

Replication and division of nuclei and cells

Mark Scheme 4

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 4

Time Allowed : 77 minutes

Score : / 64

Percentage : /100

Grade Boundaries:

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

1 (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]

(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 $5000 = \frac{30 \times 100}{\text{actual size}}$

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]

- 2 (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]
- (d) *T helper / Th*,
 secrete, cytokines / interleukins ;
 activate B-lymphocytes to, divide / form plasma cells ; **A** idea that leads to enhanced
 antibody levels
 enhances / AW, phagocyte / macrophage, response ; **A** angry macrophages ;
- T cytotoxic / Tc / T killer / Tk*
 attach to / kill / AW, infected cells / damaged cells / tumour cells / cells with non-self
 antigens / AW;
 mechanism of killing ; e.g. perforin

T memory / T_m

already exposed to antigen ;

reference to role in secondary response ;

AVP ; ; e.g. T suppressor cells

function of suppressor cells

[max 3]

[Total: 13]



- 3 (a)
1. reduction division / (to) halve number of chromosomes / diploid to haploid / AW ;
 2. homologous chromosomes pair up / bivalents form ;
 3. ref. chiasmata / ref. crossing over ;
 4. homologous chromosome pairs / bivalents, line up on equator ;
 5. independent assortment ;
 6. spindle / microtubules, attached to centromeres ;
 7. chromosomes of each pair pulled to opposite poles ;
 8. by shortening of, spindle / microtubules ;
 9. nuclear envelopes re-form ;
 10. cytokinesis / AW ;

[6 max]

(b) *accept alternative symbols for alleles throughout*

11. frequency of sickle cell anaemia is highest in areas where malaria is common ;
12. sickle cell anaemia red blood cells cannot carry oxygen very well / AW ;
A sickling blocks capillaries
13. homozygous H^S / $H^S H^S$, have sickle cell anaemia / may die ;
14. homozygous H^N / $H^N H^N$, have normal, Hb / red blood cells ;
15. heterozygotes, have sickle cell trait
or
 (sickle cell trait) red blood cells not (severely) affected ;
16. malaria parasite / *Plasmodium*, affects red blood cells ;
17. malaria lethal ;
18. sickle cell trait people / heterozygotes, less likely to suffer from (severe effects of) malaria ;
19. have selective advantage ;
20. pass on both H^N and H^S ;
21. malaria selects against, homozygous H^N / $H^N H^N$;
22. sickle cell anaemia selects against, homozygous H^S / $H^S H^S$;
23. *idea that* sickle cell allele is maintained within population
 because of sickle cell trait individuals ;

[9 max]

[Total: 15]

CHEMISTRY ONLINE
 — TUITION —

- 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 mm³ 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]

5 (a) *do not credit marking points out of sequence*
prophase 1

- 1 idea of condensation of chromosomes ;
- 2 homologous chromosomes pair up / bivalent formed ;

metaphase 1

- 3 homologous chromosomes / bivalents, line up on equator ;
- 4 of spindle ;
- 5 by centromeres ;
- 6 independent assortment / described ;
- 7 chiasmata / described ;
- 8 crossing over / described ;

anaphase 1

- 9 chromosomes move to poles ;
- 10 homologous chromosomes / bivalents, separate ;
- 11 pulled by microtubules ;
- 12 reduction division ;

metaphase 2

- 13 chromosomes line up on equator ;
- 14 of spindle ;

anaphase 2

- 15 centromere divide ;
- 16 chromati move to poles ;
- 17 pulled by microtubules ;
- 18 ref. haploid number ;

allow 4 or 14
allow 11 or 17

[9 max]

- (b) 19 change in, base / nucleotide, sequence (in DNA) ;
20 during DNA replication ;
21 detail of change ; e.g. base, substitution / addition / deletion
22 frame shifts / AW ;
23 different / new, allele ;
24 random / spontaneous ;
25 mutagens ;
26 ionising radiation ;
27 UV radiation / mustard gas ;

[6 max]

[Total: 15]

