
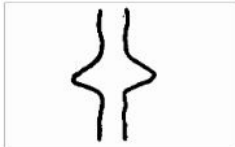


Q1.

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) <u>poles</u> ; 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 <u>template</u> ; by base/complementary pairing/ A-T and G-C; quantity of DNA doubles/two new double helices formed;	max 3
(d)	production of <u>genetically</u> identical cells/ <u>genetically</u> uniform cells/ identical DNA/maintains <u>genetic</u> stability/same number <u>and</u> kind of c-somes/no <u>genetic</u> variation;	1
		<b>[Total 7]</b>

Q2.

3 (a) (i)	6 ;	[1]
(ii)	centromere ; site of attachment to, microtubules/spindle <u>fibres</u> ; <b>A</b> holds <u>chromatids</u> together <b>R</b> ref to centromeres dividing	[2]
(iii)	any pair shaded in ; <b>A</b> more than one pair	[1]
(iv)	<i>either</i>	
		
	<i>or</i>	
		
	two daughter chromosomes shown ; centromeres leading as shown above ;	[2]

(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]

- (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.

- 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]

(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]

(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

	<i>mitosis</i>	<i>meiosis</i>
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) <u>genetically</u> identical (to, each A (cells have) same / AW, DNA / A no genetic variation	(cells) <u>genetically</u> different A (cells have) different / AW, DNA / genetic material A genetic variation ;

[max 2]

- (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  $\mu\text{m}$  ; ; *two marks for correct calculation (39 000 / 3000)*  
*allow one mark*  
*if calculation of 12.6  $\mu\text{m}$  or 13.3  $\mu\text{m}$  (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  $\mu\text{m}$  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.

- 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]



- (c) mitotic index decreases from 0.11 to 0.016, as distance from tip increases/from 0.1 to 1.9mm;  
 any ref to comparison 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.

- 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.

- 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.

- 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)  
ref. comparative data quote ; e.g. volume of 220 v 160 mm<sup>3</sup> 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 } *if stage named,*  
(metaphase) to align chromosomes } *must be correct*  
(anaphase) to separate chromatids }  
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.

- 3 (a) (i) K – (DNA) replication / synthesis / described ; [2]  
 L – cytokinesis / cytoplasmic division / cell division ;
- (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 ; [1]  
 R prophase I
- (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

**(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]

(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)

*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]

(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 =  $30 \times 1000$

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

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

*look carefully for correct use of standard form*

*allow a tolerance of  $\pm 2$  mm (28–32 mm, i.e. 28 000–32 000 in formula)*

[2]

(c) 1 *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]





