Replication and division of nuclei and cells

Mark Scheme 2

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 2

Time Allowed : **74 minutes**

Score : **/ 61**

Percentage : **/100**

Grade Boundaries:

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

1 (a *award two marks if correct answer (4500) is given*
allow +/- 1 mm in reading the line
accept anything within range 4400 to 4600

max 1 mark if unit is given

award one mark if incorrect measurement just beyond acceptable range is divided by the actual length (10 μm) using same unit

expect calculation from measurement of scale bar, but look out for alternative method, e.g. measuring the image and then using the scale bar to determine the width in μm

$\frac{45\,000}{10}$ $\frac{45\times10^{-3}}{10\times10^{-6}}$ $\frac{4.5\times10^{-2}}{10\times10^{-6}}$

4500 ;; [2]

(b) **A** = goblet cell(s), **B** = cilia / ciliated cell **;**

A / goblet cell, secrete / make / produce / release, <u>mucus</u> / <u>mucous</u> **;**
R excrete
bacteria / pathogens / dust / viruses / particles / dirt / AW, stick (to mucus) / trapped (in mucus) **;** **A** collects **R** 'contains'

B / cilia, move mucus, up(wards) / away from alveoli *or* bronchioles / away from lungs / up the trachea / to larynx / to mouth / to throat / AW **;**
bacteria / pathogens / dust / AW, do not accumulate / can be swallowed / do not cause infection (in the trachea) **;** **A** 'stops infections' **I** 'in the lungs'
must be in context of cilia or cilia and mucus [max 4]

(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 <u>poles</u> **;** **R** ends
3 nucleolus disappears **;**
4 <u>spindle</u> is formed **;** **A** 'more developed' **A** *description in terms of spindle fibres*
5 ref to assembly of <u>microtubules</u> **;** **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]

[Total: 11]

2 **(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]

3 **(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]

4 **(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 screeni

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]

5 **(a** **A** – nuclear, membrane / envelope ; **R** nucleus (unqualified)
B – mitochondrion ; **A** crista(e)
C – (Golgi) vesicle / (small) vacuole ; **A** lysosome [3]

(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]

(c) (EM has) greater / higher, resolution / resolving power ; **ora**
explanation of resolution as ability to differentiate between two points (close together) ;
width of membranes is 7 nm (±1) ;
(resolution of) LM is 200 nm (0.2 μm) and EM is 0.5 nm (0.0005 μm) ;
A 0.5 to 1 nm (0.001 μm)
ref to shorter wavelength ; **ora**
resolution is equal to half the wavelength ; [3 max]

(d) **(i)** general trend described linking temperature and percentage transmission ;
A negative correlation (with link) **R** inversely proportional
use of comparative figures (using data from both axes) to support trend ;
between 20 °C and 60 °C percentage transmission decreases, from 95% to 70% ;
between 60 °C and 70 °C, decrease is, significant / steep / from 70% to 19% ;
between 70 °C and 80 °C, decrease is, less steep / more steeply than initial temperature range / from 19% to 6% ; [3 max]

(ii) at (temperatures above) 60 °C, cell / vacuolar, membranes damaged / AW;
A tonoplast
(membrane) proteins, denatured / altered tertiary structure ;
increased fluidity (of membrane) / phospholipid bilayer more fluid ;
(so) diffusion / AW, of, betalain / pigment (out) ;
as temperature increases, rate of diffusion increases / diffusion occurs more quickly ;
[3 max]

[Total: 15]

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

(ii) centromere ;

site of attachment to, microtubules/spindle <u>fibres</u> ;
A holds <u>chromatids</u> 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]

(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]