

Practical Booklet 1

Measuring cell size

Cambridge International AS & A Level

Biology 9700

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Introduction

Practical work is an essential part of science. Scientists use evidence gained from prior observations and experiments to build models and theories. Their predictions are tested with practical work to check that they are consistent with the behaviour of the real world. Learners who are well trained and experienced in practical skills will be more confident in their own abilities. The skills developed through practical work provide a good foundation for those wishing to pursue science further, as well as for those entering employment or a non-science career.

The science syllabuses address practical skills that contribute to the overall understanding of scientific methodology. Learners should be able to:

1. plan experiments and investigations
2. collect, record and present observations, measurements and estimates
3. analyse and interpret data to reach conclusions
4. evaluate methods and quality of data, and suggest improvements.

The practical skills established at AS Level are extended further in the full A Level. Learners will need to have practised basic skills from the AS Level experiments before using these skills to tackle the more demanding A Level exercises. Although A Level practical skills are assessed by a timetabled written paper, the best preparation for this paper is through extensive hands-on experience in the laboratory.

The example experiments suggested here can form the basis of a well-structured scheme of practical work for the teaching of AS and A Level science. The experiments have been carefully selected to reinforce theory and to develop learners' practical skills. The syllabus, scheme of work and past papers also provide a useful guide to the type of practical skills that learners might be expected to develop further. About 20% of teaching time should be allocated to practical work (not including the time spent observing teacher demonstrations), so this set of experiments provides only the starting point for a much more extensive scheme of practical work.

Guidance for teachers

Aim

To prepare temporary slides of plant tissue to measure the size of the cells using an eyepiece graticule and stage micrometer.

Outcomes

Syllabus learning objective 1.1 (c)

use an eyepiece graticule and stage micrometer scale to measure cells and be familiar with units (millimetre, micrometre, nanometre) used in cell studies

Skills included in the practical

AS Level skills	How learners develop the skills
MMO collection	Using different methods to measure the size of cells
PDO recording	Recording quantitative data in a table
ACE analysis	Calculating a mean
PDO display	Showing all the steps in their calculations
ACE evaluation	Deciding which method provides the most accurate results and therefore develop an understanding of how modifying a procedure can increase accuracy

Method

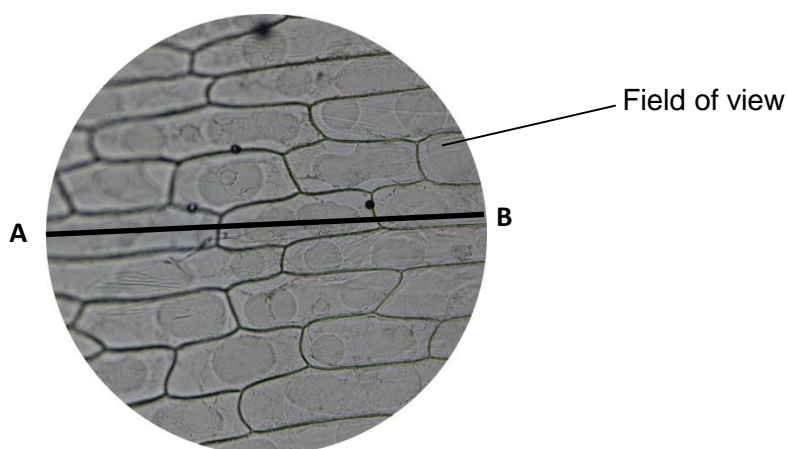
In preparation for this practical learners should have a basic understanding of how to use a light microscope. There are two experiments to measure the size of onion cells under a light microscope, the first using a ruler, the second using a stage micrometer and eye piece graticule.

Safety glasses must be worn when preparing the slide.

Experiment 1: Measuring the size of onion cells using a ruler on the stage.

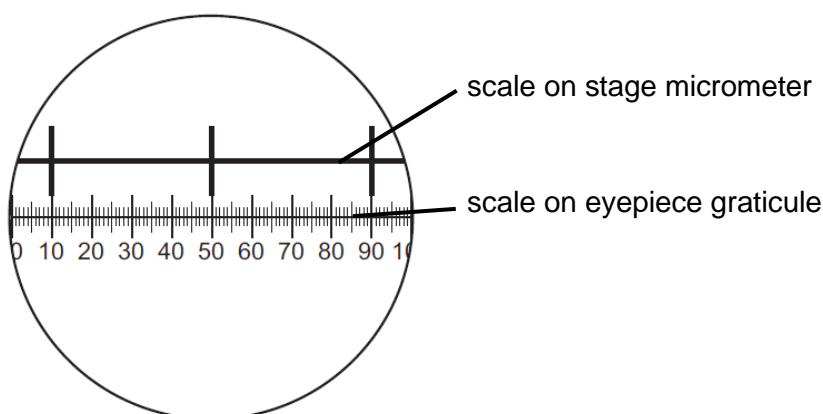
- Learners make slides of onion epidermis stained with iodine and view these under a light microscope using low power. They can identify the cell wall and other visible organelles such as the nucleus.
- They will count the number of cells across the field of view of their microscope from one side to the other. For example between points **A** and **B** on the photomicrograph below.
- This exercise should be repeated a number of times, viewing different areas of the slide to obtain an average number of cells.
- The slide is removed from the microscope and a transparent ruler is now placed onto the stage of the microscope. Learners will measure the diameter of the field of view in mm, using the same magnification that was used to view the cells.

Guidance for teachers, *continued*



Experiment 2: Measuring the size of onion cells using a stage micrometer and eye piece graticule.

- Learners will now use an eyepiece graticule to measure the length of the cells.
- A stage micrometer should be used to calibrate the eyepiece graticule. This can be done as explained in the following example.



- The diagram shows a stage micrometer, with divisions 0.1 mm apart, viewed through an eyepiece containing a graticule. There are 40 divisions of the eyepiece graticule in every division of the stage micrometer, so each division of the eyepiece graticule is 0.0025 mm or 2.5 μm .
- The eyepiece graticule can then be used to measure individual cells in the field of view. Learners need to sample the slide and take measurements from different areas of the slide. The need for a large sample size should also be emphasised.

Guidance for teachers, *continued*

Results

Experiment 1: Measuring the size of onion cells using a ruler on the stage.

- The raw results from the experiment are recorded in a table.

Sample	Number of cells across the diameter of the field of view
1	
2	
3	
4	
5	

Experiment 2: Measuring the size of onion cells using a stage micrometer and eye piece graticule.

- The raw results from the experiment are recorded in a table. At this stage, the units are in epu (eyepiece graticule units).

Sample	Length of cell / epu
1	
2	
3	
4	
5	

Interpretation and evaluation

Experiment 1: Measuring the size of onion cells using a ruler on the stage.

- Learners can calculate the length of one onion cell by dividing the diameter of the field of view by the number of cells they have counted.
- The length of the onion cells can be converted from millimetres into micrometers which is a more suitable unit of measurement for cell studies.

Sample	Number of cells across the diameter of the field of view	Length of 1 cell / mm	Length of 1 cell / μm
1			
2			
3			
4			
5			

- This method is inaccurate as it is based on the assumption that each onion cell is the same length – this can be discussed. This error can be reduced by collecting a large number of results and calculating a mean length of the onion cells. This could be done as a class activity. Learners should be encouraged to show how they calculated the mean length by showing every step in the calculation.
- The idea of raw results (the number of cells and the diameter of the field of view) and processed results (the length of the cells and the mean length) can be introduced.

Guidance for teachers, *continued*

Experiment 2: Measuring the size of onion cells using a stage micrometer and eye piece graticule.

- Learners use the calibration of their eyepiece graticule to calculate the actual length of each cell. They should be asked to show all the steps in one of their calculations.

Sample	Length of cell / epu	Length of cell / μm
1		
2		
3		
4		
5		

- The two methods used to measure the length of the cells can be evaluated and a conclusion drawn about which method provides the most accurate results.
- The eyepiece graticule method is not reliant on the assumption that all the cells are equal size, and will almost certainly confirm that this assumption is incorrect, and therefore it is a more accurate method. The divisions on the eyepiece graticule are finer than those of the ruler allowing more accurate results to be collected.

Information for technicians

Each learner will require:

- Microscope with eyepiece graticule inserted
- 1 × piece of onion
- 1 × white tile
- 1 × knife
- 1 × forceps
- 1 × glass slide
- 1 × cover slip
- iodine in potassium iodide solution, labelled **iodine solution [H]**
- 1 × dropping pipette (teat)
- 1 × piece of filter paper or paper towel
- 1 × mounted needle
- 1 × transparent ruler
- 1 × stage micrometer
- Safety glasses

Hazard symbols

C = corrosive substance

F = highly flammable substance

H = harmful or irritating substance

O = oxidising substance

N = harmful to the environment

T = toxic substance

Worksheet

Aim

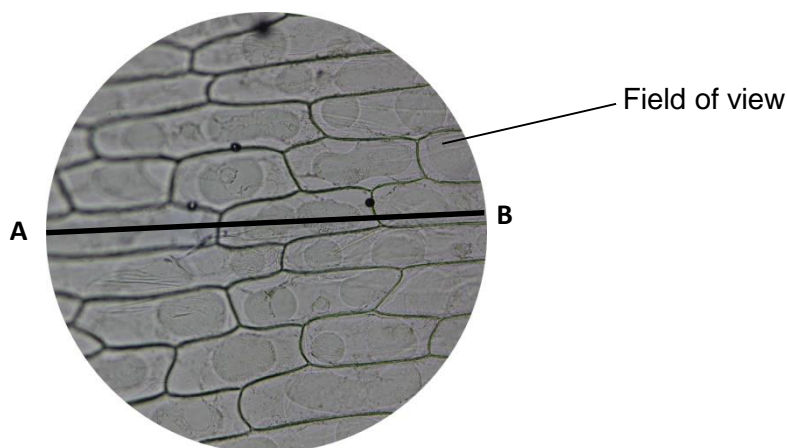
To prepare temporary slides of plant tissue in order to measure the size of the cells using an eyepiece graticule and stage micrometer.

Method

Safety glasses must be worn when preparing the slide.

Experiment 1: Measuring the size of onion cells using a ruler on the stage.

1. Prepare a slide of onion epidermis stained with iodine solution.
2. View the slide under a light microscope using low power.
3. Count the number of cells observed across the field of view from one side to the other. For example, on the photomicrograph below, this would be between points **A** and **B**. Record your results.

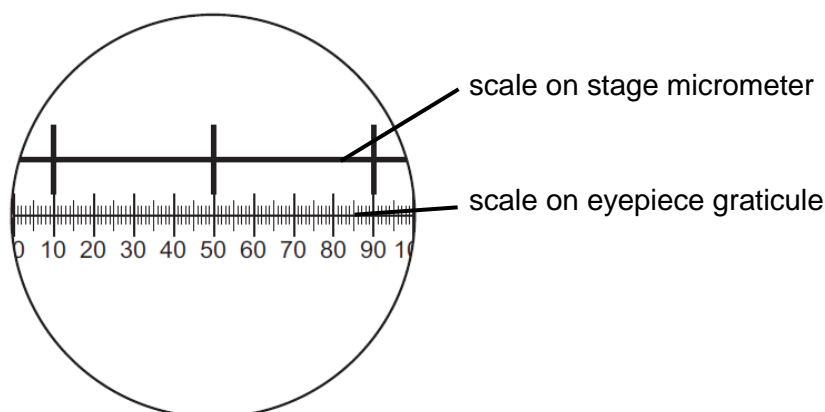


4. Repeat step **3** several times, viewing different areas of the slide to obtain a mean number of cells.
5. Remove the slide from the microscope and put to one side. You will need it during Experiment 2.
6. Place a transparent ruler onto the stage of the microscope.
7. Use the ruler to measure the diameter of the field of view in mm. Record your result. Ensure the same magnification is used as in Experiment 1.

Experiment 2: Measuring the size of onion cells using a stage micrometer and eye piece graticule.

8. Place the stage micrometer on the stage of the microscope. You must calibrate the stage micrometer using the eyepiece graticule. Use the example below to help you calibrate your micrometer.

Worksheet, *continued*



The diagram shows a stage micrometer, with divisions 0.1 mm apart, viewed through an eyepiece containing a graticule. There are 40 divisions of the eyepiece graticule in every division of the stage micrometer, so each division of the eyepiece graticule is 0.0025 mm or 2.5 μm .

9. Remove the stage micrometer from the microscope.
10. Place your prepared slide back onto the stage of the microscope. Use your eyepiece graticule to measure the length of an individual cell. Record your result.
11. Repeat step **10** several times, viewing different areas of the slide to obtain a mean length of cell.

Results

Record your results in the tables provided.

Experiment 1: Measuring the size of onion cells using a ruler on the stage.

Sample	Number of cells across the diameter of the field of view
1	
2	
3	
4	
5	

Diameter of field of view _____ mm

Worksheet, *continued*

Experiment 2: Measuring the size of onion cells using a stage micrometer and eye piece graticule.

Sample	Length of cell / epu
1	
2	
3	
4	
5	

Interpretation and evaluation

Experiment 1: Measuring the size of onion cells using a ruler on the stage.

- Calculate the length of one onion cell by dividing the diameter of the field of view by the mean number of cells you observed. Convert your answer from mm to μm . Record your results in the table below.

Sample	Number of cells across the diameter of the field of view	Length of 1 cell / mm	Length of 1 cell / μm
1			
2			
3			
4			
5			

- Is this an accurate method for measuring the length of onion cells?
- Pool your results with the rest of your group and calculate a mean length of onion cell.

Experiment 2: Measuring the size of onion cells using a stage micrometer and eye piece graticule.

- Use the calibration of your eyepiece graticule to calculate the actual length of each cell. Show all the steps in one of your calculations. Record your results in the table below.

Sample	Length of cell / epu	Length of cell / μm
1		
2		
3		
4		
5		

- Which method provides the most accurate result? Evaluate both methods.

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