CAMBRIDGE INTERNATIONAL AS & A LEVEL BIOLOGY · 9700

BIOLOGY



MARK SCHEME

5 THE MITOTIC CELL CYCLE

SCORE	PERCENTAGE
/	%

STEMUP

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Paper 1 Multiple Choice Answers: The Mitotic Cell Cycle

Question	Paper	Q. No.	Answer
692	9700_m20_qp_12	19	B
693	9700_m20_qp_12	20	D
694	9700_m20_qp_12	21	C
695	9700_s20_qp_11	17	C
696	9700_s20_qp_11	18	D
697	9700_s20_qp_11	19	D
698	9700_s20_qp_12	19	D
699	9700_s20_qp_12	20	C
700	9700_s20_qp_12	21	A
701	9700_s20_qp_13	17	B
702	9700_s20_qp_13	18	C
703	9700_s20_qp_13	19	D
704	9700_w20_qp_11	18	B
705	9700_w20_qp_11	19	B
706	9700_w20_qp_11	20	D
707	9700_w20_qp_12	17	B
708	9700_w20_qp_12	18	A
709	9700_w20_qp_12	19	C
710	9700_w20_qp_13	19	A
711	9700_w20_qp_13	21	D
712	9700_m19_qp_12	19	B
713	9700_m19_qp_12	20	D
714	9700_s19_qp_11	18	B
715	9700_s19_qp_11	20	D
716	9700_s19_qp_12	15	B
717	9700_s19_qp_12	16	A
718	9700_s19_qp_12	17	A
719	9700_s19_qp_13	21	C
720	9700_s19_qp_13	22	B
721	9700_s19_qp_13	23	C
722	9700_w19_qp_11	19	D
723	9700_w19_qp_11	20	B
724	9700_w19_qp_12	20	B
725	9700_w19_qp_12	21	D
726	9700_w19_qp_13	17	B
727	9700_w19_qp_13	18	D
728	9700_m18_qp_12	20	D
729	9700_m18_qp_12	21	D
730	9700_s18_qp_11	19	D
731	9700_s18_qp_11	20	D
732	9700_s18_qp_11	21	A
733	9700_s18_qp_12	18	A
734	9700_s18_qp_12	19	B
735	9700_s18_qp_12	20	C
736	9700_s18_qp_12	21	D
737	9700_s18_qp_12	22	D

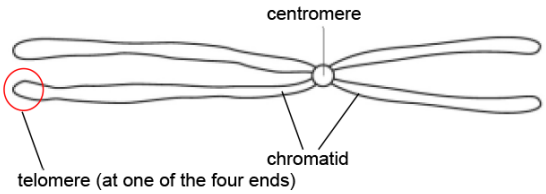
Paper 1 Multiple Choice Answers: The Mitotic Cell Cycle (continued)

Question	Paper	Q. No.	Answer
738	9700_s18_qp_13	19	D
739	9700_w18_qp_11	19	B
740	9700_w18_qp_11	20	B
741	9700_w18_qp_11	21	C
742	9700_w18_qp_11	22	B
743	9700_w18_qp_12	20	C
744	9700_w18_qp_12	21	B
745	9700_w18_qp_13	20	D
746	9700_w18_qp_13	21	A
747	9700_m17_qp_12	20	C
748	9700_m17_qp_12	21	C
749	9700_m17_qp_12	22	A
750	9700_s17_qp_11	21	B
751	9700_s17_qp_12	16	A
752	9700_s17_qp_12	17	D
753	9700_s17_qp_13	16	B
754	9700_w17_qp_11	17	B
755	9700_w17_qp_12	19	C
756	9700_w17_qp_12	20	B
757	9700_w17_qp_12	21	A
758	9700_w17_qp_13	20	D
759	9700_w17_qp_13	21	C
760	9700_w17_qp_13	22	D
761	9700_m16_qp_12	16	A
762	9700_m16_qp_12	17	C
763	9700_m16_qp_12	18	A
764	9700_s16_qp_11	18	B
765	9700_s16_qp_11	19	C
766	9700_s16_qp_12	16	A
767	9700_s16_qp_12	17	C
768	9700_s16_qp_12	18	B
769	9700_s16_qp_13	17	D
770	9700_s16_qp_13	18	A
771	9700_w16_qp_11	17	D
772	9700_w16_qp_11	18	A
773	9700_w16_qp_12	21	D
774	9700_w16_qp_13	17	A
775	9700_w16_qp_13	19	B
776	9700_s15_qp_12	18	B
777	9700_s15_qp_12	19	D
778	9700_s15_qp_13	18	B
779	9700_w15_qp_12	18	D
780	9700_w20_qp_13	20	B
781	9700_s19_qp_11	19	C
782	9700_s19_qp_11	21	D
783	9700_w19_qp_13	19	A

Paper 1 Multiple Choice Answers: The Mitotic Cell Cycle (continued)

Question	Paper	Q. No.	Answer
784	9700_m18_qp_12	22	C
785	9700_s18_qp_11	18	B
786	9700_s18_qp_13	20	B
787	9700_s18_qp_13	21	A
788	9700_w18_qp_12	22	B
789	9700_m17_qp_12	23	B
790	9700_s17_qp_11	22	C
791	9700_s17_qp_11	23	C
792	9700_s17_qp_13	17	B
793	9700_w17_qp_11	16	D
794	9700_s16_qp_11	17	C
795	9700_w16_qp_12	20	D
796	9700_s15_qp_11	18	C
797	9700_s15_qp_11	19	B
798	9700_w15_qp_11	18	C
799	9700_w15_qp_13	18	D

46. 9700_s20_ms_21 Q: 2

(a)	**P** – chromosomes, arranged randomly / AW *or* *idea that* chromosomes present but not (yet) visible as consisting of two sister chromatids (joined by centromere) ; **A** description related to idea of chromosomes becoming visible / chromatin condensing **Q** – chromosomes are, arranged / aligned / AW, at the, (cell / spindle) equator / metaphase plate ; **A** equatorial plate **R** – no chromosomes visible / nucleolus is present / chromatin not condensed / euchromatin present ;	**3**
(b)(i)	*drawing* two chromatids of identical length joined at the centromere ; *labels* chromatid ; *one label line is sufficient* **R** if second line drawn to arm of sister chromatid centromere ; telomere ;  	**4**
(b)(ii)	histone(s) ; **A** highly basic (protein)	**1**
(b)(iii)	*accept spindle fibres / microtubules as alternative to spindle* *max 2 if stages are named and are incorrect* *any three from:* (prophase) attachment to centromere of each chromosome ; **A** *ref. to* kinetochore *in correct context* (prophase) arranging / orientating / AW, chromosomes at the, equator / metaphase plate / AW ; **A** *ref. to* metaphase in correct context (anaphase) centromere division / separation of sister chromatids ; (anaphase) pulling, chromatids / daughter chromosomes, apart / towards poles ; (because) spindle fibres contract / (as) lengths of microtubules decreases / microtubules are disassembled ; (elongates in telophase to) push, poles / nuclei, apart ;	**3**

47. 9700_w20_ms_21 Q: 1

(a)(i)	(sister) chromatids ; centromere ; histone ;	**3**
(a)(ii)	prophase / metaphase ; **I** late / early **A** prometaphase	**1**
(a)(iii)	**I** *ref. to* replication or cytokinesis *any **two** from:* provides energy ; movement of centrioles to poles ; spindle formation / organisation of microtubules (for spindle) ; movement of chromosomes to the, spindle equator / AW ; separation of, (daughter) chromosomes / (sister) chromatids, to opposite poles (of the cell) / during anaphase ; AW AVP ; e.g. (for) condensation / AW, of, chromatin / chromosomes	**2**
(b)	*assume reference to binary fission unless stated otherwise* *any **two** from:* DNA replication ; **A** *idea* of, doubling / duplicating, DNA cell, elongation / gets longer ; **A** cell increases in size cell wall formation ; (includes) cytokinesis / described ; *max 1 if two ideas correct describing events that only occur in mitosis*	**2**

48. 9700_w20_ms_23 Q: 3

<table>
<tr><td>(a)(i)</td><td>A – G1 / gap 1 ;
B – S / synthesis ; A DNA replication I S1 / S2 / replication unqualified</td><td>2</td></tr>
<tr><td>(a)(ii)</td><td>telophase ;</td><td>1</td></tr>
<tr><td>(a)(iii)</td><td>any two from:
increase in cytoplasm / increase in number of (named) organelle(s), during interphase ; A synthesis of organelles
I cell growth

(re)formation of nuclear envelope ;
nuclear envelope, forms around each group of chromosomes ;
A nuclear membrane as an ECF if used for mp2

(movement of) organelles to be shared between two daughter cells ;

spindle, disassembles / breaks down / degrades / disappears / AW ;

cleavage furrow forms ;
A cytoplasm / cell membrane, pinches in / constricts / infolds

AVP ;
e.g. (actin) microfilaments / microtubules, form contractile ring / AW, around equator of cell / beneath cell surface membrane
A cytoskeleton for microtubules / microfilaments</td><td>2</td></tr>
<tr><td>(a)(iv)</td><td>one mark per row
<table><tr><td></td><td colspan="3">stages of cell cycle</td></tr><tr><td></td><td>A</td><td>B</td><td>D</td></tr><tr><td>number of nuclei within the stem cell</td><td>1</td><td>1</td><td>2 ;</td></tr><tr><td>number of chromosomes ineach nucleus</td><td>12</td><td>12</td><td>12 ;</td></tr></table></td><td>2</td></tr>
<tr><td>(b)</td><td>1 stem cells) continue to divide / divide repeatedly (by mitosis) ;
A at least one daughter cell, retains ability to divide / is a stem cell / A ‘repeated mitosis’ / A ‘to produce more stem cells’

any two from mps 2-5:
to produce cells
2 for growth ;

3 for repair of tissues ; R repair of cells

4 for replacement of, worn out / old / dead, cells ;
A damaged cells if repair of tissues not given

5 to differentiate for formation of, tissues / organs ;
A specialised cells for forming, tissue / organs

and:
6 AVP ; e.g. ref. to potency of stem cells (multipotent or pluripotent)</td><td>3</td></tr>
</table>

49. 9700_s18_ms_23 Q: 1

(a)	(nucleus of cell) **D** has two nucleoli v **E** has one nucleolus ;	**1**
(b)	**A** = (early / mid) prophase ; **R** late **B** = (mid / late) prophase ; **R** early **C** = anaphase ;	**3**
(c)	**I** name of stage *two from:* ref. to (daughter) chromosomes at poles ; **A** (sister) chromatids at poles **R** chromatids move to poles **A** two separate groups of (daughter) chromosomes **A** two nuclei form (enclosing chromosomes) **I** there are two nuclei *in context of at each pole* nuclear envelope reassembles (around chromosomes) ; **A** nuclear membranes reassemble nucleolus reappears / nucleoli reappear ; (daughter) chromosomes, become diffuse / become long and thin / decondense / uncoil ; **A** become chromatin **I** disappears spindle, disassembles / AW ;	**2**

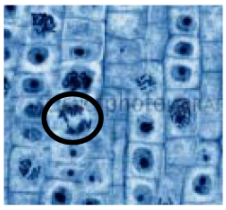
50. 9700_w18_ms_22 Q: 3

(a)	*any two from* **1** (division that) produces, new / daughter, cells **A** produces more cells **or** (so) replaces, damaged / lost / dead, cells ; **2** new / daughter, cells, genetically identical ; **A** *ref. to* clone if correct context **A** genetic information not lost **I** same number of chromosomes **3** (all) new cells can retain function ; AW	**2**
(b)	*any two from* **1** cell cycle continuous / continually divide / AW ; **2** (produce cells that) can, differentiate / specialise / described ; **A** multipotent / pluripotent **I** totipotent *divide to produce a cell that can divide and a cell that differentiates = 2 marks* **3** can produce, cells / tissue, that can still function (as before) ;	**2**
(c)	*any three from* **1** chemicals (released) are cell signalling, molecules / compounds ; **2** liver cells, are target cells ; **A** liver tissue for liver cells **3** binding of, chemicals / cell signalling molecules, to receptors (of liver cells) ; **R** receptor cells **4** *ref. to* specificity (of receptors) / chemicals complementary to receptors ; *if **R** above, then allow ecf for idea of complementary* **5** (specific) response is, cell enters the cell cycle / mitosis / cell division ; **A** DNA replication **6** AVP ; e.g. *idea of* communication between cells suggestion of detail following binding, e.g. second messenger activated / enzyme cascade /signal transduction / phosphorylation events / enzyme activation **I** cascade of reactions	**3**

51. 9700_m17_ms_22 Q: 3

(a)	all three correct ; *with the non-competitive inhibitor* **Z** *with the competitive inhibitor* **Y** *without any inhibitor* **X**	**1**
(b)	*four from:* V_{max} 1 **X** and **Y** same V_{max} of 10 au ; 2 V_{max} of, **X** / **Y**, higher than **Z** / ORA ; **A** (V_{max} of), **X** / **Y**, 10 au v **Z** 5 au **A** (V_{max} of), **X** / **Y**, double the V_{max} of **Z** K_m 3 **X** and **Z** same K_m ; **A** K_m of both is 4 mmol dm^{-3} 4 **X** / **Z**, lower K_m than **Y** / ORA ; **A** K_m of, **X** / **Z**, 4 mmol dm^{-3} v **Y** 6.5 mmol dm^{-3} 5 reference to affinity for substrate ;	**4**
(c)	*four from:* 1 double helix ; 2 strands are held together by hydrogen bonds (between bases) ; 3 complementary base pairing / described as A-T and C-G ; **A** purine pairs with pyrimidine R thiamine 4 antiparallel stands / strands are 3' to 5' and 5' to 3' ; **A** strands run in opposite directions 5 (each strand has a sugar phosphate backbone with) phosphodiester bonds ; 6 (monomers / units / DNA) are (DNA) nucleotides / polynucleotide strands ; 7 (nucleotide =) deoxyribose sugar, phosphate, nitrogenous (organic) base ; ***A** points from a diagram*	**4**
(d)	*two from:* 1 *idea that,* hydrogen peroxide, damage / breaks, DNA and repair errors (may) occur ; 2 (so leads to) incorrect, nucleotide / base, inserted (during replication) / change in, nucleotide / base, sequence (of DNA / RNA) ; 3 new allele (may be) formed ; 4 may result in an altered polypeptide / AW ;	**2**

52. 9700_w17_ms_21 Q: 1

(a)	 ;	**1**
(b)	*two from* can observe living, specimens / cells ; (so) the process of mitosis can be seen happening / AW ; **R** easier to see mitosis happening **I** to study cell division ease of use, qualified ; e.g. no need for heavy metal staining, preparation of specimen less time-consuming **I** *ref. to* colour **I** portable	**2**
(c)	*three from* production of genetically identical cells ; asexual reproduction ; repair of damaged tissue ; **A** replace damaged cells **R** repair damaged cells replace, dead / worn out / old / non-functioning, cells ; gamete production *in context* ;	**3**

53. 9700_w17_ms_21 Q: 4

(a)	*codon that* terminates / AW, translation / polypeptide synthesis **R** stops production of amino acids **or** does not specify any amino acid **or** has no complementary, tRNA / anticodon **or** causes the release of the (completed) polypeptide chain ;	**1**
(b)	*four from* Asp and Gln R groups, hydrophilic / AW, and Ile R group, hydrophobic / AW ; *ref. to* R group interactions and, folding / coiling, of polypeptide chain (to give globular structure) ; *ref. to* (charged / polar R groups) forming, ionic / hydrogen, bonds ; (amino acids with), hydrophobic / non-polar, R groups, on the inside / AW ; **A** hydrophobic amino acids (amino acids with), hydrophilic / charged / polar, groups on outside / AW ; **A** hydrophilic amino acids detail ; e.g. ionic R groups can interact with water, hydrogen bonds form with water *ref. to* promotes stability / helps to maintain globular structure ; *in context of interaction with water / formation of (compact) hydrophobic core*	**4**
(c)	glycosidic ;	**1**
(d)	*four from* 1 both, increase and decrease / peak ; 2 both active, over range of temperature tested / between 20 to 55°C ; 3 free enzyme lower, optimum temperature / temperature for maximum activity ; **ora** 4 (free) 37°C v (immobilised optimum) 46°C; 5 free enzyme higher, maximum activity / activity at optimum temperature ; **ora** 6 (free) 8.2 / 8.3, a.u. v 7.5 a.u. ; 7 between 20°C and 39°C the activity of free is higher ; **ora** 8 between 39°C and 55°C the activity of free is lower ; **ora** *if mp 7 and 8 not gained, allow 1 mark for free activity higher at lower temperatures and lower at higher temperatures (than immobilised) ora* 9 comparative data to support mp 7 or 8 ; **A** comparison at one temperature (stated or use of numerical data) 10 AVP ; e.g. both have same activity at 39°C, similar activity between 20°C and 30°C	**4**
(e)	substrate concentration that gives half V_{max} / AW ; **A** description of how to use a graph to derive (must refer to substrate concentration)	**1**
(f)	*two from* *look for ora throughout* free / low(er) K_m , has higher affinity for substrate ; free needs a lower concentration of substrate to reach, V_{max} / maximum activity / ½ V_{max} ; takes lower substrate concentration to saturate active sites in free ; free active site more, likely to be saturated with substrate / accessible ; active site (may be) distorted by immobilising ; *ref. to* substrate passing through matrix when immobilised ; *ref. to* some product retained within matrix ;	**2**

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54. 9700_w16_ms_21 Q: 1

(a)
A nuclear envelope ; **A** nucleus **A** nuclear membrane
I nuclear pore

B mitochondrion ; **A** mitochondria **A** mitochondrial envelope

C lysosome / Golgi vesicle / secretory vesicle ; **A** vesicle / vacuole **A** plural
I qualification e.g. transport / temporary / phagocytic [3]

(b) ribosome(s) / cell surface membrane ; **A** vesicles **A** plasma membrane **I** cytoplasm [1]

(c) *two from*
organise microtubules ;
(to), form spindle / assemble spindle fibres (in prophase) ; AW
ref. to centriole pair / centrioles, at (both) poles ; **R** if description is linked to incorrect mitotic stage
ref. to role in contraction of spindle fibres, at anaphase / to separate sister chromatids ;
AVP ; e.g. make microtubules (as part of the centrosome) [2]

(d) *three from*
(sodium ions are) charged / hydrophilic ; **I** *ref. to* size / polar
cannot pass through hydrophobic, core / interior, (of phospholipid bilayer) ;

(so) must pass through, transport proteins / carrier proteins / channel proteins *(facilitated diffusion)* ;

ref. to hydrophilic (amino acids lining) channels ;
ref. to active transport only way to move sodium ions against concentration gradient / AW ; [3]

[Total: 9]

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55. 9700_w19_ms_22 Q: 6

(a)	**I** maintains length of chromosomes / prevents chromosome shortening *any two from:* permit continued replication ; prevent loss of genes ; **I** prevents gene damage genetic material is neutral **A** genetic / coded, information *for genes* **A** information on DNA **A** protein coding regions of DNA **A** exons protect ends of chromosomes from being, degraded / AW ; AVP ; e.g. prevents ends of chromosomes from being attached to each other not mistaken for a break in DNA that needs repairing	**2**
(b)	*Idea that,* mitosis / cell cycle / (DNA) replication / (cell) division, occurs in both cell types (continuously / regularly / AW) ; **R** uncontrolled mitosis **R** meiosis	**1**
(c)	induced fit ;	**1**
(d)	*allow low(er) rate for 0.2 μmol dm^{-3} and high(er) rate for 1.6 μmol dm^{-3}* *any two from:* comparison in terms of <u>active site(s)</u> ; e.g. (low rate) active sites, not all occupied / spare / not all saturated **or** (high rate) active sites all occupied / no spare active sites / active sites saturated bod 'active sites are limited' comparison in terms of enzyme-substrate complexes formed (per unit time) e.g. (low rate) few(er) ES complexes formed **or** (high rate) many / more, ES complexes formed ; **A** (low rate) few(er) collisions between enzyme and substrate ora (low rate) substrate concentration limiting factor **or** (high rate) limiting factor is, enzyme concentration / not substrate concentration;	**2**

56. 9700_w19_ms_23 Q: 2

(a)

name	one example of cell from 2.1
interphase	B / G
prophase	A
metaphase	D
anaphase	E / F / C
telophase	C / H **R** C *if stated for anaphase*

all five correct = 3 marks
three or four correct = 2 marks
one or two correct = 1 mark

3

(b) (29 as a percentage of 5000 =) 0.58 (%) ; **A** 0.6 (%)
(0.0058 × 720 minutes =) 4 (min) / 4.2 / 4.18 / 4.176 ; *allow ecf*

2

(c) *mark first answer*
one from

1 cell plate forms (across equator of cell) ;

2 cell wall / cellulose, laid down ; **A** cell wall forms (between the two)

3 cytoplasm divided (into two) ;
R cytoplasm, constricts / pinches in
I 'separates into two daughter cells'
I events at late telophase

4 *idea that* organelles shared out ;

5 AVP ; detail of cell plate formation
e.g. *ref. to* vesicles transported to equator / involvement of cytoskeletal structures / *ref. to* phragmoplast

1

57. 9700_s18_ms_21 Q: 1

(a)(i)	*answers must be comparative* *one from:* *idea that* the sections are orientated differently / cut in different planes / cut at different angles / AW ; **A** is a cross section / AW, and **B** is a longitudinal section / AW mitochondria show a variety of, sizes / shapes ; mitochondria, are flexible / change shape ; **A** and **B** are of, different ages / stages of development ;	**1**
(a)(ii)	*two from:* replace, old / worn out / damaged, mitochondria ; require more mitochondria as cells, enlarge / grow ; more mitochondria are needed, for new cells / when cell divides ; **A** so numbers remain the same in the new cells / after cell division **A** *idea that* mitochondria are shared out (between daughter cells) (mitochondria) provide (most), energy / ATP ; **I** cell needs (much) energy without stating mitochondria provide energy **R** energy production **I** uses of energy	**2**
(b)	*two from:* nuclear envelope shown as two membranes with closed ends and a gap ; label to nuclear pore ;	**2**
(c)	*four from:* 1 contains / AW, chromosomes / chromatin / DNA / genes / genetic material / inherited material / genetic information ; 2 (coded) information for synthesis of, polypeptides / proteins ; **A** controls protein synthesis 3 ref. to sequence(s) of bases (in DNA) ; 4 transcription (of genes) / production of mRNA ; 5 contains nucleolus ; 6 manufacture of ribosomal sub-units ; **A** makes ribosomes 7 *idea that* DNA is protected from degradation / enzymes / AW ; 8 AVP ; e.g. responds to signals that control, gene expression / AW post-transcription modification / modifies mRNA / any example repairs DNA **I** controls cell's activities **I** sends mRNA to cytoplasm / mRNA travels through nuclear pores	**4**

58. 9700_s18_ms_22 Q: 4

(a)	**1 / 4** ; **3** ; **5** ;	**3**
(b)	*two from:* centromere (of each chromosome) divides ; **A** sister chromatids separated at the centromere spindle fibres, contract / shorten ; **A** spindle contracts (sister / identical) chromatids / daughter chromosomes, pulled / move, to opposite poles ; **A** (sister) chromatids separated **I** chromosomes are at opposite poles centromeres, leading (towards poles) / AW ; **A** ref. to V-shape / diagram	**2**
(c)	*one from:* not sectioned to include (nucleus) ; did not take up the stain / not stained (correctly) / AW ; AVP ; e.g. cells may be dead **I** destroyed / eliminated / AW	**1**

59. 9700_m17_ms_22 Q: 1

(a)	label line and letter G to one of the ends of the chromosome ;	**1**
(b)	anaphase / telophase ;	**1**
(c)	cytokinesis ;	**1**
(d)	receptor(s) ; **I** description of receptor	**1**

60. 9700_w17_ms_22 Q: 1

(a)	**C** ; **R** if more than one area given	1
(b)(i)	*three from* two chromatids drawn ; *must be connected at some point* (sister) chromatid label to correct structure ; centromere label to correct structure ; **A** kinetochore telomere label to end of chromatid ; DNA and histone (proteins) label to chromatid ;	3
(b)(ii)	*two from* disassembles / breaks down / disintegrates / AW, at, prophase ; **A** prometaphase re-forms / re-assembles / AW, after anaphase / at telophase ; *if mp 1 and 2 not gained, one mark can be awarded for knowledge of disassembles and then reassembles* detail ; e.g. breakdown into vesicles re-forms from vesicles / vesicles fuse to form new membranes re-forms around both sets of (daughter) chromosomes	2

61. 9700_w17_ms_23 Q: 6

(a)	EGF binds to receptor(s) on cell **A** ; **ora** **A** has receptor for, EGF / cell signaling compound **A** EGF does not bind to receptor on **B** *idea of* complementary / specific ; **ora** **R** antigen to antibody **I** active site	2
(b)	*accept* ***ora*** *one from* more, proteins / polypeptides, are made ; proteins are required for growth / to provide (named) protein for DNA synthesis / proteins are required for organelles / AW ; **A** S phase for DNA synthesis during mitosis DNA is highly condensed ;	1
(c)	*three from* ATP ; (activated / free / DNA) nucleotides ; **R** in context of transcription DNA polymerase ; (DNA) ligase ; AVP ; e.g. topoisomerase / gyrase helicase	3
(d)(i)	centromere ; **A** kinetochore *one from* holds / joins / AW, (sister) chromatids together ; attach to spindle	2
(d)(ii)	*max 1 if more than one chromosome shown* *two from* separate chromatids that are identical in shape ; one arm larger than the other on both separate chromatids ; V-shaped chromatids with centromeres pointing towards the poles ;	2

62. 9700_s16_ms_22 Q: 5

(a) (i) coiling / supercoiling / condenses / condensation ;
A become shorter and thicker **R** contracts **[1]**

(ii) *accept from labelled diagram*
two chromatids ;
identical / sister, chromatids ;
joined by a centromere ; **A** kinetochore

one from
(reach chromatid) DNA complexed with protein
histone proteins / histones
telomeres at end of chromatids ; **[max 3]**

(b) *metaphase versus anaphase*
idea of single chromosome of two chromatids versus two separated chromatids / daughter chromosomes
e.g. two chromatids versus, one chromatid / one daughter chromosome ;
sister chromatids joined at centromere versus chromatids separated
distance between sister chromatids zero versus increasing distance between chromatids
share a centromere versus do not share a centromere / centromere divides

two DNA molecules versus one DNA molecule ;

at, equator / metaphase plate versus towards / at, poles ; **R** centre **R** ends

linear / straight versus V shape / AW ; **[max 2]**

(c) acts at target cell ;

binds to receptor ; **R** receptor cells *allow ecf for other mps*
R trapped / caught
ref. specificity ; **A** receptor complementary (shape) for cytokinin
A cytokinin fits into receptor *this is also mp2*
A recognition of cytokinin by receptor

receptor (located) in, cell surface / plasma, membrane ;
A cell membrane **A** phospholipid bilayer **A** transmembrane receptor

sets off / AW, response in the cell / described response(s) ; e.g.
triggers secondary messenger
activates enzyme(s)
I signals / causes / stimulates, cell to divide / cytokinesis

(acts) extracellularly / extracellular signal **or** (acts) intracellularly / intracellular signal ; *must be in context of candidate's answer* **[max 3]**

[Total: 9]

63. 9700_w16_ms_22 Q: 1

A = chloroplast ;
B = tonoplast ; **A** vacuolar membrane
C = spindle / spindle fibre(s) ;
D = (bacterial / prokaryotic) cell wall ; **R** eukaryotic / cellulose / chitin / plant
E = nucleolus ; [5]

[Total: 5]

---

64. 9700_s15_ms_21 Q: 1

(a) *one mark for the stages of the cell cycle in the correct sequence*
one mark for correct matching of each stage with a cell

stage of mitosis	label from Fig. 1.1
prophase	**A** / **H** ;
metaphase	**G** ;
anaphase	**C** / **E** / **F** ;
telophase ;	**B** ;

[5]

(b) microtubules / spindle (fibres), attach to centromere / kinetochore (of chromosome during prophase) ; **I** metaphase
arranging / aligning / orienting / AW, chromosomes at the equator / metaphase plate ; **R** centre
fibres, shorten / contract / retract ; **A** microtubules disassemble / AW
move / pull, (sister) chromatids / (daughter) chromosomes, to opposite poles / centrioles ;
idea that equal number of chromosomes in each daughter, nucleus / cell ; [max 2]

(c) maintaining number of chromosomes ;
ensuring genetic stability / maintaining genetically identical cells / AW ;
asexual reproduction ; **A** vegetative reproduction / cloning
cloning / clonal expansion, of (named) lymphocytes ; **A** B / T cells
replacement of (worn out / dead / damaged) cells ;
regeneration, of (named) tissues / organs ;
(wound) repair (of tissues) ; **R** repair of cells
ref. to production of gametes ;
e.g. mitosis in gametogenesis / gamete production in plants
R 'copying of cells' [max 2]

(d) (i) *accept biological N fixation or Haber-Bosch process for mp1*

1 *either*
converts, (inorganic) nitrogen / dinitrogen / N_2, into organic nitrogen / ammonia / NH_3 / ammonium / NH_4^+ ; **R** if nitrate given
or
lightning converts, nitrogen / ammonia / NH_3 / ammonium / NH_4^+, into, nitrite / nitrate (ions) ;

2 reduces nitrogen / breaks triple bond ;

3 makes (fixed) nitrogen available to, legumes / other organisms / community / AW ; **A** ref. to amino acids / proteins
not to be awarded if it follows nitrification

4 increase soil fertility ;

5 balances the loss of fixed nitrogen in, denitrification / ocean deposits ; [max 2]

(ii) 1 *idea of* decay / decomposition ;
e.g. breakdown by, (saprophytic) bacteria / fungi

2 legumes eaten by, detritivores ; **A** named detritivores

3 decomposers produce proteases ;

4 to, hydrolyse / convert / change / AW, protein to amino acids ;

5 amino acids are deaminated ;

6 (amino acids) to, ammonia / NH_3 / ammonium (ions) / NH_4^+ ;

7 nitrifying bacteria / *Nitrosomonas*, convert ammonia to nitrite (ions);

8 nitrifying bacteria / *Nitrobacter*, convert nitrite to nitrate (ions) ;

if mp7 or mp8 not awarded allow one mark for the following as mp9
9 (named) nitrifying bacteria convert, ammonia / ammonium, to nitrate (ions) ;

mp10 only to be awarded following nitrification
10 nitrate (ions) used for making, amino acids / proteins (hence increase in growth of cereals) ;

[max 3]

[Total: 14]

65. 9700_w15_ms_22 Q: 3

(a) **A** = interphase **I** *ref. to early / late*
C = metaphase **;**
both needed for one mark [1]

(b) (**C**) **L**, **N**, **M**, **K ;** [1]

(c) **1** *idea that* centromere, has divided / divides (separating, sister / identical, chromatids) **;**
2 centromere attached to spindle fibre; **A** spindle
3 shortening / contraction, of spindle fibres (pulling centromeres) **;** **A** spindle, contracts / shortens
4 (so) sister / identical, chromatids, move to opposite poles **;** *need idea of separated, so* **A** ends / sides / halves **A** sister / identical, chromatids, will end up, at separate poles / in separate cells

[max 3]

[Total: 5]

66. 9700_s20_ms_22 Q: 1

(a)	*any two from* protein coat / capsid **;** **A** capsomeres nucleic acid core / DNA or RNA **;** acellular / AW **;**	**2**
(b)	*any three from* *no, because* resolution of light microscope, too low / not high enough **;** only able to distinguish points 200nm or more apart *or* size of virus / 30 nm, too small for resolution of (light microscope) of 200 nm **;** **A** range 100-300 nm wavelength of light too long **;** *idea that* virus too small to interfere with light waves **;**	**3**
(c)	*any three from* virus binds to receptors (on host cell surface membrane) **;** *ref. to* specificity / complementary shapes / complementary binding **;** endocytosis **;** description **;** e.g. membrane infolds / pinches in vesicle formed **;** **A** vacuole	**3**

1.	A	21.	C
2.	D	22.	D
3.	C	23.	C
4.	D	24.	D
5.	C	25.	C
6.	B	26.	C
7.	D	27.	
8.	C	28.	
9.	D	29.	D
10.	D	30.	C
11.	A	31.	A
12.	B	32.	D
13.	D	33.	D
14.	C	34.	A
15.	A	35.	B
16.	A	36.	A
17.	C	37.	A
18.	B	38.	C
19.	D	39.	A
20.	C	40.	C

41.	D
42.	B
43.	A
44.	C
45.	D
46.	B
47.	B
48.	C
49.	B
50.	A
51.	B
52.	C
53.	C
54.	B
55.	B
56.	A
57.	D

Q1.

Question	Expected Answers	Marks
1 (a)	C, E, D, B;	1
(b)	centromeres have divided/duplicated; R. split R. replicated (sister) chromatids/(daughter) chromosomes pulled/moved/ separate/migrate to (opposite) poles; ref. to the spindle/microtubules/spindle fibres; R. fibres	max 2
(c)	replication/DNA synthesis; assembly of nucleotides/polynucleotide (chain) formed; (alongside) old/original/both strands, act as template; by base/complementary pairing/ A-T and G-C; quantity of DNA doubles/two new double helices formed;	max 3
(d)	production of genetically identical cells/genetically uniform cells/ identical DNA/maintains genetic stability/same number and kind of c-somes/no genetic variation;	1
		[Total 7]

Q2.

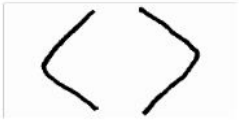
3 (a) (i) 6 ; [1]

(ii) centromere ;

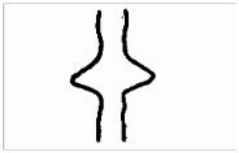
site of attachment to, microtubules/spindle fibres ;
A holds chromatids together **R** ref to centromeres dividing [2]

(iii) any pair shaded in ; **A** more than one pair [1]

(iv) *either*



or



two daughter chromosomes shown ;
centromeres leading as shown above ; [2]

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(b) chromosome, unravels/becomes chromatin/AW (during telophase) ;
transcription ;
described/mRNA produced ;
replication/new DNA produced ;
semi-conservative/description e.g. unzips and bases pair up ;
ref to histone proteins ; [max. 3]

(c) halved/6 -> 3 ; A diploid -> haploid/2n -> n

to restore diploid number at fertilization/
to avoid chromosome number doubling in every generation ; [2]

[Total: 11]

Q3.

(b) (during), mitosis / meiosis / nuclear division ; ignore 'cell division' / phases
replicate, after / before, each division ; **A** at interphase
move / separate, to poles ;
assemble / organise, microtubules ;
centre for growth of / forms, spindle fibres / for formation of spindle / AW ;
modified centrioles found elsewhere such as in flagella / cilia ; [3 max]

Q4.

6 **(a)** chromosomes / chromatids, on equatorial plate / at equator / AW ;
A in, centre / middle, of cell
nuclear, membrane / envelope, dispersing / breaking up / (partially) visible / AW ;
A disappearing
chromosomes, in one group / not in two groups / not arrow shaped / not going to poles / not separated / AW ;
R chromosomes at poles [2 max]

(b) smoke / tar, is carcinogenic / contains carcinogens ; **A** named carcinogen e.g. benzpyrene / phenol
genes control, cell division / mitosis ;
mutation / change to DNA (in these genes) ; **A** DNA damaged **A** ref. to mutagenic
gene expression affected / AW ; e.g. ref to oncogenes / proto – to onco – / tumour suppressor genes switched off
cells, grow / divide, uncontrollably / continuously ; **A** uncontrolled mitosis
cancer cells do not respond to signals ;
(and) form a (malignant) tumour ;
(tar) settles on bronchial, epithelial cells / epithelium ; [4 max]

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(c) idea of, a long time gap / years, qualified ; e.g. before symptoms of, cancer / tumour, appear between decreased number smoking and lower mortality rates
correct ref. to data to support above ; *trends must be anchored in both graphs*
if data is used, must be anchored in both graphs and numerically correct
increasing mortality rate
increase in lung cancer deaths linked to rise in smoking in 1930s+ ;
valid ref. to other direct risk factors (for lung cancer) in 1930s+ ; e.g. air pollution, mass chest X-ray screening

decreasing mortality rate because
earlier diagnosis (so fewer die) ;
improved, health care / treatment (extends life) ;

ref. to epidemiological evidence linking smoking and lung cancer / almost all cases of lung cancer, are caused by smoking / occur in smokers ; [3 max]

[Total: 9]

Q5.

1 **(a)** **A =** anaphase ;
B = prophase ;
C = metaphase ; [3]

(b) ref. newly formed / daughter cells (following, telophase / mitosis) ;
cells, entering / at early interphase ;
cells, at synthesis stage / making proteins ;
cells growing (to, mature/normal, size) *or* cells not grown to, mature / normal, size ; AW **R** not elongated [max 1]

(c) *any 2 relevant e.g.*
cells metabolically active / AW ;
protein synthesis ;
transcription ;
translation ;
gene expression ;
DNA / semi-conservative, replication ;
respiration ;
synthesising, organelles / named organelle(s) ; e.g. **A** centrioles replicate
synthesising, macromolecules / named macromolecule ; [max 2]

[Total: 6]

Q6.

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1 **(a)** **(i)** metaphase ; [1]

(ii) chromosomes / (sister) chromatids, line up at the, equator / equatorial plate / metaphase plate ; **A** move to **I** middle / centre
centromeres attached to, spindle / spindle fibres ;
A (spindle) microtubules **A** kinetochore
centrioles, reach / located at / AW, poles ; **R** ends
ref. spindle fully formed ; **A** spindle fibres extend from poles / AW
R ref. to nuclear envelope absent (in anaphase also) [max 3]

(b) replacement of cells ;
repair of tissue ; **R** repair of cells
growth / increase in cell numbers ;
asexual reproduction / vegetative propagation ; **R** cloning
maintains / same, number of chromosomes ; **A** two sets of chromosomes / diploid / 2n
genetically identical to parents ;
A produces daughter cells that are genetically identical **A** ref. clone(s)
ref to rejection / self vs non-self ; [max 3]

(c) ref. coordination of growth / limiting growth ;
ref. minimising exposure to mutations / alterations to DNA (during replication) / AW ;
prevent tumour formation ; **A** prevent, cancer / uncontrollable growth
effect of, tumour / cancer ; e.g. compress other organs / invades other tissues or organs
AVP ; e.g. example of timing of cell cycle linked to cell function / idea of producing cells when required [max 2]

[Total: 9]

Q7.

(b) **(i)** **1** part of the immune response ; **A** primary / secondary, response

many plasma cells
2 to produce high, concentration / level / AW, of, antibody / immunoglobulin ;
3 (high concentration antibody so) more effective against pathogens / AW ;

identical plasma cells
4 specific / particular / AW, to an, antigen / epitope ;
in context of antibodies or plasma cells
5 antibody (molecules) produced are all the same ; **A** ora, qualified
6 only the gene coding for particular antibody, switched on / transcribed / expressed ; [max 3]

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(ii) *accept from annotated diagrams*

cell cycle stages are not required for mark points 1, 3, 4 and 7
reject if incorrect mitotic stage given for these mark points

1 ref. to, duplication / replication, of centrioles (in late interphase / before prophase);
A dividing
R splitting
2 (centriole pairs) move to opposite poles in prophase ;
accept asters or centrosomes for centrioles
3 (movement allows) spindle formation / organisation of spindle fibres / microtubule assembly / microtubule organisation / AW, (in prophase) ;
4 (late prophase / early metaphase / metaphase), chromosomes / centromeres, attach to, spindle fibres / microtubules ;
5 chromosomes, line up / aligned / AW, at, equator / metaphase plate ;
6 ref. separation of, sister / identical, chromatids, at anaphase (to poles) ;
A sister chromatids move to opposite poles at anaphase
A daughter chromosomes *for sister chromatids*
7 ref., pulling / shortening, by, microtubules / spindle fibres ; AW [max 4]

Q8.

6 (a) ref. to mutation(s) ;
in context of initiating uncontrolled mitosis OR as a consequence of uncontrolled mitosis
proto-oncogenes convert to oncogenes / oncogenes switched on / tumour suppressor genes switched off ;
(cell division is by) mitosis ;
formation of, tumour / mass of (unspecialised) cells ;
no response to (extracellular / intracellular) signals to control mitosis / AW ;
no contact inhibition / AW ;
no cell death / no apoptosis ;
immune system does not recognise the cells as foreign and destroys them ;
A reference to, not non-self / self
metastasis / described ; [max 3]

(b) **R** way in which cancer develops / epidemiological evidence
A beagles for dogs

1 tar painted on skin of, mice / rabbits / rats / (small) mammal, led to development of (cancerous / malignant) tumour ;
2 dogs that smoked (plain) cigarettes developed, cancer / tumour ;
3 dogs that smoked filter-tipped cigarettes did not develop cancer / tumour ;
A developed precancerous changes
4 control group / dogs, which did not smoke and did not develop, cancer / tumour ;
5 AVP ;
e.g. evidence from any other named mammal
e.g. inhaling substances from, tar / tobacco [max 3]

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(c) *similarities*

1 all (named) countries, increase and decrease / reach a peak and decrease ;

differences

2 peaks / AW, have occurred at different years in at least two countries ;

3 all maximum mortality rates are different ;

4 any comparative, data quote / calculation, with units given at least once ;
e.g. dates and mortality rates for at least two countries
e.g. mortality rates for one country at two different dates [max 3]

accept a range or a single figure within the ranges given

countries	peak mortality rate	year
USA	53–57	1984–1990
Spain	45-48	1993–1997
Finland	69–71	1970–1973
UK	72–75	1970–1975
Hungary	83–87	1996–2000

[Total: 9]

Q9.

1 **(a)** **(i)** *if one box of a pair left blank, no mark for that row*
mark first on row unless one row left completely blank

	mitosis	*meiosis*
1	diploid / two chromosome sets / 2n	haploid / one chromosome set /n ;
2	same number of chromosomes as parent / AW	half the number of chromosomes as parent / AW ;
3	two, copies / alleles / forms, of each	one, copy / allele / form, of each ;
4	(cells) genetically identical (to, each **A** (cells have) same / AW, DNA / **A** no genetic variation	(cells) genetically different **A** (cells have) different / AW, DNA / genetic material **A** genetic variation ;

[max 2]

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(ii) **1** for sexual reproduction ; **A** for, gamete / sperm and egg / pollen and ovum, formation *or* **A** gametogenesis

2 to produce, haploid cells / cells with one set of chromosomes, for, fertilisation / fusion ; **A** to form zygote
A cells with half the number of chromosomes for, fertilisation / fusion

3 restores / AW, diploid / original, number when, fertilisation / fusion (of gametes) occurs ; *only need ref. to fertilisation / zygote once*

4 *idea of* ploidy consequences at fertilisation if not ;
e.g. ref. to doubling of chromosome number of original

5 ref. genetic variation, linked to evolution / natural selection; [max 2]

(b) **(i)** 13 μm ; ; *two marks for correct calculation*
(39 000 / 3000)
allow one mark
if calculation of 12.6 μm or 13.3 μm (i.e. measured as 38 mm or 40 mm and not rounded to nearest micrometre)
measurement of, 39 mm / 3.9 cm, incorrectly converted to μm but correct formula used (i.e. divided by 3000) [2]

(ii) *assume cancer cell unless stated otherwise*
(undergoing) uncontrolled, mitosis / division ; **A** fast / rapid / abnormally

mitochondria, provide / produce, ATP ; **R** ATP energy
A provide energy **R** produce energy

RER, produce / synthesise / make / AW, (more), proteins / enzymes, for (cell) growth / mitosis / division ; *if mp 1 gained, no need ref. to mitosis* [max 2]

[Total: 8]

Q10.

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5 **(a)** growth (by increase in cell number) ;
production of genetically identical cells ;
replacing (damaged) cells ;
repair (of tissue) ; *allow 'regeneration' if mp3 and mp4 not awarded*
R repair cells
asexual reproduction ;
A cloning **A** vegetative propagation [max 3]

(b) one tick in each box ; [1]

(c) appearance of chromosomes / condensation of chromatin / AW ;
chromosomes visible as two, sister chromatids / chromatids joined by a centromere ;
spindle formation / spindle fibres form / microtubules assemble / AW ;
centrioles, move to / reach, opposite poles ;
R sides / ends
disappearance of nucleolus ;
disassembly / breakdown of, nuclear envelope ;
A nuclear membrane [max 4]

(d) mitosis / prophase, will begin again, too soon / immediately ;
uncontrolled / repeated, cell division / mitosis ;
ignore (risk of), tumour formation / cancerous growth
ref. to consequences on the timing of the cell cycle ; [max 3]

[Total: 11]

Q11.

4 **(a)** *ignore references to prophase*
at D/during metaphase

chromosomes arrange, on metaphase plate/at equator/on equatorial plate; **R** middle of cell
chromosomes with two (sister) chromatids/AW;
chromosomes attached to spindle at centromeres; **[max 2]**
at E/during anaphase

centromere(s), break/divide/duplicate; **R** replicate/split chromosomes/ chromatids, move/separate to opposite poles; **R** ends
ref microtubules/spindle (fibres), with centromeres leading;

[max 2]

(b) chromosomes uncoil/AW; e.g. become longer and thinner
nuclear, membrane/envelope reforms/AW;
new cell membrane formed;
cell plate/(new) cell wall/middle lamella, forms;
cytokinesis; **R** if say cytoplasm constricts as ref to animal cells **[max 3]**

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(c) mitotic index decreases from 0.11 to 0.016, as distance from tip increases/from 0.1 to1.9mm;
any ref to comparision plus distance from tip figs ;;
e.g. steep/AW decrease 0.6 to 0.7 mm
small/AW decrease 0.7 to 1.3 mm
slight/AW increase 1.3 to 1.8 mm
A for 1 mark if describe main pattern plus 2 overall ref points
R rapid or slow increases and decreases
if mm not used at least once, penalise once **[max 3]**

(d) during, interphase/S phase/before, mitosis/prophase, replication of DNA;
semi-conservative replication;
some ref to base pairing/any example, to template strand;
(during anaphase), sister chromatids are separated/move to opposite poles/go into separate cells";
new cells have same number, and kind of chromosomes/AW e.g. same, genes/DNA/chromosomes as parents; **[max 3]**

[Total: 13]

Q12.

1 **(a)** no membrane-bound organelles / no named organelle(s) ;
murein / peptidoglycan, in cell wall ;
smaller / 70s / 18nm, ribosomes ;
no nucleus / no nucleolus / no nuclear envelope ;
loop of DNA / circular DNA / no chromosomes / naked DNA / no histones ;
mesosome ;
plasmid ;
capsule ; **A** slime / mucilage, around cell wall ; [3 max]

(b) **(i)** growth ;
repair ;
regeneration ;
replacement / renewal ;
asexual / vegetative, reproduction / propagation ; **[3 max]**

(ii) *idea that* identical / sister chromatids, separate (in anaphase) ;

identical because
semi-conservative replication ;
base pairing / A – T and C – G ;
idea that each, strand / polynucleotide, of DNA acts as a template ;
two double helices produced are identical ;
cells have same, genotype / alleles / DNA / number and kind / set of chromosomes ;
no valid aspect of meiosis ; [3 max]

[Total: 9]

Q13.

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3 **(a)** **(i)** anaphase / early telophase ; [1]

(ii) **1** chromosomes / chromatids, move to / at, poles / centrosomes ;
2 attached to, spindle / microtubules ;
3 by, centromeres / kinetochores ; **A** centromeres leading
4 pulled by, microtubules / spindle fibres / AW ;
A contracting / shortening / disassembling [2 max]

(iii) *these points are independent*
1 cannot follow, movement of chromosomes / AW ;
e.g. 'processes in mitosis'
2 can only view dead material ;
3 sections have to be thin ;
4 overstaining obscures details (of chromosomes) ; **A** artefacts
5 cannot see, all of the chromosomes / whole chromosomes ; [2 max]

(b) **(i)** **1** carcinogen / cancer-causing / named carcinogen (in tobacco smoke / tar) ;
e.g. benzpyrene / phenol / nicotine *check any others*
2 mutation / change to DNA ;
3 ref to named gene ; e.g. oncogene / tumour suppressor
4 in (bronchial) epithelium ;
5 uncontrolled, cell division / mitosis / cell cycle ; **R** 'rapid'
6 grows into, mass of cells / lumen of airway(s) / lung tissue ;
A squeezes against blood vessels / enters lymphatic vessels
7 growth of blood capillaries (into tumour) ;
A angiogenesis / vascularisation / ref to thrombospondin
8 no programmed cell death ; [3 max]

(ii) must be a sign or symptom
1 coughing up blood ;
2 persistent cough / coughing a lot ;
3 coughing up increased volume of sputum / AW ;
4 chest / shoulder / back, pain ;
5 wheezing / breathlessness / breathing difficulty ;
6 weight loss ;
7 AVP ; e.g. fatigue **R** tiredness [2 max]

[Total: 10]

Q14.

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3 **(a)** so they have the same number of chromosomes (as parent cell) ;

idea that cells would be rejected (if genetically different) ;
ref. to role of the immune system in removing genetically different cells ; [2]

(b) *reject 'smoking' or 'radioactive transmissions' unqualified*

(chemical) carcinogen(s) / named ;
any two named chemical carcinogens to max 2 if term carcinogen not used
e.g. benzpyrene / ethidium bromide / phenol / tar *check any others*

UV ;
X rays ;
ionising radiation ;
gamma rays ;
radon ;
virus(es) / correctly named virus ; **A** HIV / HPV / HTLV / HSV **R** named disease
genetic / hereditary, factors ; [2 max]

(c) (i) cytokinesis ; [1]

(ii) chromosomes, uncoil / become diffuse / decondense / AW ;
A chromosomes unwind / become long and thin
A chromosomes become chromatin
A cell enters interphase
spindle breaks down / microtubules disassemble / AW ; **R** disappears

nuclear envelope, reforms / forms / forming ; **A** nuclear membrane **R** (re)appears
nucleolus / nucleoli, reform(s) / forms / forming ; **R** (re)appears

cell membrane, drawn together / furrows / AW ;
idea of role of, microfilaments / AW, in 'drawstring' effect ;

division of cytoplasm / cell separation / cleavage / cleavage furrow develops ;
A cytokinesis *if not credited in* ***(i)***
cell membrane fuses ; [3 max]

(iii) divide / replicate, uncontrollably ; **ignore** quickly / fast
A uncontrolled mitosis **R** grow uncontrollably
do not, differentiate / become specialised ; **A** loss of function
form an (irregular) mass (of cells) / AW ; **A** (a) growth
promotes growth of blood vessels / AW ;
AVP ; e.g. ref to genes / no programmed cell death / loss of contact inhibition [2 max]

[Total: 10]

Q15.

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4 (a) (i) chemical carcinogens ; **A** *named carcinogenic chemical e.g.* asbestos / tar / benzpyrene / aniline dyes / mustard gas / ethidium bromide ; *allow two named chemicals for two marks*
virus, qualified ; e.g. with oncogene / ability to convert host proto-oncogene / named virus e.g. HPV / retrovirus / HIV / HTLV
ionizing radiation / X-rays / gamma rays / particles from radioactive decay / ultraviolet light / alpha particles / beta particles ;
allow two named radiation examples for two marks
free radicals ;
hereditary predisposition / AW ;
tobacco smoking ;
obesity ; **A** qualified ref. to diet
AVP ; e.g. if immunocompromised [max 2]

(ii) not transmissible from one person to another / AW ;
not caused by a pathogen ; **R** bacterium / virus / fungus / AW / 'worm' [max 1]

(b) both drugs effective in treating tumours (compared to no drug) ;
comparative data quote, both drugs compared to no drug ;

ref. T138067 more effective than vinblastine against, tumour A (after day 18) / tumour B / both tumours (A and B)
relevant comparative data quote ; e.g. volume of 220 v 160 mm^3 at day 25 for tumour A
little difference in effectiveness between vinblastine and T138067 against tumour A up to day 18 ; AW
ref. similar effectiveness against tumour B until after day 15 ;
ref. to effectiveness of both drugs detectable from about 7–10 days ; AW
both drugs, not completely effective in stopping growth / tumours continue to grow ;
AVP ; e.g. greater effectiveness of, T138067 with B / vinblastine with A [max 4]

(c) ref. growth of tumour involves mitosis ; **A** cell division
not simple enlargement of cells / AW ;
mitosis stops / metaphase → anaphase → telophase, cannot proceed ;
accept two named stages
ref. to role of spindle during stages of mitosis ; ;
e.g. (prophase) to attach to chromosomes
(metaphase) to align chromosomes
(anaphase) to separate chromatids
} *if stage named, must be correct*
no separation of chromatids at centromere ;
AVP ; e.g. detail of assembly of microtubules
ref. apoptosis when cell cycle disrupted [max 3]

[Total: 10]

Q16.

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3 (a) (i) **K** – (DNA) replication / synthesis / described ;
L – cytokinesis / cytoplasmic division / cell division ; [2]

(ii) 3 ; [1]

(iii) remain the same / stays constant / stay at 46 / AW ; *ignore description of events occurring before and during mitosis* [1]

(b) transcription (of specific genes) ; **A** reference to gene switching
protein / polypeptide, synthesis ; **A** translation
production of haemoglobin ;
further detail ; e.g. assembly of quaternary structure
(production of) carbonic anhydrase ;
loss of, mitochondria / named organelles ;
loss of nucleus ;
adopts biconcave disc shape ; [max 3]

(c) occurs in both primary and secondary (immune) responses ;
selected / specific / AW ;
lymphocytes / B -cells / T-cells / divide (by mitosis) ;
clonal expansion / described in terms of producing, clone / many cells ;
A *idea that* different types of immune cell can result
reference mitosis in memory cells (for rapid) secondary response ; [max 3]

Q17.

1 (a) (i) prophase ;
R prophase I [1]

(iii) two homologous chromosomes shaded ; [1]

(iii) centriole ; **A** centrosome / microtubule organising centre / MTOC

one from
produces spindle / produces spindle fibres ;
produce / organises, microtubules ;
disassembles / AW, spindle / spindle fibres / microtubules ; [max 2]
A one e.g. of role of, spindle fibres / microtubules *if a link to centriole has been made allow if centriole incorrectly named or if not given*

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(b) *max 2 if no attempt made at both **X** and **Y***

***X** / cell surface membrane*

1 forms a (cleavage) furrow ; **A** 'pinches in' / constricts / AW

2 ref. fusion ;

3 to divide cell into two ; **A** *idea of* formation of two (separate) cells linked to behaviour of (cell surface) membrane;

4 ref. to cytokinesis / contractile ring ;

Y / *nuclear envelope*

5 disassembles / breaks down / AW ;

6 during prophase / by end of prophase / before metaphase ;
A by the end of prometaphase

7 re-forms / AW, during telophase (from ER) ; [max 3]

[Total: 7]

Q18.

(d) (i) *(produce genetically identical daughter epithelial cells for)*

1 (for tissue) repair ;
R cell repair

2 *idea of* replacing, dead / destroyed / damaged / worn-out / AW, cells ;
A replacement of cells, unqualified *if mp 1 gained*

3 ref. protection of, underlying tissue / muscle and elastic layer / tunica media / AW ;

4 meiosis produces, haploid cells / cells with n chromosomes / cells with one set of chromosomes ;
A cells with half the number of chromosomes

5 meiosis for gamete formation ;
A sex cells
R meiosis in gametes [max 2]

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(ii) *ignore ref. to 23/46 chromosomes*

(mitosis to), maintain genetic stability / produce genetically identical cells / produce clones ora
or
meiosis produces genetically different cells ;

(mitosis), ensures cells retain function / cells function as tissue / AW ;
(mitosis) maintains chromosome number ;
A maintains, diploid number / 2n
meiosis produces, haploid cells / cells with n chromosomes / cells with one
A cells with half the number of chromosomes
meiosis for gamete formation ;
A sex cells
R meiosis in gametes [max 2]

(e) *ignore labels*
max 1 if nuclear, membrane / envelope, shown
no marks if chromosomes with two chromatids drawn

1 four separate, chromatids / daughter chromosomes, shown in each half ;

2 all centromeres leading
A 'V' shapes if centromere not obvious *(point of V towards pole)*
or
all centromeres attached to spindle fibres ; [2]

Q19.

3 (a) (i) **R** *if more than one stage given*
A = prophase ; **I** early / late
B = interphase ; [2]

(ii) *no ecf from* **(a)(i)**
I *information about other phases*
1 chromatin / chromosomes / chromatids, condense / become visible ;
A described e.g. coiling, supercoiling, shorten, thicken
2 each chromosome is two (sister) chromatids joined together (at a centromere) ;
R 'two chromatids, join together / pair up'
3 nucleolus disappears ;
4 nuclear envelope, disassembles / breaks down / AW ;
5 centrioles / centrosomes, move to poles ;
A MTOC / microtubule organising centre
R 'ends' / 'sides'
6 ref to spindle ; e.g. spindle (fibres) start to form
centrioles organise microtubules (to form spindle fibres)
microtubules assemble [max 4]

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(b) 6 ;;

if answer not given or incorrect allow one mark for correct measurement and correct use of formula

distance between **P** and **Q** is 30 mm, conversion to micrometres = 30 × 1000

either (magnification) = $\frac{30000}{5000}$

or $5000 - \frac{30 \times 100}{\text{actualsize}}$

look carefully for correct use of standard form
allow a tolerance of ± 2 mm (28–32 mm, i.e. 28 000–32 000 in formula) [2]

(c) **I** *general references to LM v EM*
A ora *for electron microscope*

1 living cells can be viewed (with light microscope) ;
2 can watch the cell cycle happen (in real time / time lapse) / AW ;
3 all chromosomes can be seen (at once) ;
4 can see, whole chromosomes / all the stages of mitosis or cell cycle ;
5 do not need take sections to see mitosis ;
6 dyes / stains, can be used ; **I** ref. to natural colours of specimens
A ref. to fluorescence microscopy [max 3]

[Total: 11]

Q20.

(c) *marks can be taken from labels / annotations*

1 chromatids / chromosomes / chromatin, condense / become shorter / become thicker / coil / supercoil / AW ; **A** 'become (more) visible'
2 centrioles, move to / reach, opposite poles ; **R** ends
3 nucleolus disappears ;
4 spindle is formed ; **A** 'more developed' **A** *description in terms of spindle fibres*
5 ref to assembly of microtubules ; **A** 'makes' microtubules **R** 9+2
6 nuclear envelope, disintegrates / breaks down / destroyed / AW ; **A** membrane
7 chromosomes, move to / at, equatorial plate / equator / metaphase plate / AW ; *ignore* middle / centre
8 centromeres attach to, spindle / fibres ;
9 ref to random arrangement of chromosomes ; **A** 'not in pairs' **R** scattered [max 5]

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