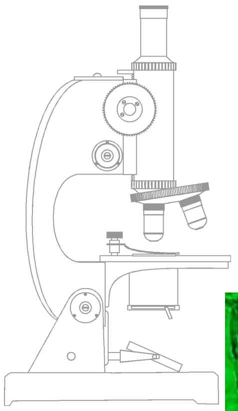
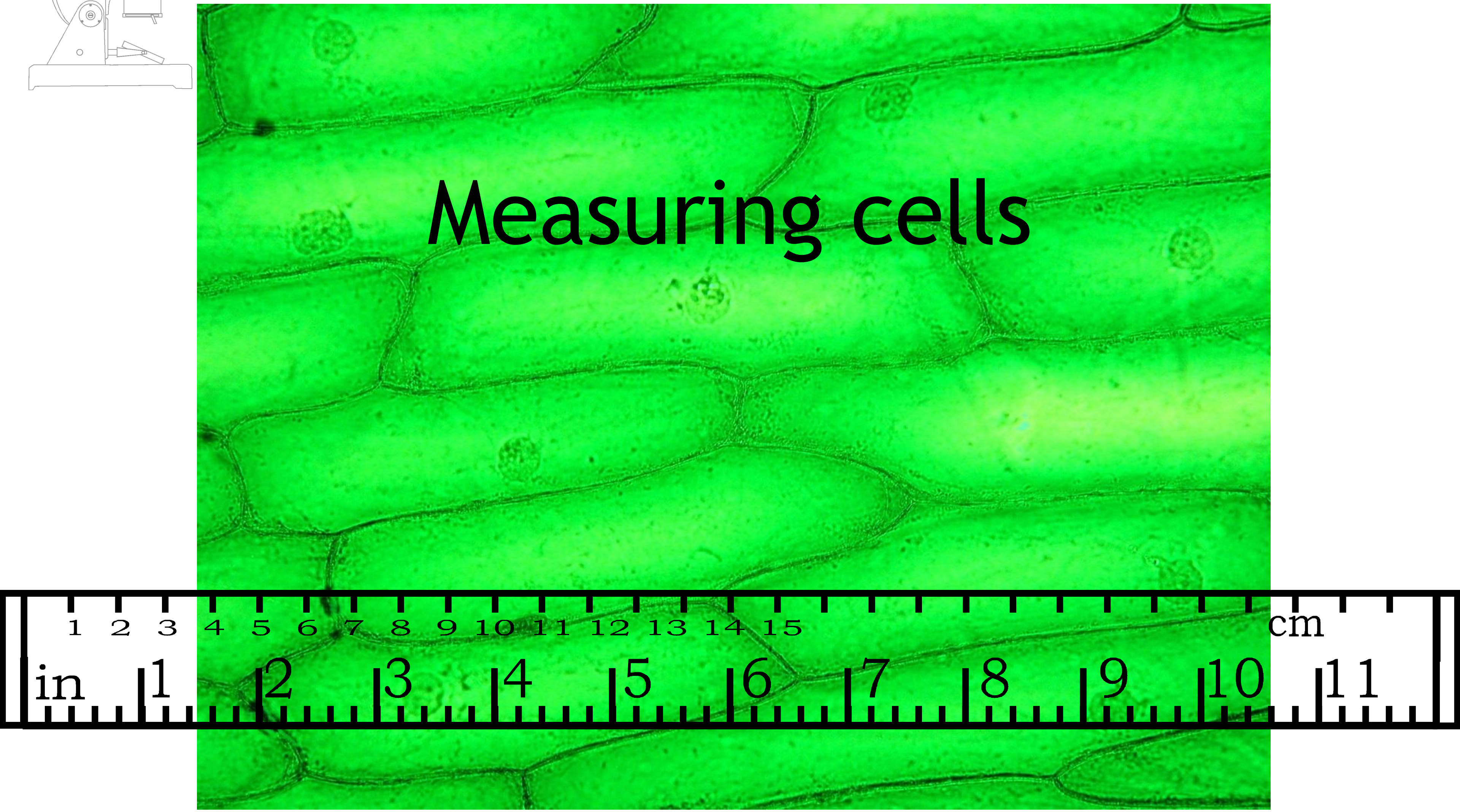
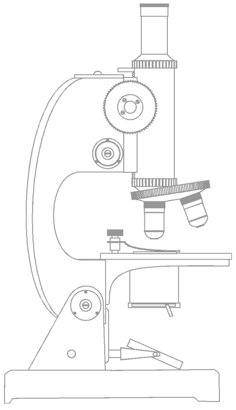


Measuring cells

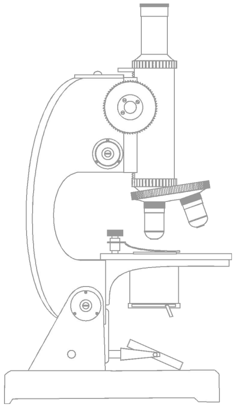


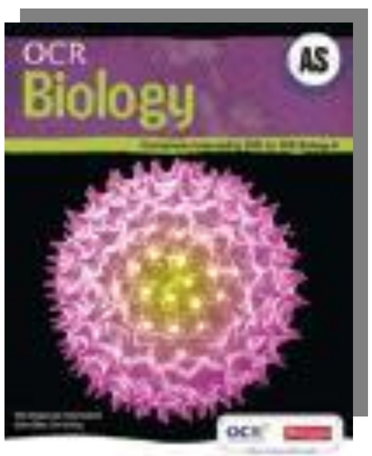


Syllabus reference:

Candidates should be able to:

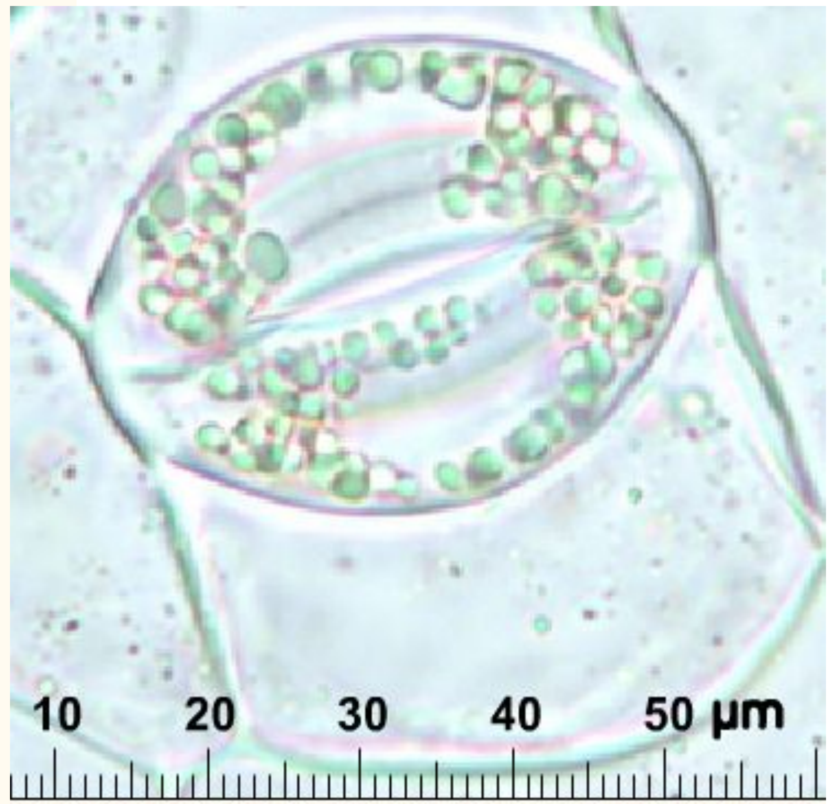
(d) calculate the linear magnification of an image (HSW3);

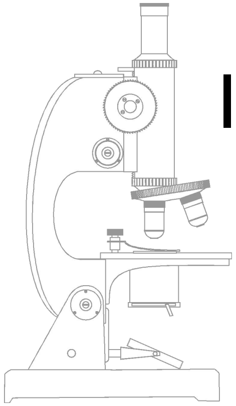




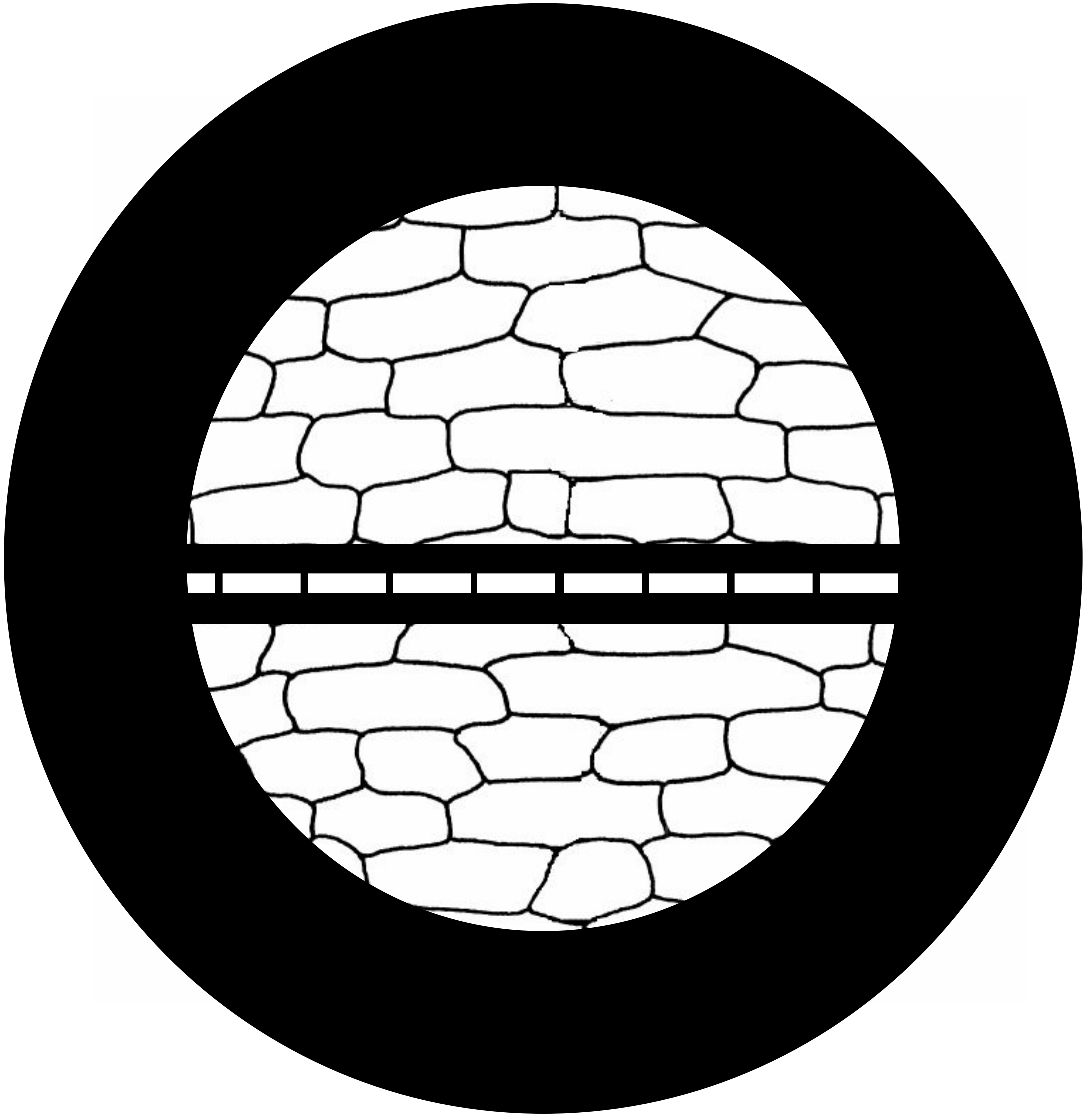
- *This symbol in the corner of a slide indicates a picture, diagram or table taken from your text book*

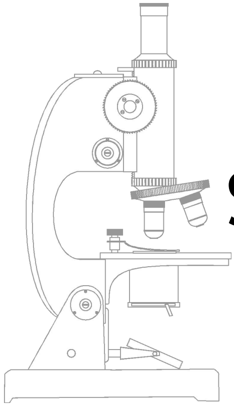
To accurately measure the size of cellular structures we need a suitable scale:



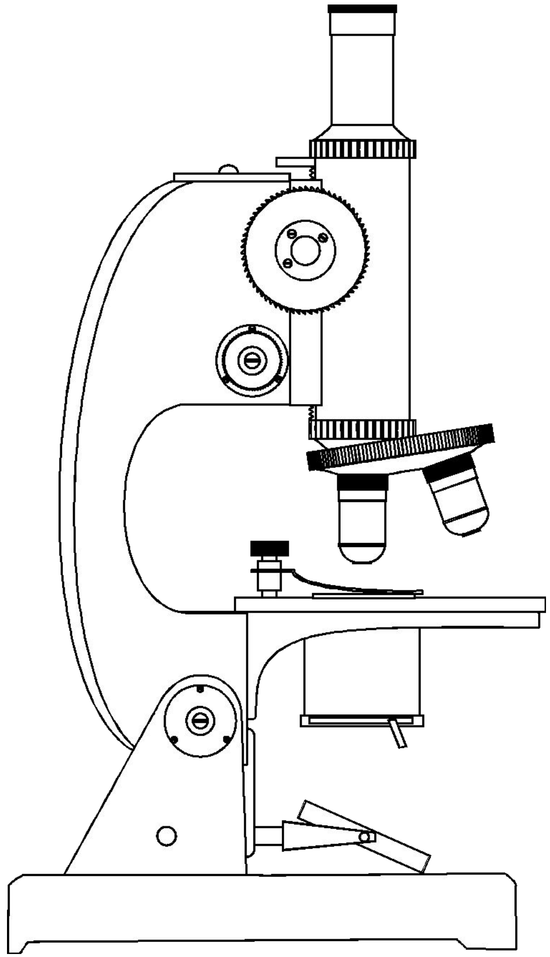


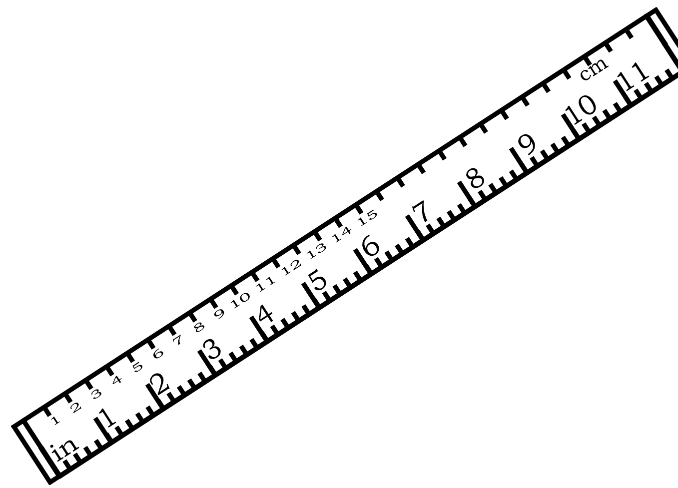
Ideally, we need a scale we can see directly alongside the cells we are observing:

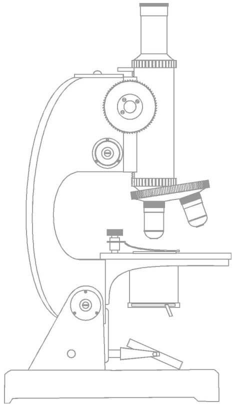




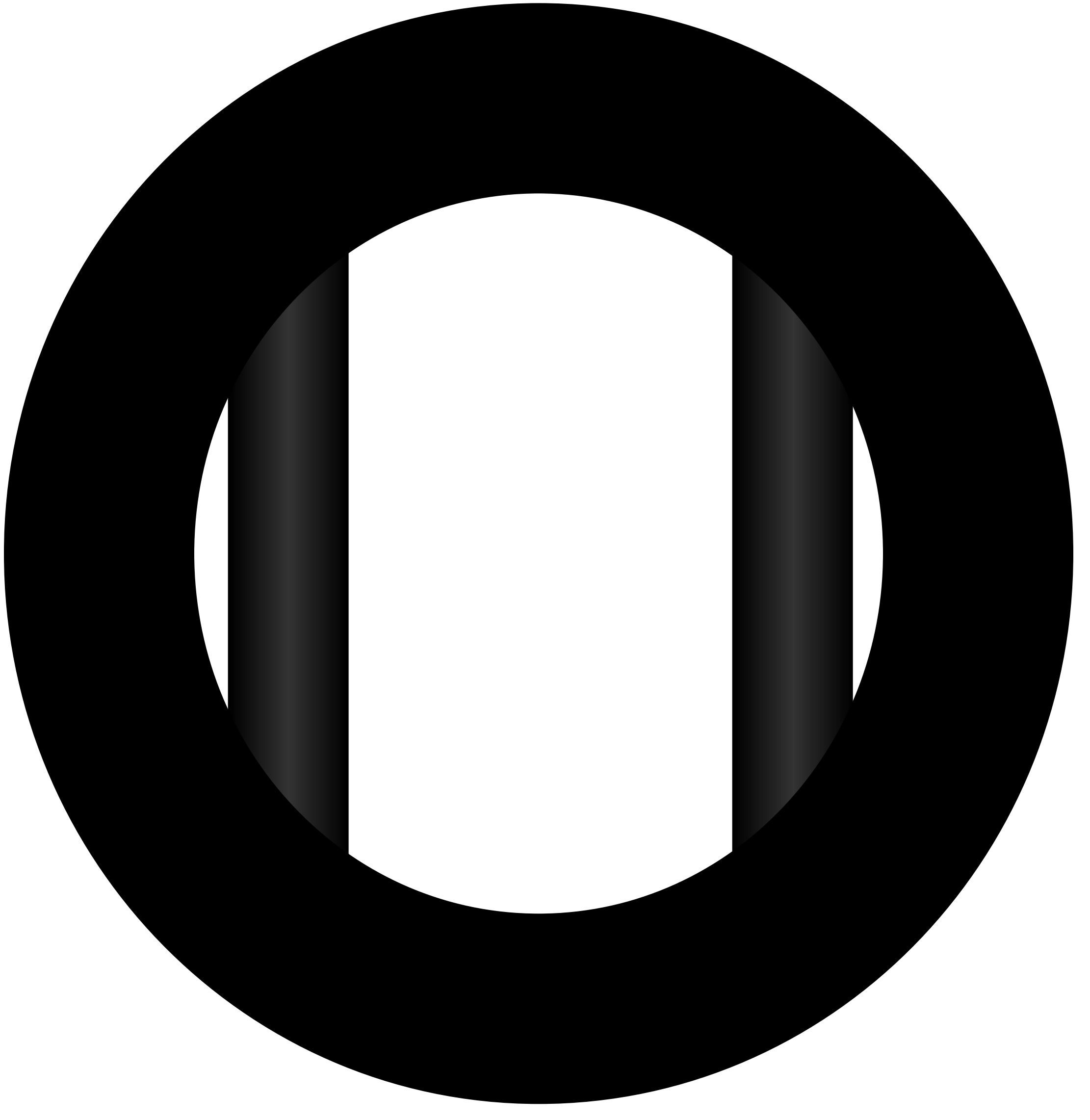
Start by putting a ruler under the microscope:

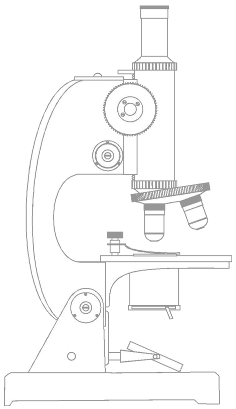




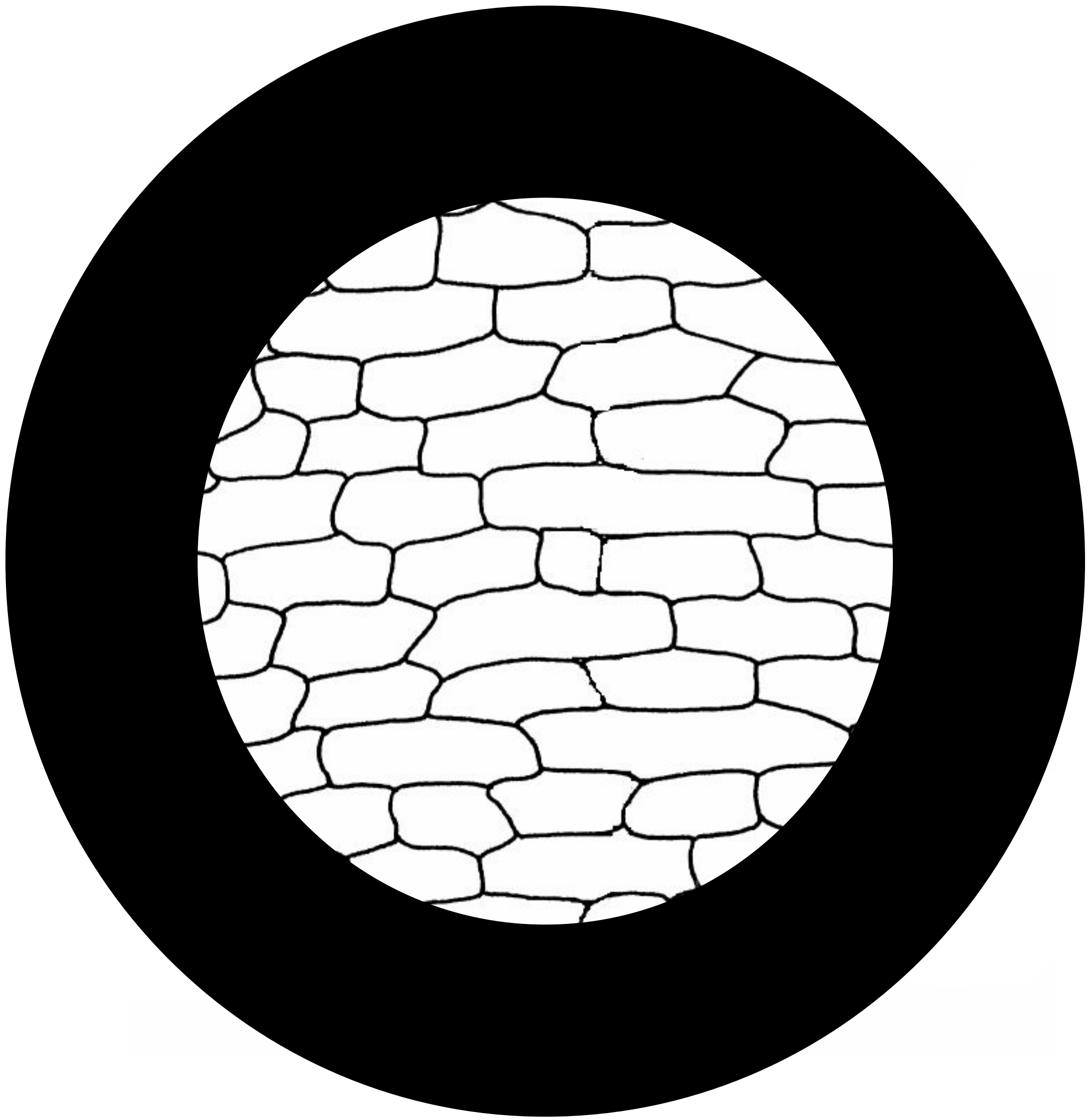


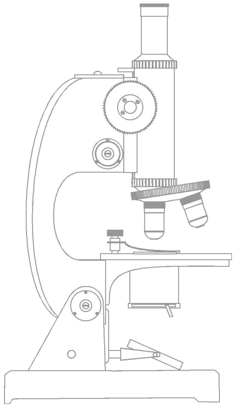
Appearance of ruler at medium magnification



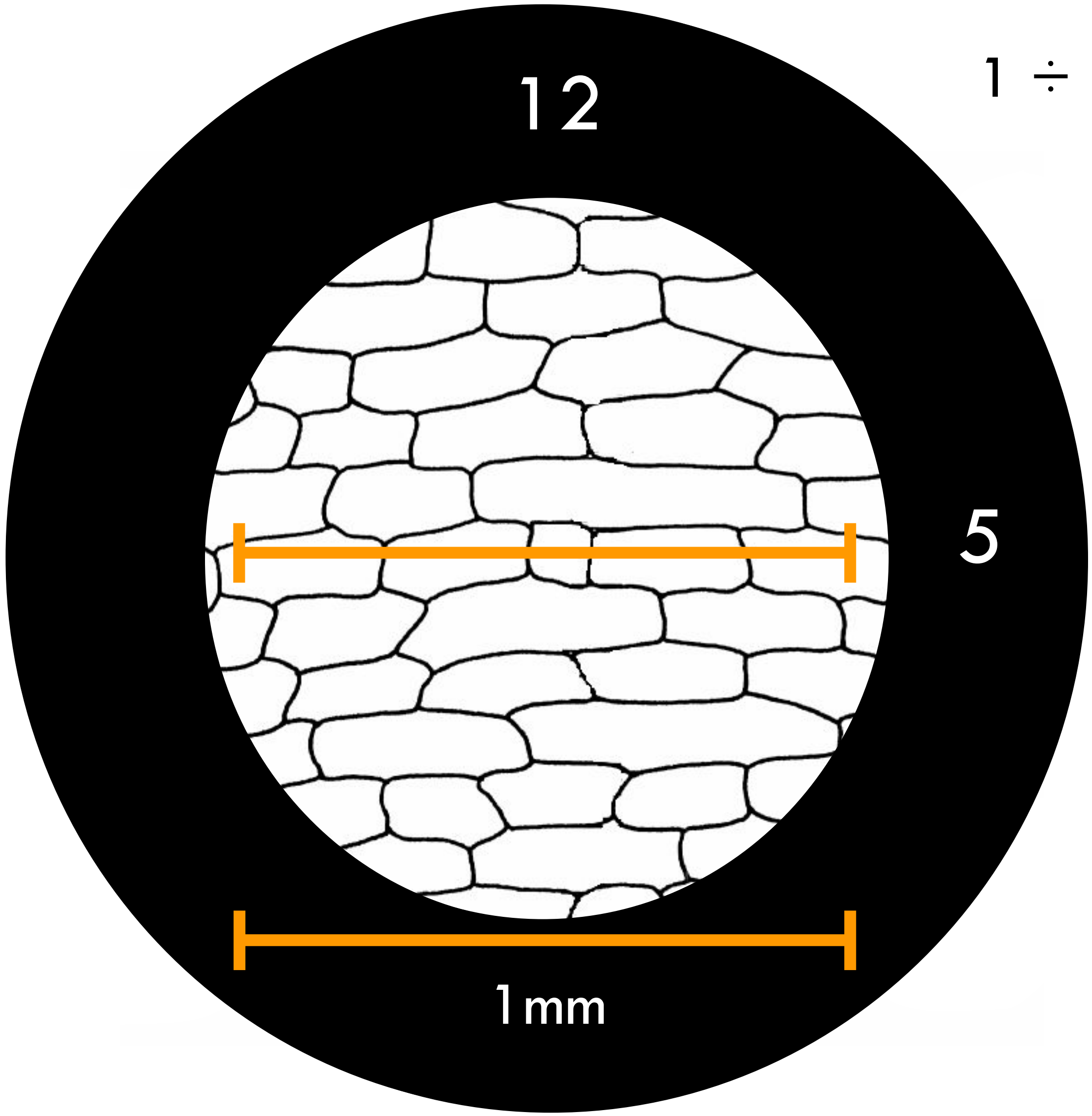


Appearance of tissue at medium magnification



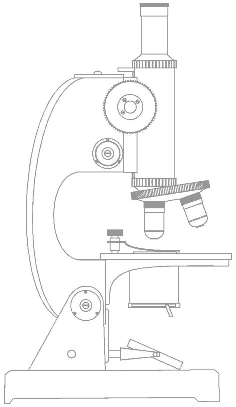


Estimating cell size at medium magnification

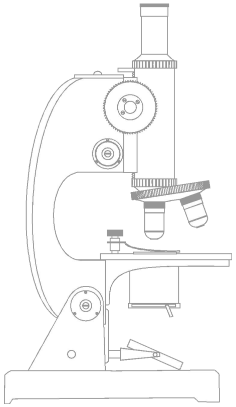


$1 \div 12 = 0.083\text{mm}$

$1 \div 5 = 0.2\text{mm}$



Diameter of field of view/mm	No. of cells lengthways	No. of cells widthways	Mean length (mm)	Mean width (mm)
1.00				

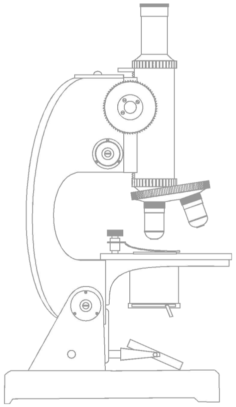


1mm = 1000μm

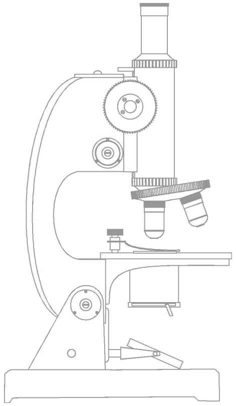
Diameter of field of view/mm	No. of cells lengthways	No. of cells widthways	Mean length (mm)	Mean width (mm)
1.00	5	12	0.2	0.083

Mean length of cells = 0.2 x 1000 = 200μm

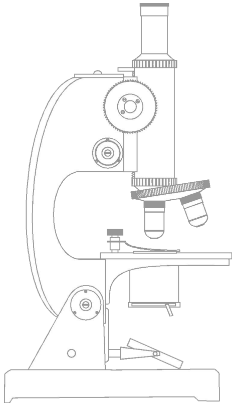
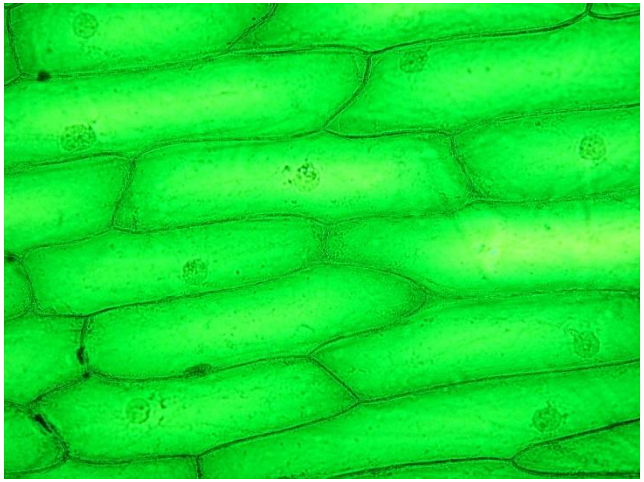
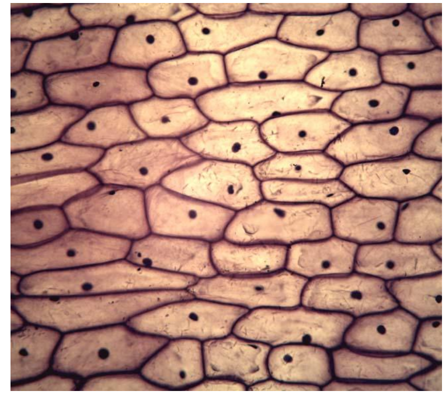
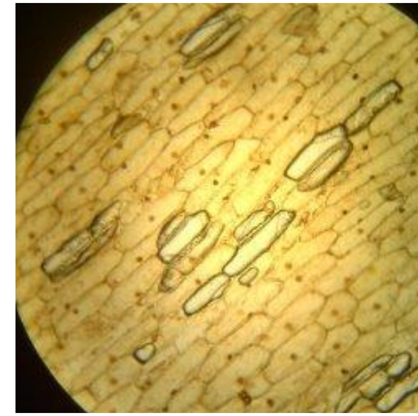
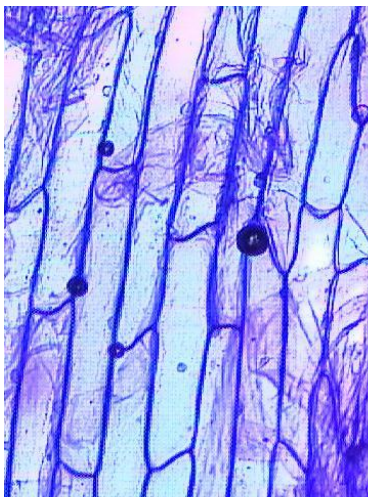
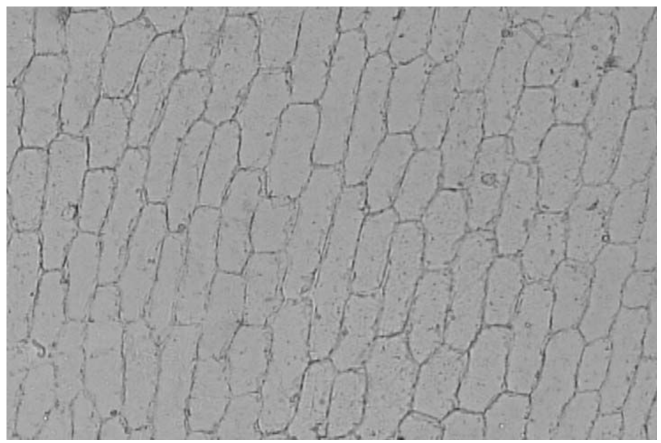
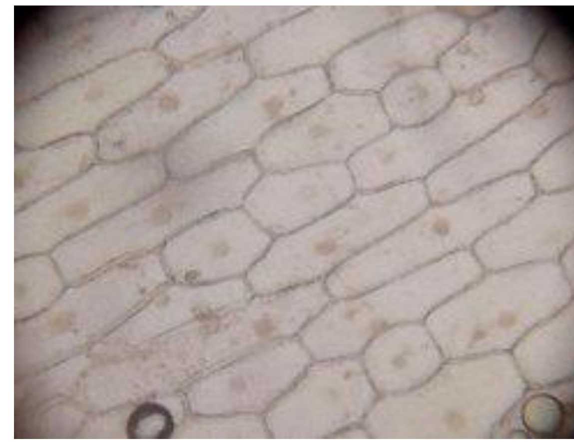
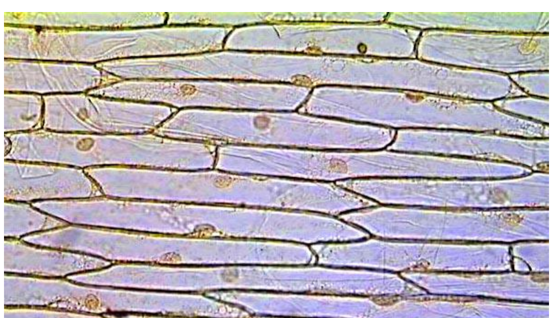
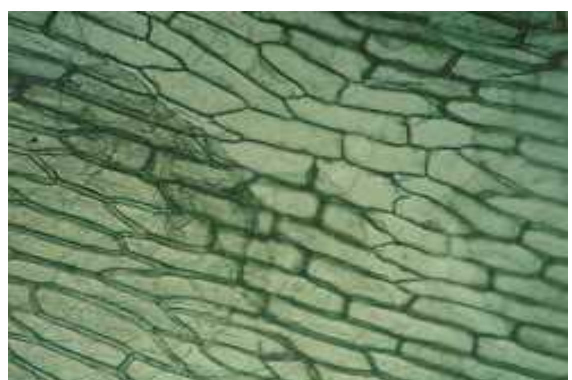
Mean width of cells = 0.083 x 1000 = 83μm

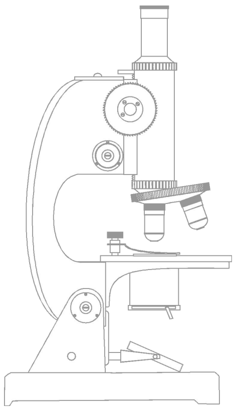


Mean length (µm)	Mean width (µm)
200	83.3
125	67
167	90
100	67
125	100
111	47
111	43.5
100	50
330	100
220	105
166	111
100	91
133	85
52	38
100	30



Mean length (µm)	Mean width (µm)
200	60
170	40
91	48
250	63
250	55
142	48
250	56
200	90
500	59
330	125
200	59
140	50
90	77
100	45
77	42

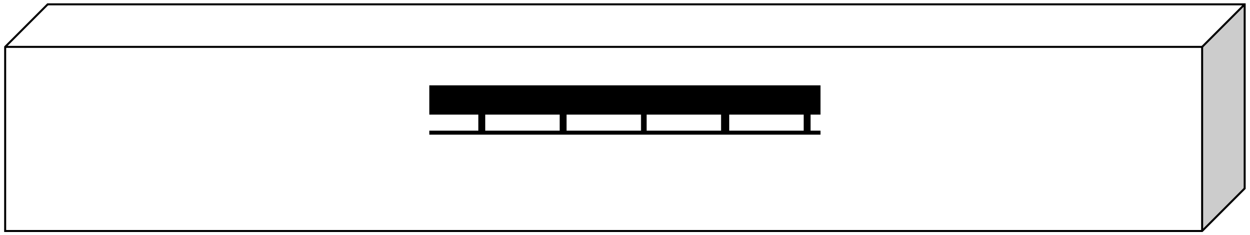










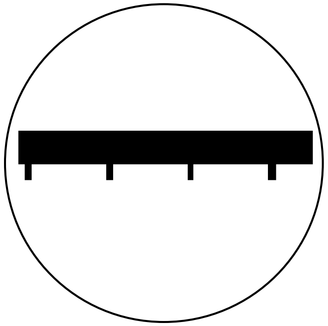
The graticule

a more suitable 'ruler' for measuring cells

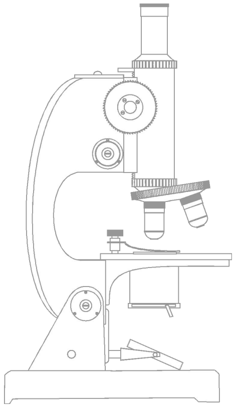
- The slide graticule:

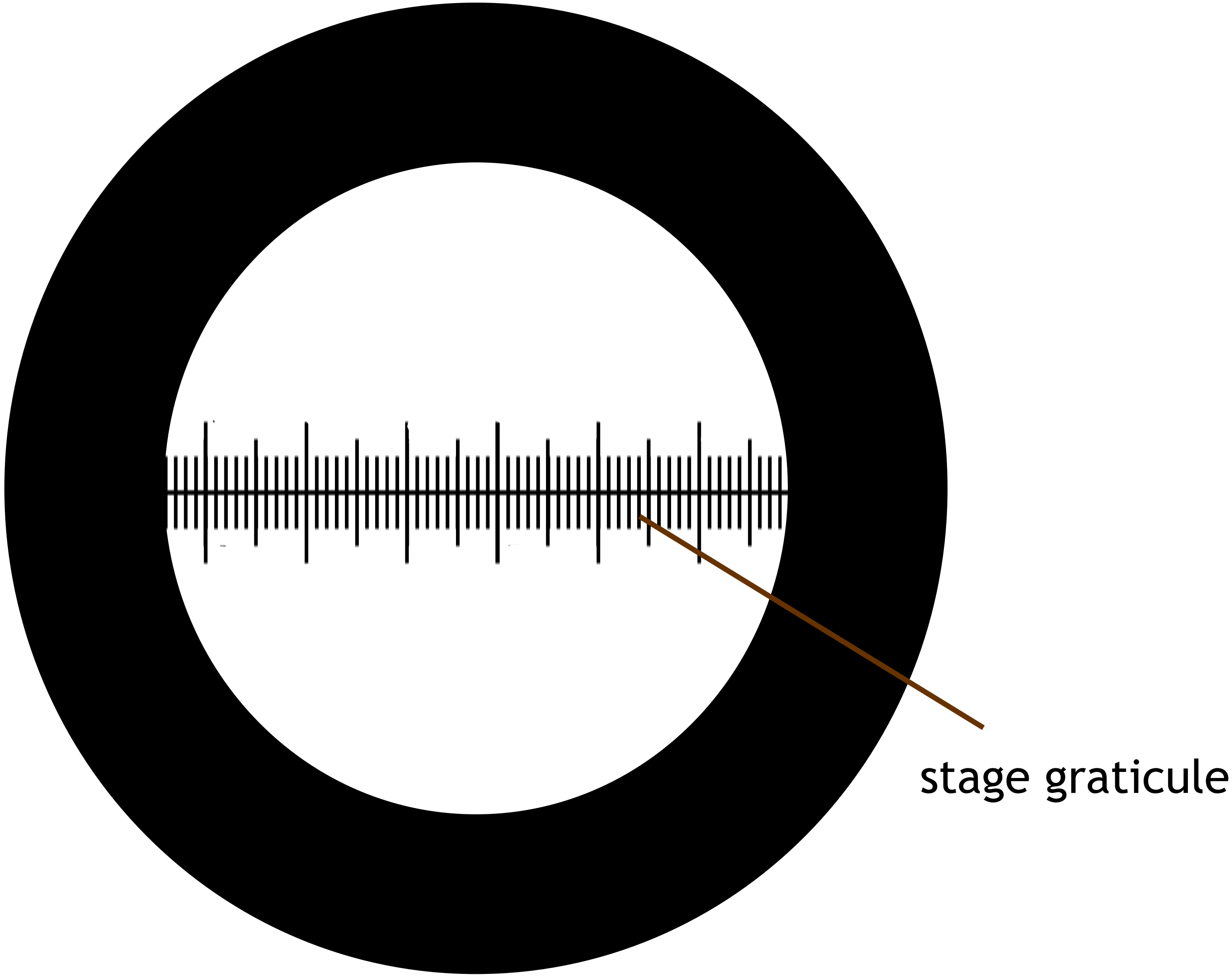


- The eyepiece graticule:

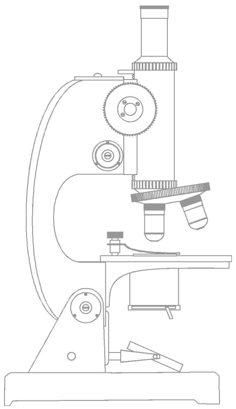


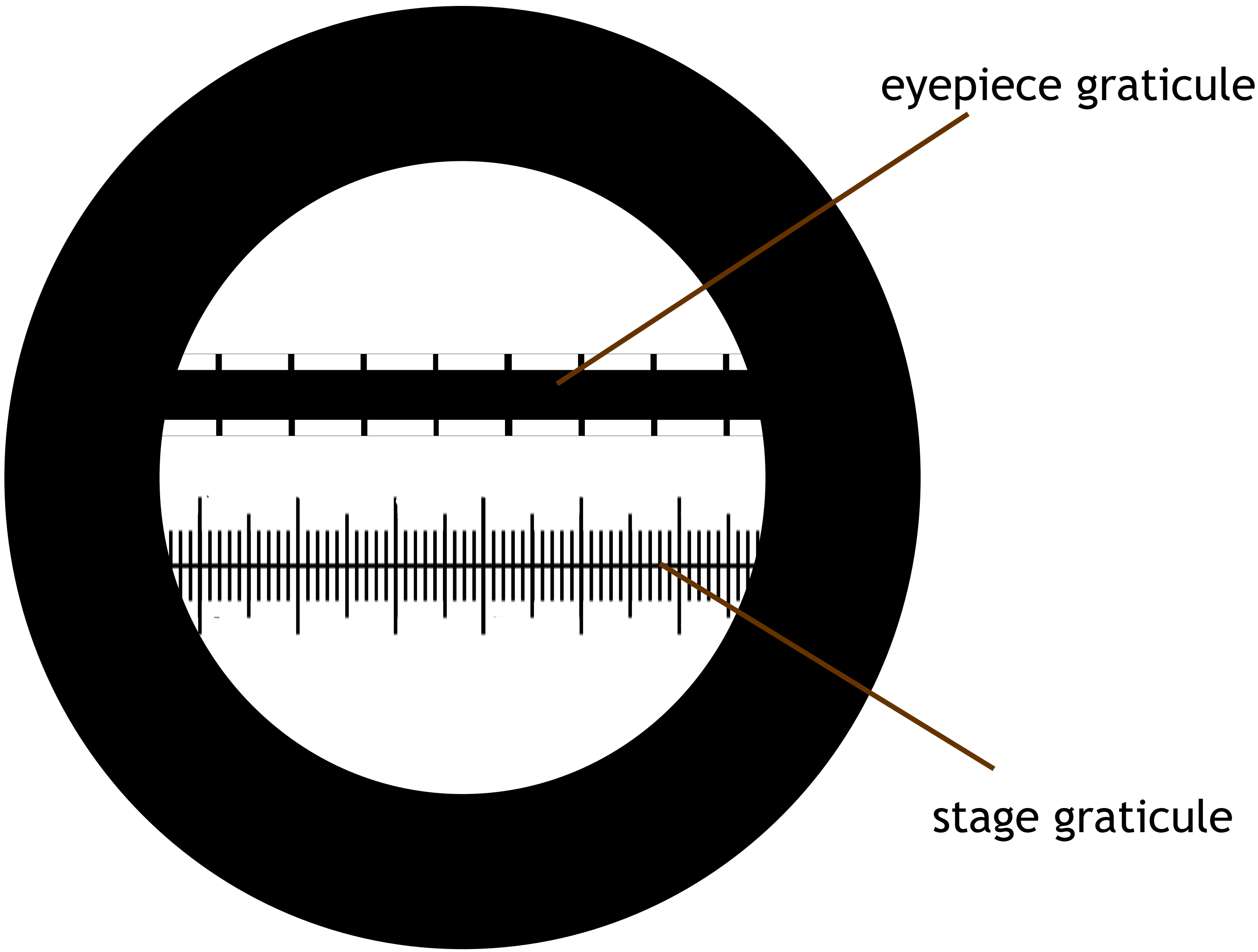
The stage graticule shows *true* lengths



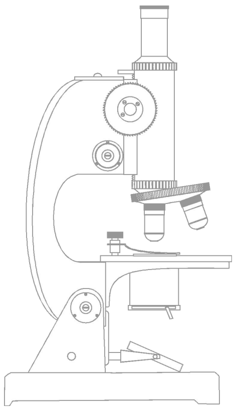


The eyepiece graticule has regular divisions.
These need to be calibrated for each magnification

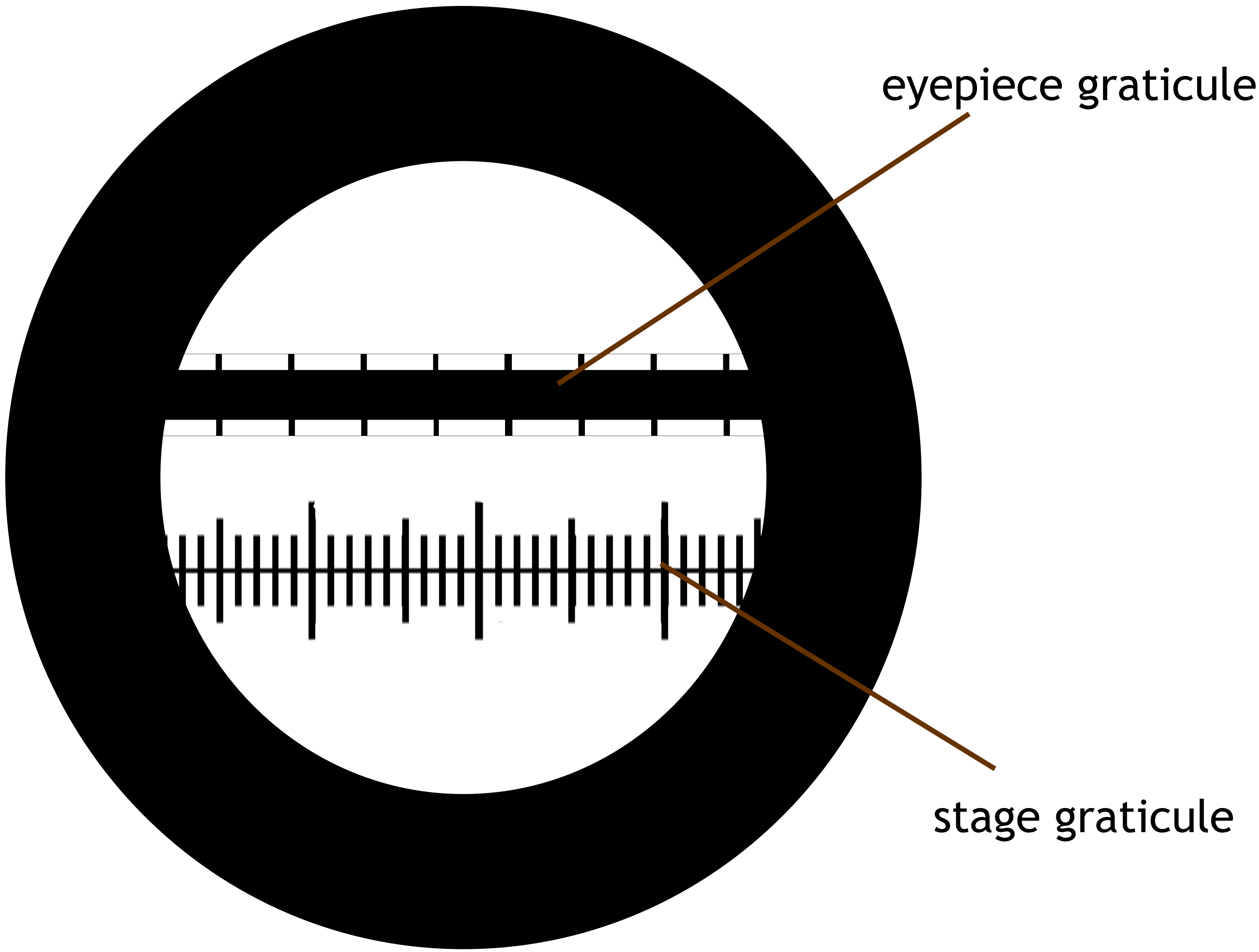




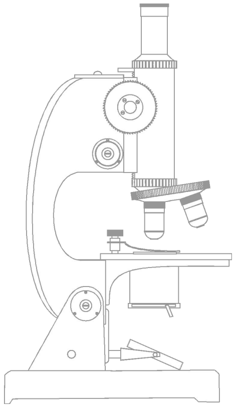
e.g. x100

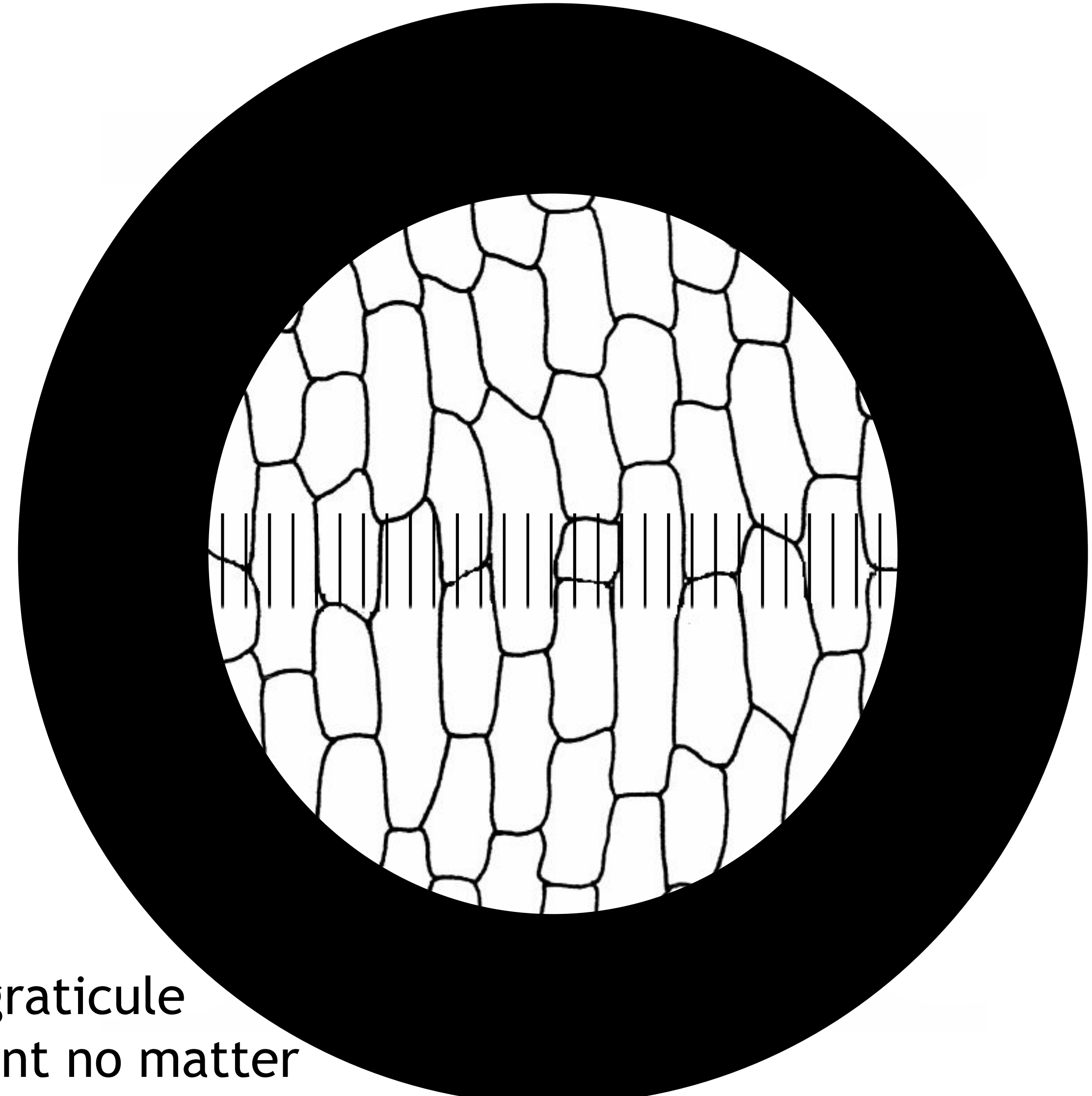


The eyepiece graticule has regular divisions.
These need to be calibrated for each magnification

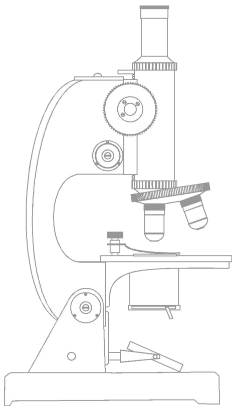


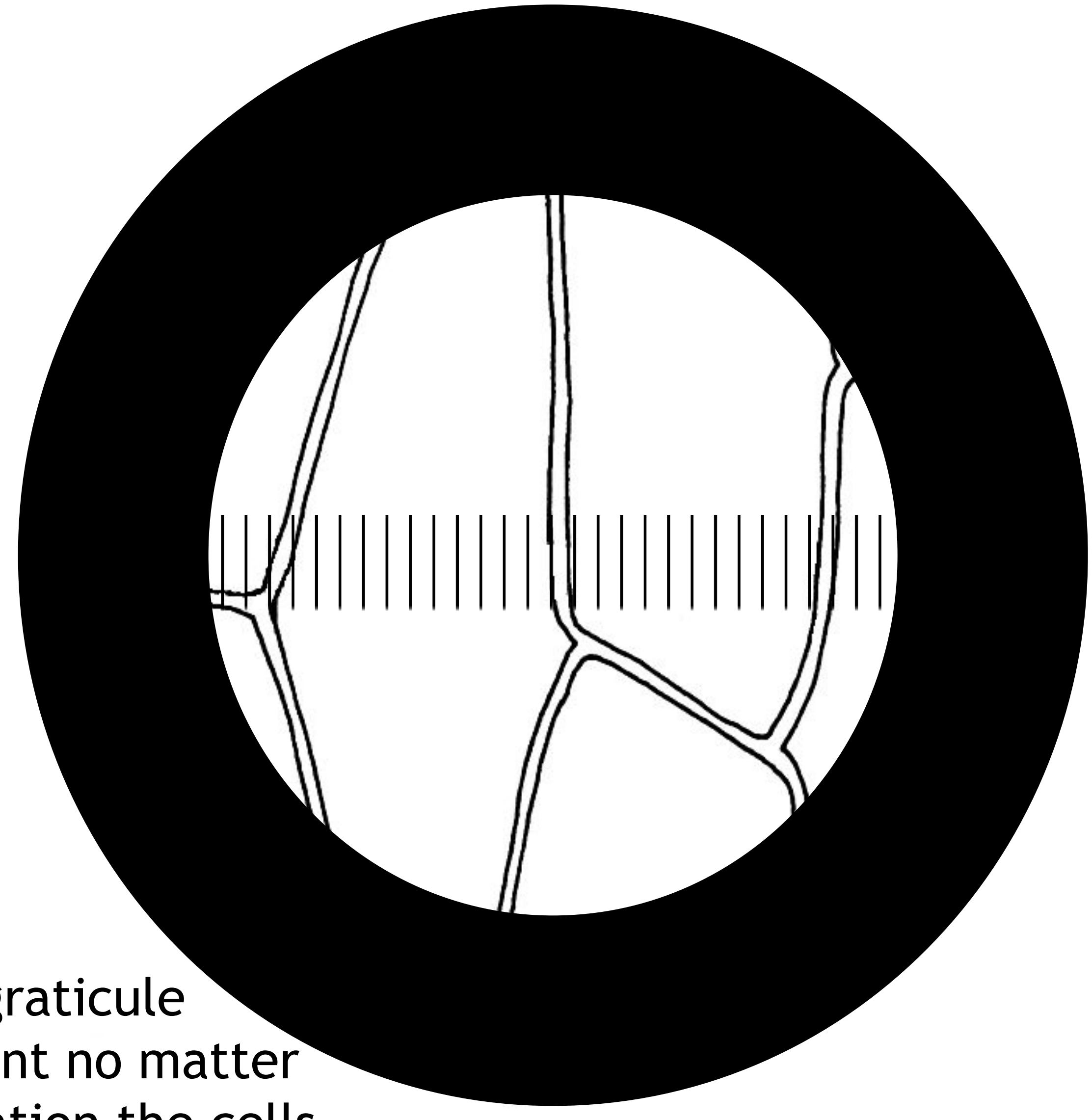
e.g. x400



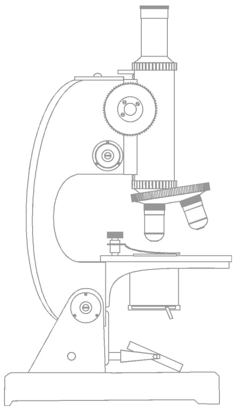


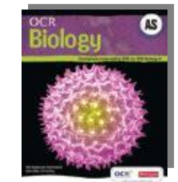
The eyepiece graticule remains constant no matter what magnification the cells are viewed at.

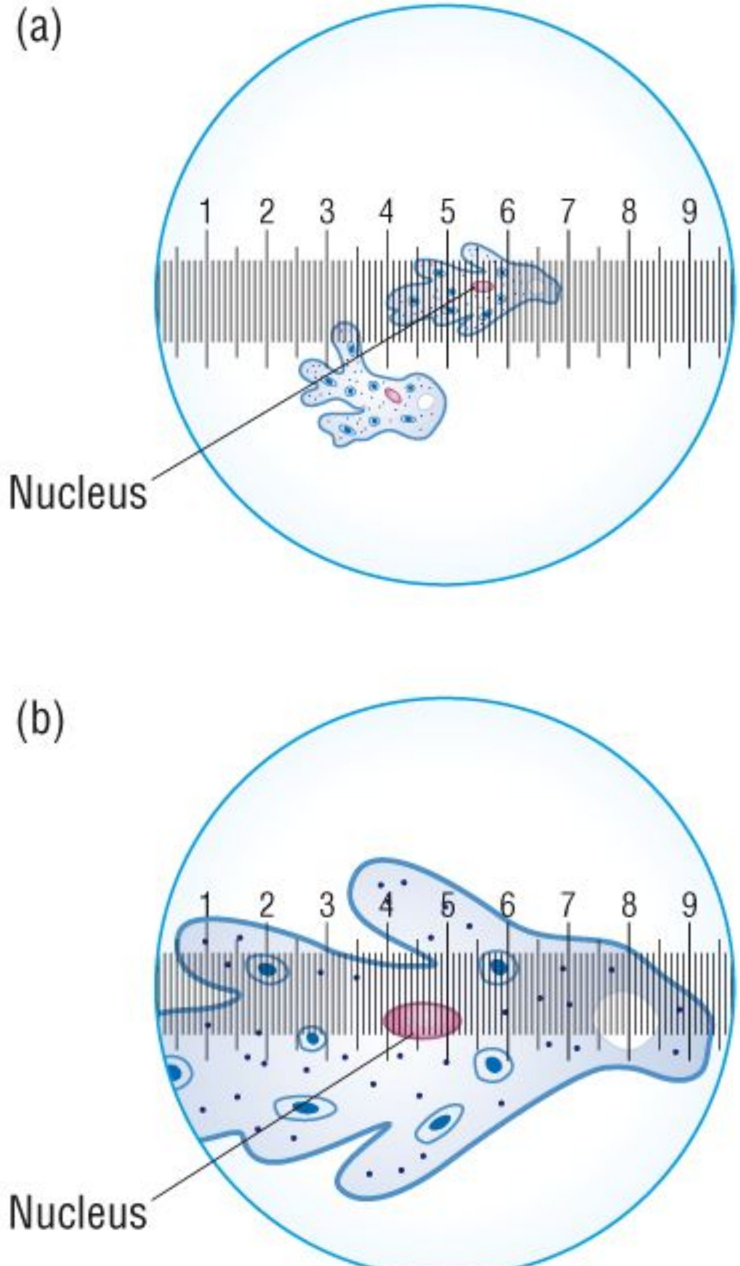




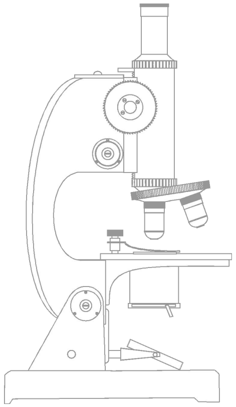
The eyepiece graticule remains constant no matter what magnification the cells are viewed at.



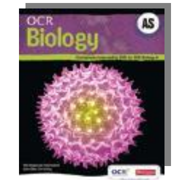




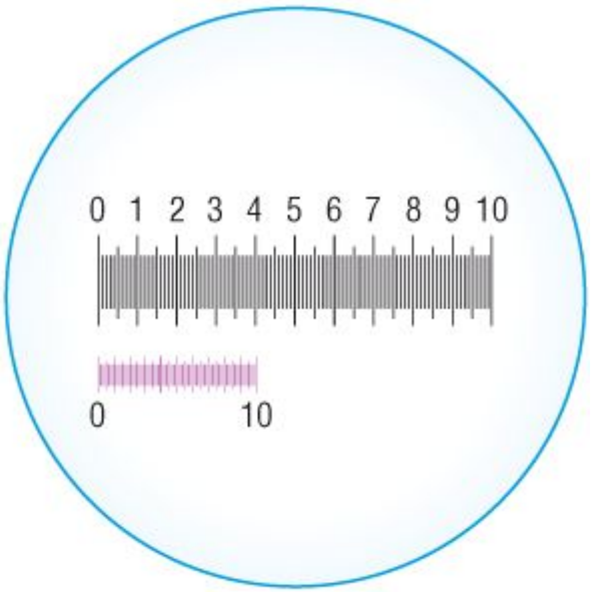
The eyepiece graticule remains constant no matter what magnification the cells are viewed at.



Eyepiece & stage graticules

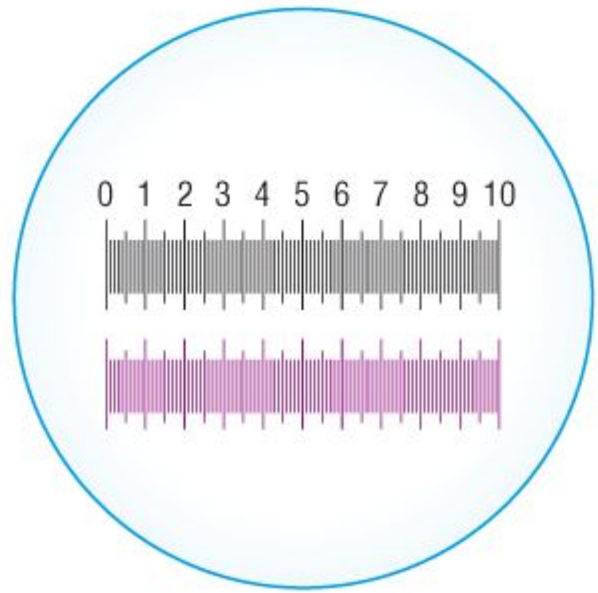


(a)



Low magnification

(b)



High magnification

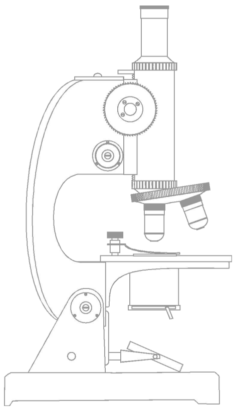
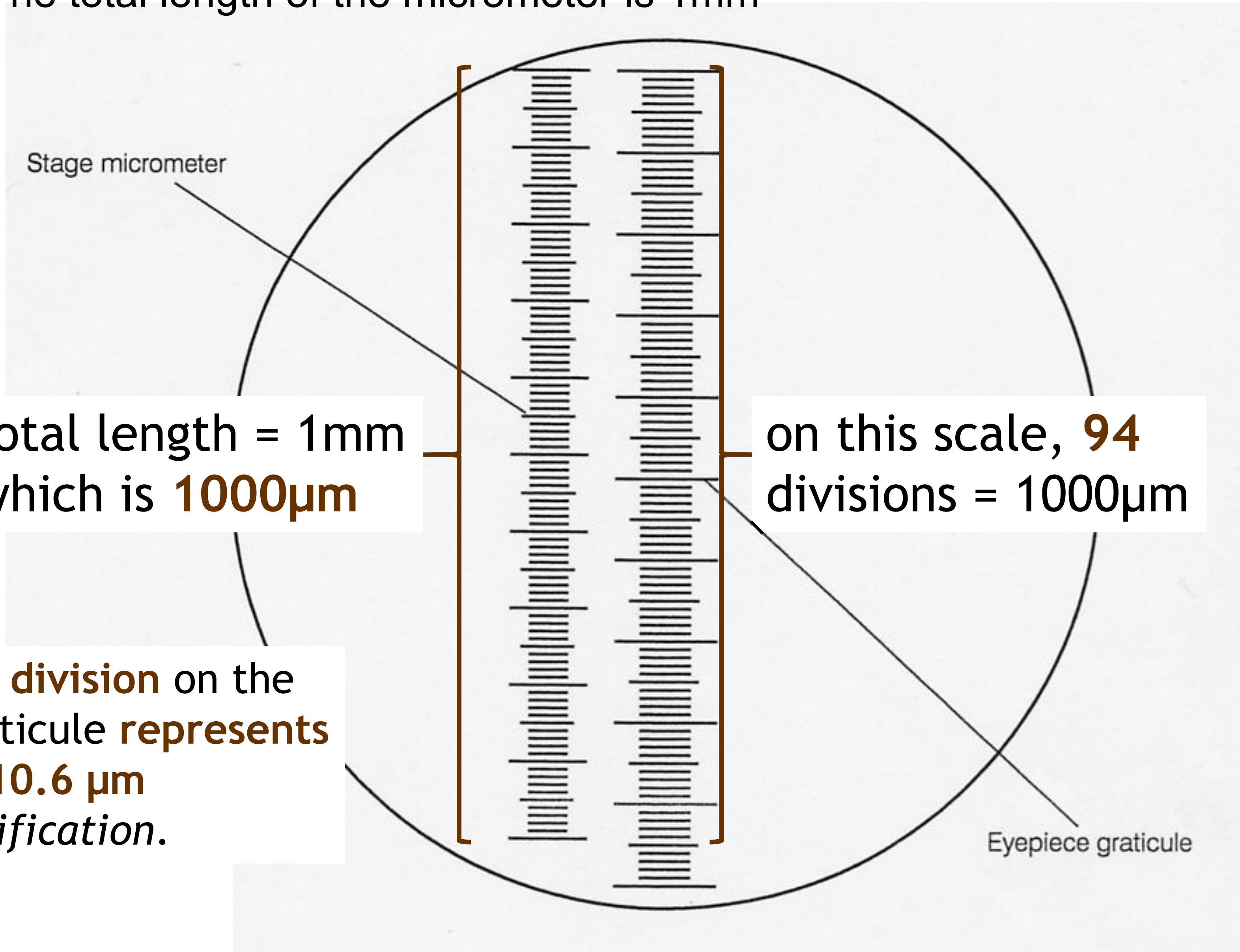


Figure 4.3
Stage micrometer viewed at x100 magnification.
The total length of the micrometer is 1mm



total length = 1mm which is **1000µm**

on this scale, **94** divisions = 1000µm

Therefore, **1 division** on the eyepiece graticule **represents** 1000 ÷ 94 = **10.6 µm** *at this magnification.*

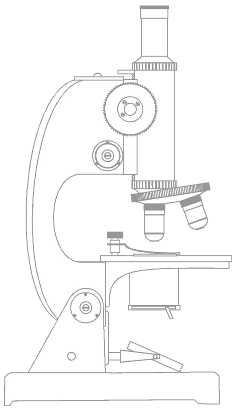
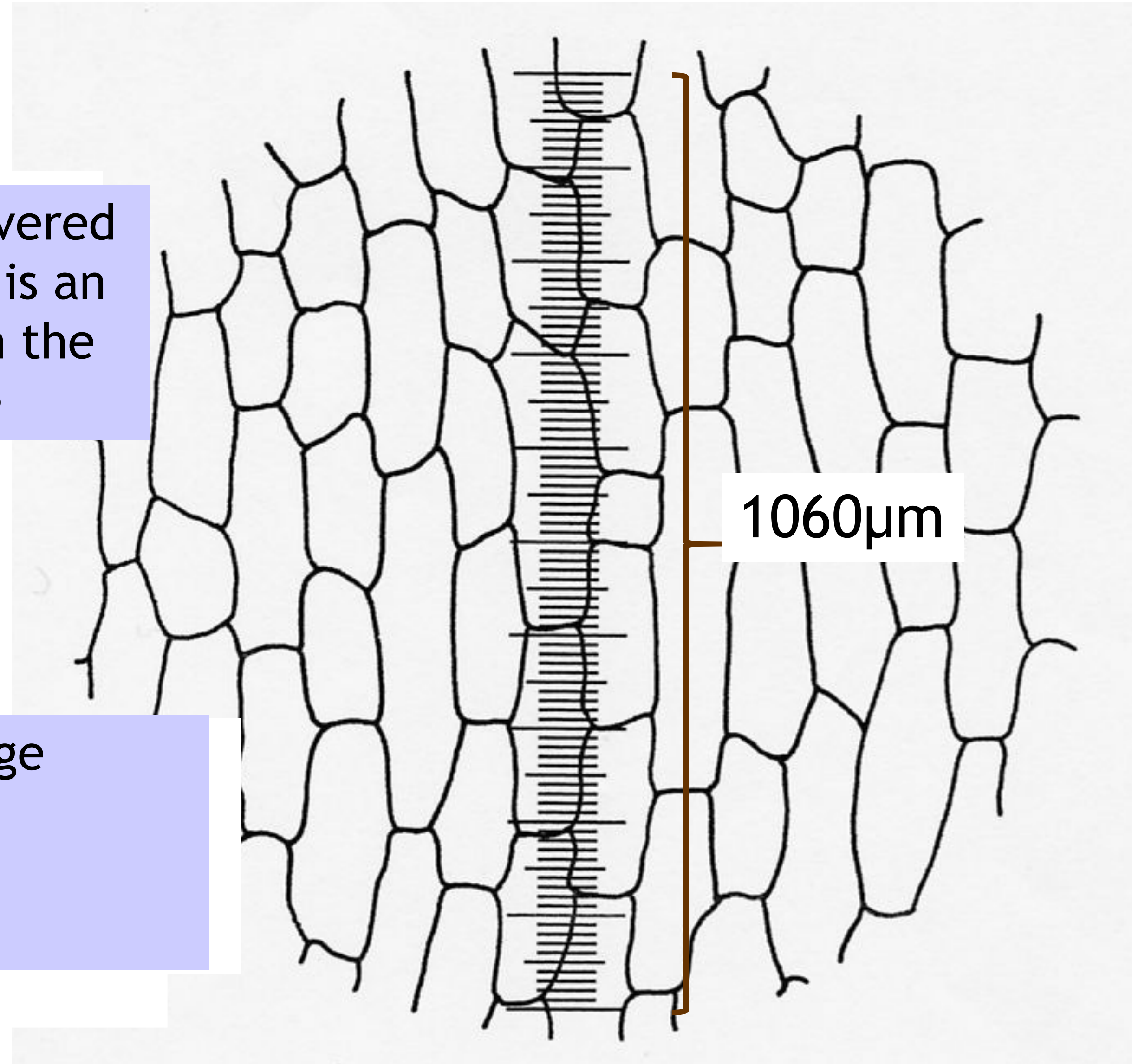


Figure 4.1
Cells of onion epidermis as viewed at x100 magnification with a graticule in the eyepiece of the microscope



In the two columns covered by the graticule there is an average of five cells in the length of the graticule

Therefore the average length of **one cell** is
1060 ÷ 5 = **212µm**

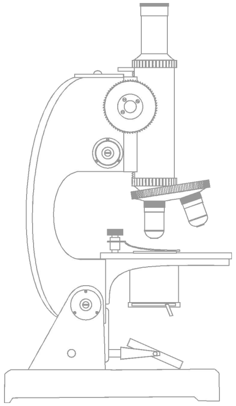
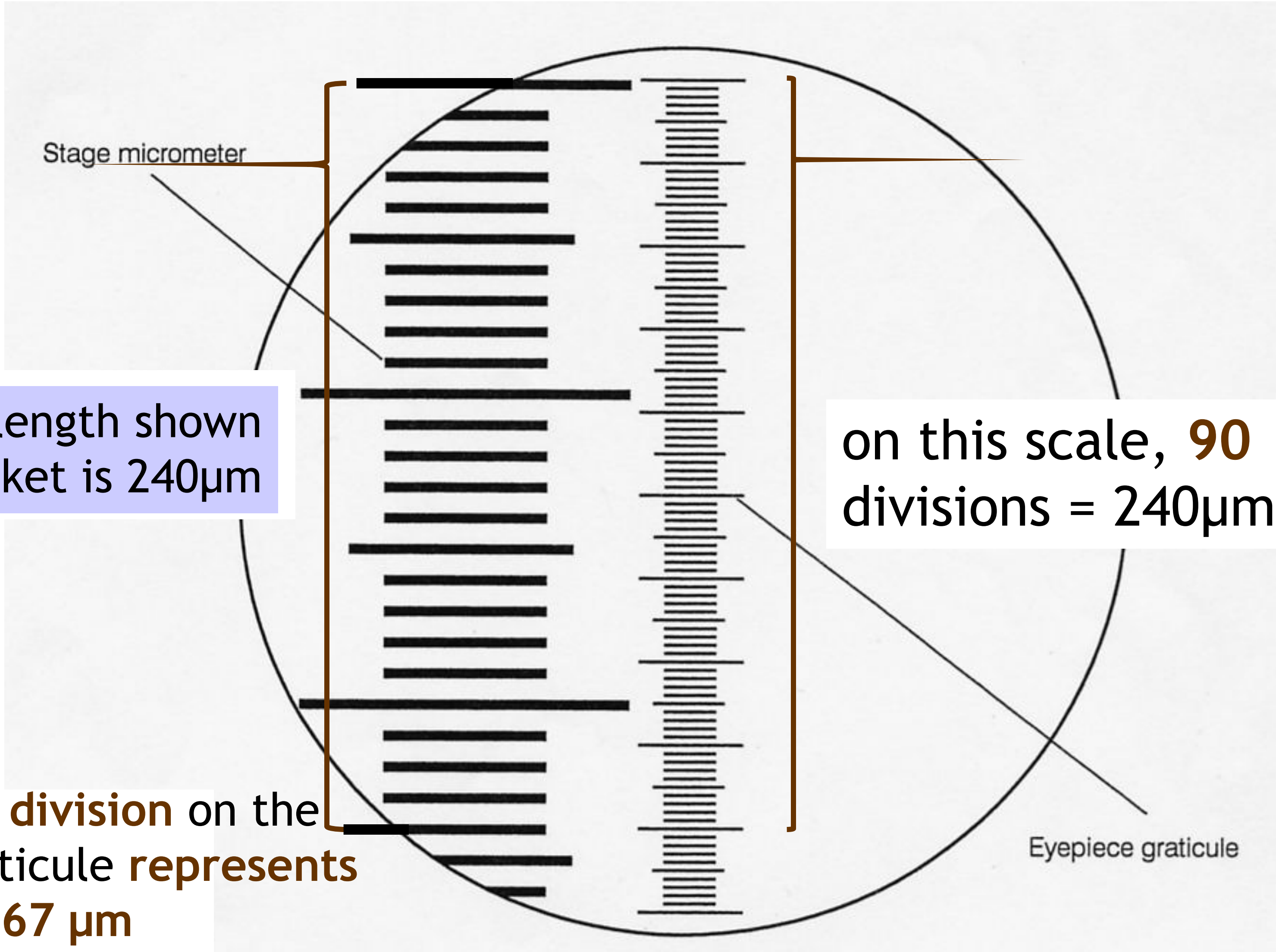


Figure 4.4
Part of the stage micrometer viewed at x400 magnification



so the length shown by the bracket is 240µm

on this scale, **90** divisions = 240µm

Therefore, **1 division** on the eyepiece graticule **represents** 240 ÷ 90 = **2.67 µm** *at this magnification.*

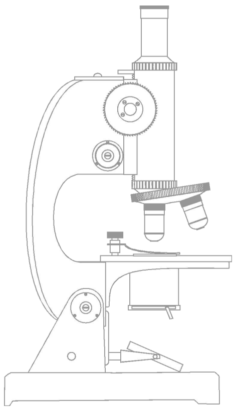
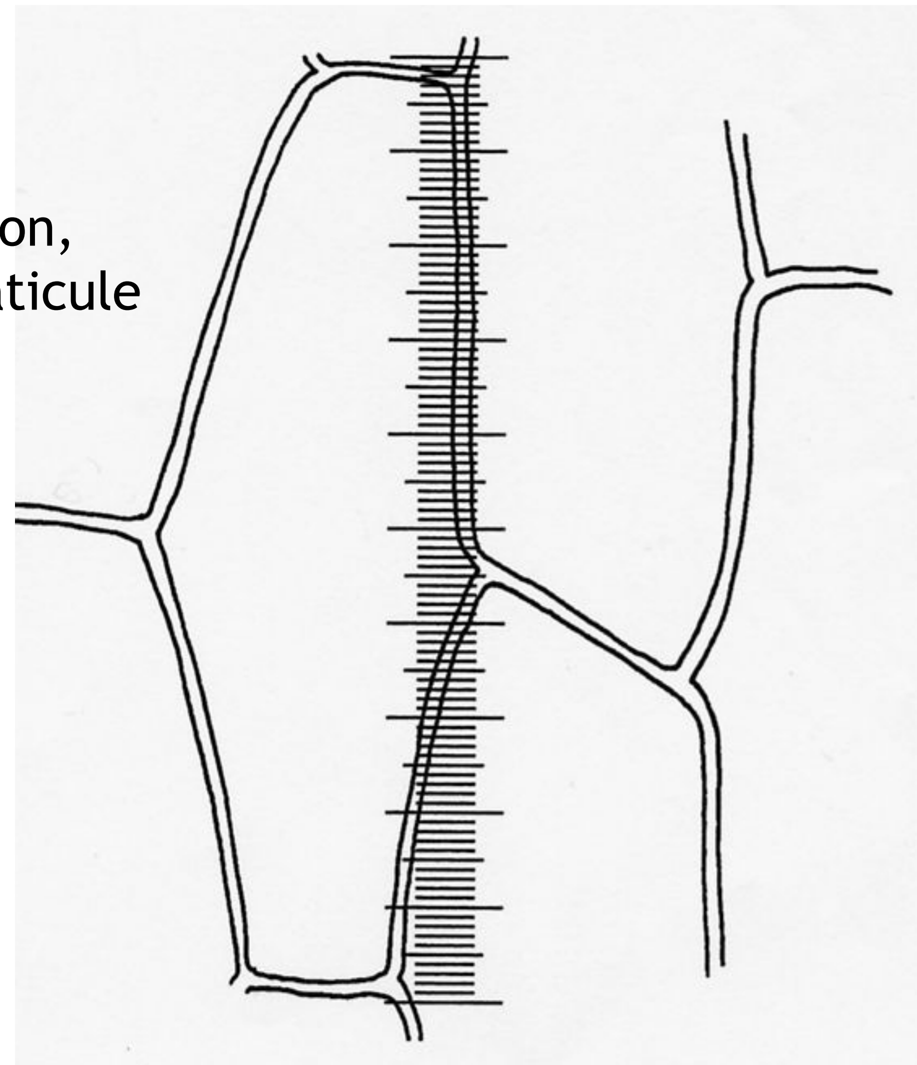
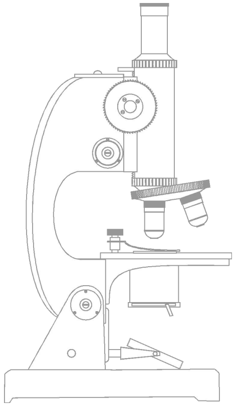


Figure 4.2
Cells of onion epidermis as viewed at x400 magnification with the same graticule in the eyepiece



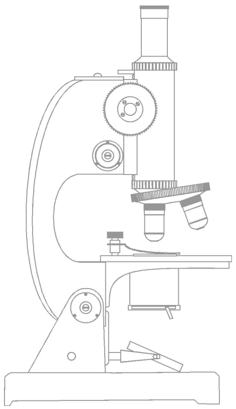
We know that at this magnification, each division of the eyepiece graticule represents 2.67μm

The length of the cell covered by the graticule is 98 divisions, therefore the length of this cell is 2.67 x 98 = **262μm**



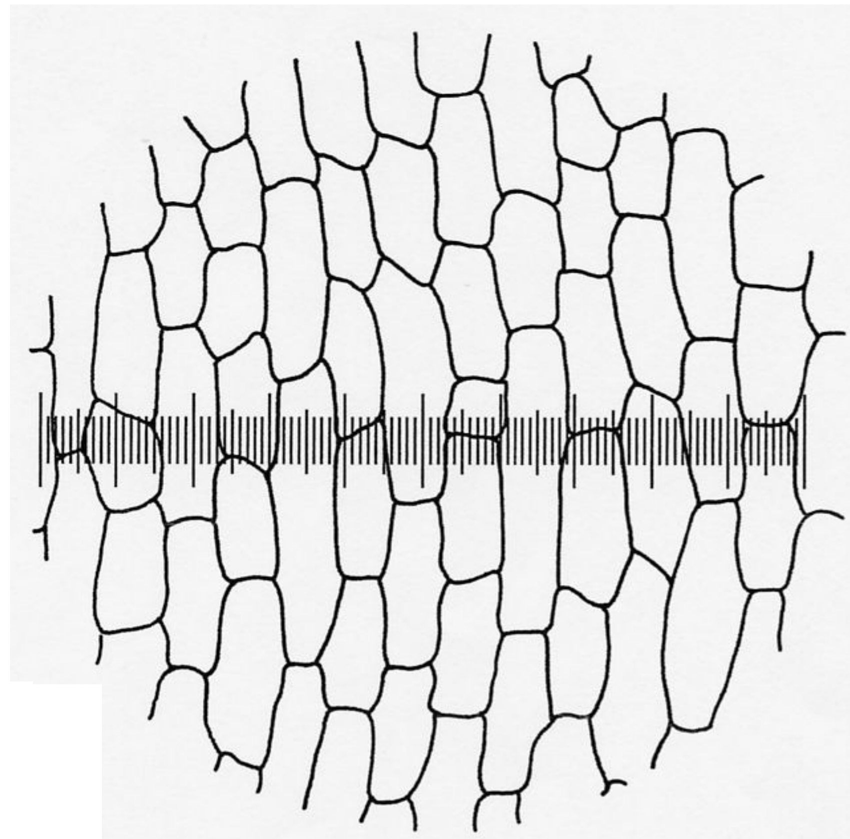
We now have two measurements for the length of an onion cell; 212μm and 262 μm.
Which of these is the more accurate estimate of the length of onion epidermal cells?

- The answer from Q. 2 [212 μm]
- because this is a mean of several cells.
- Only one cell was measured in Q.3, and this one may not be representative.



Estimating cell width. Figure 4.5.
Cells of the onion epidermis as viewed at x100 magnification with a graticule in the eyepiece of the microscope

Remember the total length of the eyepiece graticule represents 1060µm at this magnification



There are approximately thirteen cells in the length of the graticule

Therefore the average width of **one cell** is
1060 ÷ 13 = **81.5µm**

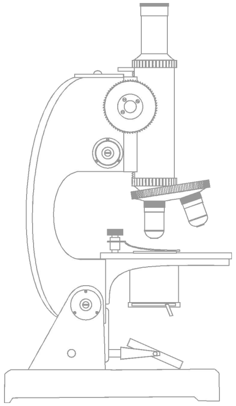
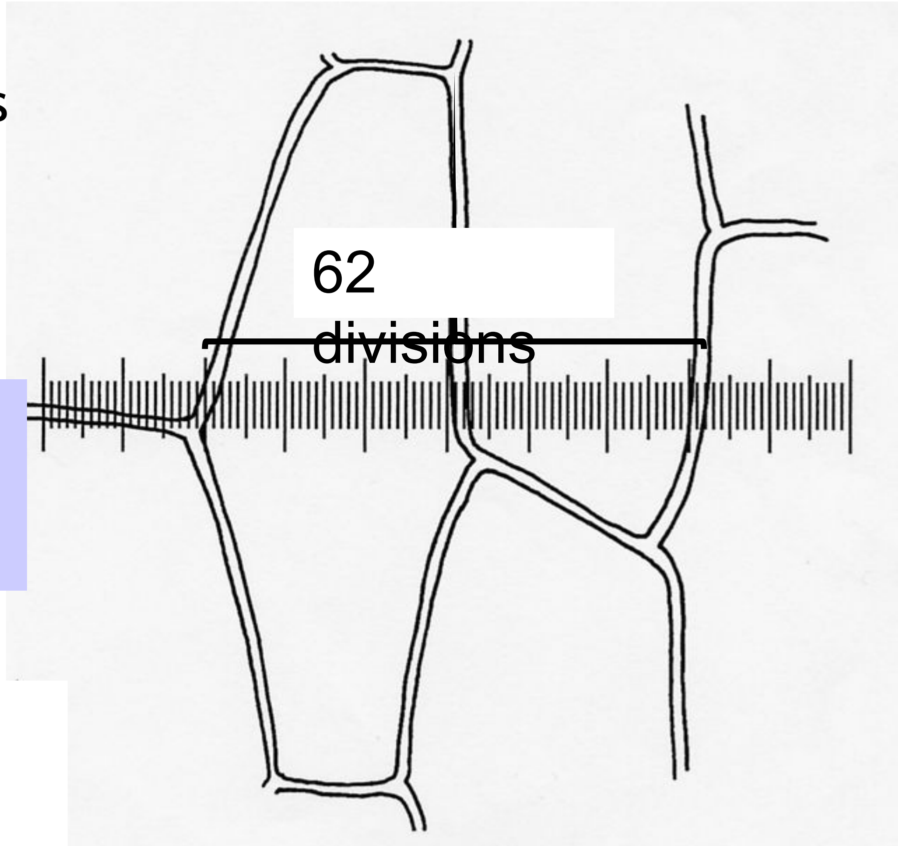


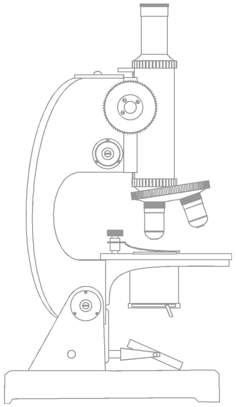
Figure 4.6.
Cells of the onion epidermis as viewed at x400 magnification with the same graticule in the eyepiece of the microscope

Remember, we know that at this magnification, each division of the eyepiece graticule represents 2.67µm



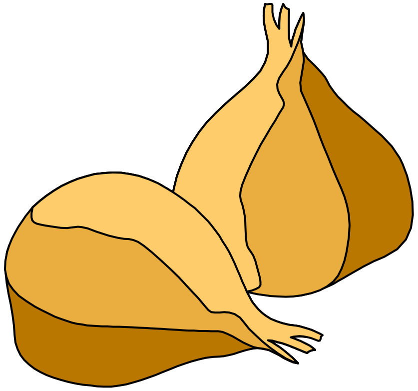
Here, two cells span 62 divisions on the eyepiece graticule. This represents 2.67 x 62 = 165.5 µm

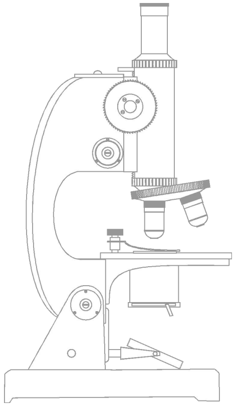
Therefore the average width of **one cell** is
165.5 ÷ 2 = **82.8µm**



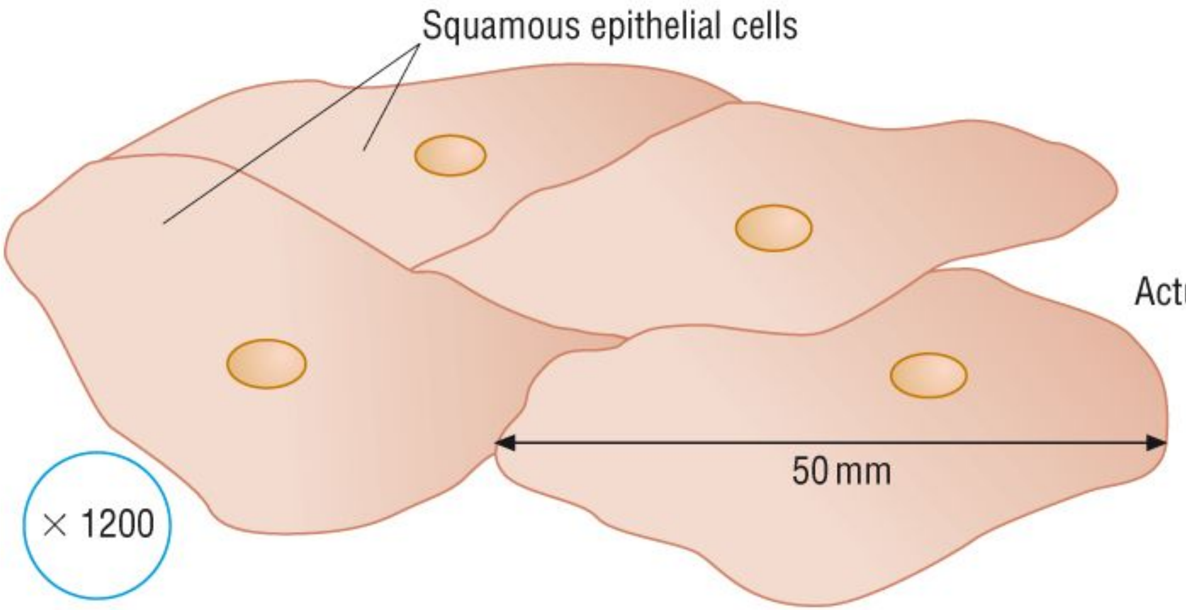
Comparison of estimates from Ws1 with those from Ws3

- The answers on Ws1 are means of several samples
- Whilst the answers on Ws3 are based on a single sample
- The variety of onion used may be different
- The samples may have come from onions at different stages of growth





Calculating actual size:

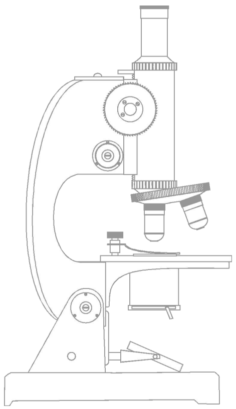


(I) Image size = 50 mm

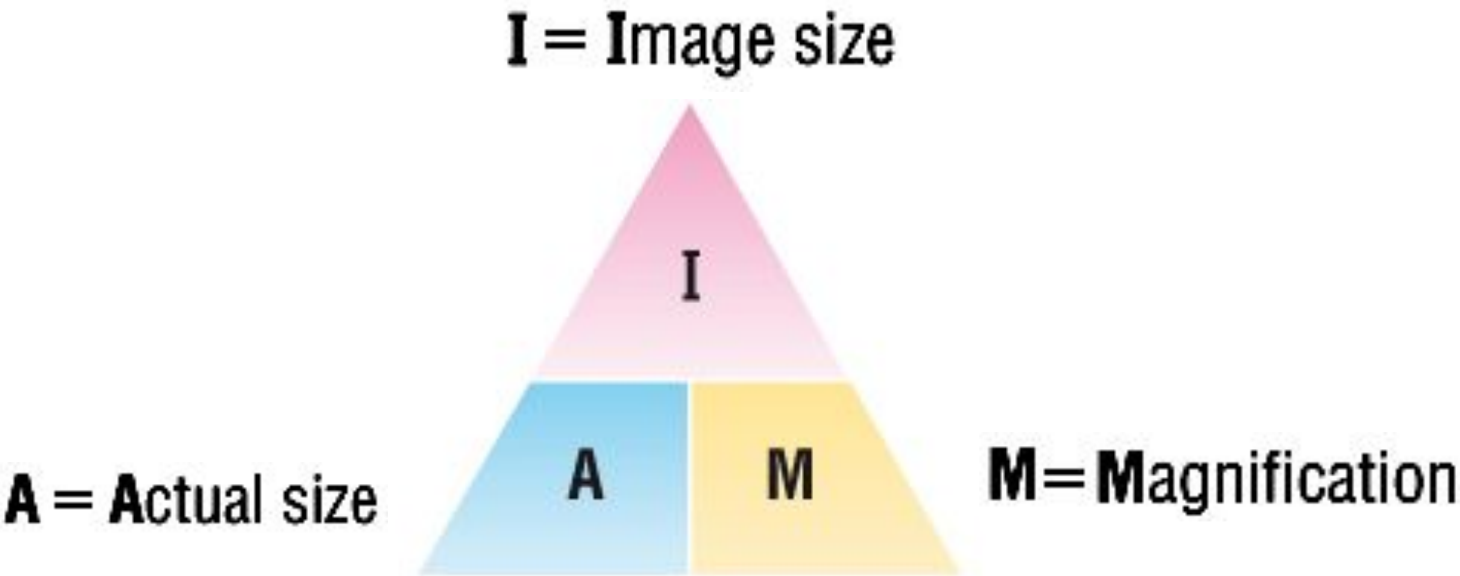
(M) Magnification = 1200

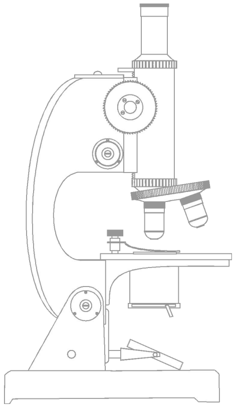
$$\text{Actual size} = \frac{I}{M} = \frac{50}{1200} = 0.0416\ \text{mm}$$

$$= 41.6\ \mu\text{m}$$

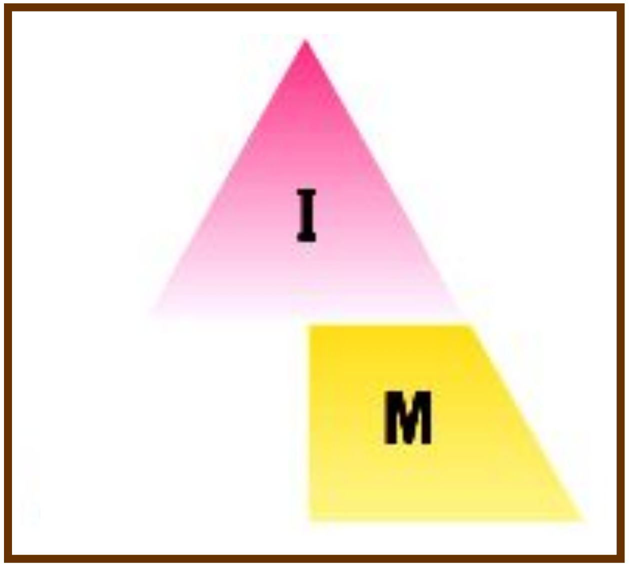


Calculating magnification & actual size:

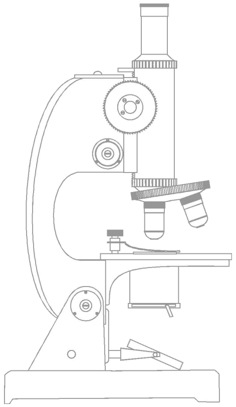




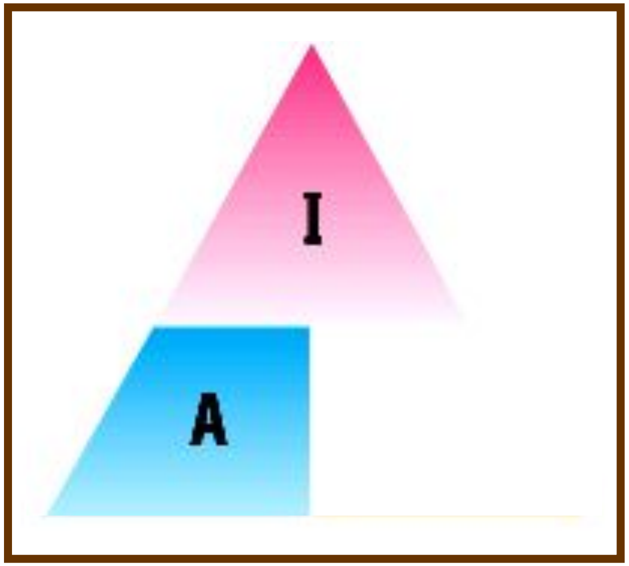
Calculating actual size:



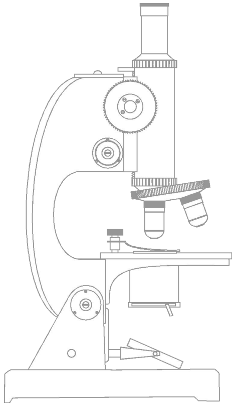
Actual size



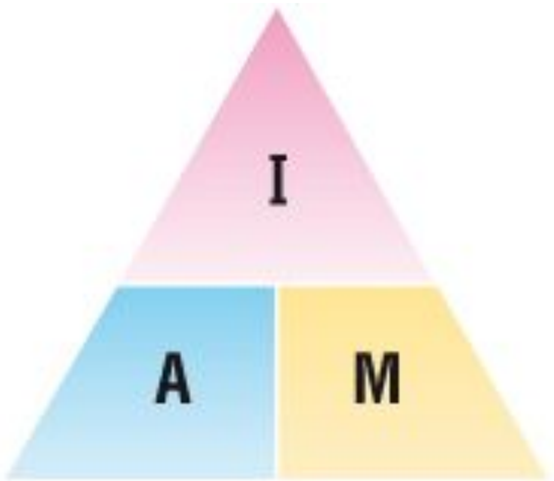
Calculating magnification:



Magnification

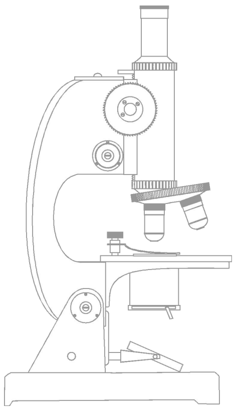


Calculating magnification & actual size:

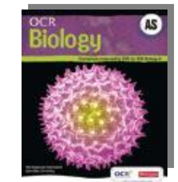


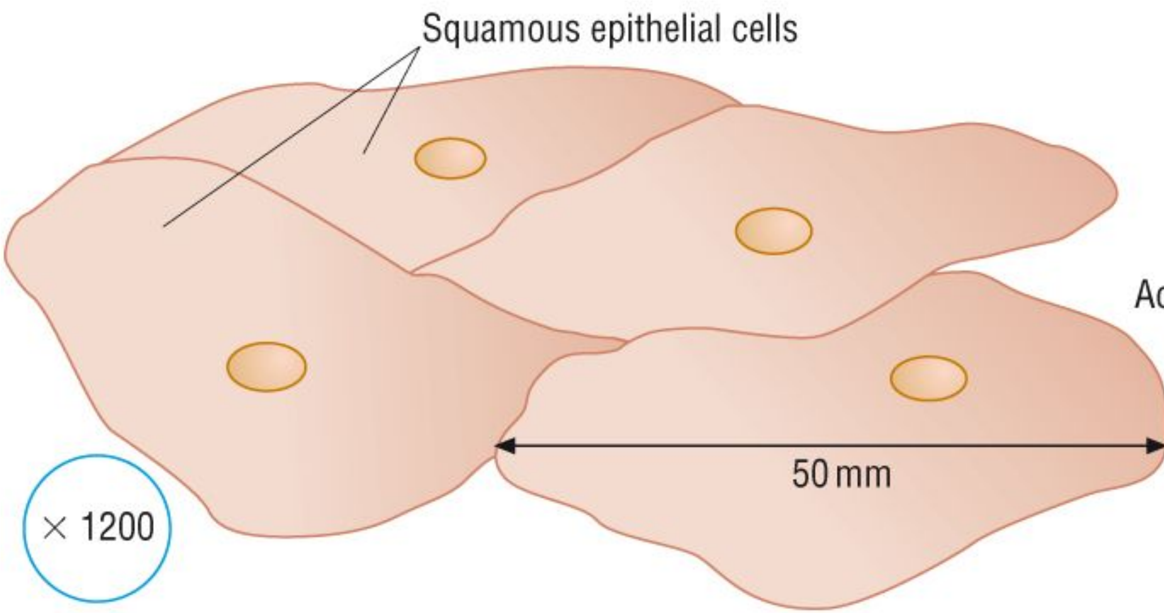
$$\textbf{A}\text{ctual size} = \frac{\textbf{I}\text{mage size}}{\textbf{M}\text{agnification}}$$

$$\textbf{M}\text{agnification} = \frac{\textbf{I}\text{mage size}}{\textbf{A}\text{ctual size}}$$



Calculating actual size:





(I) Image size = 50 mm
(M) Magnification = 1200

$$\text{Actual size} = \frac{I}{M} = \frac{50}{1200} = 0.0416\ \text{mm}$$
$$= 41.6\ \mu\text{m}$$