



## Mark schemes

Q1.

 (a) *Phytophthora* 1

(b) the fungus can get oxygen from the air 1

(c) the variety of species of organisms in the river 1

 (d) pesticide washed into river  
*allow spray drift*  
*allow reference to run-off*  
*allow carried by rainfall* 1

pesticide kills (some) organisms / plants / animals in river 1

(e)

	R	r
R	RR	Rr
r	Rr	rr

*all 3 correct = 2 marks*  
*2 correct = 1 mark*  
*0 or 1 correct = 0 marks*

2

 (f) ring drawn around RR / rr in the diagram  
*allow around both RR and rr* 1

 (g) 75%  
*percentage must match student's*  
*answer in the diagram*  
*allow 75% if no answer to question (e)* 1

 (h) no fusion of gametes  
 or  
 (asexual reproduction involves) mitosis  
*allow no fertilisation* 1

 (so) offspring are genetically identical (to parent plant)  
*allow offspring are a clone*

allow offspring have same DNA  
 allow no mixing of genes / DNA  
 allow no mixing of genetic material  
 allow all offspring inherit R

1  
 [11]

Q2.

(a) chromosome(s)

allow chromatid(s) / gene(s) / allele(s)

1

(b) sugar

allow deoxyribose  
 allow pentose  
 do not accept ribose

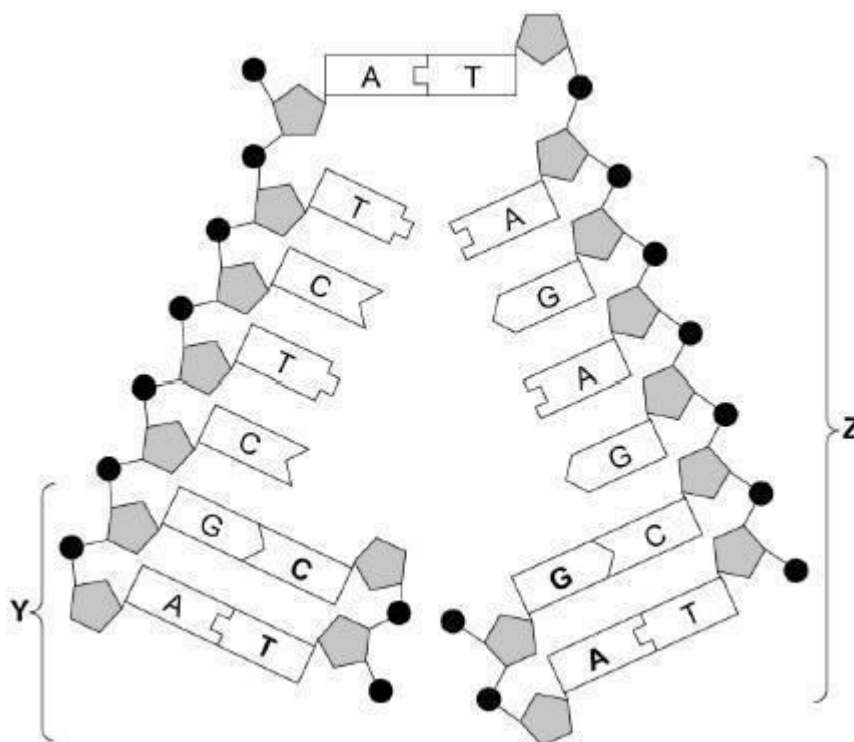
1

(c) base(s)

allow nitrogenous base(s)  
 allow adenine and cytosine and  
 guanine and thymine

1

(d)



all four required for the mark

1

(e) replication

- |     |                                     |     |
|-----|-------------------------------------|-----|
|     |                                     | 1   |
| (f) | protein<br><i>allow polypeptide</i> | 1   |
| (g) | $3 \times 10^{-12}$ grams           | 1   |
| (h) | meiosis                             | 1   |
|     |                                     | [8] |

Q3.

- |     |   |   |
|-----|---|---|
|     | (a) mutation means less oxygen for (aerobic) respiration<br><i>allow haemoglobin or red blood cell carries oxygen for (aerobic) respiration</i><br><i>do not accept no oxygen for respiration</i> | 1 |
| (b) | $4 \div 17$<br><i>allow 4:13</i>  | 1 |
|     | $0.235(29\dots)$<br><i>allow 0.24 or 24%</i><br><i>allow ratio 1 : 3.25</i>   | 1 |
| (c) | father / 8's gametes correct: HA + HA<br><br>mother / 9's gametes correct: HA + HS<br><i>allow 1 mark for both sets of gametes if parents not identified</i>                                      | 1 |
|     | correct derivation of offspring genotypes:<br>HAH A HAH A HAHS HAHS<br><i>allow correctly derived offspring genotypes from incorrect parental gametes</i>   | 1 |
|     | correct phenotype for each derived genotype   | 1 |
|     | $0.25 / \frac{1}{4} / 25\% / 1 \text{ in } 4 / 1:3$<br><i>allow only a probability consistent with student's derivations</i>  | 1 |
| (d) | any three from:   |   |

*points for:*

- HAHS do not get malaria
- HAHS survive sickle cell anaemia

*points against:*

- HAAA may die from malaria
- HSHS may become (severely) ill with sickle cell anaemia
- Judgement:  
if parents HAHS then some offspring survive both malaria and sickle cell anaemia  
or  
if parents HAHS then some offspring may become (severely) ill with malaria and some become (severely) ill with sickle cell anaemia

*to gain full marks both point(s) for and point(s) against must be given*

3

[11]

Q4.

(a) 4 / four

1

(b) 23 / twenty three

*do not accept 23 pairs*

1

(c) a different form of a gene

1

(d) heterozygous

1

(e)

		Dd/dD
	dd	dd

*allow 2 correct for 1 mark*

2

(f) ring around any Dd

*allow ecf from question (e)*

1

(g) percentage must match answer given to questions (e) and (f) *if no answer in question (e) allow 50 %*

1

(h) mutation / mutated

*do not accept mutant*

1

(i) any one from:

- to help them prepare
- to inform whether to consider having an abortion
- to find out if they have passed on the disorder

*allow to see if the child / embryo has the disorder*

*allow answers referring to genetic disorders, or specific example such as Dupuytren's / cystic fibrosis*

1

[10]

Q5.

(a) any two from:

- double  
*allow two strands*
- helix  
*allow twisted / spiral / coiled*
- long / thin

2

(b) bases

1

(c) protein

1

(d) nucleotide

1

(e)  $0.34 \times 6\,000$

1

2040 (million nm)

1

(f) answer from question (e) correctly converted

*if no answer to question (e), allow 2.04 (m)*

1

(g) any one of:

- to determine if the cancer is genetic (or caused by lifestyle factors)
- to inform / help treatment
- to allow embryo screening to ensure allele is not passed on
- to inform relatives if they have inherited (affected) gene / allele
- to detect cancer early or before symptoms show
- to understand cause of the cancer

1

[9]

Q6.

(a) many (joined) nucleotides or monomers  
*allow (long) molecule / chain made of repeating units*

1

(b) phosphate

1

(phosphate attached to a) sugar

1

(which has 1 of 4) base(s) (attached to sugar)  
*ignore phosphorus*  
*allow deoxyribose / pentose*  
*allow 2 marks if position of sugar / phosphate / base is incorrect*

1

(bases) are A, C, G and T  
*allow bases are adenine, cytosine, guanine and thymine do not accept thiamine / adenosine*  
*allow description of a pair of nucleotides*

1

(c)  $0.34 \times 12\,000\,000\,000$   
*an incorrect answer for one step does not prevent allocation of marks for subsequent steps*

1

4 080 000 000

1

4 080 000 000  
1 000 000 000

*allow conversion from nm to m at any point in the calculation*

1

4.08 (m)

1

2.04 (m)  
 (divided by 2 due to base pairs)  
*allow division by 2 at any point in the calculation*

1

(d) (non-coding parts) can switch genes on / off

1

[11]

Q7.

(a) any three from:

- mitosis produces two (daughter) cells but meiosis produces four (daughter) cells

*answers must be comparative*

- one cell division in mitosis but two cell divisions in meiosis
- mitosis produces cells with two of each chromosome, but meiosis produces cells with one of each chromosome

*allow mitosis produces diploid cells but meiosis produces haploid cells*

*allow mitosis maintains the number of chromosomes or mass of DNA or mass of genetic material but meiosis halves the number / mass*

*allow mitosis produces cells with 23 pairs or 46 chromosomes but meiosis produces cells with 23 chromosomes*

- mitosis produces genetically identical cells, but meiosis produced genetically different cells

*allow other correct differences between the processes of mitosis and meiosis*

3

(b) any one from:

- DNA doubles / copies / replicates (once)

*allow chromosomes or genetic material or genetic information double / replicate / are copied*

- increase in the number of mitochondria / ribosomes / sub-cellular structures

*ignore mitochondria / ribosomes are copied / duplicated*

*allow chromosomes / chromatids pulled to side (of cell)*

*allow other correct similarities between the processes of mitosis and meiosis*

1

(c) Dd / dD

*allow heterozygous*

1

has D because has Dupuytren's and has d because child / person 6 is homozygous recessive or does not have Dupuytren's or is dd

*allow has D because has Dupuytren's and person 1 and person 2 both passed d to child / person 6*

*allow has D because has Dupuytren's and cannot be homozygous / DD or all the children would have Dupuytren's*

- 1
- (d) male / person 7 gametes correct: D and d
- 1
- female / person 8 gametes correct: d and d  
*allow 1 mark for both sets of gametes  
 correct if parents not identified*
- 1
- correct derivation of offspring genotypes:  
 Dd Dd dd dd  
*allow correct derivation of offspring  
 genotypes from incorrect gametes*
- 1
- offspring with Dupuytren's identified  
*allow correct for genotypes stated in  
 mp3*
- 1
- probability correct from the correct identification given  
*allow probability correct from offspring  
 genotypes if identification not given*
- 1
- (e) female(s) / person(s) 3 / 11 / 12 have Dupuytren's  
*allow some females have Dupuytren's*
- 1
- females don't have Y chromosome  
 or  
 Dupuytren's is passed from fathers / 1 / 7 to daughters / 3 / 12, (so is not  
 on the Y chromosome)  
*allow only males have Y chromosomes  
 allow females are XX  
 allow Dupuytren's is passed from  
 mothers / 11 to children / 15, (so is not  
 on the Y chromosome)*
- 1
- [13]

Q8.

- (a) an allele expressed even if a person only has one copy of the allele
- 1
- (b)



		<b>Woman</b>	
		e	e
<b>Man</b>	E	Ee	<b>Ee</b>
	e	<b>ee</b>	<b>ee</b>

*all 3 correct = 2 marks  
1 or 2 correct = 1 mark*

2

- (c) correct probability from Figure 1  
*if no answer in part (b) allow 0.5*

1

(d)

		<b>Woman</b>	
		X	X
<b>Man</b>	X	XX	XX
	Y	XY	XY

*gametes = X + X and X + Y  
allow in incorrect positions*

*X, X, X and Y in correct boxes*

1

1

(e)

*an answer matching the answer from part (c) × 0.5 scores 2 marks  
if no answer in part (c), an answer of 0.25 / ¼ / 1 in 4 / 25% scores 2 marks*

answer from part (c) × 0.5  
*if no answer in part (c) allow 0.5 × 0.5*

1

answer to calculation in mp 1  
*if no answer in part (c) allow 0.25 / ¼ / 1 in 4 / 25%*

1

[8]

Q9.

(a) 46

- 1
- (b) half the mass of the DNA in cell A 1
- (c) meiosis 1
- (d) mutation 1
- (e) any two from:
- different egg / sperm each time
  - genes from two parents
  - each gamete / egg / sperm has different alleles / genes / DNA / genetic information
- ignore different chromosomes*
- ignore the children have different genes / alleles*
- 2
- (f) 8 1
- (g) 40 1
- allow in range 39 to 41*
- (h) 1
- an answer of 80 scores 3 marks*
- allow ecf from part (g) for 3 marks*
- an answer of 0.08 scores 2 marks*
- $\frac{40}{500}$
- allow  $\frac{\text{answer to part (g)}}{500}$*
- × 1000 1
- 80 1
- an answer from mp1 but not × 1000 scores 2 marks*
- (i) embryo is (very) small 1
- (so) embryo not seen / felt
- or
- lost in normal menstrual flow
- ignore not noticed*
- 1

[13]

Q10.

- (a) chromosome(s)  
*allow gene(s) / allele(s)* 1
- (b) X = sugar 1  
Y = nucleotide 1  
Z = base 1
- (c) double helix 1
- (d) 3 1
- (e) any two from:  
*allow descriptions or named examples*
- diagnosis of inherited / genetic disorder *allow research / understand genetic disorders*
  - gene therapy or treatment of inherited disorders
  - understanding (human) evolution or understanding ethnic origins (of a person) or understanding ancestry
  - tracing human migration patterns  
*allow other examples – eg identification of criminals (1) paternity determination (1)*
- 2 [8]

Q11.

- (a) same kingdom + phylum + class + order or same order  
or  
they have the top four groups the same  
*allow both Poales* 1
- (b) Rr / rR  
*do not accept RR or rr*  
*ignore heterozygous*  
*do not accept homozygous* 1
- (c) CWCW 1
- (d) *allow R and W throughout*

*allow own symbols if defined*

parental genotypes / gametes correct for both parents:

CR CW CR CW / CR and CW

1

genotypes of offspring correctly derived in a Punnett square:

CRcR cRcW cWcW

*allow correctly derived genotypes from incorrect gametes*

1

correct identification of phenotypes from their cross:

CRCR = red

CRCW = pink

CWCW = white

*allow colours correctly identified from different offspring, only if pink and other colour(s) are given*

1

- (e) answer correctly derived from part (d) to match stated phenotypes *allow 50(%) if no offspring given in part (d)*  
*allow to match genotypes if no phenotypes given*

1

- (f) *(several groups)*  
so many / several plants can be produced  
*allow each (group) will give a new plant*

1

*(nutrients)*

for making protein / amino acids or for making chlorophyll or for providing energy or for respiration

*allow other examples*

*do not accept making energy*

*ignore for growth*

1

*(add hormones)*

so differentiation occurs or so roots / shoots develop

*allow for the formation of different tissues / organs / named*

*allow to stimulate cell division*

1

*(sterile conditions)*

to prevent growth / entry of microorganisms / named type or prevent decay / disease

*ignore to kill microorganisms*

*ignore contamination unqualified*

1

*(temperature = 20 °C)*  
 so optimum / good growth  
*allow reference to enzymes working well*  
*ignore enzymes not denatured*  
*ignore reference to pathogens / microorganisms*

1

- (g) (all new plants have been) produced by asexual reproduction / mitosis or produced without (fusion of) gametes

*ignore produced from one parent*

1

(so) all are genetically identical / clones or all are CRCW / heterozygous  
*allow all are the same genotype / alleles / genes / DNA*

1

[14]

Q12.

- (a) nucleus

1

- (b) gene(s)

*allow allele(s)*

1

- (c) copying of chromosomes

1

- (d) mitochondria

1

- (e) 60–45  
 or  
 120 – 105

1

15 (minutes)

1

*an answer of 15 (minutes) scores 2 marks*

- (f) C

1

- (g) 8

1

- (h) to repair tissues

1

[9]

Q13.

- (a) Gregor Mendel 1
- (b) DNA 1
- (c) when the dominant allele is not present 1
- (d) tt 1  
*allow homozygous recessive*

(e)

	T	t
T	TT	Tt
t	Tt	tt

*all 3 correct = 2 marks*  
*2 correct = 1 mark*  
*0 or 1 correct = 0 marks*  
*allow tT for Tt*

2

- (f) circle drawn around either TT or tt on Figure 2 1  
*allow circles drawn round both*
- (g) correct ratio from part (e) e.g. 3 : 1 1  
*allow multiples of stated ratio*  
*allow 3 : 1 if no answer to part (e)*

[8]

Q14.

(a)

	statement is true for		
	mitosis only	meiosis only	both mitosis and meiosis
all cells produced are genetically identical	✓		

in humans, at the end of cell division each cell contains 23 chromosomes		✓	
involves DNA replication			✓

3 correct = 2 marks

2 correct = 1 mark

0 or 1 correct = 0 marks

2

(b) any two from:

*ignore references to one parent only*

- many offspring produced
- takes less time  
*allow asexual is faster*
- (more) energy efficient
- genetically identical offspring  
*allow offspring are clones*
- successful traits propagated / maintained / passed on (due to offspring being genetically identical)
- no transfer of gametes or seed dispersal  
*allow no vulnerable embryo stage*  
*allow no need for animals*
- not wasteful of flowers / pollen / seeds
- colonisation of local area  
*must imply local area*

2

(c) genetic variation (in offspring)

1

(so) better adapted survive

*allow reference to natural selection or survival of the fittest*

1

(and) colonise new areas by seed dispersal

or

can escape adverse event in original area (by living in new area)

*must imply new area*

1

many offspring so higher probability some will survive

1

*allow bluebell example described (max 3 if not bluebell)*

[8]

Q15.

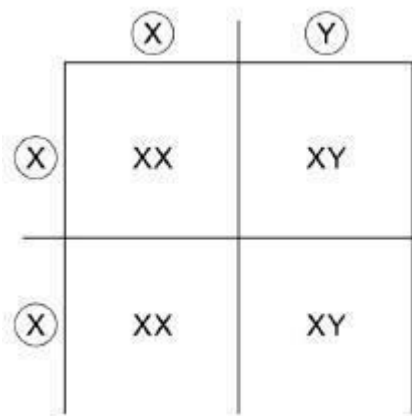
- (a) 3.7 1
- (b) 2 1
- (c) (different combinations of alleles cause) many / 22 values  
*allow continuous variation*
- or  
 in-between values  
 or  
 large range of values  
 or  
 there are not only two values  
*allow there are not only 3 values if 3 is given in part (b)* 1
- (d) different protein made  
*allow change in shape (of enzyme) or change in 3-D structure*  
*ignore denature* 1
- active site changed 1
- so substrate does not fit / bind  
*allow description of substrate*  
*allow cannot form E-S complex*  
*ignore lock and key description* 1
- (e) produces (some) offspring with high-fat milk or not all offspring have low-fat milk *ignore reference to alleles* 1
- (f) takes less time (to obtain results) or more offspring at the same time  
*allow other sensible suggestion – e.g. allows screening or allow cow 7 to continue to produce eggs or avoid injury to cow 7 during mating or giving birth* 1
- (g) male gametes correct: d (and d) 1
- female gametes correct: D and d 1



	<i>allow 1 mark if gametes are correct but gender not identified</i>	
	correct derivation of offspring genotypes from given gametes <i>allow 2 × 2 or 2 × 1 derivation</i>	1
	Dd identified as low-fat and dd identified as high-fat in offspring <i>if DD offspring are produced, must also identify as low-fat</i>	1
(h)	find female with low(est) fat in milk and high(est) milk yield <i>allow choose from 7, 9, 12, 13 which has the highest yield</i>	1
	find male whose female offspring have high(est) milk yield and low(est) fat in milk <i>allow choose from 16 or 18 whose female offspring has the highest yield</i>	1
	or	
	find female with lowest fat in milk or cow 13 (1)* <i>*or allow female with high(est) milk yield</i>	
	find male whose female offspring have high(est) milk yield (1)* <i>*or allow male whose female offspring have lowest fat in milk / male 16</i>	
	cross the best (for both features) female with the best male	1
	select best offspring (for both features) from each generation and repeat for several generations	1
		[16]
Q16.		
(a)	46	1
(b)	23 <i>allow ecf from 2.1 – ie half of answer given in 2.1</i>	1
(c)	egg	1

sperm	1
ovary	1
meiosis	1
fertilisation	1

*correct order only*  
*correct spelling only*



(d)

*all 4 correct = 2 marks*  
*2 or 3 correct = 1 mark*  
*0 or 1 correct = 0 marks*  
*ignore correct / incorrect identification of male and female offspring*

(e) 1 in 2

(f) any two from:

- multiple genes determine appearance  
*allow several / many genes determine appearance*
- different combinations of alleles  
*allow description of combinations of alleles' allow genes for alleles*
- different environmental effects  
*allow example e.g. eat different diets*
- from different egg / sperm

2

1

2

[12]

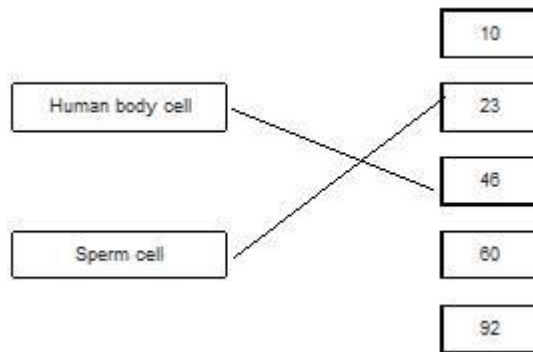
Q17.

- (a) red blood cell 1
- (b) 44 1
- (c) retina 1
- (d) 7 and 8 / the parents  
do not have A (allele)  
or only have a (allele) or are aa  
*allow converse – if parents had an A (allele) they  
would have Stickler syndrome* 1
- so children cannot inherit A  
or can only inherit a
- or
- the parents show the recessive characteristic
- so must be homozygous  
(recessive)  
or must be aa  
or parents cannot have A 1
- (e) parental genotypes:  
12 = Aa and 18 = aa  
or parental gametes:  
12 = A + a and 18 = a + a 1
- derivation of offspring genotypes  
*allow ecf* 1
- identification of Aa offspring as Stickler 1
- probability =  $0.25 / \frac{1}{4} / 1 \text{ in } 4 / 25\% / 1:3$   
*allow ecf – e.g. 0.5 if 12 = AA*  
*do not accept 3:1*  
*do not accept 1:4* 1
- [9]

Q18.

- (a) A 1

(b)



2

(c) one x circled under mother  
*accept if clearly indicated choice even if not circled*

1

(d) XY  
*allow YX*

1

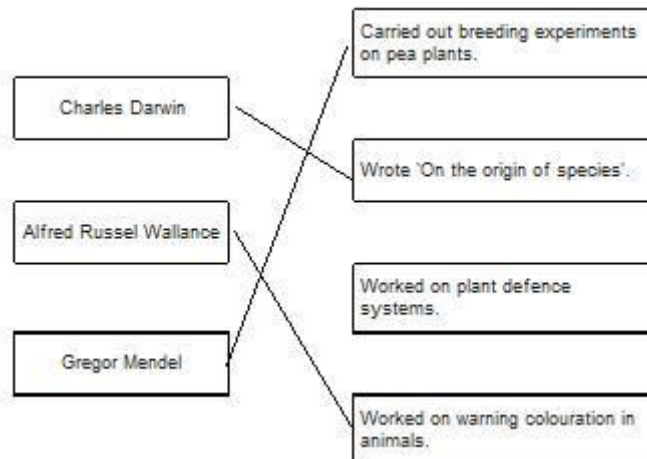
(e) 50 (%)

1

[6]

Q19.

(a)



3

(b) a gene  
*allow allele*

1

(c) 4

1

(d) correct derivation of children's genotypes

		1	
	identification of children with cystic fibrosis (dd)		1
	0.25		
	<i>allow ecf</i>		
	<i>allow 1/4 / 25% / 1 in 4 / 1:3</i>		1
	<i>do not accept 1:4</i>		
(e)	heterozygous		1
			[9]
Q20.			
(a)	phosphate		
	<i>allow PO<sub>4</sub><sup>3-</sup></i>		1
	<i>do not allow P</i>		
(b)	A / adenine and T / thymine and C / cytosine and G / guanine		
	<i>do not allow U / uracil</i>		1
(c)	(mutation) changes from C to T DNA code or there is a change in the three bases / triplet from CAG to TAG		1
	(mutation) changes the amino acid		1
	(this could) change the protein		1
	(so it) forms a different shape / changed active site		
	<i>accept different tertiary structure</i>		1
	(therefore) the enzyme no longer fits the substrate / carbohydrate		1
(d)	mother / woman's gametes correct: A      a		1
	father / man's gametes correct: a      a		1
	correct derivation of offspring		
	<i>ecf</i>		1

identification of child with syndrome H or genotype aa

1

0.5

*ecf*

*allow 50% / 1 / 2 / 1 in 2 / 1:1*

*do not accept 1:2*

1

[12]

Q21.

(a) When the dominant allele is not present.

1

(b) (i) Bb

1

		Woman Brown hair	
		B	b
Person 3 Red hair	b		bb
	b	Bb	bb

(ii)

*3 correct = 2 marks*

*2 correct = 1 mark*

*1 or 0 correct = 0 marks*

*allow bB for Bb*

(iii) 1 in 2

2

*allow ecf from part ii*

1

[5]

Q22.

(a) testis / testes

*allow testicle(s)*

(b) (i) B = 13.2  
C = 6.6  
E = 3.3

1

*all 3 correct = 2 marks 2*

*or 1 correct = 1 mark*

*If no marks awarded allow ecf for C and E based on answer to B*

*ie C = ½ B and E = ½ C for one mark*

2

(ii) 6.6

*allow twice answer for cell E in part bi*

1

(iii) mitosis

*correct spelling only*

1

(c) (i) any two from:

- cells that are able to divide
- undifferentiated cells / not specialised
- can become other types of cells / tissues or become specialised / differentiated

*allow pluripotent*

2

(ii) 4-day embryo is a (potential) human life or

destroying/damaging (potential) human life

*allow cord would have been discarded anyway*

*ignore reference to miscarriage*

*allow cannot give consent*

1

(iii) perfect tissue match or hard to find suitable donors

*allow same/matching antigens*

*allow no danger of rejection*

*allow no need to take immunosuppressant drugs (for life)*

*ignore genetically identical or same DNA*

1

(iv) stem cells have same faulty gene / allele / DNA / chromosomes *allow*

*genetically identical*

*ignore cells have the same genetic disorder*

1

[10]

Q23.

(a) (i) man has (inherited) polydactyly (PD) allele (from mother)

1

man has (inherited) other / normal / recessive allele from father

1

because father does not have PD allele or if father had it father would have had PD or father only has normal allele or father is homozygous recessive

1

*allow gene for allele*

(ii) 0.5 / 1/2 / 1 in 2 / 1:1 / 50%

*do not allow 1:2 or 50/50*

*allow 50:50*

1

(b) parental phenotypes: both brown

1

parental genotypes: both Bb

1

gametes: B b and B b

1

*allow only on gametes answer line*

*allow ecf from genotypes*

offspring genotypes: BB (2)Bb bb

*allow ecf from gametes*

1

offspring phenotypes correctly assigned to genotypes:

BB & Bb = brown bb = red

*do not penalise confusion of 'phenotypes' & 'genotypes' here*

1

[9]