

Replication and division of nuclei and cells

Mark Scheme 3

Level	International A Level
Subject	Biology
Exam Board	CIE
Topic	The Mitotic Cell Cycle
Sub Topic	Replication and division of nuclei and cells
Booklet	Theory
Paper Type	Mark Scheme 3

Time Allowed : 70 minutes

Score : / 58

Percentage : /100

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	77.5%	70%	62.5%	57.5%	45%	<45%

Question	Marks
1 (a) metaphase 1 / (late) prophase 1 ; R early / middle	1
(b) 1 ref. (homologous chromosomes) pairing / synapsis ; 2 ref. to chiasma / crossing over ; 3 exchange of genetic material ; 4 between non-sister chromatids / AW ;	3 max
(c) 1 breakage of linkage groups / ref. new linkage groups ; 2 may have different alleles ; 3 creates new combinations of alleles ; 4 when sister chromatids separate ;	2 max
(d) ref. idea of random orientation at metaphase I and II / random alignment of homologous chromosomes on spindle equator ; subsequently leads to independent assortment ; 2^n possible combinations when n is number of chromosome pairs ; ref. to chromosome mutation qualified ; extra detail ; ref. gametes haploid (so can fuse) ; random fusion of gametes ;	4 max Total: 10

N.B. 3 sets of 2/3 marks

Question	Expected Answers	Marks
2 (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 <u>and</u> 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
		[Total 7]

CHEMISTRY ONLINE
— TUITION —

3 (a) one mark for correct cells in column 2 ;

name of stage	cell in Fig. 4.1	behaviour of chromosomes	nuclear envelope
interphase ;	B	chromosomes uncoiled, may be replicating	intact
prophase	D	chromosomes, coiling/condensing/seen as two sister chromatids/AW ;	intact, but then breaks down
metaphase	A	chromosomes on equator/AW ;	not present
anaphase	C	chromosomes/chromatids, moving to opposite poles	not present ;
telophase	E	chromosomes uncoiling	reforming/present/intact ;

[max 5]

(b) *mitosis*

needs number of chromosomes to remain constant/diploid ;
needs all daughter cells to be genetically identical/have no genetic variation ; **A** clones
needs genetic stability ;

meiosis

halves the number of chromosomes/diploid → haploid ; **A** undergoes a reduction division
daughter cells are all genetically different ; *accept once only*
produces genetic variation ; *accept once only*
involved in sexual reproduction (in flowering plants) not growth ; **A** production of gametes
idea that cells that are genetically different will not function together in tissues ; ora [max 3]

(c) asexual reproduction/vegetative propagation ;

(tissue) repair ; **R** cell repair

(cell/tissue) replacement ;

AVP ; e.g. clonal expansion/part of gametogenesis/spores in fungi

[max 2]

[Total: 10]

- 4 (a) cell wall(s) ;
vacuoles ;
regular shape of cells / fixed shape / description of shape / AW ;
I 'no centrioles', 'thicker' as in 'thicker cell walls' [max 1]
- (b) (i) B ; [1]
- (ii) C ; [1]
- (c) chromosomes / chromatin / chromatids, condense / coil up / thicken / AW ;
A chromosomes / chromatids, become visible / shorten
spindle formation / spindle fibres made / assembly of microtubules / AW ;
nucleolus disappears ;
nuclear envelope, breaks down / disintegrates / disassembles / AW ;
A nuclear membrane
I ref. to centrioles and centromeres [max 2]
- (d) (i) producing (more) cells ;

genetically identical / no genetic variation ;
same, number / type, of chromosomes ; A 'remain diploid'
I 'set of chromosomes'
repair / replacement (of root tip / tissue) ; R 'repair of cells'

idea that mitosis makes cells for, different tissues / for differentiation ;
e.g. use of examples, xylem / phloem / root hair / epidermis

I ref. to elongation [max 2]
- (ii) change in DNA, nucleotide / base, sequence ;

substitution, deletion, insertion, inversion, frameshift
change in, DNA / (m)RNA, codons / triplets
change in, amino acid sequence / primary structure, protein / polypeptide ; [2]
- (e) acceptable range for measuring line 14 mm to 16 mm
if the answer is between 700 and 800 allow 2 marks

if measurement of 14–16 mm is incorrectly converted allow one mark for correct
measurement and correct formula – scale length divided by 20

15 000 / 20

750 ;; [2]

5 (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]

CHEMISTRY ONLINE
— TUITION —

- 6 (a) 1.4 mm ; ;
two marks for the correct answer
A 1.3 / 1.34 / 1.37 / 1.43 / 1.46 / 1.5

tolerance on measurement of 49 mm = ± 2 mm (i.e. 47 to 51 mm)

if answer not given or incorrect allow one mark for correct measurement and correct use of formula (measurement divided by the magnification of 35 or showing the rearranged formula)

[2]

- (b) 1 large / wide, lumen (relative to thickness of wall) ;
A artery narrow lumen
- 2 irregular shape ; AW
A flattened / oval / not round(ed) (shape) ;
A artery, round(ed) / regular (shape)
I ref. to (vein) not spherical / artery spherical
- 3 thin / AW, tunica media / middle layer / (smooth) muscle and elastic layer
or
 (proportionately) less, elastic / (smooth) muscle, in, tunica media / middle layer ;
- 4 (relatively) thin, tunica externa / tunica adventicia / outer layer / fibrous coat / fibrous layer ;
R small(er)
- 5 tunica intima / tunica interna / inner layer / endothelium, smooth / not 'crinkly' / not wavy / AW ;
- alt *if mp 3 not awarded, award 1 mark only for*
 thin (smooth) muscle layer / less (smooth) muscle }
 thin elastic layer / less elastic tissue }

[max 3]

- (c) (i) short distance for diffusion (of molecules / ions / named) ;
A reduced distance / thin / short pathway / AW
- increased rate / AW, of diffusion (of molecules / ions / named) ;
A fast(er) / (more) efficient
I easy / better

[max 1]

- (ii) 1 small size allows contact with (many body) cells / AW ;
A *idea of* extending into small spaces
- 2 red blood cell, close to, (body) cells / tissue for (efficient), diffusion / AW ;
A in contact with / close to, capillary wall / endothelium, for diffusion
- 3 red blood cells / blood flow, slow(s) down / *idea of* more time, for (efficient) diffusion / cells to obtain sufficient nutrients / AW ;
treat ref. to lower pressure as neutral
- 4 (plasma / blood, containing), glucose / nutrients / named nutrient / oxygen, close to / AW, body cells ;

[max 1]

(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]

[Total: 13]