1. Cell Structure

1.1 The Microscope in Cell Studies

Paper 2

Marking Scheme

Q1.

(b)(i)	stage micrometer / stage micrometer scale ;	1
(b)(ii)	yes, qualified ; e.g. 0.2 mm = 200 μm 0.2 mm / smallest student can see, is less than 0.25 mm 250 μm = 0.25 mm 250 μm / cell length, is longer than 200 μm the cell is 50 μm longer (than 0.2 mm) the cell is 0.05 mm longer (than 0.2 mm) *allow if converted to standard form* (2×10^{-4} v 2.5×10^{-4} m) *must have units* *must include numerical values*	1

Q2.

(b)	the number of times larger an image is than actual ; AW **I** or smaller **A** formula stated in words **A** symbolised I/A *to support a weakly worded answer* **A** *(in context of describing an image)* enlargement / making larger / making bigger / increase in size / AW	1

Q3.

(a)	**I** *ref. to* resolution *any* ***one*** *from:* Fig. 1.1**A** is scanning (EM), qualified ; e.g. shows, surface / contour / 3-D, views shows (only the), the outer / external, view (of microvilli) idea of good focus with different depths does not have stated feature of TEM (see mp2) Fig. 1.1**B** is transmission (EM), qualified ; e.g. showing, 2D / flat, views (of, microvilli / mitochondria) image in one plane showing section through, mitochondria / microvilli / cell **I** thin shows, internal view of cell / contents of cell / AW does not have stated feature of SEM (see mp1) scanning (EM) stated plus feature and transmission (EM) stated plus feature } ; if Fig. 1.1, **A** / **B** not identified	1
(b)	*any* ***two*** *from: max 1 if stating to measure one of the sides of the figure* (for each image) measure a number of microvilli and calculate a mean ; same units for actual and measured images / example given ; e.g. *if microvillus measurement is in mm* convert, microvillus measured length to μm / actual length to mm **R** if extra detail given is incorrect e.g. divide by 1000 for mm to μm divide, microvillus / image, length by, actual length / AW / 1(μm) ; **A** *idea that* value for, microvillus / image, length is the magnification	2

Q4.

(b)	*any **two** from* *information needed* **1** magnification of, image / (electron) micrograph / Fig. 5.1 ; **A** scale bar **I** magnification of (electron) microscope **2** length of flagellum (in, image / Fig. 5.1) ; **I** width / diameter / size **3** *formula* actual length of flagellum = measured length of flagellum divided by magnification ; **A** A= I / M **or** magnification triangle	**2**

Q5.

(b)	170 (nm) ;	**1**

Q6.

(b)	*any **three** from:* higher magnification (without loss of detail) ; higher resolution / ability to see object that are close together as separate objects ; *ref. to* resolution of (up to) 0.5 nm compared to, 200 nm / 0.2 µm (light microscope) ; **A** ranges, e.g. 0.5–30 nm and 100–300 nm ability to see organelles such as, SER / ribosomes / other named organelle ; AVP ; e.g. very thin sections, qualified, e.g. for greater internal detail	**3**

Q7.

(a)	actual width = image width ÷ magnification ; **A** A = I ÷ M M = I ÷ A I = A × M or magnification triangle working = width divided by 4275 ; e.g. 16 000 ÷ 4275 17 000 ÷ 4275 18 000 ÷ 4275 19 000 ÷ 4275 ; 3.7 (μm) 4.0 (μm) 4.2 (μm) 4.4 (μm) ; **R** answer if given to more than 1 dp or whole number	**3**
(c)	*any two from* **1** (section at) high resolution ; **A** suggestion of a correct value of resolution for a TEM **2** any named structure visible in Fig. 1.1 that can, only be seen in a TEM / not be seen in a photomicrograph ; e.g. internal structure of chloroplasts / thylakoid(s) / grana e.g. internal structure of mitochondria / cristae **3** high magnification / higher magnification (magnification > 1000 / higher than with light microscope) ; *in context of higher than light microscope* **4** (very) thin ; **5** 2D / no surface contours / no surface features / AW ; **A** not 3D	**2**

Q8.

(b)	*any three from* *no, because* resolution of light microscope, too low / not high enough ; only able to distinguish points 200nm or more apart *or* size of virus / 30 nm, too small for resolution of (light microscope) of 200 nm ; **A** range 100-300 nm wavelength of light too long ; *idea that* virus too small to interfere with light waves ;	**3**

Q9.

(c)	**1** correct formula ; (magnification) = image length ÷ actual length ; **A** rearranged formula **A** magnification triangle  **2** correct working ; **3** correct answer for magnification ; **R** if units given (×) 1440 (36 mm) / 1460 (36.5 mm) /1480 (37 mm) / 1500 (37.5 mm) 1520 (38 mm) / 1540 (38.5 mm) / 1560 (39 mm) ; *if answer given to 2 sig. figs, look for the correct answer at the end of working* ***or*** *allow if stated by answer that this is to 2 sig. figs.* *allow ecf for incorrect conversions used in working or incorrect measured value of X–Y*	**3**

Q10.

(a)(i)	*any **three** from:* **I** heterochromatin / euchromatin envelope / two membranes / double membrane / inner and outer membrane ; nuclear pores ; **A** pores in nuclear envelope *for two marks* (outer surface of) outer membrane with ribosomes ; *ref. to* (outer nuclear) membrane continuous with RER ; **R** inner membrane AVP ; e.g. perinuclear space **A** intermembranous space pore complexes	**3**
(a)(ii)	*any **two** from:* resolution / resolving power, is, low / lower / poor / AW / 200 nm / 0.2 µm ; (**A** range 100–300 nm) **A** electron microscope has a higher resolution further detail ; e.g. ribosomes / ER, smaller than 200 nm can only see cell structures greater than (limit of) resolution cannot see structures smaller than 200 nm cell structures too small for the resolution (*needs ref. to resolution)* cell structures, too small to / do not, interfere with light waves ; AW	**2**

Q11.

(a)	*any two from:* **1** higher / better, resolution **A** higher resolving power **I** clearer resolution **or** greater ability to distinguish between two points / AW ; *ignore wavelength values if stated as wavelength but **R** if stated as resolution values* **2** *ref. to* resolution values ; e.g. able to see points closer together than 200 nm (range 100–300 nm) can see, points up to 0.5 nm (0.0005 µm) apart (range 0.2–1.0 nm) can see structures larger than 0.5 nm **3** thinner sections can be obtained ; **A** idea that complete image will be in better focus **4** able to see, ribosomes / membranes / detail within organelles ;	**2**

Q12.

(b)	ref. to conversion of measured (**X**-**Y**) line to ∝m / AW ; e.g. line is measured in, mm and then multiplied by 1000 / cm and then multiplied by 10 000 evidence that, 60 (±1 mm) is multiplied by 1000 / 6 cm is multiplied by 10 000 measured diameter is 60 000 ∝m (and) divide by, magnification / 2000 ;	**2**

Q13.

(b)	(actual diameter) = image / observed, length, ÷ magnification ; **A** (A =) I ÷ M **or** magnification triangle 300 ∝m ; (12 000 / 40) **A** 275 ∝m (11 000 / 40) **A** 288 ∝m (11 500 / 40) **A** 313 ∝m (12 500 / 40) **A** 325 ∝m (13 000 / 40)	**2**

Q14.

(a)	correct formula ; (×) 1200 ; **A** 1171 (41 000 ÷ 35) 1229 **or** 1228.6 (43 000 ÷ 35) *max 1 if units given*	**2**