

Replication and division of nuclei and cells

Mark Scheme 1

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 1

Time Allowed : 66 minutes

Score : / 55

Percentage : /100

Grade Boundaries:

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

- 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 ;	;

[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 2]

[Total: 14]

2 (a) *idea of* cross-pollination involves two (parents)/ self-pollination one (parent) ;

ref. outbreeding / inbreeding ;

(two parents) have different, genotypes / sets of alleles ;

idea of new combinations of alleles in offspring ;

[max 3]

(b) (total) DNA / genome, cut into fragments ;

by restriction enzymes ;

DNA, denatured / made single stranded ;

ref. primers / (modified) PCR ;

ref. dideoxynucleotides / chain termination ;

DNA / Taq, polymerase ;

copies of different lengths produced ;

electrophoresis ; **A** description

detection, of fluorescence / by laser scanner ;

sequence of, bases / nucleotides, read (by computer) ;

[max 4]

(c) cross(-pollinate) them ; **A** description

(if same species) offspring, are fertile / can themselves produce seeds; **ora**

[2]

[Total: 9]

- 3 (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 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 origin
- 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 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]

- 4 (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]

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5 (a) allow immunoglobulin for antibody

structure	name of structure	function of structure within plasma cell
A	<u>nucleus</u> ; A (eu)chromatin R heterochromatin R chromosome	ref. gene(s) / genetic information / genetic material / DNA, (coding) for, antibody / protein / polypeptide ; transcription (occurring) / mRNA synthesis ; AW (ref. antibodies) <i>allow ecf for nucleolus</i>
B	mitochondrion ; A mitochondria	provides / synthesises / produces / makes, <u>ATP</u> (for antibody synthesis / exocytosis) ; <i>treat as neutral other uses of ATP</i> <i>allow ecf for lysosomes</i>
C	<u>rough</u> endoplasmic reticulum ; ignore RER	synthesis / modification / processing / transport, of, antibody / protein / polypeptide ; A translation <i>allow ecf for Golgi or SER or ER</i>

[max 6]

- (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]

[Total: 13]

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