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*

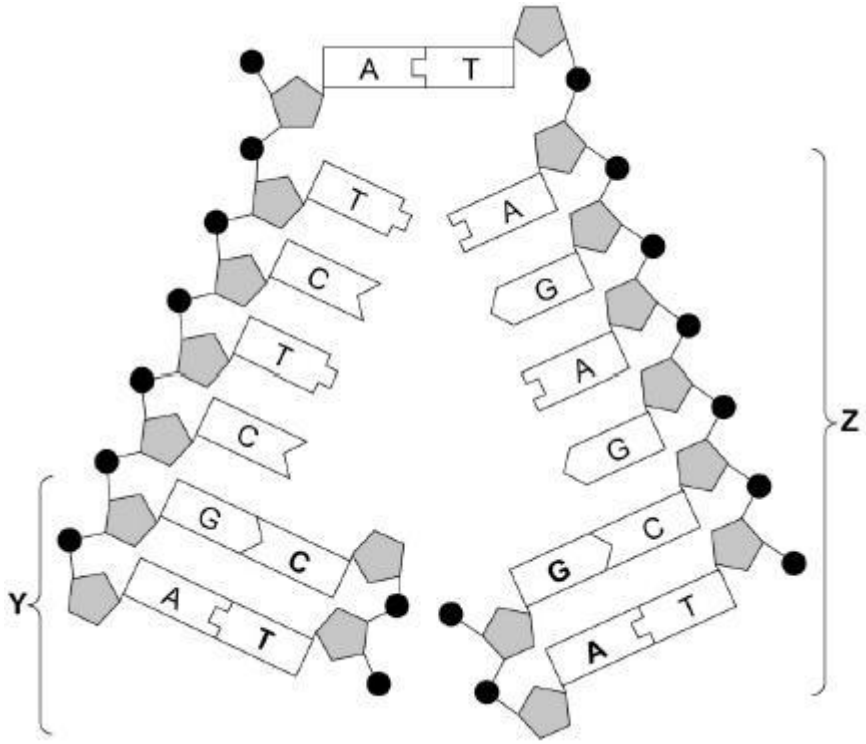
1

(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

allow polypeptide

1

(g) 3×10^{-12} grams

1

(h) meiosis

1

[8]

Q3.

(a) mutation means less oxygen for (aerobic) respiration

*allow haemoglobin **or** red blood cell carries oxygen for (aerobic) respiration*

*do **not** accept no oxygen for respiration*

1

(b) 4 ÷ 17

allow 4:13

1

0.235(29...)

*allow 0.24 **or** 24%*

allow ratio 1 : 3.25

1

(c) father / **8**'s gametes correct: $\mathbf{H^A}$ + $\mathbf{H^A}$

1

mother / **9**'s gametes correct: $\mathbf{H^A}$ + $\mathbf{H^S}$

*allow **1** mark for both sets of gametes if parents not identified*

1

correct derivation of offspring genotypes:
$\mathbf{H^AH^A}$ $\mathbf{H^AH^A}$ $\mathbf{H^AH^S}$ $\mathbf{H^AH^S}$

allow correctly derived offspring genotypes from incorrect parental gametes

1

correct phenotype for each derived genotype

1

0.25 / ¼ / 25% / 1 in 4 / 1:3

*allow **only** a probability consistent with student's derivations*

1

(d) any **three** from:

points for:

- **H^AH^S** do not get malaria
- **H^AH^S** survive sickle cell anaemia

points against:

- **H^AH^A** may die from malaria
- **H^SH^S** may become (severely) ill with sickle cell anaemia
- Judgement:
  if parents **H^AH^S** then some offspring survive both malaria and sickle cell anaemia
  or
  if parents **H^AH^S** 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 × 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 × 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

$$\frac{4\,080\,000\,000}{1\,000\,000\,000}$$

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)

		Woman	
		e	e
Man	E	Ee	**Ee**
	e	**ee**	**ee**

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)

		Woman	
		X	X
Man	X	XX	XX
	Y	XY	XY

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

1

X, X, X and Y in correct boxes

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

allow in range 39 to 41

1

(h)

*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 $\frac{\text{answer to part } \textbf{(g)}}{500}$

1

× 1000

1

80

*an answer from mp1 but not × 1000 scores **2** marks*

1

(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) $\mathbf{C^wC^w}$

1

(d)

*allow **R** and **W** throughout*

allow own symbols if defined

parental genotypes / gametes correct for both parents:
C^R C^W C^R C^W / C^R and **C^W**

1

genotypes of offspring correctly derived in a Punnett square:
C^RC^R C^RC^W C^WC^W

allow correctly derived genotypes from incorrect gametes

1

correct identification of phenotypes from their cross:
C^RC^R = red
C^RC^W = pink
C^WC^W = 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 C^RC^W / 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

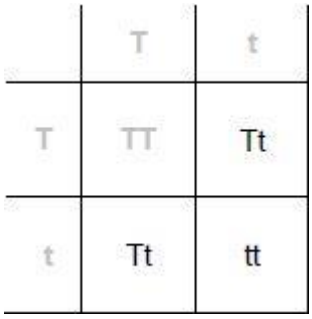
1

(d) tt

allow homozygous recessive

1

(e)



*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

allow circles drawn round both

1

(g) correct ratio from part **(e)** e.g. 3 : 1

allow multiples of stated ratio
*allow 3 : 1 if no answer to part **(e)***

1

[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

<u>active site</u> 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 **o**r 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

*allow **1** mark if gametes are correct but gender not identified*

correct derivation of offspring genotypes from given gametes

*allow 2 × 2 **or** 2 × 1 derivation*

1

Dd identified as low-fat **and** dd identified as high-fat in offspring

if DD offspring are produced, must also identify as low-fat

1

(h) find female with low(est) fat in milk **and** high(est) milk yield

allow choose from 7, 9, 12, 13 which has the highest yield

1

find male whose female offspring have high(est) milk yield **and** low(est) fat in milk

allow choose from 16 or 18 whose female offspring has the highest yield

1

or

find female with lowest fat in milk
or cow 13 (1)*

or
allow female with high(est) milk yield

find male whose female offspring have high(est) milk yield (1)*

or
allow male whose female offspring have lowest fat in milk / male 16

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

allow ecf from 2.1 – ie half of answer given in 2.1

1

(c) egg

1

sperm

1

ovary

1

meiosis

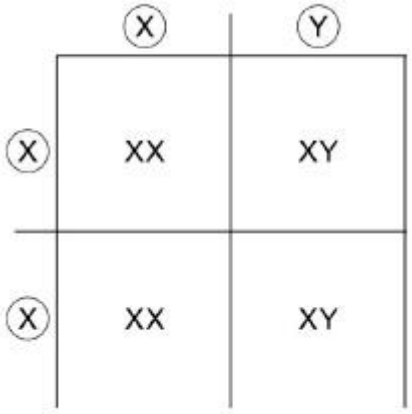
1

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

2

(e) 1 in 2

1

(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

[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 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

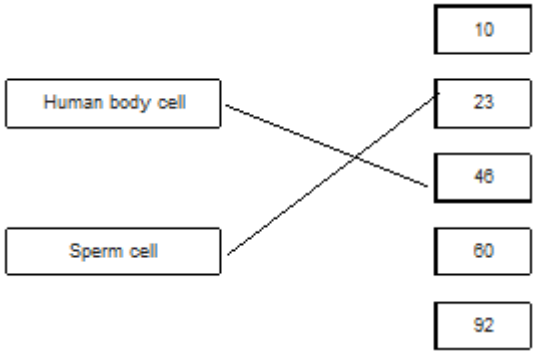
[9]

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

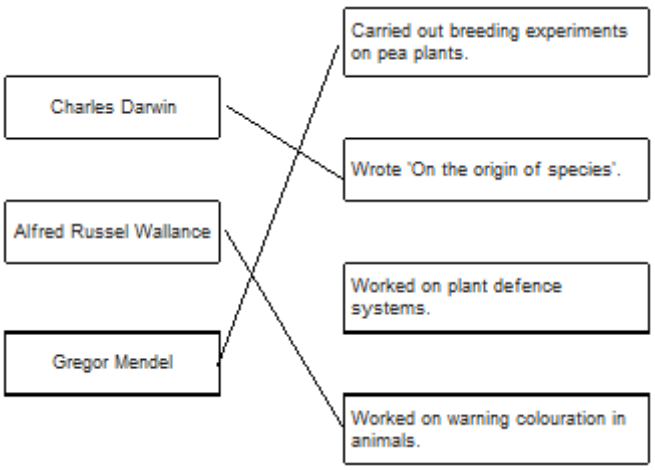
(e) 50 (%)

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

allow ecf

allow ¼ / 25% / 1 in 4 / 1:3

1

*do **not** accept 1:4*

(e) heterozygous

1

[9]

Q20.

(a) phosphate

allow PO_4^{3-}

1

*do **not** allow P*

(b) A / adenine and T / thymine
and
C / cytosine and G / guanine

*do **not** allow U / uracil*

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

accept different tertiary structure

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

ecf

1

identification of child with syndrome H or genotype aa

1

0.5

ecf

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

1

*do **not** accept 1:2*

[12]

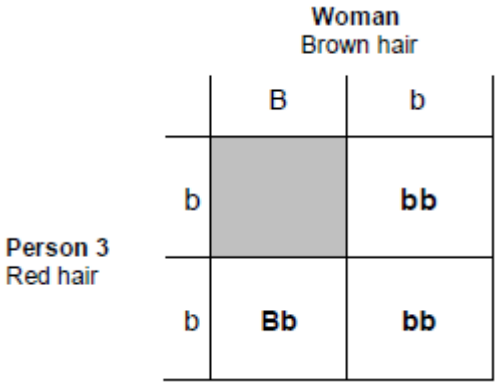
Q21.

(a) When the dominant allele is not present.

1

(b) (i) Bb

1



(ii)

3 correct = 2 marks

2 correct = 1 mark

1 or 0 correct = 0 marks

allow bB for Bb

2

(iii) 1 in 2

allow ecf from part ii

1

[5]

Q22.

(a) testis / testes

allow testicle(s)

1

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

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 / ½ / 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]