# Lesson Element

# Comparing light and electron microscopes

## Instructions and answers for teachers

These instructions cover the learner activity section which can be found on [page 7](#_Learner_Activity). This Lesson Element supports OCR GCSE (9–1) Gateway Science Biology A and the Twenty First Century Science Biology B qualifications.

**When distributing the activity section to the learners either as a printed copy or as a Word file you will need to remove the teacher instructions section.**

### Mapping to specification level (Learning outcomes)

**GCSE (9–1) Gateway Science Biology A/Combined Science A**

B1.1a describe how light microscopes and staining can be used to view cells

B1.1c explain how electron microscopy has increased our understanding of sub-cellular structures

**GCSE (9–1) Twenty First Century Science Biology B/Combined Science B**

B1.1.1 b describe how to use a light microscope to observe a variety of plant and animal cells

B2.4.1 b describe how to use a light microscope to observe microorganisms

B3.2.5 b describe how to use a light microscope to observe the structure of the xylem and phloem

B3.2.6 b describe how to use a light microscope to observe the structure of stomata

B4.2.1 explain how electron microscopy has increased our understanding of sub-cellular structures

B4.3.1 b describe how to use a light microscope to observe stages of mitosis

### Introduction

This activity is designed to be used as a consolidation tool for the light microscope. This activity will introduce electron microscopes. The relative advantages, disadvantages and uses of each microscope will be studied. The term resolution will be introduced and explained using a very simple activity.

**Prior Knowledge**

At Key Stage 3 learners should have been introduced to cells as the basic units of life. They will also have been introduced to simple methods to magnify samples (hand lens, microscopes, bioviewers etc).

**Misconceptions**

Learners often can mis-calculate the magnification of a light microscope. They can add the objective and eyepiece lens together rather than multiply together.

There is often confusion between mm, μm and nm; particularly with respect to the scale.

**Extension activity**

There is an extension activity at the end of the sheet to apply the learners knowledge and to evaluate their effectiveness in a novel situation.

### Running the activity

The PowerPoint activity could be done as a presentation, with break outs in small groups to do the various activities. Learners could work individually or in pairs.

* At the end of the PowerPoint there is a quiz to check learners’ understanding.
* The resolution sheet would need to be printed out and stuck to a suitable wall that would allow learners to walk towards the sheet and mark how far away from the sheet it is when they could resolve two lines. The learners could mark their position on the floor with a named label.
* A worksheet has been provided to check learners understanding of the topic.

### Activity answers

* How much bigger the image of a sample is relative to its actual size
* Mathematically: magnification = the size of the image of a sample ÷ the actual size of the sample
* A magnification of 400x means that the image is 400x bigger than the actual object

Magnification is:-

Resolution is:-

* The ability of a microscope to distinguish two separate items
* The shortest distance between two objects that can be distinguished by an observer as separate entities
* The clarity of a magnified object

Complete the following table

|  |  |  |
| --- | --- | --- |
|  | **Light microscope** | **Electron microscope** |
| Magnification | High (1500x, although school microscopes go to ~400x) | Very high (500,000x) |
| Resolution | Low (250nm) | High (0.25nm) |
| Type of radiation used | Light | Electron beam |
| Focussed by | Optical/glass lenses | Electromagnet lenses |
| Type of material that can be viewed | Living/moving/dead/abiotic | Dead/abiotic |
| Size of microscope | Small and portable | Large and static |
| Preparation and cost of material | Cheap and easy. May require staining to increase contrast or define specific organelles | Difficult and expensive. Time consuming (requiring trained scientists/technicians). May require staining with electron dense stains |

Put these in size order starting with the biggest (numbering 1-9)

|  |  |  |
| --- | --- | --- |
| **Organelle** | **Size** | **Order** |
| Cilia | 10 µm | **5** |
| Mitochondrion | 2 µm | **7** |
| Sperm cell | 55 µm | **4** |
| Ribosome | 20nm | **9** |
| Human kidney | 13cm | **2** |
| Nerve cell from a giraffes neck | 3m | **1** |
| Red blood cell | 9 µm | **6** |
| HIV virus | 100nm | **8** |
| Human egg | 100µm | **3** |

Convert the following:-

|  |  |  |
| --- | --- | --- |
|  | **Convert** | **Units** |
| 10mm = | 10,000 | µm |
| 3mm = | 3,000 | µm |
| 670 µm = | 0.67 | mm |
| 0.75mm | 750 | µm |
| 24 µm = | 24,000 | nm |
| 186nm = | 186,000 | µm |

A light microscope is good for:-

* Looking at samples quickly – relatively quick sample preparation time
* Looking at living samples
* Looking at samples in the field rather than in a laboratory
* High magnification at a relatively inexpensive price – higher magnification than a hand lens, less expensive than an electron microscope
* Colour images
* Sample is relatively undistorted

An electron microscope is good for:-

High magnification

High resolution

A scanning electron microscope is good for?

High magnification

High resolution

Looking at the 3D image of an object

### Stretch and challenge:-

What have we learnt using electron microscopes to help biology and medicine?

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Ultrastructure of the cell – the discovery of additional organelles

Observation of DNA e.g. circular structure of bacterial DNA and plasmids

Cell-to-cell interactions – bacterial conjugation/cell-to-cell signalling

Structure of viruses

Host/virus interaction – e.g. bacteriophages

Discovery of new pathogens – e.g. Prion/viroid

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## Learner Activity

### Resolution

 How close do you have to be to the paper before you can see two lines rather than one?

|  |  |
| --- | --- |
|   |  |

Magnification is:-

Resolution is:-

Complete the following table

|  |  |  |
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| Focussed by |  |  |
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An electron microscope is good for:-

A scanning electron microscope is good for?

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