

## Practical support 9 Size and scale

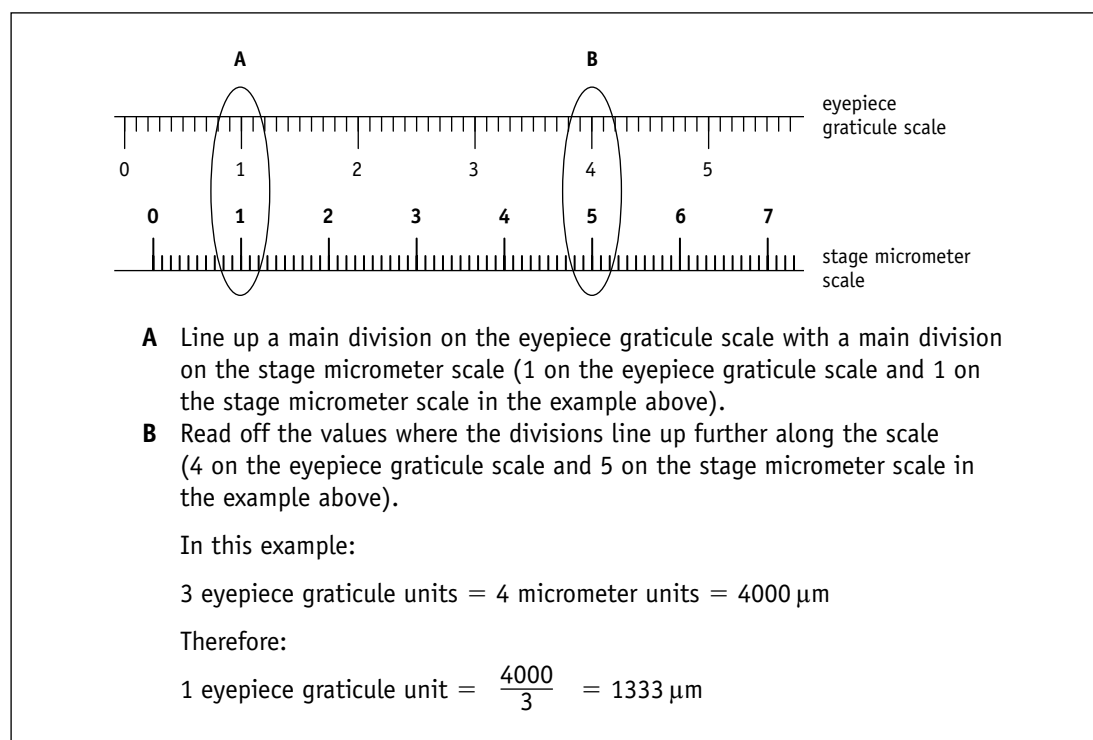
### Measuring sizes under the light microscope

When measuring the size of a cell, organelle or specimen down a microscope, an **eyepiece graticule** is used. This is similar to a normal eyepiece but it contains a disc engraved with a scale. The divisions that make up the scale are called eyepiece graticule units. The eyepiece graticule units have to be calibrated before the scale can be used to measure specimens.

### Calibrating the eyepiece graticule

Calibrating the eyepiece graticule is done using a **stage micrometer**, which is a slide with an accurate linear scale engraved on it. This slide is placed on the microscope stage. Looking down the microscope, both scales can be seen at the same time. This allows the size of the divisions on the eyepiece graticule to be measured. One large division on the stage micrometer is 1000  $\mu\text{m}$  (1 mm). Each large division is divided into 10 smaller divisions, each 100  $\mu\text{m}$  (0.1 mm) wide.

- 1 Place the stage micrometer on the microscope stage.
- 2 Line up the divisions on the eyepiece graticule with those of the micrometer as shown in Figure 1.
- 3 Work out the length of one eyepiece graticule unit in micrometres as shown in Figure 1.
- 4 Repeat for each of the objective lenses on the microscope.



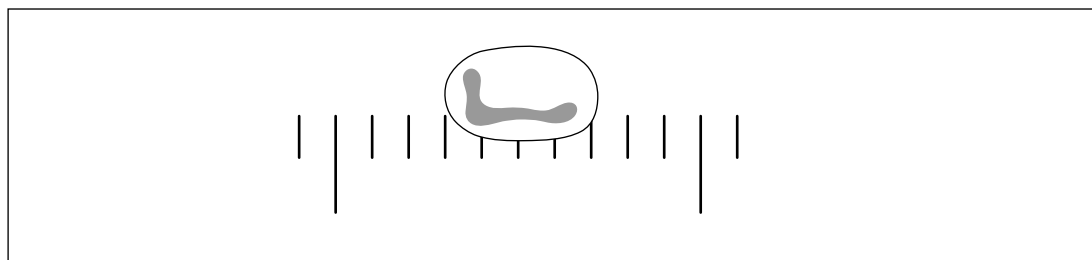
**Figure 1** How to measure the length of one eyepiece graticule unit.

### Using the eyepiece graticule to measure the length of objects

- 1 Place a slide on the microscope stage.
- 2 Measure the length of the specimen (e.g. the length of one cell) in eyepiece graticule units using the eyepiece graticule scale.
- 3 Calculate the length of the specimen in  $\mu\text{m}$  by multiplying the length in eyepiece graticule units by the calibration value for 1 unit ( $1333 \mu\text{m}$  in the example on p. 1).

### Questions

- Q1** Convert the lengths below to micrometres.
- a 2 mm
  - b 0.5 mm
  - c 0.01 mm
- Q2** Convert the measurements below to millimetres.
- a  $300 \mu\text{m}$
  - b  $3500 \mu\text{m}$
  - c  $15 \mu\text{m}$
- Q3** Under a low-power lens exactly 1 mm was equal to 7 eyepiece graticule units. What is the length of 1 eyepiece graticule unit in micrometres?
- Q4** Under a high-power objective lens 87.0 small divisions (8.70 eyepiece graticule units) measure  $300 \mu\text{m}$ . What is the size of each eyepiece graticule unit in micrometres?
- Q5** The same lens and eyepiece graticule as calibrated in Question 4 was used to view a white blood cell. The diagram in Figure 2 shows the cell and eyepiece graticule scale. Work out the diameter of the white blood cell.



**Figure 2** Cell and eyepiece graticule scale.

### Scales and magnification

If you draw a specimen and measure its length, or the length of part of the specimen, such as the width of a single alveolus, a scale bar should be added to the drawing. This gives an indication of the size of the specimen.

If you draw a specimen from a slide, the magnification should be added to the diagram. This is often just given as the magnification of the microscope lens used. The magnification of the eyepiece lens is multiplied by the objective lens magnification to give the total magnification. For example, most high-power lenses are  $\times 40$  and eyepiece lenses are  $\times 10$ , giving a total magnification of  $\times 400$ . This does not give any indication of the size of the specimen.

If you draw a specimen from a slide and measure its length using an eyepiece graticule, you can work out the magnification of the drawing.

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## Student skills

- 1 Measure the length of the specimen in eyepiece graticule units.
- 2 Work out the specimen's length in micrometres ( $\mu\text{m}$ ).
- 3 Measure the length of specimen on the drawing in cm or mm and convert to  $\mu\text{m}$ .
- 4 Work out the magnification by dividing the length of the drawn specimen in  $\mu\text{m}$  by the length of actual specimen in  $\mu\text{m}$ .

For example, using the lens calibrated in Figure 1, if the specimen measured is 4 eyepiece graticule units wide, then the cell's width is:

$$1333 \mu\text{m} \times 4 = 5332 \mu\text{m}$$

Suppose the drawing of the specimen is 70 mm wide (this is 70 000  $\mu\text{m}$ ):

$$\text{magnification} = \frac{70\,000}{5332} = \times 13$$

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### Answers

- Q1** a 2000  $\mu\text{m}$       b 500  $\mu\text{m}$       c 10  $\mu\text{m}$   
**Q2** a 0.3 mm      b 3.5 mm      c 0.015 mm  
**Q3** 143  $\mu\text{m}$   
**Q4** 34.5  $\mu\text{m}$

**Q5** Diameter of cell is 4.2 eyepiece graticule units. 1 eyepiece graticule unit is 34.5  $\mu\text{m}$ . Diameter of cell in micrometres is 140  $\mu\text{m}$  (to 2 s.f.).