;
3 Add primers;
4 Add nucleotides;
5 Cool;
6 (to allow) binding of nucleotides / primers;
7 DNA polymerase;
8 Role of (DNA) polymerase;9 Repeat cycle many times;

**max 6**

**[15]** (a) Endonuclease / restriction enzyme;

**11**

**1**

(b) DNA made of base pairs;
Each base pair is same length / occupies same distance along backbone;

**2**

(c) (i) Second blank box from left labelled 6;

**1**

(ii) Distance moved depends on length / number of base pairs /second longest fragment / second shortest distance identified;

**1**

(d) 5;

1

**[6]** (a) only small amounts obtained / PCR increases the amount / mass of DNA;

**12**

so enough DNA available for genetic fingerprinting;

2

(b) (i) to separate the two strands of the DNA /to break the hydrogen bonds;

*(Reject "unzip")*

**1**

(ii) short lengths / fragments of DNA / nucleotides /single stranded DNA;

**1**

(iii) to mark beginning and / or ends of the part of DNA needed /for attachment of enzymes or nucleotides / initiator / keeps strands apart;

**1**

(iv) would not be denatured;must be heated to 95 °C / must withstand high temps;

**2**

(c) 1 DNA extracted from sample;
2 DNA cut / hydrolysed into segments using restriction endonucleases;
3 must leave minisatellites / required core sequences intact;
4 DNA fragments separated using electrophoresis;
5 detail of process e.g. mixture put into wells on gel and electric current passed through;
6 immerse gel in alkaline solution / two strands of DNA separated;
7 Southern blotting / cover with nylon / absorbent paper (to absorb DNA);
8 DNA fixed to nylon / membrane using uv light
9 radioactive marker / probe added (which is picked up by required fragments) / complementary to minisatellites;
10 (areas with probe) identified using X-ray film / autoradiography;

**max 6**

(d) adult 3;this is only one which, (with number 1), can provide (all) the DNA fragments which children have / all bars match;

*(Reject 'genes')*

**2**

**[15]**

**13**

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]**

**14**

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

**15**

**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]**