Life Sciences

CLASS TEXT & STUDY GUIDE

Liesl Sterrenberg, Helena Fouché & Grace Elliott

GRADE

10

CAPS

3-in-1

THE ANSWER SERIES
Your Key to Exam Success

Grade 10 Life Sciences 3-in-1 CAPS

CLASS TEXT & STUDY GUIDE

This Grade 10 Life Sciences 3-in-1 study guide enables you to understand the basic concepts of the Grade 10 curriculum and creates a strong foundation for success in Grades 11 and 12. The subject material is organised into logical easy-to-understand units and sections which simplify the curriculum content.

Key Features:

- Comprehensive, learner-friendly notes per module
- Carefully selected, graded questions and answers per module
- 'Rapid-fire' questions for key concepts and terms
- Clear, explanatory diagrams
- Up-to-date, relevant material

This study guide will stimulate your understanding of Life Sciences and, as you work through the material, boost your exam performance.

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THIS CLASS TEXT & STUDY GUIDE INCLUDES

1. Notes
   - Life at the Molecular, Cellular and Tissue level
   - Life Processes in Plants and Animals
   - Environmental Studies
   - Diversity, Change and Continuity
2. Questions and Rapid Fire Questions
3. Detailed Memos

REVISED EDITION

E-book available

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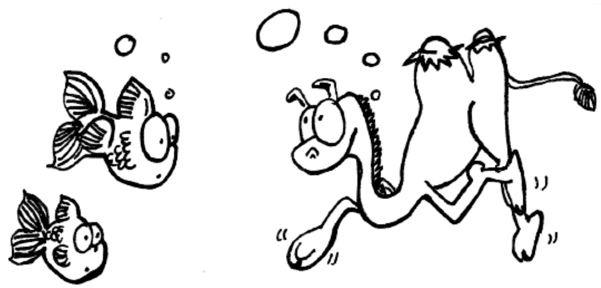


Ensuring Meaningful Results

The following aspects must be considered to ensure your results answer the investigative question and are meaningful.

1 validity 2 reliability 3 accuracy

NOTE

*Although **validity** and **reliability** are the most important aspects, **accuracy** is included with a brief explanation to ensure a comprehensive list of aspects that ensure meaningful results. Fair testing and precision are other aspects that also affect the validity and reliability of results, but they are not discussed in this curriculum.*

1 Validity

Validity refers to **experimental method/scientific process** and if it appropriately addresses the aim of the investigation, i.e. a test is valid if it measures what it claims to measure.

NOTE

*Validity tests: **HOW** the experiment is performed.*
Remember *the **V**: **HOW** are **V**ariables controlled?*

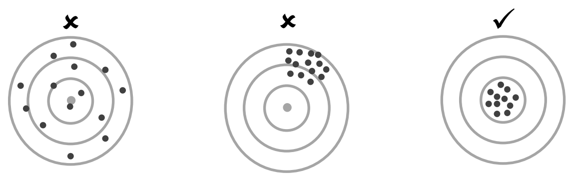
To ensure that results are valid:

- test only **one variable** (the independent variable) at a time
- identify the controlled/fixed variables and keep them constant
- choose an appropriate design for the experiment

NOTE

*An experimental **control group** contributes to the validity of an investigation. It eliminates the effect of other variables. The **control** has exactly the **same set-up** as the experiment except the **factor being investigated is excluded**, i.e. no treatment is given to the control group.*

***Validity** may be illustrated in throwing darts.*
*The centre 'bull's eye' is what you aim to achieve in the experiment. If darts (results) are off the target – the results are not valid / less valid. If darts are all near the target/centre/bull's eye – then the results are considered **valid**.*



Low validity **Low validity** **High validity**

2 Reliability

TERMS

***reliability:** the degree of the consistency and repeatability of an experiment*

A **reliable** experiment has results which can be obtained **consistently**.

To ensure that results are reliable:

- **repeat** the experiment and obtain consistent and significant results (within an acceptable margin of error)
- increase the sample size to ensure a more accurate **average** that can be generalised to a larger group with more certainty
- take **many readings** and use the average
- select a **random sample**

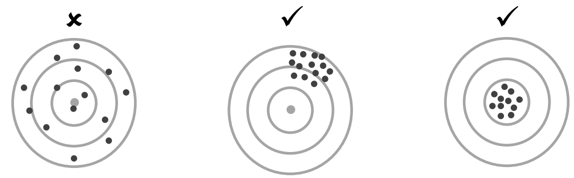
NOTE

Reliability:
*Remember the **R's***
- ***R**epeat the investigation*
- ***R**aise the sample size*
- ***R**eadings - take more*
- ***R**andom sampling*

*An experiment with 100 plants is reliable. But an experiment with 200 plants is **more reliable**.*

Ensure that other researchers will be able to perform exactly the same experiment, under the same conditions, and generate the same results. Consistent results from the same experiment will reinforce the findings of the experiment and ensure acceptance of the hypothesis by the wider scientific community.

***Reliability** may be illustrated in throwing darts. If darts (results) consistently hit the same number and are close together, this is considered a **reliable result**. If darts hit different numbers / a wide range of numbers, this would be considered an unreliable result.*



Low reliability **High reliability** **High reliability**

*Check the **context** of questions on **reliability** and **validity**. If the question refers to:*

- *the **past***
  → the answer will be provided in the question
- *the **future***
  → the answer must be determined from the data provided

*'what was **already done** in the investigation'*

*'what **should be done** in the investigation'*

3 Accuracy

Accuracy refers to the care taken by the investigator in making measurements.

To ensure that results are accurate:

- use appropriate apparatus
  i.e. use a measuring tape, not a ruler, to measure a person's height
- make sure apparatus is correctly calibrated
  i.e. 1 gram on a scale is actually 1 gram on any calibrated scale

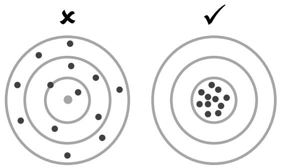
NOTE

__Validity__ and __reliability__ are often asked in exam questions. __Accuracy__ is not often referred to, as it is taken for granted that the investigator will take care in making measurements.

Human error in misreading measurements as well as **faulty apparatus** contribute to inaccurate results.

__Accuracy__ may also be illustrated in throwing darts.

If darts (results) are off the target – the results are inaccurate – they are not the true value. If darts are all near the target/centre/bull's eye – then the results are considered __accurate__.



SUMMARY

To ensure meaningful results:

- only change the independent variable (**validity**)
- repeat as many times as possible, or increase your sample size, and take an average (**reliability**)
- ensure your equipment is properly calibrated and there is no human error in the testing (**accuracy**)

PRECAUTIONARY MEASURES

In every investigation there are steps that must be taken to ensure that the **design** of an investigation is correct. These include:

- safety measures to protect samples/subjects
- ethical studies to ensure investigation is legally and morally acceptable
- results that are recorded accurately

WORKED EXAMPLE OF SCIENTIFIC INVESTIGATION QUESTION

Lerato conducted an investigation to determine the effect of exercise on skin temperature. She asked 100 learners in her school to participate in the investigation. The sample consisted of 100 girls of the same age.
The investigation was conducted as follows:

- The learners were divided into two groups of 50 each (Groups A and B).
- The skin temperature was measured for all the participants.
- Group A was asked to run around the sports field for 10 minutes.
- Group B was asked to remain seated on the benches next to the field for 10 minutes.

After 10 minutes the skin temperature of all participants was measured and the average was calculated for each group (A and B).

HINT

Always keep a highlighter at hand when reading this type of question. Then you can underline the __aim__, __variables__, __sample size__ and other important information to simplify the answering of questions.

1. What is the value of a large sample to an investigation? (2)

It makes the results more ✓ reliable ✓

Remember the '__R__' for __r__eliability: __R__aise the sample size.

2. Complete the sentence by choosing the correct word between brackets.
   If Lerato had group A run for 10 minutes and group B sit for 1 hour next to the field, her experiment would be (more / less) valid. (1)

Less ✓

3. Explain your answer in Question 2. (2)

- *if the time for the two activities differed ✓*
- *it would introduce another variable ✓*
- *that could potentially influence the skin temperature ✓*
- *therefore you won't only be observing the effect of the activity ✓* (any two)

As soon as more than one factor is being tested at a time, the validity of the investigation decreases, because we cannot determine which variable is responsible for the change we observe. With validity we must always ask ourselves: 'Is the experiment measuring what it intended to measure?'

4. State the aim of Lerato's investigation. (2)

To determine the effect of exercise ✓ on the skin temperature. ✓

> *Always read carefully through the experimental setup. In this case the aim was given clearly in the first sentence.*

5. State a suitable hypothesis for Lerato's investigation. (2)

Exercise ✓ increases the skin temperature. ✓

> *Change the aim into a hypothesis by stating a relationship between the two variables. Remember this must be a statement.*

6. In this investigation, identify:
   - 6.1 the independent variable (1)
   - 6.2 the dependent variable (1)
   - 6.3 how the dependent variable was measured (1)

6.1 Exercise ✓

> *This is the variable that we manipulate that is different in the two groups. It is taken from the aim of the investigation: 'to determine the influence of **exercise** on the skin temperature'.*

6.2 Skin temperature ✓

> *The dependent variable is also drawn from the aim of the investigation: 'to determine the influence of exercise on the **skin temperature**.' The qualitative dependent variable differs from the quantitative way in which it was measured.*

6.3 In ºC ✓

> *This is the way in which we quantified the dependent variable (gave it a value).*

7. What are the expected results for the participants in group **A**? (1)

The skin temperature will increase. ✓

> *Use your general knowledge to answer this question.*

8. State **THREE** factors that Lerato kept constant during the investigation. (3)

> *This question is stated in the past. Therefore, you must look at what Lerato **already** did. Remember that validity relates to constant variables. Re-read the experimental setup to identify these variables.*
> *Because the question asks for **three** ways, only the first three answers will be marked, regardless of whether the 4th or 5th answers are correct.*

- *All the participants were girls / the same gender. ✓*
- *The same number of learners were divided into each group (50). ✓*
- *All the participants were the same age. ✓*
- *The same time was allocated for each exercise (10 minutes). ✓* *(any 3)*

9. State **TWO** other factors that Lerato should have kept constant during her investigation. (2)

> *This question refers to the future, so list factors that have not already been mentioned.*

- *investigations should take place on the same day ✓*
- *same time of day ✓*
- *same person taking measurements ✓*
- *same measuring apparatus ✓*
- *same fitness level in participants ✓* *(any 2)*

10. Which of the two groups (**A** or **B**) will release more sweat? (1)

Group A. ✓

> *Use your general knowledge to answer this question.*

11. What is the value of Lerato calculating an average temperature for each group of 50 girls? (1)

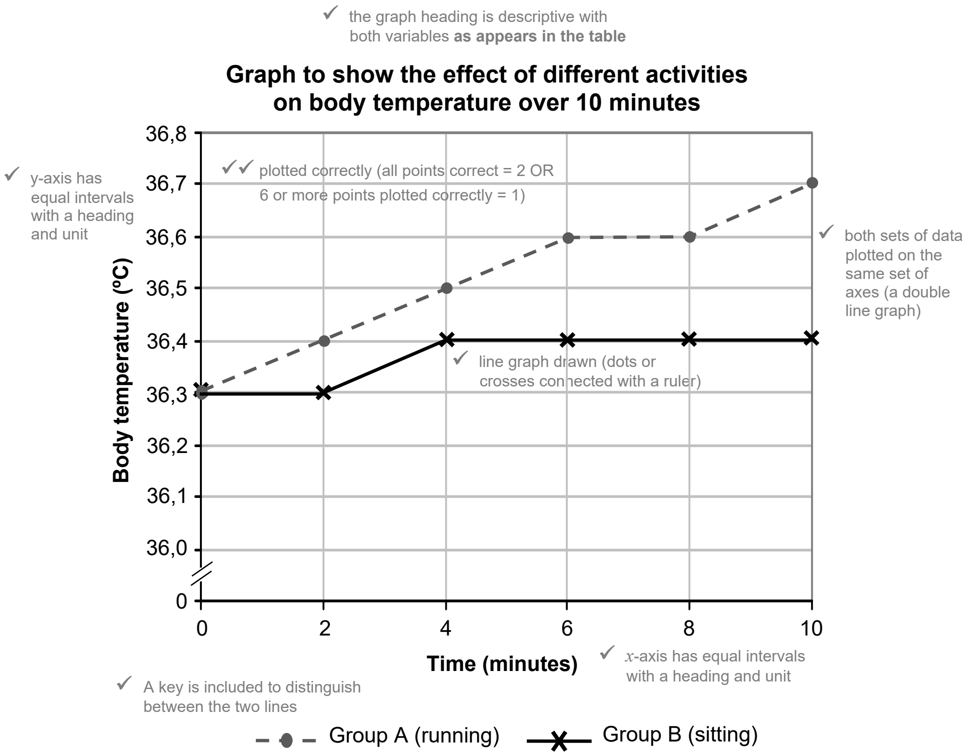
It makes the information more reliable. ✓

> *By calculating an average, you actually repeated the experiment with more than one person (a larger sample). Therefore, this is another way to ensure reliability in an experiment.*

12. In a similar study Megan recorded the change in body temperature of 100 girls in two similar groups to Lerato's experiment. The results of her investigation are shown in the table below. Draw a **line graph** with **both** sets of data on **one** axis to compare the results.

Time (minutes)	Change in body temperature (ºC)	
	Group A ran for 10 minutes	Group B sat for 10 minutes
0	36,3	36,3
2	36,4	36,3
4	36,5	36,4
6	36,6	36,4
8	36,6	36,4
10	36,7	36,4

(8)



REPRESENTING DATA

Criteria for presenting data:

1 Tables

- **Heading**
  - clearly states what the data represents
  - includes both the **independent** and the **dependent variables**
  - e.g.: A table to show the relationship between the *independent variable* and the *dependent variable* over a period of time

REMEMBER

*The **independent variable** is the variable that you control and may change during the experiment.*

*The **dependent variable** is the variable that is measured during the investigation and affected by the change in the independent variable.*

- **Rows** and **columns** are labelled with the relevant variable and the **unit** in brackets.
  - The independent variable is on the top / left side of the table / 1st column.
  - The dependent variable is on the bottom / right side of the table / 2nd column.
- If the independent variable is numerical, the values are arranged from the lowest to the highest.

Table to show heart rate over time before, during and after a race

NOTE
Tables may be represented in a vertical or horizontal format.

appropriate table heading that includes both independent and dependent variables

***bpm** = beats per minute*

Time (mins)	**Heart rate** (bpm)
0	70
5	82
10	120
15	136
20	118
25	102
30	70

independent variable | **dependent variable**

OR

Time (mins)	0	5	10	15	20	25	30
Heart rate (bpm)	70	82	120	136	118	102	70

units of variable in heading (not in the body of the table with recorded data)

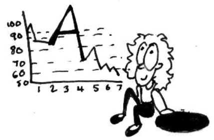
2 Graphs

- **Variables**
  - **independent variable**
    - labelled on the ***x*-axis**
    - values are manipulated (determined/controlled) by the investigator
  - **dependent variable**
    - labelled on the **y-axis**
    - data is measured by the investigator

NOTE

***Independent** variable – x-axis = manipulated variable*
***Dependent** variable – y-axis = measured variable*

- **Axes**
  - each axis must be labelled with the relevant **variable**
  - ***x*-axis** – independent variable
  - **y-axis** – dependent variable
  - appropriate **units** must be included after the variable name, e.g. Time (s) or Mass (kg)
  - axes must have the correct **scale** to maximise the space available
  - graphs should be large enough to read data easily i.e. approximately 10 lines or larger
- **Scale**
  - non-continuous data must be spaced at equal intervals on each axis
  - continuous data uses a scale that starts at 0 and increases at equal intervals
  - each variable has its own independent scale
  - the scale should maximise the space available on the axes
- **Heading**
  - all graphs must have a heading
  - clearly states what the data represents
  - includes both the independent and the dependent variables and the relationship between them



Line Graph

A line graph shows continuous **quantitative** (numerical) **data**, e.g. time, distance, mass, etc.

STEPS to draw a LINE GRAPH

1. Identify the independent and dependent **variables** from the data provided
2. Draw a set of **axes** (*x*-axis: independent variable & **y**-axis: dependent variable) with **labels** and **units**
3. Choose a **scale** for each axis with equal intervals that include lowest/ highest values and maximise the available space on the axes
4. **Plot points** where values from each axis meet on the graph

NOTE

*Data points are plotted using a cross (**x**) or a small dot (⊙) where the value from the dependent variable (y-axis) meets the value of the independent variable (x-axis).*

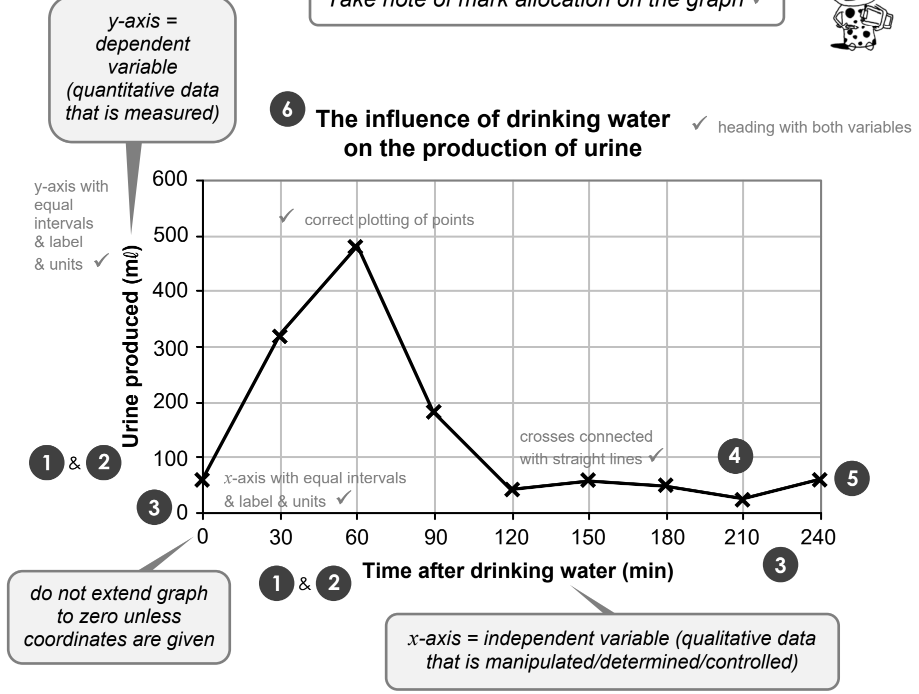
5. Use a ruler to join the dots with **straight lines** or 'line of best fit' between the dots
6. Provide a **heading** that includes both variables and the relationship between them

NOTE

Read values off a graph by drawing a perpendicular dotted line from the known point on the relevant axis to the graph, then another perpendicular dotted line from the graph to the other axis. Read the value where this line intersects the second axis.

NOTE

Take note of mark allocation on the graph ✓



NOTE

A best fit curve/line is often more accurate, but it is preferred to use a 'dot-to-dot' straight line with biological data.

NOTE

Multiple graphs should be drawn on the same set of axes with a key/legend or individual labels to identify each graph (see Compound Graphs on p. xi).

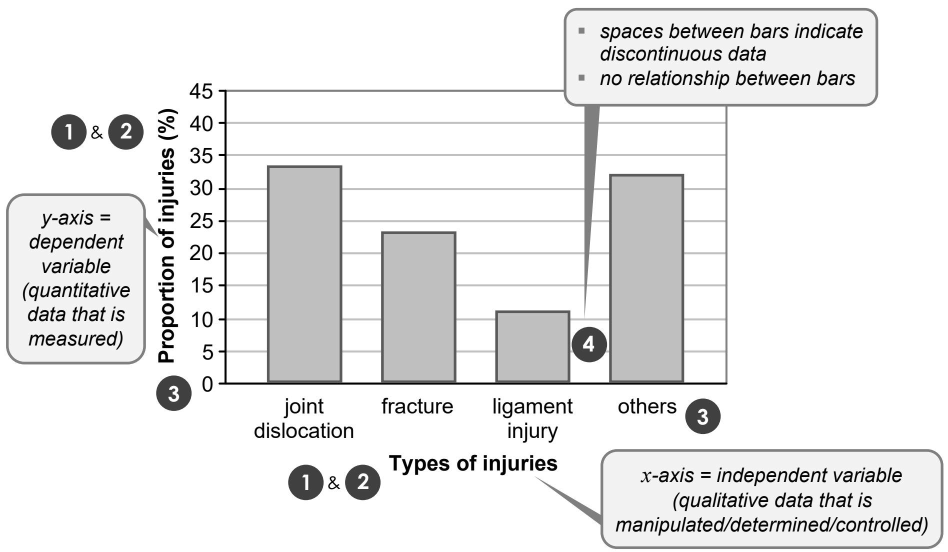
Bar Graph

A bar graph shows discontinuous **qualitative** (non-numerical categories) **data**, e.g. types of food/areas/months, etc.

STEPS to draw a BAR GRAPH

1. Identify the independent and dependent **variables** from the data provided
2. Draw a set of **axes** with **labels** and **units** (if provided):
   - ***x***-axis: independent variable with **qualitative data**
   - **y**-axis: dependent variable with **quantitative data**
3. Choose a **scale** for each axis with regular intervals that include lowest/highest values and maximise the available space on the axes
4. Data is plotted as **blocks/bars/columns**, not points.
   - there are **spaces** between each bar because the data on the *x*-axis is **discontinuous**
   - each bar must be the same width
   - spaces between each bar should be the same width
5. Provide a **heading** that includes both variables and the relationship between them

5 Sports injuries in male basketball players



NOTE

continuous data *can be represented by any value in an interval, e.g. temperature or height*

discontinuous data *can only be represented by separate values in distinct categories or groups, e.g. different chemicals in fertiliser*

Histogram

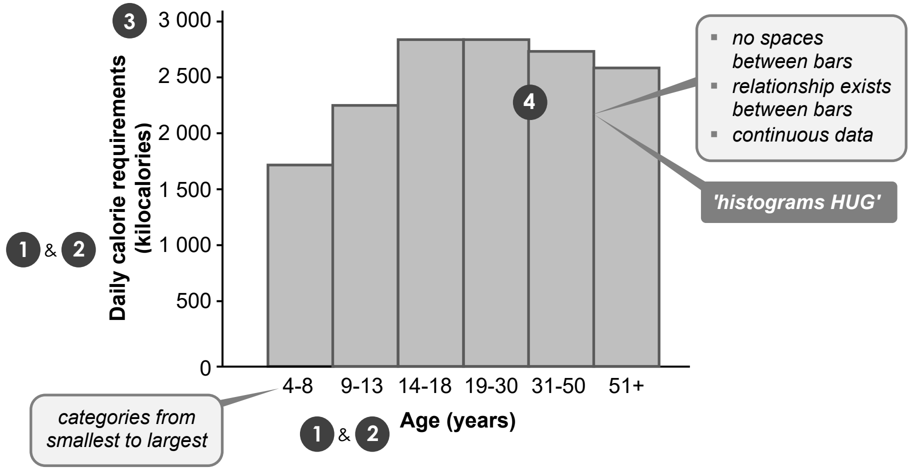
A histogram shows **groups of quantitative** (numerical) **data** on a continuous scale.

- Data is grouped into categories of **continuous data**, e.g. 0-5, 5-10.
- The *x*-axis has **ranges of values** (e.g. 4-8 years) rather than exact values (e.g. 4 years).
- Categories start with the smallest value on the left to the largest on the right.

STEPS to draw a HISTOGRAM

1. Identify the independent and dependent **variables** from the data provided
2. Draw a set of **axes** with **labels** and **units** (if provided):
   - ***x***-axis: independent variable with **quantitative data**
   - **y**-axis: dependent variable with **qualitative data**
3. Choose a **scale** for each axis with regular intervals that include lowest/highest values and maximise the available space on the axes
4. Data is plotted as **blocks/bars/columns**, not points.
   - bars should be equal in width.
   - bars touch each other with **no spaces** in between because the data on the *x*-axis is **continuous**
5. Provide a **heading** that includes both variables and the relationship between them

Calorie requirements for active people of different ages 5



Pie Graph/Chart

- A pie graph shows data as a **part** or **percentage** of the **whole**.
- Pie graphs are used for **discontinuous** data.
- Pie graphs can be used instead of bar graphs where there are six or less parts/**sectors**.
- A circle represents 100% of the total = 360° with sectors that represent the size of each of the parts.

STEPS to draw a PIE CHART

1. Calculate the **sum** of all the values (total)
2. Convert the value of each sector to **degrees** by dividing by the sum total and multiplying by 360°:

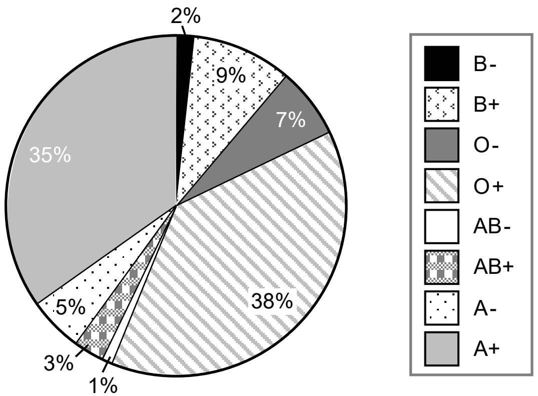
$$\textbf{degrees} = \frac{\textbf{value of sector}}{\textbf{sum of values}} \times \textbf{360°}$$

> **NOTE**
> *e.g.* $\frac{\textit{25 beetles}}{\textit{750}} \times 360° = 12°$
> *360° is the total number of degrees in a circle*

3. Use a compass to draw a circle
4. Draw a line from the centre to the edge of the circle (radius) and use a protractor to measure the degrees for each sector
5. Shade all the sectors differently
6. Include a key OR label each sector to indicate the value/percentage of each sector on the graph
7. Provide a **heading** that includes both variables and the relationship between them

> **NOTE**
> *In exam questions, always show your calculations for a pie graph.*

Pie chart to show the relationship between different blood groups in a particular population



Sample calculation

Blood group **A+** = 35%

Size of sector on pie graph:

$$\frac{\text{value of sector}}{\text{sum of values}} \times 360°$$

$$\frac{35}{100} \times 360° = 126°$$

When to use which graph?

Line: Both variables are numerical, e.g. time

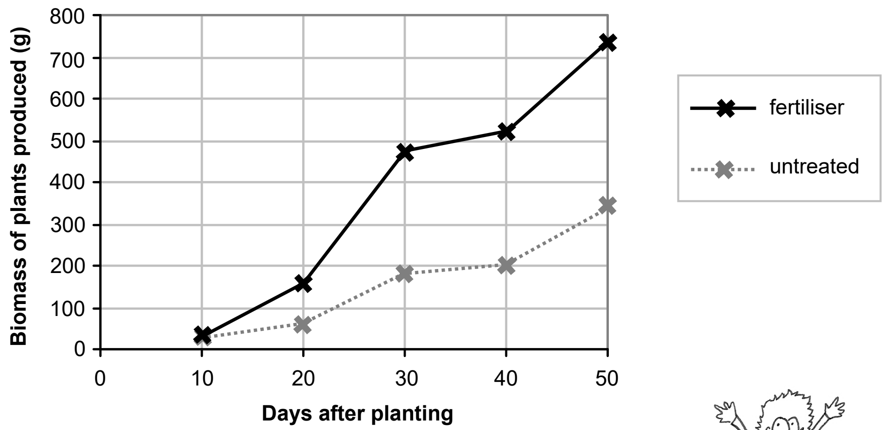
Bar/pie: Independent variable is a category (qualitative/non-numerical) and **discontinuous**, e.g. biomes, colour, countries, languages, types of responses

Histogram: Independent variable is a category (quantitative/numerical) of **continuous** data, e.g. length, temperature, sound, age groups

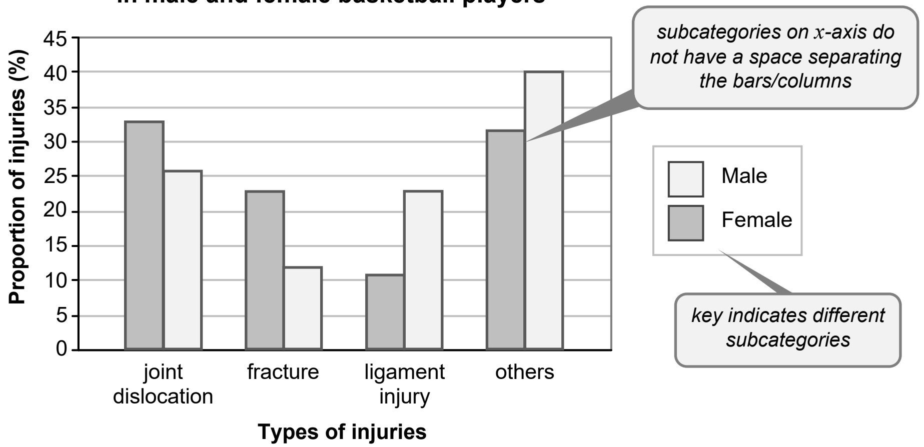
Compound Graphs

- Two dependent variables are plotted on the same set of axes.
- They are distinguished by using a solid and broken line (line graph) or different shadings (bar graph).
- There is a **key** to describe each set of data.

Line graph showing the biomass of plants produced over time with fertiliser or untreated



Bar graph showing sports injuries in male and female basketball players



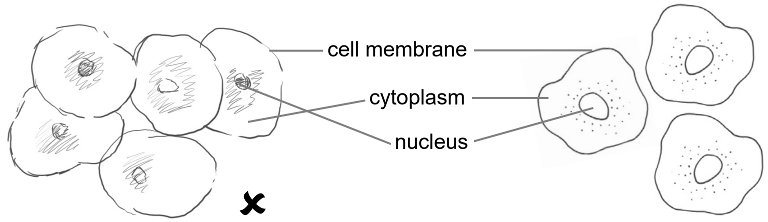
NOTE

*In a compound **bar graph** the spaces are between each category, e.g. fracture and ligament injury.*

3 Biological Drawings

Drawings are used to record an image of a specimen.

- **DRAW WHAT YOU SEE!** Do not include what you think you should see.
- Drawings must be large enough to see all labelled parts clearly.
- Draw in pencil ONLY.
- Always use distinct, single lines when drawing – no 'sketching'.
- To illustrate darker areas on a specimen, use stippling or dots.
- Do not shade in any area of your drawing.
- All drawings must have the following:
  - **Heading**
    - a full, clear and concise title that describes the drawing
  - **Magnification**
    - indicate the magnification (scale) at which the specimen was observed, e.g. 400×
  - **Labels**
    - always include labels of the important features of the specimen
    - label lines should be drawn in ink and with a ruler
    - label lines should not cross
    - labels may be written on both sides of the drawing
    - label lines should end at the same point so that labels are aligned below each other



Incorrect drawing format — **Diagram of animal cell (100X)**

Correct drawing format — **Diagram of animal cell (100X)**

Calculating Magnification/Reduction

Drawings in Life Sciences are often much larger or smaller than the actual specimen. We use simple formulae to determine:

- the total **M**agnification of an object under the microscope
- the magnification/reduction of an **I**mage/drawing compared to the actual size of an object
- the **A**ctual size of an object using a scale on an image (e.g. micrograph)
- the **A**ctual size of an object from the microscope image using the diameter of the field of view

NOTE

*See the **A** = $\frac{I}{M}$ formula **triangle** on p. xiii that shows an easy way to calculate **Image size** or **Actual size** or the **Magnification**.*

Calculating the TOTAL MAGNIFICATION of an object under the microscope

Read the magnification of the eyepiece lens (usually 4× or 10×) and multiply it by the magnification of the objective lens (4×, 10× or 40×).

Total magnification
= magnification of eyepiece lens × magnification of objective lens

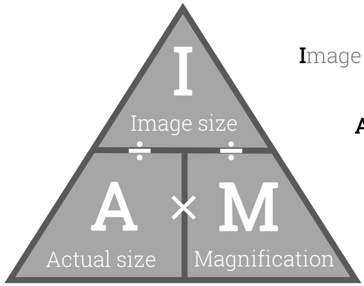
EXAMPLE

Calculate the magnification if the magnification of the eyepiece (ocular) lens is 4× and the objective lens 10×.

Total magnification is $4 \times 10 = 40\times$.

The specimen is magnified 40 times bigger than the object.

This $A = \frac{I}{M}$ formula triangle simplifies calculations and rearranging the formula to calculate the **Image size** or **Actual size** or the **Magnification**.



$$\text{Image size} = \text{Actual size} \times \text{Magnification}$$

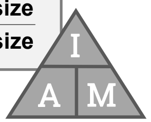
$$\text{Actual size} = \frac{\text{Image size}}{\text{Magnification}}$$

$$\text{Magnification} = \frac{\text{Image size}}{\text{Actual size}}$$

Calculating the MAGNIFICATION/REDUCTION of an image/drawing compared to the actual size of an object

Use this formula to calculate the **magnification** of an image, i.e. the number of times an image is enlarged:

$$\textbf{Magnification} = \frac{\textbf{image size}}{\textbf{actual size}}$$

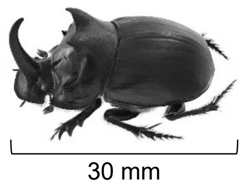


NOTE

It is important to ensure that both sizes are in the ***same*** *unit (e.g. µm; mm; cm; m).*

EXAMPLE

Determine the magnification of a drawing of a beetle with an actual size of 10 mm.



- Measure the size of the image using a ruler (in mm) = 30 mm
- Use the formula:

$$\text{Magnification} = \frac{\text{Image size}}{\text{Actual size}} = \frac{30\text{ mm}}{10\text{ mm}} = 3$$

The image/drawing is 3× larger than the actual beetle

Calculating the ACTUAL SIZE of an object USING A SCALE on an image/drawing (e.g. micrograph)

Cells are so small that their size is generally measured in micrometres (µm).
The **magnification** of a specimen (cell or organelle) is often indicated on a micrograph.

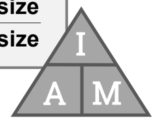
REMEMBER

1 000 µm = 1 mm
(micrometres) (millimetres)

If a **scale** is indicated on the micrograph, it can be used to calculate the **actual size** of the specimen/object in two steps:

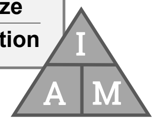
1. Calculate the **magnification** using the scale bar

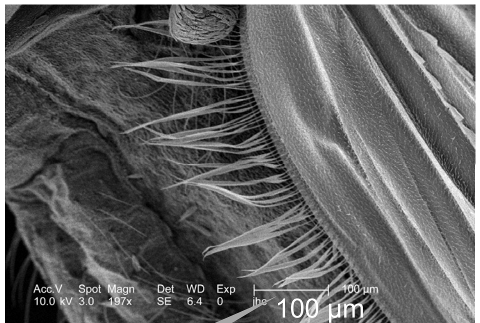
$$\textbf{Magnification} = \frac{\textbf{image size}}{\textbf{actual size}}$$



2. Use the magnification to calculate the **actual size** of the specimen

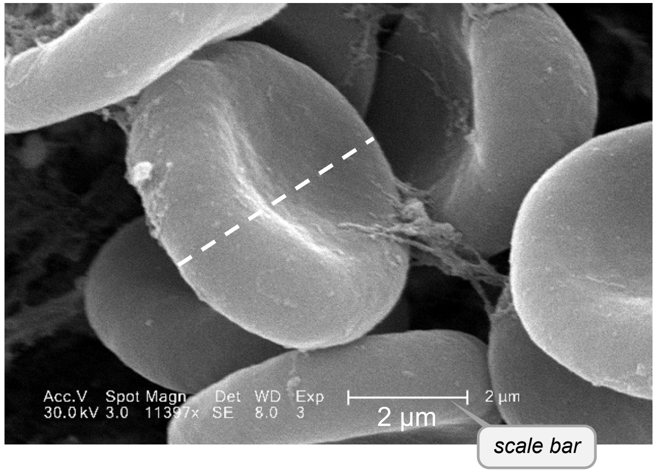
$$\textbf{Actual size} = \frac{\textbf{image size}}{\textbf{magnification}}$$





Micrograph of fringe detail on mosquito wing

scale bar



EXAMPLE

Use the micrograph above to determine the actual size of the red blood cell.

1. Calculate magnification from the scale bar:

$$\text{magnification} = \frac{\text{image size}}{\text{actual size}} = \frac{\text{measured length of scale bar}}{\text{scale on scale bar}}$$

$$= \frac{16\text{ mm}}{2\text{ μm}} = \frac{16\,000\text{ μm}}{2\text{ μm}} = 8\,000\times$$

2. Calculate actual size using magnification 8 000×:

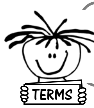
$$\text{actual size} = \frac{\text{image size}}{\text{magnification}} = \frac{32\text{ mm}}{8\,000} = \frac{32\,000\text{ μm}}{8\,000} = 4\text{ μm}$$

NOTE

Remember to convert all measurements to the same unit, e.g. μm.

Calculating the ACTUAL SIZE of an object from the microscope image using the FIELD OF VIEW diameter

The **size of a specimen** can also be determined by measuring the diameter of the microscope's **field of view**.



field of view: *the diameter of the circular area that is visible when you look through the eyepiece*

- Place a transparent plastic ruler with mm scale (or a microscope slide with ruler markings) on top of the microscope stage.
- Use the lowest magnification and focus the image of the ruler.
- Count the number of visible intervals of the ruler across the field of view.

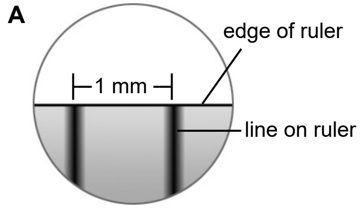
NOTE

Remember that each interval is actually 1 mm.

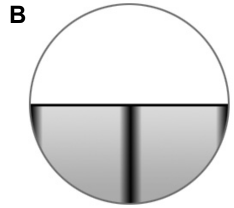
- Multiply the number of intervals by 1 000 to convert the diameter of the field of view from mm to μm (micrometres).

NOTE

At higher magnifications, the field of view decreases in size.



At a 40× magnification, the ruler lines are visible. Shift a line to the edge of the field of view to measure the field of view accurately (see image B).



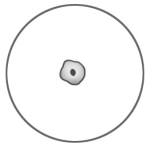
With the line against the edge, it is easier to determine the field of view: 2 mm × 1 000 = 2 000 μm

1 mm = 1 000 μm

- To determine the diameter of a specimen in the field of view:
  1. estimate how many specimens of the same size can fit across the diameter of the field of view.
  2. calculate one specimen as a fraction of the total and multiply by the diameter of the field of view.

EXAMPLE

Determine the size of the cell in a field of view measured at 3 000 μm.



1 specimen in field of view with a diameter of 3 000 μm

estimated 6 specimens fit into the field of view

1. estimated 6 specimens fit in field of view (diameter 3 000 μm)
2. ∴ estimated size of 1 specimen $= \frac{1}{6}$ of 3 000 μm = 50 μm