Microscope and Microscopy (Advanced)

Standard difficulty · 20 questions · 40 marks · Time: 36 minutes

Name: _____ Date: _____ Score: ____ / 40

Show your working for Sections B and C. Answers are on the last page — try every question first!

Section A — Choose the correct answer 8 × 1 = 8 marks

1. A microscope has a 5X eyepiece and a 15X objective. Its total magnification is:
   (a) 750X **(b)** 20X **(c)** 15X **(d)** 75X

2. Under a total magnification of 2,000X, the image of a cell is 30 mm across. Its real size is: (Give the answer to 2 decimal places where needed.)
   (a) 1.5 µm **(b)** 60,000 µm **(c)** 15 µm **(d)** 150 µm

3. At 40X total magnification the field of view is 5 mm across. Taking the field of view as inversely proportional to magnification, at 200X it is: (Give the answer to 2 decimal places where needed.)
   (a) 5 mm **(b)** 25 mm **(c)** 1 mm **(d)** 0.2 mm

4. 12 cells fit side by side across a field of view of 4.5 mm. The approximate size of one cell is: (Give the answer to 2 decimal places where needed.)
   (a) 375 µm **(b)** 54,000 µm **(c)** 37.5 µm **(d)** 3,750 µm

5. The unaided human eye, from about 25 cm, can just see two points as separate when they are about:
   (a) 0.1 mm apart **(b)** 0.1 nm apart **(c)** 0.1 µm apart **(d)** 1 cm apart

6. Which instrument is best to follow one kind of protein in a cell after tagging it with a glowing dye?
   (a) a transmission electron microscope (TEM) **(b)** a simple magnifying glass
   (c) a fluorescence microscope **(d)** a light (compound) microscope

7. Two points in a specimen are 42 µm apart. Which is the simplest instrument that shows them as two separate points? (Eye about 0.1 mm, light microscope about 0.2 µm, electron microscope about 0.2 nm.)
   (a) none of them **(b)** the unaided eye
   (c) a light microscope **(d)** an electron microscope

8. Assertion (A): A 15X eyepiece used with a 20X objective gives a total magnification of 35X.
   Reason (R): The eyepiece magnifies the image already formed by the objective, so the magnifications multiply.
   (a) Both A and R are true, and R is the correct explanation of A.
   (b) Both A and R are true, but R is not the correct explanation of A.
   (c) A is true, but R is false.
   (d) A is false, but R is true.

Section B — Short answer 8 × 2 = 16 marks

9. A student wants a total magnification of 100X with a 5X eyepiece. What objective should she use?

10. A cheek cell's image measures 7.9 cm at a magnification of 80X. Find its real size in µm. (Give the answer to 2 decimal places where needed.)

11. At 50X the field diameter of a microscope is 6 mm. Predict the field diameter at 500X, taking it as inversely proportional to the magnification. (Give the answer to 2 decimal places where needed.)

12. About 11 cells fit across a field of view of 3.5 mm. Estimate the size of one cell in µm. (Give the answer to 2 decimal places where needed.)

13. Convert 0.58 cm into µm.

14. A light microscope can resolve 0.25 µm and an electron microscope 2 nm. How many times finer is the electron microscope's resolution?

15. Resolving power is the reciprocal of resolution. An instrument resolves 2.5 µm. What is its resolving power, in μm^{-1} (per µm)?

16. A bacterium 5 µm long is viewed at 100X. How long is its image, in mm? (Give the answer to 2 decimal places where needed.)

Section C — Word problems — 4 × 4 = 16 marks

17. A microscope has a 5X eyepiece and a 40X objective. (a) Find its total magnification. (b) At this setting the field of view is 1.8 mm and 3 cells fit across it. Estimate the size of one cell in µm. (c) How big does one cell's image look, in mm? (Give the answer to 2 decimal places where needed.)

18. A microscope with a 15X eyepiece shows a field of view 1.25 mm across with its 10X objective. (a) Find the total magnification with the 10X objective. (b) Find it with the 100X objective. (c) Find the field of view with the 100X objective. (d) How many cells, each 25 µm across, fit across the field at the higher power? (Give the answer to 2 decimal places where needed.)

19. A researcher wants to study the internal structure of a virus particle. (a) Which microscope should she choose? (b) Give the reason. (c) Why would an electron microscope not be used for living specimens?

20. A TEM photograph at 5,000X shows a structure 42 mm long. Find its real length (a) in µm and (b) in nm. (c) Could a light microscope, which resolves about 0.2 µm, show its two ends as separate points? (Yes or No) (Give the answer to 2 decimal places where needed.)

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Answer key

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Q	Answer	Working
1	**(d) 75X**	$M = m_o \times m_e = 15 \times 5$
2	**(c) 15 µm**	real size = image ÷ M = 30 mm ÷ 2000 = 30,000 µm ÷ 2000
3	**(c) 1 mm**	5 × 40 ÷ 200
4	**(a) 375 µm**	4.5 mm = 4,500 µm; ÷ 12
5	**(a) 0.1 mm apart**	the limit of resolution of the eye
6	**(c) a fluorescence microscope**	only the tagged structure glows
7	**(c) a light microscope**	pick the instrument whose resolution is just smaller than the separation
8	**(d) A is false, but R is true.**	A is false: 20 × 15 = 300, not 35. R is true.
9	**20X**	100 ÷ 5
10	**987.5 µm**	7.9 cm = 79,000 µm; ÷ 80
11	**0.6 mm**	6 × 50 ÷ 500
12	**318.18 µm**	3.5 × 1,000 ÷ 11
13	**5,790 µm**	1 cm = 10 mm = 10,000 µm
14	**125**	0.25 µm = 250 nm; 250 ÷ 2
15	**0.4**	1 ÷ 2.5 = 0.4 per µm
16	**0.5 mm**	image = real × M = 5 × 100 = 500 µm; ÷ 1,000
17	**(a) 200X; (b) 600 µm; (c) 120 mm**	(a) 40 × 5; (b) 1,800 µm ÷ 3; (c) 600 µm × 200 ÷ 1,000
18	**(a) 150X; (b) 1,500X; (c) 0.13 mm; (d) 5**	(c) 1.25 × 150 ÷ 1,500; (d) 125 µm ÷ 25
19	**(a) a transmission electron microscope (TEM); (b) its resolution, about 0.1 nm, reveals details far below the light limit; (c) the specimen must be in a vacuum and treated with chemicals and metal stains or coatings, which kill living cells**	choose by resolution, contrast or kind of image
20	**(a) 8.4 µm; (b) 8,400 nm; (c) Yes**	(a) 42 mm = 42,000 µm, ÷ 5,000; (b) × 1,000; (c) compare with 0.2 µm