

# Cell Division Answers

## Mitosis and Meiosis

1

Question	Part	Sub Part	Marking Guidance	Mark	Comments
5	(a)		(Different) form/type/version of a gene / different base sequence of a gene;	1	
5	(b)		Two/sister <u>chromatids</u> ; Due to <u>DNA</u> replication; Joined by a <u>centromere</u> ;	1 1 1	2 max
5	(c)	(i)	Crossing over; Exchange (of alleles) between chromatids/chromosomes;	1 1	Negate first marking point for answers which refer to independent segregation.  Chiasma/chiasmata = first marking point
5	(c)	(ii)	Is infrequent/rare;	1	References to it being 'random', 'occurs by chance' or 'doesn't always occur' should not be credited without a clear idea that it is rare or infrequent.
5	(d)	(i)	Three chromosomes shown; One from each homologous pair;	1 1	For first mark point allow drawings showing three chromosomes as single or double structures.
5	(d)	(ii)	8;	1	

Question	Marking Guidelines	Mark	Comments
2(a)(i)	Anaphase	1	
2(a)(ii)	<ol style="list-style-type: none"> <li>1. Sister/identical chromatids/ identical chromosomes;</li> <li>2. To (opposite) poles/ends/sides;</li> </ol>	2	<ol style="list-style-type: none"> <li>1. Reject: Homologous chromosomes separate.</li> <li>1. Allow any reference to chromatids/ chromosomes being identical e.g. same DNA</li> </ol>
2(b)(i)	<ol style="list-style-type: none"> <li>1. 8.4/cells with twice DNA content = replicated DNA / late interphase / prophase / metaphase / anaphase;</li> <li>2. 4.2 = DNA not replicated / (early) interphase / telophase / cell just divided / finished mitosis;</li> </ol>	2	<ol style="list-style-type: none"> <li>1. Any reference to interphase must suggest towards end of interphase.</li> <li>1. 'Chromosomes replicate' is not enough for DNA replicates.</li> </ol>
2(b)(ii)	2.1;	1	


3

Question	Marking Guidelines	Marks	Comments
4(a)	<ol style="list-style-type: none"> <li>1. Growth / increase in cell number;</li> <li>2. Replace cells / repair tissue / organs /body;</li> <li>3. Genetically identical cells;</li> <li>4. Asexual reproduction /cloning;</li> </ol>	2 max	<p>Ignore growth of cells</p> <p>Ignore repair cells</p> <p>Reject bacteria</p> <p>3. 'Produces 2 genetically identical cells' does not reach MP1 as well as MP3</p> <p>4. Allow example or description</p>
4(b)(i)	(Ensures) representative (sample);	1	<p>Accept find some cells in mitosis/not in interphase. Accept 'more reliable' only if linked to percentage (of cells). 'Improves reliability' on its own does not gain this mark</p> <p>Neutral: Large sample</p>
4(b)(ii)	<ol style="list-style-type: none"> <li>1. A = metaphase;</li> <li>2. Chromosome / chromatids lie on equator;</li> <li>3. B = anaphase;</li> <li>4. Chromatids /chromosomes separating / moving apart / moving to poles;</li> </ol>	4	<ol style="list-style-type: none"> <li>2. Reject homologous chromosomes</li> <li>Allow centre/middle</li> <li>4. Reject homologous chromosomes</li> </ol>
4(c)	2 hours / 120 minutes;;	2	Allow 1 mark if working shows candidate understood that mitosis would take 10%

Question	Marking Guidance	Mark	Comments
4 8(a)	<ol style="list-style-type: none"> <li>1. Strands separate / H-bonds break;</li> <li>2. DNA helicase (involved);</li> <li>3. Both strands/each strand act(s) as (a) template(s);</li> <li>4. (Free) nucleotides attach;</li> <li>5. Complementary/specific base pairing / AT <u>and</u> GC;</li> <li>6. DNA polymerase joins nucleotides (on new strand);</li> <li>7. H-bonds reform;</li> <li>8. Semi-conservative replication / new DNA molecules contain one old strand and one new strand;</li> </ol>	6 max	<ol style="list-style-type: none"> <li>1. <b>Q</b> Neutral: strands split</li> <li>1. Accept: strands unzip</li> <li>4. Neutral: bases attach</li> <li>4. Accept: nucleotides attracted</li> <li>6. Reject: if wrong function of DNA polymerase</li> <li>8. Reject: if wrong context e.g. new DNA molecules contain half of each original strand</li> </ol>
8(b)(i)	18;	1	Do not accept 17.5
8(b)(ii)	10;	1	
8(b)(iii)	<ol style="list-style-type: none"> <li>1. Horizontal until 18 minutes;</li> <li>2. (Then) decreases as straight line to 0 <math>\mu\text{m}</math> at 28 minutes;</li> </ol>	2	<ol style="list-style-type: none"> <li>1. Allow +/- one small box</li> <li>2. Allow lines that start from the wrong place, ending at 0 at 28 minutes</li> </ol>
8(c)(i)	<p>Two marks for correct answer of 19.68 or 19.7;;</p> <p>One mark for incorrect answers in which candidate clearly multiplies by 0.82;</p>	2	<p>Accept 19hrs 41mins</p> <p>Allow one mark for incorrect answers that clearly show 82% of 24 (hours)</p>
8(c)(ii)	<ol style="list-style-type: none"> <li>1. No visible chromosomes/chromatids;</li> <li>2. Visible nucleus;</li> </ol>	1 max	
8(c)(iii)	<p><b>D</b> (no mark)</p> <ol style="list-style-type: none"> <li>1. <u>Lower</u> % (of cells) in interphase / <u>higher</u> % (of cells) in mitosis/named stage of mitosis;</li> <li>2. (So) more cells dividing / cells are dividing quicker;</li> </ol>	2	<ol style="list-style-type: none"> <li>1. Accept: 'less' or 'more' instead of '%'</li> <li>1. Do not accept: higher % (of cells) in each/all stage(s)</li> <li>2. Accept: uncontrolled cell division</li> <li>2. Do not award if Tissue <b>C</b> is chosen</li> </ol>

Question	Marking Guidance	Mark	Comments
5 1(a)(i)	Centromere;	1	Accept: if phonetically correct Reject: centriole
1(a)(ii)	<ol style="list-style-type: none"> <li>Holds chromatids together;</li> <li>Attaches (chromatids) to spindle;</li> <li>(Allows) chromatids to be separated/move to (opposite) poles / (centromere) divides/splits at metaphase/anaphase;</li> </ol>	2 max	<ol style="list-style-type: none"> <li><b>Q</b> Neutral: chromosomes or chromatids split/halved/divided</li> <li>Reject: reference to homologous chromosomes being separated</li> </ol> Accept 'chromosomes' instead of 'chromatids' Ignore incorrect names for <b>X</b>
1(a)(iii)	(Homologous chromosomes) carry different alleles;	1	Accept alternative descriptions for 'alleles' eg different forms of a gene / different base sequences Neutral: reference to maternal and paternal chromosomes
1(b)(i)	(In <b>Figure 2</b> ) <ol style="list-style-type: none"> <li>Chromatids have separated (during anaphase);</li> <li>Chromatids have not replicated;</li> <li>Chromosomes formed from only one chromatid;</li> </ol>	1 max	<ol style="list-style-type: none"> <li><b>Q</b> Neutral: split/halved/divided</li> <li>Reject: reference to homologous chromosomes being separated</li> </ol> 1. & 2. Accept 'chromosomes' instead of 'chromatids' Accept converse arguments for <b>Figure 1</b> Ignore references to the <i>cell</i> not dividing as in the question stem Ignore: named phases
1(b)(ii)	<ol style="list-style-type: none"> <li>Three chromosomes;</li> <li>One from each homologous pair;</li> </ol>	2	Ignore shading Only one mark for three chromosomes shown as pairs of chromatids

1(b)(iii)	Crossing over / alleles exchanged between chromosomes or chromatids / chiasmata formation / genetic recombination;	1	Accept: description of crossing over eg sections of chromatids break and rejoin Neutral: random fertilisation Reject: reference to sister chromatids <b>Q</b> Neutral: genes exchanged Neutral: mutation
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Question	Marking Guidance	Mark	Comments
 8(a)	<ol style="list-style-type: none"> <li>1. Sugar-phosphate (backbone)/double stranded/helix <b>so</b> provides strength/stability /protects bases/protects hydrogen bonds;</li> <li>2. Long/large molecule <b>so</b> can store lots of information;</li> <li>3. Helix/coiled <b>so</b> compact;</li> <li>4. Base sequence allows information to be stored/ base sequence codes for amino acids/protein;</li> <li>5. Double stranded <b>so</b> replication can occur semi-conservatively/ strands can act as templates;</li> <li>6. Complementary base pairing / A-T <u>and</u> G-C <b>so</b> accurate replication/identical copies can be made;</li> <li>7. (Weak) hydrogen bonds <b>for</b> replication/ unzipping/strand separation;</li> <li>8. Many hydrogen bonds <b>so</b> stable/strong;</li> </ol>	6 max	<p>Must be a direct link/obvious to get the mark</p> <p>Neutral: reference to histones</p> <p>3. Accept: can store in a small amount of space for 'compact'</p> <p>4. Accept: base sequence allows transcription</p> <p>Accept: 'H-bonds' for 'hydrogen bonds'</p> <p>8. Must convey the idea of 'many'</p>
8(b)	<ol style="list-style-type: none"> <li>1. (Mutation) in <b>E</b> produces highest risk/1.78;</li> <li>2. (Mutation) in <b>D</b> produces next highest risk/1.45;</li> <li>3. (Mutation) in <b>C</b> produces least risk/1.30;</li> </ol>	3	<p>Must be stated directly and not implied</p> <p><b>E&gt;D&gt;C</b> = 3 marks</p> <p>Accept: values of 0.78, 0.45 and 0.30 for MP1, MP2 and MP3 respectively</p> <p>If no mark is awarded, a principle mark can be given for the idea that all mutant alleles increase the risk</p>



8(c)	<b>180;</b>	1	
8(d)	<p><b>(Similarities):</b></p> <ol style="list-style-type: none"> <li>1. Same/similar pattern / both decrease, stay the same then increase;</li> <li>2. Number of cells stays the same for same length of time;</li> </ol> <p><b>(Differences):</b> (Per unit volume of blood)</p> <ol style="list-style-type: none"> <li>3. Greater/faster decrease in number of healthy cells / more healthy cells killed / healthy cells killed faster;</li> <li>4. Greater/faster increase in number of healthy cells / more healthy cells replaced/divide / healthy cells replaced/divide faster;</li> </ol>	3 max	<ol style="list-style-type: none"> <li>2. Ignore: wrong days stated</li> <li>3. &amp; 4. Accept: converse for cancer cells</li> <li>3. Accept: greater <u>percentage</u> decrease in number of cancer cells / greater <u>proportion</u> of cancer cells killed</li> </ol> <p>For <b>differences</b>, statements made must be comparative</p>
8(e)	<ol style="list-style-type: none"> <li>1. More/too many healthy cells killed;</li> <li>2. (So) will take time to replace/increase in number;</li> <li>3. Person may die/have side effects;</li> </ol>	2 max	<ol style="list-style-type: none"> <li>2. Neutral: will take time to 'repair'</li> </ol>

7

**Question 1**

- |     |      |   |       |
|-----|------|---|-------|
| (a) | (i)  | DACB  | 1     |
|     | (ii) | Attachment of centromeres;<br>Separation of (daughter) chromatids;  | 2     |
| (a) |      | Meiosis halves the number of chromosomes;<br>Restoration of diploid number at fertilisation;<br>Introduces variation;<br>Correct reference to natural selection / survival; | 2 max |
| (c) | (i)  | Sperm is haploid, liver is diploid / sperm formed by<br>meiosis, liver cell formed by mitosis;  | 1     |
|     | (ii) | It has no nucleus;  | 1     |



**Question 2**

- |     |       |  |          |
|-----|-------|--|----------|
| (a) | (i)   | 20   | <b>1</b> |
|     | (ii)  | 10   | <b>1</b> |
|     | (iii) | 10   | <b>1</b> |
| (b) | (i)   | (Daughter) chromatids will not separate / centromere won't divide;<br><u>Centromere</u> attaches to spindle fibres;<br><i>NOT 'chromosomes can't be pulled apart'. Ignore references to stages of mitosis.</i> | <b>2</b> |
|     | (ii)  | Red blood cells <u>formed</u> / <u>produced</u> by mitosis;  | <b>1</b> |

Total 6 marks

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Q

**Question 2**

- |         |  |   |
|---------|--|---|
| (a)     | replication / duplication / doubling of chromosomes / replication of DNA / transcription of DNA;                                   | 1 |
| (b) (i) | cell to show correct number of chromosomes;<br>correct shape and position of centromere;   | 2 |
| (ii)    | as (i) except everything halved – <i>Ignore crossing over</i> ;<br>(if mitosis and meiosis reversed, allow 1 if otherwise correct) | 2 |
| (c)     | to replace cells;  | 1 |

Total 6 marks

**BYA2****10** *Question 1*

- (a) (i) Prophase; 1
- (ii) Chromosomes/chromatids moved apart; 1
- (iii) *A wide range of processes occurs during interphase. This list is by no means exhaustive, but we would expect to see answers such as:*
- Increase in volume of cell/volume of cytoplasm / increase in mass / cell bigger;  
increase in number of organelles;  
synthesis of protein/named protein;  
DNA replication/increase / chromosomes copied;  
ATP synthesis / respiration; max 2
- (b) Divide real length of bar (in mm)/10 by 0.02; 1
- (c)  $12/200 \times 24$  / single error in otherwise correct method;  
1.44 hours (1 hour 26 min); 2

Total 7 marks

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**Question 4**

- 11 (a) (i) where mitosis/division/growing/ occurs 1  
(*reject growing cells*)
- (ii) to distinguish chromosomes/chromosomes not visible without stain; 1
- (iii) to let light through/thin layer; 1
- (b) (i)  $74 + 18/982$ ;  
 $= 9.4\% / 9\%$ ; 2  
(*allow 1 mark for identifying prophase & metaphase i.e. 92 or correct method using wrong figures*)
- (ii) genetic differences/different types of garlic;  
time of day; chance;  
age of root tip;  
water availability;  
temperature;  
nutrient availability; 2 max  
(*environmental factors = 1 but cannot be awarded in addition to a name environmental factor*)

Total 7

12 **Question 3**

(a)	Chromosomes: <b>C</b> = 8 <i>and</i> <b>D</b> = 4; DNA: <b>C</b> = 300 <i>and</i> <b>D</b> = 150;	2
(b)	(i) testis / ovary; <i>accept anther / carpel / stamen / testicle</i>	1
	(ii) to make chromosomes / chromatids / DNA / genetic material visible;	1
		Total 4

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13

**Question 3**

- |              |      |   |          |
|--------------|------|---|----------|
| (a)          | (i)  | 95 - 100 minutes;   | 1        |
|              | (ii) | It shows the distance between the (sister) chromatids increases at this point;<br>As they begin to separate/ move to opposite poles;  | 2        |
| (b)          |      | Chromatids cannot be seen;<br>Valid reason, e.g. chromosomes have not condensed / too diffuse /<br>still in interphase;   | 2        |
| (c)          | (i)  | Zygote;   | 1        |
|              | (ii) | Avoids doubling of chromosomes number at each generation / maintains<br>chromosome number from generation to generation/<br>diploid/correct number/ 46 restored at fertilisation; | 1        |
| <b>Total</b> |      |   | <b>7</b> |



**Question 2**

- |              |      |   |          |
|--------------|------|---|----------|
| (a)          | (i)  | Attaches (chromosome) to spindle/holds (sister) chromatids together;        | 1        |
|              | (ii) | Separate chromatids/centromeres/chromosomes/ aligns chromosomes at equator; | 1        |
| (b)          | (i)  | $n, n, 2n$ ;  | 1        |
|              | (ii) | X on arrow going from $2n$ to $n$ ;   | 1        |
| <b>Total</b> |      |   | <b>4</b> |

15

**Question 2**

- |     |  |   |
|-----|--|---|
| (a) | Interphase/S-(phase)/synthesis;  | 1 |
| (b) | (i) B;<br>Acts during DNA replication;<br><i>Ignore reference to wrong named stage</i> | 2 |
|     | (ii) This is when chromosomes/ chromatids are separating;<br>Pulled by spindle fibres; | 2 |

**Total 5**

16	(b)	(i)	<p>One mark for curve basically similar in shape to that plotted;                  Two marks for curve basically similar in shape to that plotted and with values roughly twice those shown;;  <b>Q</b> <i>Max 1 if increase starts in regions E or G</i></p>	2
		(ii)	<p>Telophase;</p>	1
		(iii)	<p>Shortening of spindle (fibres);  <b>Q</b> <i>Answer must relate to spindle but accept references to chromatids/chromosomes/centromeres being pulled/separated by the spindle fibres.</i></p>	1
Total				7

17 **Question 1**

- |       |       |   |   |
|-------|-------|---|---|
| (a)   | (i)   | <b>A</b> anaphase;  | 1 |
|       | (ii)  | <b>(C) B,A,D</b> ;  | 1 |
|       | (iii) | (original) chromosome/DNA has been replicated;<br>each chromosome consists of two chromatids/<br>chromatids attached at centromere;<br>(accept reference to condensed state of chromosomes) | 2 |
| (b)   | (i)   | it has doubled/now 8;   | 1 |
|       | (ii)  | chromosome/DNA replication but no<br>separation/anaphase/cell division;   | 1 |
| Total |       |   | 6 |
- 

18 **Question 2**

- |       |   |       |
|-------|---|-------|
| (a)   | meiosis halves the chromosome number / from diploid to haploid/<br>produces haploid/n cells;<br>when gametes fuse/at fertilisation, the diploid number is restored;<br>this keeps the chromosome number constant/correct from one generation<br>to the next/after sexual reproduction;<br>introduces <u>genetic</u> variation/independent assortment/crossing over; | 3 max |
| (b)   | <b>M</b> between moss plant and spore;  | 1     |
| (c)   | (gamete <b>B</b> , <i>no mark</i> )<br>gamete <b>B</b> has/ <b>A</b> does not have:<br>few reserves/nutrients;<br>smaller size;<br>flagella, so mobile;   | 2 max |
| Total |   | 6     |
-

19

**Question 4**

- (a) to get haploid/n/half number of chromosomes (in cells);  
so that each cell gets one copy of each chromosome/gene/full set of genes;  
so that fertilisation produces diploid/constant chromosome number;  
results in independent assortment; 2 max
- (b) (i) 4; 1
- (ii) meiosis (has halved the chromosome number); 1
- (ii) (mitosis because) zygote gets two chromosomes from each gamete/  
has four chromosomes;  
(accept haploid for two and diploid for four)  
gamete-producing plant has two chromosomes, so mitosis to  
produce gametes with two; 2
- Total 6
-

20

**Question 2**

- |     |       |  |   |
|-----|-------|--|---|
| (a) | (i)   | anaphase;  | 1 |
|     | (ii)  | sister / identical <u>chromatids</u> (separate);<br>move to opposite poles / ends / sides; | 2 |
| (b) | (i)   | interphase;  | 1 |
|     | (ii)  | <u>ATP</u> production / protein synthesis / replication of centrioles;                     | 1 |
|     | (iii) | 1.2;   | 1 |
| (c) |       | short duration of <u>interphase</u> ;  | 1 |

**Total 7**

**Question 2**

- 21
- |     |       |   |   |
|-----|-------|---|---|
| (a) | (i)   | (D) B E A C;  | 1 |
|     | (ii)  | <u>metaphase</u> ;  | 1 |
| (b) |       | interphase/S phase;   | 1 |
| (c) | (i)   | 0.06 x 100;<br>6(%)<br><i>(correct answer 2 marks)</i>  | 2 |
|     | (ii)  | more (cancer cells) killed, cancer cells divide more (often) (so are more likely to be killed, more susceptible); | 1 |
|     | (iii) | longer time to recover;<br>reduced rate of mitosis / divide more slowly/increased doubling time;                  | 2 |

**Total 8**

## 22 Question 8

(a)

$$\begin{array}{c|c} A & A \\ \hline b & b \end{array}$$

$$\begin{array}{c|c} a & a \\ \hline B & B \end{array}$$

1

(b) bivalent;

1

(c) (i) Ab, aB;

(ii) AB, ab;

2

(d) mutation;

different/new allele formed / genes deleted or duplicated/ sequence of genes changed (*reject genetic information*);

random fusion of gametes / fertilisation;  
new combination of alleles;

independent assortment (of chromosomes) (*accept random*);  
shuffling of maternal and paternal chromosomes/new combination  
of alleles;

(*ignore references to stages of meiosis*)

any 2x2

4 max

Total 8



**Question 2**

23

- |     |       |   |   |
|-----|-------|---|---|
| (a) | (i)   | (D) B E A C;  | 1 |
|     | (ii)  | <u>metaphase</u> ;  | 1 |
| (b) |       | interphase/S phase;   | 1 |
| (c) | (i)   | 0.06 x 100;<br>6(%)<br><i>(correct answer 2 marks)</i>  | 2 |
|     | (ii)  | more (cancer cells) killed, cancer cells divide more (often) (so are more likely to be killed, more susceptible); | 1 |
|     | (iii) | longer time to recover;<br>reduced rate of mitosis / divide more slowly/increased doubling time;                  | 2 |

**Total 8**

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**Question 1**

- 24 (a) (i) Stage A is anaphase;  
Chromatids/chromosomes moving apart/centomere divided; 2
- (ii) Stage B is telophase;  
Chromosomes are uncoiling;  
(Accept new nuclei forming) 2
- (b) Embryo split into separate cells;  
These (cells) are undifferentiated/totipotent;  
Each cell grows by mitosis (into new embryo/organism); 2 max

**Total 6**

25

- (a) Centromeres divide/chromatids separate;  
One chromatid/chromosome moves to each pole;  
Spindle fibres shorten; 2 max
- (b) Rate of removal (of tubulin) proportional to shortening of spindle fibres/  
speed of movement of chromatids/fibres control speed of movement;  
Provides force/pulls chromatids or chromosomes apart/movement linked  
to shortening of fibres; 2

**Total 4**