1

(a) Reverse transcriptase;

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 (each cycle) / 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]

2

(a) 1. To allow comparison;

2. Because different number of cells in samples / different times for incubation / numbers become easier to manipulate;

2

(b) 203.7(%);;

Allow 1 mark for 21.8 / 10.7

Allow 1 mark for correct answer (203.74) but not correctly to 1 dp

204 = 1 mark

2

(c) (i) 1. (At every concentration) uptake is faster at 37°C / at higher temperature;

2. Due to faster respiration / ATP production;

2

(ii) 1. Uptake at 37°C only small increase / levelling off / almost constant as carrier proteins full;

Accept 'no (significant) change'

Ignore use of numbers

2. Concentration of imatinib is not the limiting factor;

2

[8]

3

(a) 250 000;

1

(b) (i) Loss of 3 bases / triplet = 2 marks;;

'Stop codon / code formed' = 1 mark max unless related to the last amino acid

Loss of base(s) = 1 mark;

eg triplet for last amino acid is changed to a stop codon / code = 2 marks

3 bases / triplet forms an intron = 2 marks

Accept: descriptions for 'intron' eg non-coding DNA

'Loss of codon' = 2 marks

2

(ii) 1. Change in tertiary structure / active site;

Neutral: change in 3D shape / structure

2. (So) faulty / non-functional protein / enzyme;

Accept: reference to examples of loss of function eg fewer E-S complexes formed

2

[5]

4

(a) Cytosine with Guanine and (Adenine) with Uracil;

Ignore G, C and U

1

(b) Two reasons, with suitable amplification;;

Q

Only infected cells have HIV protein on surface;

So carrier only attaches to / specific to these cells / siRNA can only enter these cells;

OR

siRNA (base sequence) complementary / specific to one mRNA;

Accept idea of specificity

Only infected cells contain mRNA of HIV / this gene / stops translation of this gene / only binds to this mRNA / destroys this mRNA;

Accept could not inhibit other / non-HIV mRNA

4 max

(c) 1. Carrier binds to (protein on) HIV;

1. Accept references to HIV membrane

2. Prevents HIV / it binding to (receptor on human) cell;

2. Reject references to binding to HIV protein on human cell

2

[7]

5 (a) 1. Carriers are heterozygous / have one normal copy and one mutant copy of gene / have one recessive allele / don't have the condition;

2. Both have DNA that binds (about) half / 50% amount of probe (that non-carrier does);

3. Probe binds to dominant / healthy allele so only one copy of exon in their DNA / have one copy of gene without exon / base sequence for probe to bind to;

3. Accept normal and gene

3. Accept have a deletion mutation

3

(b) 1. Introns not translated / not in mRNA / (exons) code for amino acids / introns do not code for amino acids;

1. Accept not expressed

1. Accept polypeptide / protein for amino acids

2. Mutations of these (exons) affect amino acid sequences (that produce) faulty protein / change tertiary structure of protein;

2. Accept deletion leads to frameshift

2. In this context, accept affects protein made

3. So important to know if parents' exons affected, rather than any other part of DNA / introns;

Accept converse arguments involving - eg introns do not code for amino acids / proteins

Reject references to making amino acids, once

3

(c) 1. Restriction mapping / described;

2. DNA / base sequencing (of fragments) / description / name of method;

2

[8]

6

(a) 1. No effect at 25°C

The question only refers to plants <u>with</u> GB

1. Reject same mass

2. Keeps growing at 30°C and 35°C / up to 35°C (more than without GB);

3. Above 35°C, falls but grows more than plant without GB;

3. Accept at all temperatures above 25°C more growth than without GB

2 max

(b) (i) <u>Significantly</u> different / SEs do not overlap ;

Accept converse without GB

1

(ii) (As temperature increases,)

1. Enzyme activity reduced / (some) enzymes denatured;

2. Less photosynthesis, so fewer sugars formed;

3. Less respiration / less energy / ATP for growth;

4. Less energy for named function associated with growth

4. Eg mitosis, uptake of mineral ions

4

(c) 1. (Rubisco activase attaches to thylakoid and) this changes shape / tertiary structure (of enzyme) / blocks active site / changes active site;

Note - question states enzyme stops working when it attaches to thylakoid, not before

1. Accept rubisco in this context

2. (This) prevents substrate / RuBP entering active site / binding;

2. Accept prevents ES complex forming

2. Accept no longer complementary to substrate / RuBP

2

(d) 1. GB prevents / reduces binding of rubiscoactivase to (thylakoid membrane);

1. Accept enzyme instead of rubiscoactivase. Accept rubisco

2. (Prevents it) up to 35°C;

3. (So) rubiscoactivase / enzyme remains active;

4. (So) photosynthesis / light-independent stage still happens;

4. Accept descriptions of light-independent stage

5. Above 35°C, some binding still occurs but less than without GB, so less reduction in growth;

4 max

(e) 1. Looked for information / journals, on crop plants that grow at high temperatures;

1. "other research" is minimum accepted

1. Accept previous experiments research with temperature resistant crops

Ignore simple references to looking at previous studies / other plants - need to relate to this context

2. (Crop plants cited in this research) contain / make GB;

3. So assumed making plants produce GB makes them resistant to high temperatures;

2 max

[15]

7

(a) 1. Cell wall not formed / production inhibited;

*1. **Q** Accept: weakened cell wall, but do not accept 'cell wall is broken down'*

2. Lower <u>water potential</u> in bacterium;

2. Accept: converse

2. Must be clear that the lower water potential is in the bacterium

3. <u>Water enters</u> and causes lysis / expansion / pressure;

2 max

(b) Human cells lack enzyme (**B**) / have a different enzyme / produce different fatty acids / use different substrates;

Neutral: 'human cells do not have cell walls' as out of context

1

(c) 1. Change in base sequence (of DNA / gene) leading to change in amino acid sequence / primary structure (of enzyme);

1. Accept: different amino acids coded for

1. Reject: different amino acids produced

2. Change in hydrogen / ionic / disulphide bonds leading to change in the tertiary structure / active site (of enzyme);

2. Neutral: alters 3D structure / 3D shape

3. Substrate not complementary / cannot bind (to enzyme / active site) / no enzyme-substrate complexes form;

3

[6]

8

(a) Restriction / endonuclease;

Ignore specific names of restriction enzymes e.g. EcoR1

1

(b) (i) 1. (Acts as a) marker gene to show that the (human) gene has been taken up / expressed;

1. Accept: gene marker

2. (Only) implant cells / embryos that show fluorescence / contain the jellyfish gene;

2

(ii) 1. Factor IX present in / extracted from milk;

2. Gene only expressed in mammary glands / udder / gene not expressed elsewhere;

2. Ignore references to milk

The 'only' aspect is important here.

3. Do not need to kill sheep (to obtain Factor IX);

2 max

(c) (i) 1. Mutation / nucleus / chromosomes / DNA may be damaged / disrupts genes;

1. Neutral: cell may be damaged

2. May interfere with proteins (produced) / gene expression / translation;

Ignore references to hormone levels or time of implantation

OR

3. Embryo / antigens foreign;

3. Neutral: antigens change

4. Embryo is rejected / attacked by immune system;

4. sNeed idea that the immune system is involved if mark point 3 has not been given

'Embryo foreign so rejected' = 2 marks

'Embryo rejected by immune system' = 1 mark

'Embryo is rejected' = 0 marks

2 max

(ii) 1. Saves time / money for others;

2. Same work is not repeated / methods can be compared / improved / amended / same errors are not made;

2

[9]

9 (a) 1. Adenylate cyclase activated / cAMP produced / second messenger produced;

2. Activates enzyme(s) (in cell so) glycogenolysis / gluconeogenesis occurs / glycogenesis inhibited;

2. Neutral: 'glucose produced' as given in the question stem

Accept: correct descriptions of these terms

2

(b) (i) 1. Glucose / sugar in food would affect the results;

1. Accept references to starch / carbohydrate

Or

2. Food / eating would affect blood glucose (level);

Or

3. (Allows time for) blood glucose (level) to return to normal;

3. Neutral: allows time for insulin to act

1 max

(ii) Type 2 diabetes is a failure to respond to insulin / still produces insulin / is not insulin-dependent;

1

(iii) (For) – 3 max

A maximum of three marks can be awarded for each side of the argument

1. Avoids injections / pain of injections;

2. Long(er) lasting / permanent / (new) cells will contain / express gene;
Ignore references to methodology e.g. sample size not known

3. Less need to measure blood sugar / avoids the highs and lows in blood sugar;

4. Less restriction on diet;

(Against) – 3 max

5. Rats are different to humans;

6. May have side effects on humans;
6. Accept: virus may be harmful / disrupt genes / cause cancer

7. Long(er) term effects (of treatment) not known / may have caused effects after 8 months;

8. (Substitute) insulin may be rejected by the body;

4 max

[8]

10 (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]