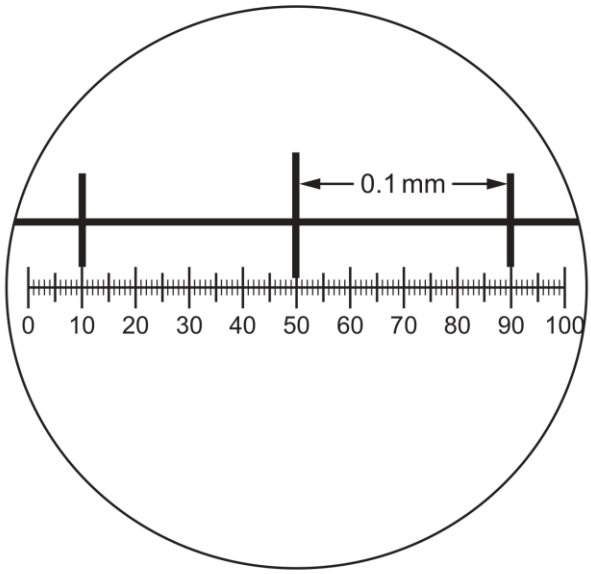
1. Cell Structure

1.1 The microscope in cell studies

Paper 1

Question Paper

1 The diagram shows a stage micrometer scale viewed with an eyepiece graticule, using a magnification of ×200.



Using the same magnification, a chloroplast is measured as 4 eyepiece graticule divisions long.

How long is the chloroplast?

A $1.0 \times 10^{1}\,\mu m$

B $4.0 \times 10^{2}\,\mu m$

C $2.5 \times 10^{-1}\,\mu m$

D $2.5 \times 10^{-2}\,\mu m$

2 A prokaryotic cell which is 1 μm in diameter is magnified 50 000 times in an electron micrograph.

What is the diameter of the cell in the electron micrograph?

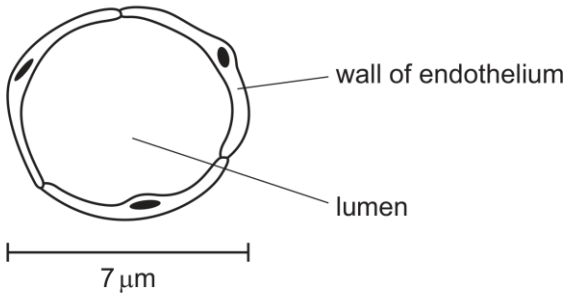
A 5×10^{-1} mm

B 5×10^{0} mm

C 5×10^{1} mm

D 5×10^{2} mm

3 The diagram shows a transverse section through a blood capillary.



What is the magnification of the drawing?

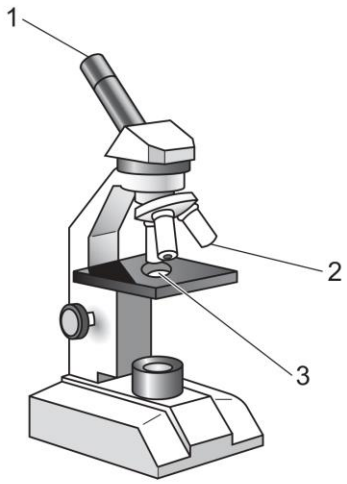
A ×200 **B** ×245 **C** ×500 **D** ×5000

4 A light microscope is used to observe two structures that are 200 nm apart on the slide.

What is the actual distance between the two structures when the magnification is changed from ×40 to ×400?

A 2 μm **B** 20 μm **C** 200 nm **D** 2000 nm

5 A graticule and a micrometer scale can be used to measure the size of biological structures that are viewed with a microscope.



Which row shows the correct locations for the placement of a graticule and a micrometer scale on the microscope shown?

	graticule	micrometer scale
A	1	2
B	1	3
C	2	3
D	3	1

6 Until recently, the typical viruses known to science were 20–150 nm in size.

In 2003, the Mimivirus was discovered with a size of approximately 680 nm.

In 2013, the Pandoravirus was discovered which has a size of over 1000 nm.

Which viruses can be seen using a light microscope with a maximum resolution of 0.25 μm **and** an electron microscope?

	typical virus	Mimivirus	Pandoravirus
A	✓	✓	✓
B	✗	✓	✓
C	✗	✗	✓
D	✗	✗	✗

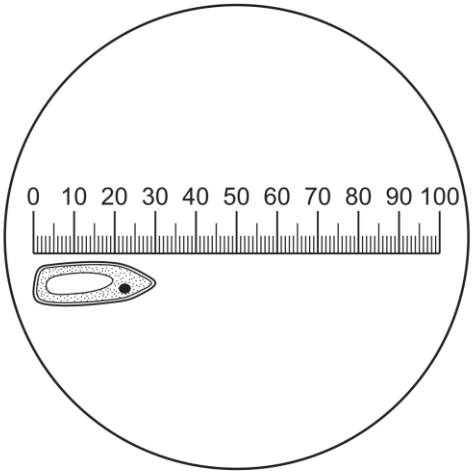
key

✓ = can be seen

✗ = cannot be seen

7 The diagram shows an eyepiece graticule and a cell viewed through a microscope. When the eyepiece graticule was calibrated at this magnification, the whole length of the graticule shown covered 12 divisions of a stage micrometer scale.

There were 100 divisions in 10 mm of the stage micrometer.



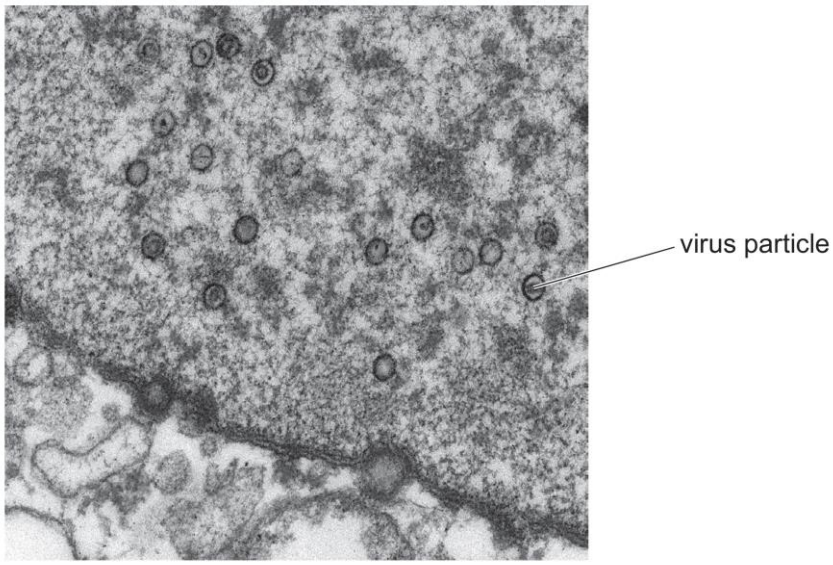
What is the actual length of the cell?

A 2.5 μm **B** 3.6 μm **C** 360 μm **D** 3 mm

8 Which combination of lenses for a light microscope will give the greatest magnification?

	eyepiece lens	objective lens
A	×5	×100
B	×10	×40
C	×15	×40
D	×15	×100

9 The diagram shows an electron micrograph of virus particles in a human nucleus.



×24 000

What is the diameter of the labelled virus particle?

A $1.5 \times 10^{0}\,\mu m$

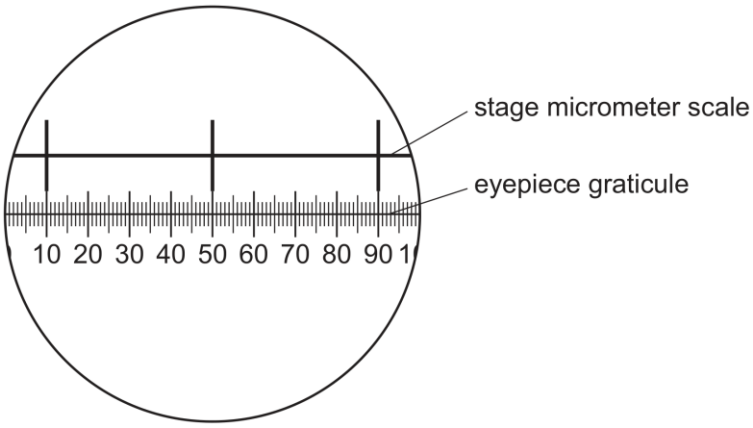
B $1.5 \times 10^{-2}\,\mu m$

C $1.5 \times 10^{0}\,nm$

D $1.5 \times 10^{2}\,nm$

10 A student used a stage micrometer scale to calibrate an eyepiece graticule.

The diagram shows the view of both the stage micrometer scale and the eyepiece graticule seen by the student. The divisions on the stage micrometer scale are 0.1 mm apart.



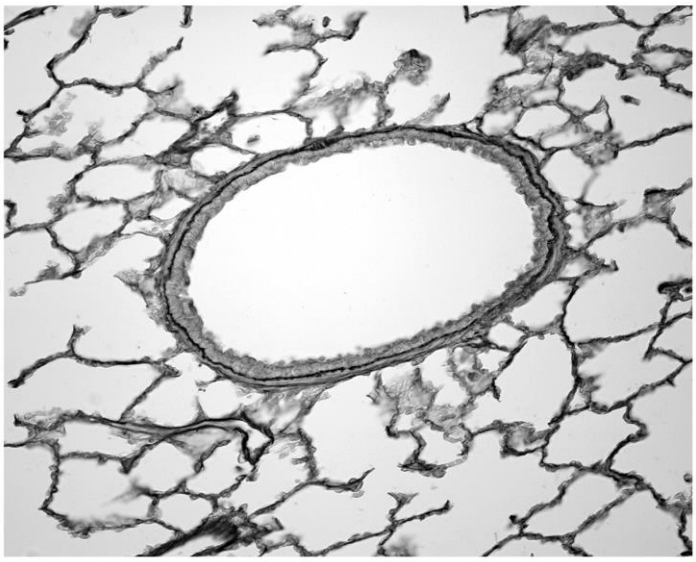
The student removed the stage micrometer scale and viewed a slide with blood cells on it. The same lenses were used so that the magnification remained unchanged.

The student measured the diameter of one of the white blood cells on the slide using the eyepiece graticule and recorded that it was 8 eyepiece units.

What is the correct diameter of this white blood cell in micrometers?

A 0.2 **B** 0.8 **C** 20 **D** 800

11 The photomicrograph shows a bronchiole and alveoli.



The magnification of the image is ×360.

What is the maximum diameter of the bronchiole lumen?

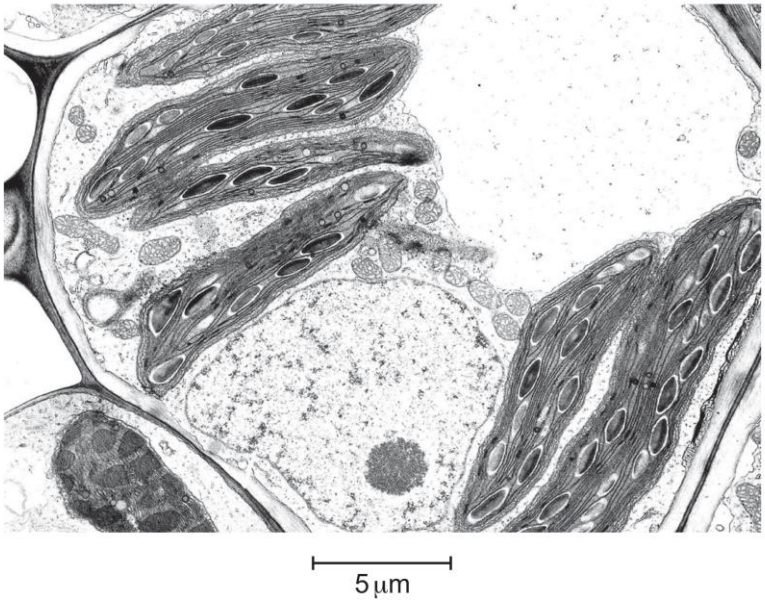
A 14 μm **B** 80 μm **C** 140 μm **D** 170 μm

12 A specimen is observed twice with a microscope, firstly using green light with a wavelength of 510 nm and then using red light with a wavelength of 650 nm.

What happens to the magnification and resolution when using red light compared to green light?

	magnification	resolution
A	decreases	remains the same
B	increases	increases
C	remains the same	decreases
D	remains the same	increases

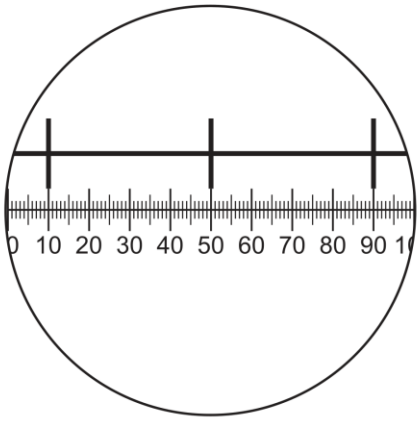
13 The photomicrograph shows part of a plant cell.



What is the magnification of the cell?

A ×250 **B** ×400 **C** ×1000 **D** ×4000

14 The diagram shows a stage micrometer, with divisions 0.10 mm apart, viewed through an eyepiece containing a graticule.



The area of the field of view of the microscope can be calculated using this formula.

$$\text{area} = \pi r^2$$

A student calculated the area of the field of view of the microscope using the information provided and a value for π of 3.142.

Which answer has been rounded correctly to an appropriate number of significant figures?

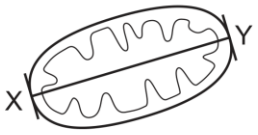
A $0.04909\,\text{mm}^2$

B $5 \times 10^{-2}\,\text{mm}^2$

C $4.909 \times 10^{4}\,\mu\text{m}^2$

D $4.91 \times 10^{4}\,\mu\text{m}^2$

15 The diagram shows a mitochondrion drawn from an electron micrograph.



The actual length of the mitochondrion, using the line X–Y, is 3000 nm.

What is the magnification of the drawing of the mitochondrion?

A ×100 **B** ×1000 **C** ×10 000 **D** ×100 000

16 A specimen of plant tissue is observed twice with a microscope, firstly using red light with a wavelength of 650 nm and then using green light with a wavelength of 510 nm.

What happens to the magnification and resolution when using green light compared to red light?

	magnification	resolution
A	decreases	decreases
B	increases	increases
C	remains the same	decreases
D	remains the same	increases

17 The mean width of mitochondria in an electron micrograph is 6 mm.

The magnification of the electron micrograph is ×9600.

What is the actual mean width of the mitochondria?

A 6×10^{-3} mm **B** 6×10^{-4} mm **C** 6×10^{-2} μm **D** 6×10^{3} μm

18 A prokaryotic cell is 5.0 μm in length.

A virus particle is 300 nm in length.

How many times larger is the prokaryotic cell compared to the virus particle?

A 2 **B** 17 **C** 60 **D** 167

19 A student observes a cell using a light microscope. The student then draws the cell.

Which items will the student need to calculate the magnification of the drawing?

1 eyepiece graticule

2 ruler

3 hand lens

4 stage micrometer scale

A 1, 2, 3 and 4

B 1, 2 and 4 only

C 1 and 3 only

D 2 and 4 only

20 Which equations correctly show the relationship between magnification, image size and actual size in microscopy?

1 $\text{magnification} = \frac{\text{image size}}{\text{actual size}}$

2 $\text{magnification} = \frac{\text{actual size}}{\text{image size}}$

3 $\text{actual size} = \frac{\text{image size}}{\text{magnification}}$

4 $\text{actual size} = \frac{\text{magnification}}{\text{image size}}$

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

21 A scale bar on an electron micrograph is 2 cm long and represents an actual length of 1 μm.

What is the magnification of the electron micrograph?

A ×200 **B** ×2000 **C** ×20 000 **D** ×200 000

22 The eyepiece of a microscope is fitted with an eyepiece graticule and a stage micrometer scale is placed on the microscope.

Which statements about the stage micrometer scale are correct?

1 The scale can be used to measure the actual length of cells directly.

2 The scale allows you to calibrate the eyepiece graticule.

3 Less of the scale is visible as the objective lens changes from ×10 to ×40.

A 1, 2 and 3 **B** 2 and 3 only **C** 1 only **D** 2 only

23 A student examined a slide of human blood with a light microscope and made a careful drawing of the different cell types. The student used an eyepiece graticule so that the relative sizes of the different cell types were drawn accurately.

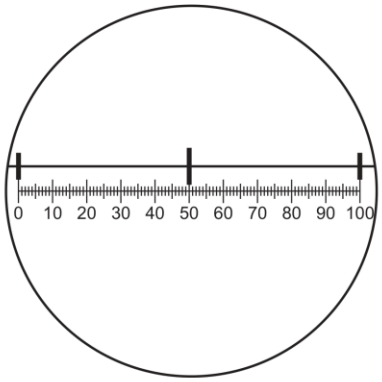
In the drawing:

- red blood cells were 7 mm in diameter
- lymphocytes were 6 mm in diameter
- neutrophils were 14 mm in diameter.

What is the linear magnification of the drawing?

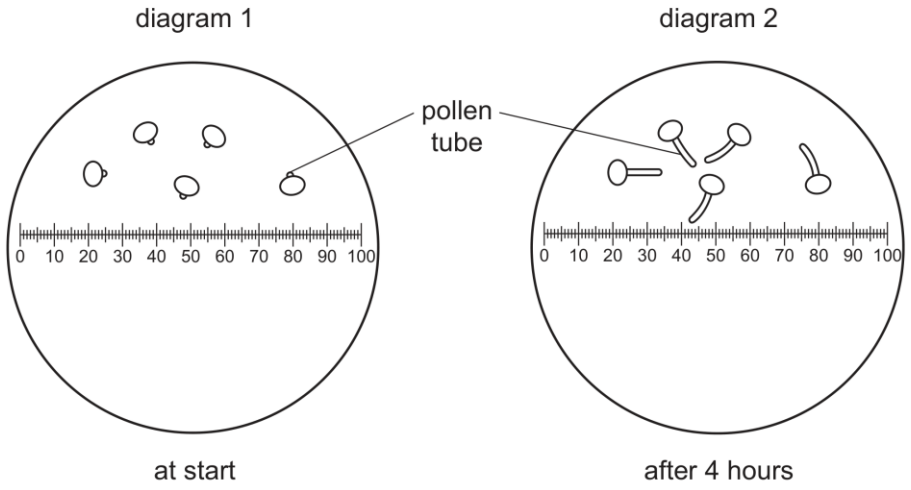
A ×10 **B** ×40 **C** ×100 **D** ×1000

24 The diagram shows a graduated slide, with divisions of 0.1 mm viewed using an eyepiece graticule.



Pollen grains were grown in a sugar solution and viewed using the eyepiece graticule.

Diagram 1 shows the pollen grains at the start. Diagram 2 shows the pollen grains after four hours.



What is the growth rate of the pollen tubes?

A $5\,\mu m h^{-1}$ **B** $10\,\mu m h^{-1}$ **C** $5\,mm h^{-1}$ **D** $10\,mm h^{-1}$

25 What is the definition of the resolution of a light microscope?

A the degree of sharpness produced by the microscope

B the greatest distance between two objects visible in the same field of view

C the minimum distance that allows two objects to be viewed as separate

D the size of the smallest object visible using the microscope

26 The electron micrograph shows a type of virus at a magnification of ×30 000.



What is the length of the virus?

A 2.2×10^3 nm

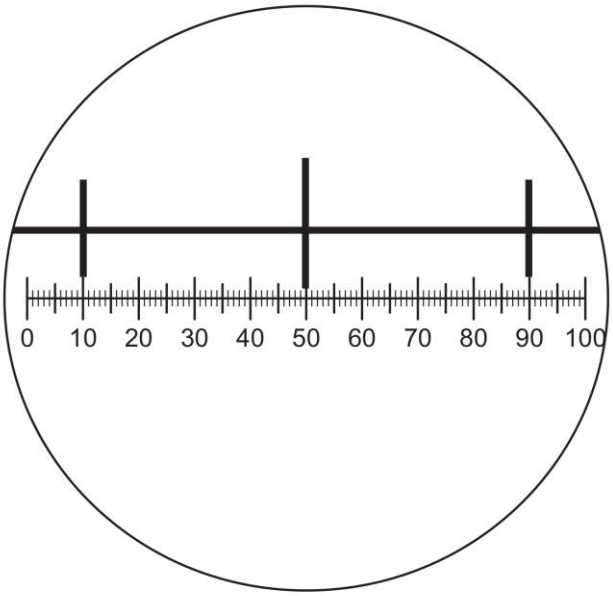
B 2.2×10^2 nm

C 2.2×10^1 nm

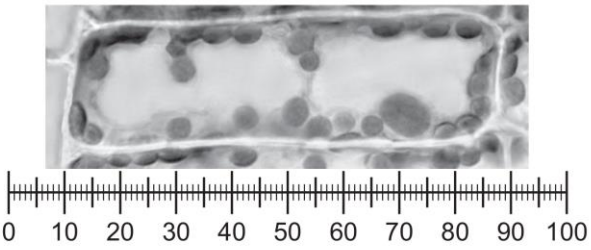
D 2.2×10^0 nm

27 The diagram shows a stage micrometer scale viewed through an eyepiece containing a graticule.

The small divisions of the stage micrometer scale are 0.1 mm.



The stage micrometer scale is replaced by a slide of a plant cell.



What is the actual length of the nucleus in the plant cell?

A 8 μm **B** 25 μm **C** 200 μm **D** 0.8 mm

28 The size of the measles virus, *Morbillivirus*, is approximately 150 nm.

The *Mimivirus* is approximately 4.5 times larger than *Morbillivirus*, whilst the *Pandoravirus* is approximately 1.5 times larger than the *Mimivirus*.

Which viruses can be seen using a light microscope with a maximum resolution of 0.25 μm **and** using an electron microscope?

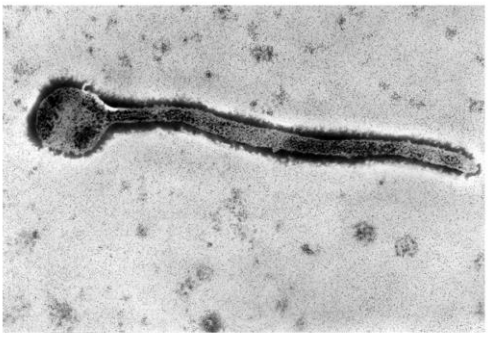
	Morbillivirus	*Mimivirus*	*Pandoravirus*
A	✓	✓	✓
B	✗	✓	✓
C	✗	✗	✓
D	✗	✗	✗

key

✓ = can be seen

✗ = cannot be seen

29 The electron micrograph shows a type of virus at a magnification of ×60 000.



What is the actual length of the virus?

A 1.1 nm **B** 11 nm **C** 110 nm **D** 1100 nm

30 A student was told that the actual length of a cell structure is 5 μm.

The student was asked to state an equation that can be used to calculate the magnification of an electron micrograph of this cell structure. The student used some of the letters *q* to *u* in the equation.

q = the length of the cell structure image on the micrograph in centimetres

r = the length of the cell structure image on the micrograph in millimetres

s = 1000

$t = \frac{1}{5}$

u = 5

Which is the correct equation to calculate the magnification?

A $\frac{q}{s} \times u$ **B** $q \times s \times t$ **C** $\frac{r}{s} \times u$ **D** $r \times s \times t$

31 The actual length of a cell structure is 8 μm.

Which steps are used to calculate the magnification of an electron micrograph of this cell structure?

step 1 measure the length of the cell structure image on the micrograph in centimetres

step 2 measure the length of the cell structure image on the micrograph in millimetres

step 3 divide the image length by 1000

step 4 multiply the image length by 1000

step 5 divide by 8

step 6 multiply by 8

A steps 1, 3 and 6

B steps 1, 4 and 6

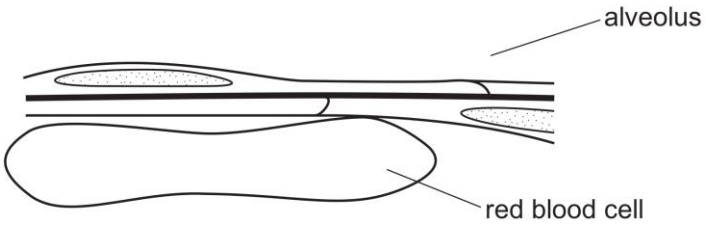
C steps 2, 3 and 5

D steps 2, 4 and 5

32 What is the typical resolution of a microscope using daylight as a light source with a ×10 eyepiece lens and a ×40 objective lens?

A 0.20 nm **B** 200 nm **C** 100 μm **D** 400 μm

33 The drawing has been made from a section showing part of an alveolus and a red blood cell in a capillary. The magnification of the drawing is ×5000.



What is the minimum distance that oxygen must diffuse from air in an alveolus into the red blood cell?

A 0.1 nm **B** 1.0 nm **C** 0.1 μm **D** 1.0 μm

34 A student calibrated the scale on an eyepiece graticule in the eyepiece lens of a light microscope. The student was given a stage micrometer scale to use.

The divisions on the stage micrometer scale were 0.1 mm apart.

Which data must the student collect in order to calibrate the eyepiece graticule?

1 magnification of the eyepiece lens of the microscope

2 number of divisions of the stage micrometer scale seen in one field of view of the microscope

3 number of divisions of the eyepiece graticule scale equivalent to each division of the stage micrometer scale

A 1 and 3 **B** 2 and 3 **C** 2 only **D** 3 only

35 The diameter of living cells varies considerably.

The diameter of a typical eukaryotic cell is 1.5×10^1 μm.
The diameter of a typical prokaryotic cell is 7.5×10^2 nm.

Using these measurements, what is the maximum number of each cell type which could fit along a line 1 cm long?

	number of white blood cells	number of *Streptococcus* cells
A	6.7×10^4	1.3×10^2
B	6.7×10^3	1.3×10^5
C	6.7×10^2	1.3×10^4
D	6.7×10^1	1.3×10^3

36 Which statements about resolution and magnification are correct?

	resolution	magnification
A	the ability to distinguish between two separate objects that are very close together	the number of times larger an image is compared with the real size of the object
B	the clarity of the image formed by the microscope	the power of the microscope to focus on very small objects
C	the number of times larger an image is compared with the real size of the object	the ability to distinguish between two separate objects that are very close together
D	the power of the microscope to focus on very small objects	the clarity of the image formed by the microscope

37 An eyepiece graticule has a scale with 100 divisions. A stage micrometer has a scale with 50 divisions, each of which is 0.040 mm apart.

Using a ×40 objective lens, the whole length of this stage micrometer scale lines up with 15 divisions of the eyepiece graticule.

What is the actual length of the 100 division scale of the eyepiece graticule?

A 1.3 mm **B** 13 mm **C** 75 μm **D** 750 μm

38 A prokaryotic cell which is 1 μm in diameter, is magnified 50 000 times in an electron micrograph.

What is the diameter of the cell in the electron micrograph?

A 5×10^{-1} mm

B 5×10^{0} mm

C 5×10^{1} mm

D 5×10^{2} mm

39 Which of these statements about light microscopy are correct?

1 The greater the resolution of a light microscope, the greater the detail that can be seen.

2 The greater the magnification of a light microscope, the greater the detail that can be seen.

3 Increasing the magnification of a light microscope up to its limit of resolution allows more detail to be seen.

4 The shorter the wavelength of light used in a light microscope, the greater the detail that can be seen.

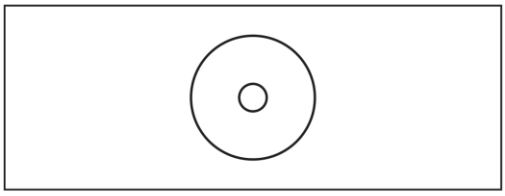
A 1, 2, 3 and 4

B 1, 3 and 4 only

C 1 and 2 only

D 4 only

40 The diagram shows a slide of a transverse section of a stem. This diagram is the same size as the actual slide.



A student observed this slide using a light microscope at a magnification of ×40. The student made a plan drawing of the stem, which was 20 cm in diameter.

The student labelled the plan 'Transverse section of a stem ×40'.

Which statement explains why this label is **not** correct?

A The actual size of the stem should have been checked using an eyepiece graticule.

B The actual size of the stem was smaller under low power.

C The image size in the drawing was larger than ×40.

D The image size in the drawing was smaller than ×40.

41 A specimen of plant tissue is first observed under a microscope using red light with a wavelength of 650 nm.

The same specimen is then observed under the same conditions, but using green light with a wavelength of 510 nm.

What happens to the magnification and resolution when using green light compared to red light?

	magnification	resolution
A	decreases	decreases
B	increases	increases
C	remains the same	decreases
D	remains the same	increases