5. The Mitotic Cell Cycle

5.2 Chromosome Behavior in Mitosis

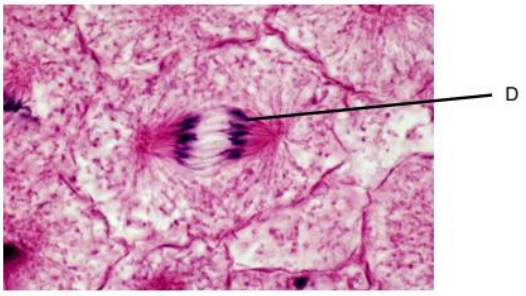
Paper 2

Marking Scheme

Q1.

(c)	*must have either mp1 or mp2 or both to gain max 4, otherwise max 3* **1** (centrioles) make / organise, microtubules ; **A** microtubular organising centre / MTOC **2** to form, the spindle / spindle fibres ; **3** (during each cell cycle) each centriole, replicates / duplicates / forms two centrioles ; **4** during, S phase / G2 phase ; **A** before mitosis *mp4 is linked to mp3* **5** centriole pairs / centrioles, move to the (opposite) poles (of cell during prophase of mitosis) ; **R** if incorrect phase **R** 'poles of nucleus' **6** centrioles, lengthen / shorten, the spindle fibres / microtubules ; **I** 'contract'	**4**

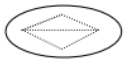
Q2.

(a)	line pointing to any chromatid ;  	**1**
(b)	anaphase ;	**1**
(c)	*any **two** from:* (fully formed) spindle seen / spindle fibres, are visible ; *idea that* chromatids are attached to, the spindle fibres / (spindle) microtubules ; *idea that* chromosomes would have orientated at the equator (ready for anaphase) ; sister chromatids have separated (Fig. 6.1) because, spindle fibres have contracted / microtubules have disassembled / AW ; in anaphase so has, completed /AW, prophase / metaphase ;	**2**

Q3.

(c)(ii)	two separate, chromatids / single-stranded chromosomes ; chromatids attached to spindle with fibres drawn to, poles / centrioles ; single chromatids drawn U-shaped or V-shaped pointing towards the poles ; centromeres drawn in both chromatids ;	**3**

Q4.

(b)	*max 2 if the spindle / centrioles extend outside the cell* 1 two chromosomes, each with two chromatids, drawn approximately along central equator area ; **R** if drawn as a, bivalent / homologous pair (close together or further apart) **A** if equator is drawn across wider diameter 2 plus one other drawn feature ; e.g. spindle  *diamond/oval shape, minimum three spindle fibres as shown* **or** spindle fibre from each pole connecting to centromere area of one chromosome **or** centromere drawn holding sister chromatids together **or** pair of centrioles at each pole **3** any three labels ; **I** label to chromosome e.g. (sister / identical) chromatid/s centromere spindle / spindle fibres spindle equator / metaphase plate **A** equator *if spindle / spindle fibre label given* centriole/s **A** centrosome(s) / pole(s) *annotations may contain more than one acceptable label* *label lines to touch structure*	**3**

(c)	*assume sequential interphase to prophase if not named* *any **three** from:* *interphase max 2* (chromosomal) DNA replicates ; **A** DNA synthesis **I** chromatin **R** if stated as in, G1 / G2 (each new molecule of) DNA, complexes / associates / AW, with, histones / proteins ; sister / identical, chromatids form, qualified ; e.g. after (DNA) replication /during / end of, S phase *must be clear they are formed before prophase* *prophase max 2* chromatids / chromosome, condense ; **R** if also in prophase **A** become(s) shorter and fatter **A** coiling / supercoiling, *in context of,* DNA / chromosomes / chromatids **R** chromosomes condense to form chromatin becomes visible / appears, as two (sister / identical) chromatids ; **I** composed of two chromatids becomes attached to the spindle fibres ; (spindle) microtubules attach to centromere / kinetochore formation ;	**3**

Q5.

(a)(i)	anaphase ;	1

(b)	*any **four** from:* as concentration of Paclitaxel increases, the ratio of cells in anaphase to those in metaphase reduces / there are a greater proportion of cells in metaphase than in anaphase ; as the concentration of Paclitaxel increases, the percentage of cells in mitosis is increasing ; use of data to support a described trend ; *idea that* as the concentration increases, more cells, stop in metaphase / spend more time in metaphase / fewer cells are able to move into anaphase ; suggested mechanism for halt in metaphase ; e.g. centromeres do not divide prevents spindle fibres shortening prevents movement of chromatids to opposite poles (because sister chromatids still held together) cells do not pass the (metaphase) checkpoint AVP ;	4

Q6.

(a)(i)	**E** = metaphase ; **F** = anaphase ; **I** early / mid / late **R** more than one stage given for either **E** or **F**	2
(a)(ii)	*any one from* (assemble) to form / become part of / AW, spindle fibres / spindle ; attach to, centromere ; **A** kinetochore *for centromere* **A** form (part of) kinetochore **A** to connect, chromatid / chromosome, to, spindle / spindle fibres **I** to connect, chromosome / centromere, to centrosome example of allowing movement of, chromosomes / chromatids ; e.g. **A** to, pull chromosomes / orientate chromosomes, at equator **A** to pull (sister) chromatids apart (at anaphase) **A** to move, (sister) chromatids / daughter chromosomes, to poles	1

Q7.

(d)	metaphase label to metaphase cell ; prophase label to one of the prophase cells ;	2

Q8.

(a)(i)	*any **two** from:* microtubules / spindle (fibres), are attached to, centromere / kinetochore ; (spindle) fibres, contract / shorten / retract ; **A** microtubules disassemble / AW move / pull, (sister) chromatids / (daughter) chromosomes, to opposite poles ;	**2**

Q9.

(a)	**P** – chromosomes, arranged randomly / AW *or* *idea that* chromosomes present but not (yet) visible as consisting of two sister chromatids (joined by centromere) ; **A** description related to idea of chromosomes becoming visible / chromatin condensing **Q** – chromosomes are, arranged / aligned / AW, at the, (cell / spindle) equator / metaphase plate ; **A** equatorial plate **R** – no chromosomes visible / nucleolus is present / chromatin not condensed / euchromatin present ;	**3**

(b)(iii)	*accept spindle fibres / microtubules as alternative to spindle* *max 2 if stages are named and are incorrect* *any three from:* (prophase) attachment to centromere of each chromosome ; **A** *ref. to* kinetochore *in correct context* (prophase) arranging / orientating / AW, chromosomes at the, equator / metaphase plate / AW ; **A** *ref. to* metaphase in correct context (anaphase) centromere division / separation of sister chromatids ; (anaphase) pulling, chromatids / daughter chromosomes, apart / towards poles ; (because) spindle fibres contract / (as) lengths of microtubules decreases / microtubules are disassembled ; (elongates in telophase to) push, poles / nuclei, apart ;	**3**

Q10.

(a)(ii)	prophase / metaphase ; **I** late / early **A** prometaphase	**1**

Q11.

(c)(i)	cytokinesis ;	**1**

Q12.

(a)	**1 / 4 ;** **3 ;** **5 ;**	**3**
(b)	*two from:* centromere (of each chromosome) divides ; **A** sister chromatids separated at the centromere spindle fibres, contract / shorten ; **A** spindle contracts (sister / identical) chromatids / daughter chromosomes, pulled / move, to opposite poles ; **A** (sister) chromatids separated **I** chromosomes are at opposite poles centromeres, leading (towards poles) / AW ; **A** ref. to V-shape / diagram	**2**