



Mark schemes

**Q1.**

(a) chromosome(s)

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

1

(b) sugar

*allow deoxyribose  
allow pentose  
do **not** accept ribose*

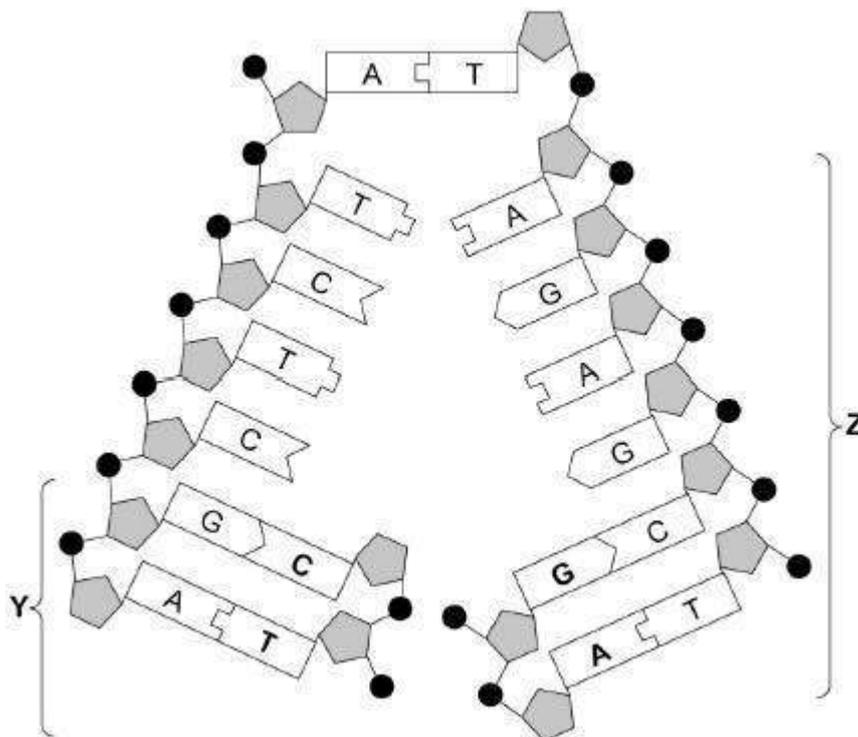
1

(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)  $3 \times 10^{-12}$  grams 1

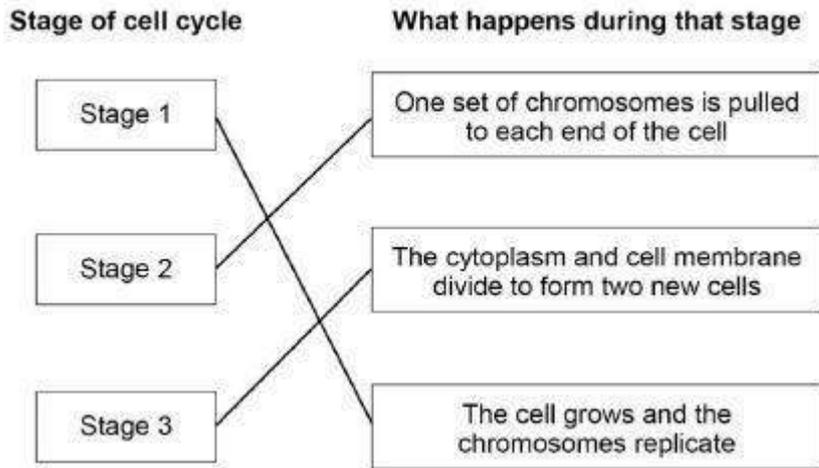
(h) meiosis 1

[8]

**Q2.**

(a) mitosis 1

(b) all lines correct = 2 marks  
1 or 2 lines correct = 1 mark



additional line from a box on the left negates the credit for that box

2

(c)

$$\frac{7}{10} \times 100$$

allow  $\frac{252}{300} \times 100$

1

70(%)

*allow answer calculated from angle in range 250° to 254°  
if no other mark awarded, allow 0.7 for 1*

1

(d) 3 1

(e) DNA 1

*allow deoxyribonucleic acid for 1*

1

(f) a gene 1

1



- (g) (bone marrow) cells differentiate into many / other types of (named) cell  
*allow (bone marrow) cells can become many / other types of (named) cell*

1

- (so) will cure diseases where new cells are needed  
**or** will cure diseases where cells are damaged  
*allow (so) will cure anaemia / leukaemia  
**or** blood cancer **or** blood disorders  
 allow (so) will cure paralysis / diabetes*

1

[10]

**Q3.**

- (a) any **two** from: (both have)

- cytoplasm
- (cell) membrane
- DNA / genetic material  
*ignore reference to shape  
 allow RNA  
 ignore genetic information*
- ribosomes

*if no other mark awarded allow sub-cellular structures for 1 mark  
 if no other mark awarded allow correct cellular process, e.g. respiration for 1 mark*

2

- (b) any **three** from:

*allow converse for eukaryotic cells  
 allow reference to bacterium instead of prokaryotic cell  
 ignore reference to features not shown in the diagram*

- prokaryotic cell is smaller
- prokaryotic cell has no mitochondria
- prokaryotic cell has no nucleus  
**or** DNA is free in the cytoplasm  
**or** genetic material is free in the cytoplasm  
*if neither mark awarded, allow prokaryotic cell has no membrane-bound organelles  
 ignore genetic information*
- prokaryotic cell has a single loop of DNA  
**or** prokaryotic cell has a single loop of genetic material  
*ignore genetic information*
- prokaryotic cell has plasmids  
*ignore circular / rings of DNA*



	<i>allow prokaryotic cells have smaller ribosomes</i>	3
(c)	1 $\mu\text{m} = 0.001 \text{ mm}$ or 1 mm = 1000 $\mu\text{m}$ or 0.05 mm = 50 $\mu\text{m}$ or 0.05 $\times$ 1000	1
	(1:) 50 <i>do not accept if a unit is given</i>	1
(d)	mitosis <i>correct spelling only</i>	1
(e)	35%	1
(f)	(stage 1) DNA / chromosomes replicate / duplicate <i>ignore names of the stages of the cell cycle</i> <i>ignore genetic material ignore DNA / chromosomes double / reproduce</i>	1
	mitochondria / ribosomes / sub-cellular structures increase in number or mitochondria / ribosomes / sub-cellular structures replicate <i>allow cytoplasm increases</i> <i>ignore cell grows unqualified</i>	1
	(stage 2) one set of chromosomes is pulled / moved to each end of the cell <i>allow one of each chromosome is pulled / moved to each end of the cell</i> <i>ignore nucleus divides</i>	1
	(stage 3) the cytoplasm <b>and</b> cell membrane divides (to form two cells) <i>allow cytoplasm divides and (new) cell membranes form ignore nucleus divides</i>	1
		[13]
<b>Q4.</b>		
(a)	any <b>three</b> from: <ul style="list-style-type: none"> <li>• mitosis produces two (daughter) cells but meiosis produces four (daughter) cells</li> </ul>	



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

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

*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

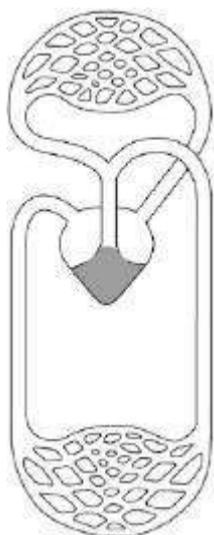
[13]

**Q5.**

(a) blood is pumped to the lungs by one / right side of the heart  
**and**  
 blood is pumped to the body by the other / left side of the heart  
*allow blood enters the heart twice for*  
*every (one) circuit around the body*

1

(b) ventricle correctly identified as any part of grey area below:



- 1
- (c) oxygenated and deoxygenated blood mixes  
*allow some deoxygenated blood is sent to the body / tissues / cells*
- 1
- (so) less oxygen reaches the body / tissues / cells  
*allow named tissues / organs*
- 1
- (d) concentration gradient (of oxygen) is shallow(er) / less steep
- 1
- (therefore) less oxygen diffuses into blood / cells / gills
- 1
- allow idea that concentration gradient is negative (i.e. out of axolotl) (1)*  
*so oxygen diffuses out of axolotl's blood / cells / gills (1)*
- (so) less (aerobic) respiration occurs so less energy is released / available  
**or**  
 (so more) anaerobic respiration occurs so less energy is released / available
- 1
- do **not** accept no respiration occurs*  
*do **not** accept energy production*
- (so) less metabolism  
*ignore reduced living processes unqualified*  
*allow reduction of building larger molecules **or** movement / muscle contraction **or** keeping warm **or** urea formation **or** chemical reactions*
- or**  
 (so when) anaerobic respiration occurs, lactic acid is produced (and



- is toxic) 1
- (e) stem (cells)  
*do **not** accept embryonic stem cell* 1
- (f) any **one** from:  
 • paralysis  
 • diabetes  
*allow other examples such as  
 Parkinson's / heart disease / stroke /  
 cystic fibrosis / cancer / burns  
 do **not** accept infectious diseases* 1
- (g) any **one** from:  
 • easy to breed  
     *allow reproduce quickly*  
 • easy / cheap to keep / rear (as are small)  
 • don't take up much space  
     *allow reference to not being dangerous  
 (to the scientist)  
 allow they are not endangered  
 allow removal of gill will not kill the  
 axolotl* 1
- (h) any **one** from:  
 • it's not a mammal **or** it is an amphibian  
 • regeneration in gills may be different to that in other organs  
 • metabolism / body processes are too different to humans  
     *allow humans do not have gills  
 allow it's an endangered species **or**  
 species need to be protected from  
 extinction  
 ignore reference to genetic differences  
**or** ethics* 1
- [12]**

**Q6.**

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

**Q7.**

- (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]

**Q8.**

(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



	<i>allow asexual is faster</i>	
	<ul style="list-style-type: none"> <li>• (more) energy efficient</li> <li>• genetically identical offspring</li> </ul>	
	<i>allow offspring are clones</i>	
	<ul style="list-style-type: none"> <li>• successful traits propagated / maintained / passed on (due to offspring being genetically identical)</li> <li>• no transfer of gametes or seed dispersal</li> </ul>	
	<i>allow no vulnerable embryo stage</i>	
	<i>allow no need for animals</i>	
	<ul style="list-style-type: none"> <li>• not wasteful of flowers / pollen / seeds</li> <li>• colonisation of local area</li> </ul>	
	<i>must imply local area</i>	2
(c)	genetic variation (in offspring)	1
	(so) better adapted survive	
	<i>allow reference to natural selection or survival of the fittest</i>	1
	(and) colonise new areas by seed dispersal	
	<b>or</b>	
	can escape adverse event in original area (by living in new area)	
	<i>must imply new area</i>	1
	many offspring <b>so</b> higher probability some will survive	1
	<i>allow bluebell example described (max 3 if not bluebell)</i>	
		<b>[8]</b>

**Q9.**

(a)	an undifferentiated / unspecialised cell	1
	that can differentiate / become / change into (many) other cell types	1
(b)	(malignant tumours) invade / spread to other tissues via the blood (benign don't)	
	<b>or</b>	
	(malignant tumours) form secondary tumours in other organs	
	<i>ignore cancer unqualified</i>	
	<i>allow converse</i>	
	<i>allow metastasises</i>	1



- (c) mitosis *correct spelling only* 1
- (d) glucose *answers in any order*  
*ignore sugar* 1
- protein / amino acids 1
- (e) no need to wait for a donor  
**or**  
can be done immediately 1
- (so) no risk of rejection  
**or**  
no need for immunosuppressant drugs  
*if no other marks awarded, allow for 1 mark idea of ethics surrounding the use of tissue from another / dead person* 1
- (f) stent opens up the trachea 1
- allowing air to flow through  
**or**  
allowing patient to breathe 1
- (g) **Level 3 (5-6 marks):**  
A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.
- Level 2 (3-4 marks):**  
Some logically linked reasons are given. There may also be a simple judgement.
- Level 1 (1-2 marks):**  
Relevant points are made. They are not logically linked.
- Level 0**  
No relevant content
- Indicative content**
- embryos advantages**
- can create many embryos in a lab
  - painless technique
  - can treat many diseases / stem cells are pluripotent / can become any type of cell (whereas bone marrow can treat a limited number)
- embryos disadvantages**



- *harm / death to embryo*
- *embryo rights / embryo cannot consent*
- *unreliable technique / may not work*

**bone marrow advantages**

- no ethical issues / patient can give permission
- can treat **some** diseases
- procedure is (relatively) safe / doesn't kill donor
- tried and tested / reliable technique
- patients recover quickly from procedure

**bone marrow disadvantages**

- *risk of infection from procedure*
- *can only treat a few diseases*
- *procedure can be painful*

**both procedures advantage**

can treat the disease / problem

**both procedures disadvantages**

- *risk of transfer of viral infection*
- *some stem cells can grow out of control / become cancerous*

[16]

**Q10.**

- (a) **C** 1
- (b) cytoplasm **and** cell membrane dividing 1  
*accept cytokinesis for 1 mark*
- to form two identical daughter cells 1
- (c) stage 4 1
- only one cell seen in this stage 1
- (d)  $(4 / 36) \times 16 \times 60$  1
- 107 / 106.7 1
- 110 (minutes) 1  
*allow 110 (minutes) with no working shown for 3 marks*
- (e) binary fission 1  
*do not accept mitosis*



- 1
- (f) shortage of nutrients / oxygen 1
- so cells die
- or**
- death rate = rate of cell division 1
- [11]**

**Q11.**

- (a) testis / testes 1
- allow testicle(s)*
- (b) (i) **B** = 13.2  
**C** = 6.6  
**E** = 3.3 2
- 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 = 1/2 B and E = 1/2 C for one mark*
- (ii) 6.6 1
- allow twice answer for cell E in part bi*
- (iii) mitosis 1
- correct spelling only*
- (c) (i) any **two** from: 2
- cells that are able to divide
  - undifferentiated cells / not specialised
  - can become other types of cells / tissues **or** become specialised / differentiated
- allow pluripotent*
- (ii) 4-day embryo is a (potential) human life 1
- or**
- destroying/damaging (potential) human life  
*allow cord would have been discarded anyway*  
*ignore reference to miscarriage*  
*allow cannot give consent*
- (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]

**Q12.**

(a) (i) fewer cows

1

any **one** from:

- less methane  
*do **not** allow CH<sup>4</sup>*
- less CO<sub>2</sub> in the atmosphere because of less deforestation **or**  
 less plants consumed.

*allow less CO<sub>2</sub> released into the atmosphere*  
*because less fuel used e.g. to heat cowsheds **or** to*  
*transport meat*  
*do **not** allow CO<sup>2</sup>*

1

(ii) any **two** from:

- could be mass produced to feed an increasing population
- disease free meat
- no / low fat
- no harm to animals or less intensive farming  
*allow (may be) suitable for vegetarians*
- antibiotic free meat
- more land available for farming crops  
*allow no energy loss along a food chain*

2

(b) fungus / Fusarium

1

with glucose (syrup)

1

in aerobic conditions **or** in presence of oxygen

*ignore air*

1

mycoprotein is harvested / purified

*allow ammonia added (as source of nitrogen)*  
*ignore stirring / mixing and temperature*



1

[8]

**Q13.**

- (a) the movement of particles from a high concentration to a low concentration 1
  
- (b) (gills) have (many) projections 1  
*allow description of projections*  
*allow have lots of / five gills*
  
- (for) large(r) surface / area
  
- or**
  
- (gills) are on the outside of the body (1)
  
- for good access to water (1) 1
  
- (c) differentiation 1
  
- (d) mitosis 1  
*do **not** accept meiosis*
  
- (e) hair 1
  
- (f) axolotls are cheap to feed 1  
  
axolotls are easy to breed 1
  
- (g) D 1
  
- (h) trachea 1  
*allow windpipe*  
*allow cartilage (ring)*
  
- (i) pulmonary artery 1

[11]