Lesson activity: GCSE to A-level progression (Biology)

Student booklet with information about:
- the specification and structure of the assessment
- and key skills activities to support the move from GCSE to A-level Biology.

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Aim of the booklet

This booklet will support your transition from GCSE science to A-level. At first, you may find the jump in demand a little daunting, but if you follow the tips and advice in this guide, you'll soon adapt. As you follow the course you will see how the skills and content you learnt at GCSE will be developed and your knowledge and understanding of all these elements will progress.

We have organised the guide into three sections:
1. Understanding the specification and the assessment
2. A transition activity to bridge the move from GCSE to start of the A-level course

Understanding the specification and the assessments

Specification at a glance

The specification is a useful reference document for you. You can download a copy from our website here.

The most relevant parts of the specification for students are the following:

Section 3:   Subject content

Section 6:   Maths requirements and examples

Section 7:   Practical assessment

In Biology, the subject content is split between AS and A level (sections 3.1 – 3.4) and A level only (sections 3.5-3.8). The section titles are listed here:

2.1   Biological molecules
2.2   Cells
2.3   Organisms exchange substances with their environment
2.4   Genetic information, variation and relationships between organisms
2.5   Energy transfers in and between organisms (A level only)
2.6   Organisms respond to changes in their internal and external environments (A level only)
2.7   Genetics, populations evolution and ecosystems (A level only)
2.8   The control of gene expression (A level only)

Each section of the content begins with an overview, which describes the broader context and encourages an understanding of the place each section has within the subject. This overview will not be directly assessed.

The specification is presented in a two-column format:
- the left-hand column contains the specification content that must cover, and that can be assessed in the written papers.
- the right-hand column exemplifies the opportunities for maths and practical skills to be developed throughout the course. These skills can be are assessed through any of the content on the written papers not necessarily in the topics we have signposted.

Assessment structure

The assessment for the A-level consists of three exams, which you will take at the end of the course.

Paper 1	Paper 2	Paper 3
What's assessed	**What's assessed**	**What's assessed**
• Any content from topics 1-4 including relevant practical skills	• Any content from topics 5 – 8 including relevant practical skills	• Any content from topics 1-8 including • relevant practical skills
How it's assessed	**How it's assessed**	**How it's assessed**
• Written exam: 2 hours • 91 marks • 35% of the A-level	• Written exam: 2 hours • 91 marks • 35% of the A-level	• Written exam: 2 hours • 78 marks • 30% of the AS-level
Questions	**Questions**	**Questions**
• 76 marks: a mixture of short and long answer questions • 15 marks: extended response questions	• 76 marks: a mixture of short and long answer questions • 15 marks: extended response questions	• 38 marks: structured questions, including practical techniques • 15 marks: critical analysis of given experimental data • 25 marks: one essay from a choice of two titles

Assessment objectives

As you know from GCSE, we have to write exam questions that address the Assessment objectives (AOs). It is important you understand what these AOs are, so you are well prepared. In Biology there are three AOs.

- AO1: Demonstrate knowledge and understanding of scientific ideas, processes, techniques, and procedures (A-level about 30-35% of the marks).
- AO2: Apply knowledge and understanding of scientific ideas, processes, techniques, and procedures;
  - in a theoretical context
  - in a practical context
  - when handling qualitative data
  - when handling quantitative data

  (A-level about 40-45% of the marks).
- AO3: Analyse, interpret, and evaluate scientific information, ideas, and evidence, including in relation to;
  - make judgements and reach conclusions
  - develop and refine practical design and procedures

  (A-level about 25–30% of the marks).

Other assessment criteria

At least 10% of the marks for AS and A-level Biology will assess mathematical skills, which will be equivalent to Level 2 (Higher Tier GCSE Mathematics) or above.

At least 15% of the overall assessment of AS and A-level Biology will assess knowledge, skills and understanding in relation to practical work.

Command words

Command words are used in questions to tell you what is required when answering the question. You can find definitions of the command words used in Biology assessments on the website. They are very similar to the command words used at GCSE

Subject-specific vocabulary

You can find a list of definitions of key working scientifically terms used in our AS and A-level specification here.

You will become familiar with, and gain understanding of, these terms as you work through the course.

Transition activities 1-10

The following activities cover some of the key skills from GCSE science that will be relevant at AS and A-level. They include the vocabulary used when working scientifically and some maths and practical skills.

Understanding and using scientific vocabulary

Understanding and applying the correct terms are key for practical science. Much of the vocabulary you have used at GCSE for practical work will not change but some terms are dealt with in more detail at A-level so are more complex.

Activity 1 Scientific vocabulary: Designing an investigation

Link each term on the left to the correct definition on the right.

Hypothesis	The maximum and minimum values of the independent or dependent variable
Dependent variable	A variable that is kept constant during an experiment
Independent variable	The quantity between readings, eg a set of 11 readings equally spaced over a distance of 1 metre would give an interval of 10 centimetres
Control variable	A proposal intended to explain certain facts or observations
Range	A variable that is measured as the outcome of an experiment
Interval	A variable selected by the investigator and whose values are changed during the investigation

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Activity 2 Scientific vocabulary: Making measurements

Link each term on the left to the correct definition on the right.

Term	Definition
True value	The range within which you would expect the true value to lie
Accurate	A measurement that is close to the true value
Resolution	Repeated measurements that are very similar to the calculated mean value
Precise	The value that would be obtained in an ideal measurement where there were no errors of any kind
Uncertainty	The smallest change that can be measured using the measuring instrument that gives a readable change in the reading

Activity 3 Scientific vocabulary: Errors

Link each term on the left to the correct definition on the right

Term	Definition
Random error	Causes readings to differ from the true value by a consistent amount each time a measurement is made
Systematic error	When there is an indication that a measuring system gives a false reading when the true value of a measured quantity is zero
Zero error	Causes readings to be spread about the true value, due to results varying in an unpredictable way from one measurement to the next

Understanding and using SI units

Every measurement has a size (eg 2.7) and a unit (eg metres or kilograms). Sometimes, there are different units available for the same type of measurement. For example, milligram, gram, kilogram and tonne are all units used for mass.

To reduce confusion, and to help with conversion between different units, there is a standard system of units called the SI units which are used for most scientific purposes.

These units have all been defined by experiment so that the size of, say, a metre in the UK is the same as a metre in China.

There are seven SI base units, which are given in the table.

Physical quantity	Unit	Abbreviation
Mass	kilogram	kg
Length	metre	m
Time	second	s
Electric current	ampere	A
Temperature	kelvin	K
Amount of substance	mole	mol
luminous intensity	candela	cd

All other units can be derived from the SI base units. For example, area is measured in metres square (written as m^2) and speed is measured in metres per second (written as $m\ s^{-1}$, this is a change from GCSE where it is written as m/s).

Using prefixes and powers of ten

Very large and very small numbers can be complicated to work with if written out in full with their SI unit. For example, measuring the width of a hair or the distance from Manchester to London in metres (its SI unit) would give numbers with a lot of zeros before or after the decimal point, which would be difficult to work with.

So, we use prefixes that multiply or divide the numbers by different powers of ten to give numbers that are easier to work with. You will be familiar with the prefixes milli (meaning 1/1000), centi (1/100), and kilo (1 × 1000) from millimetres, centimetres, and kilometres.

There is a wide range of prefixes. Most of the quantities in scientific contexts will be quoted using the prefixes that are multiples of 1000. For example, we would quote a distance of 33 000 m as 33 km.

The most common prefixes you will encounter are given in the table.

Prefix	Symbol	Power of 10	Multiplication factor	
Tera	T	10^{12}	1 000 000 000 000	
Giga	G	10^{9}	1 000 000 000	
Mega	M	10^{6}	1 000 000	
kilo	k	10^{3}	1000	
deci	d	10^{-1}	0.1	1/10
centi	c	10^{-2}	0.01	1/100
milli	m	10^{-3}	0.001	1/1000
micro	μ	10^{-6}	0.000 001	1/1 000 000
nano	n	10^{-9}	0.000 000 001	1/1 000 000 000
pico	p	10^{-12}	0.000 000 000 001	1/1 000 000 000 000
femto	f	10^{-15}	0.000 000 000 000 001	1/1 000 000 000 000 000

Activity 4 SI units and prefixes

What would be the most appropriate unit to use for the following measurements?
 	
   1. The time between heart beats
 	
   2. The diameter of a cheek cell
 	
   3. The distance that a migratory bird travelled each year
 	
   4. The thickness of a DNA helix
 	
   5. The mass of a rabbit
 	
   6. The mass of iron in the body
 	
   7. The diameter of a glucose molecule

Activity 5 Units

Choose the most appropriate unit and estimate the size of each of the following.

1. The mass of an earthworm

2. The volume of water in a teardrop

3. The volume of water in a garden pond

4. The time taken for a sunflower to grow

5. The temperature difference between the blood in the heart and in the ear on a cold day

6. The diameter of a human hair

7. The length that your fingernails grow each day

8. The total length of DNA in one human body cell

Activity 6 Converting data

Re-write the following.

1. 0.00224 metres in millimetres

2. 104 micrograms in grams

3. 6.2 kilometres in metres

4. 10 micrograms in nanograms

5. 70 decilitres in litres

6. 10 cm^3 in litres

Practical skills

The practical skills you learnt at GCSE will be further developed through the fieldwork and practicals you undertake at A-level. Your teacher will explain in more detail the requirements for fieldwork, practical work, and the research methods.

There is a practical handbook for Biology which has lots of very useful information to support you in developing these important skills. You can download a copy here.


Activity 7 Investigating how temperature and pH affect enzymes

Egg white is made of protein. The students were investigating how temperature and pH affect the digestion of protein

The students carried out the following procedure:
- Filled six narrow glass tubes with fresh egg white
- Boiled the tubes so the egg white became solid
- Placed each tube into a different beaker containing human protease enzyme at different pH values at room temperature and 3 in neutral pH but at different temperatures for 24 hours
- Measured the length of solid egg white in each tube after 24 hours

The diagram shows the investigation.
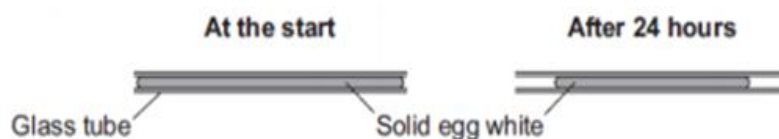
The results were recorded in the tables below:

pH	Original length of solid egg white (cm)	Final length of solid egg white (cm)	% change
4	6.0	5.6	
7	6.0	3.8	
9	6.0	5.8	

Temperature (°C)	Original length of solid egg white (cm)	Final length of solid egg white (cm)	% change
15	6.0	5.7	
35	6.0	3.8	
55	6.0	5.3	

1. State a hypothesis for this investigation.

2. The students predicted that the enzyme would be most effective in conditions similar to those found in the human body. Was their prediction correct?

3. Identify the independent and dependent variables in this investigation.

4. Suggest the control variables for this investigation.

5. Describe the difference between repeatable and reproducible.

6. What would be the most likely resolution of the ruler you would use in this investigation.

7. Suggest how repeating the investigation would be an improvement.

8. Calculate the % change for each result in this investigation. Show your answers to 3 significant figures.

Analysing data

Biological investigations often result in large amounts of data being collected. It is important to be able to analyse this data carefully in order to pick out trends.

Activity 8 Mean mode median and scatter graphs

A student investigated an area of moorland where succession was occurring. The student used quadrats to measure the area covered by; different plant species, bare ground and surface water. They did this every 10 metres along a line transect. The student also recorded the depth of soil at each quadrat. Their results are shown in the table.

	Area covered in each quadrat A to E in cm²				
	A	**B**	**C**	**D**	**E**
Bog moss	55	40	10	–	–
Bell heather	–	–	–	15	10
Sundew	10	5	–	–	–
Ling	–	–	–	15	20
Bilberry	–	–	–	15	25
Heath grass	–	–	30	10	5
Soft rush	–	30	20	5	5
Sheep's fescue	–	–	25	35	30
Bare ground	20	15	10	5	5
Surface water	15	10	5	–	–
Soil depth / cm	3.2	4.7	8.2	11.5	14.8

Calculate:

1. Calculate the mode area of soft rush in the sample.

2. Calculate the mean soil depth of the area of moorland sampled.

3. Calculate the median amount of bare ground in the sample.

4. Using the data in the table plot a **scatter graph** of the soil depth against the area covered by bare ground, soft rush and bog moss (use different colours or markers for each).

5. What conclusions can you draw from this graph?
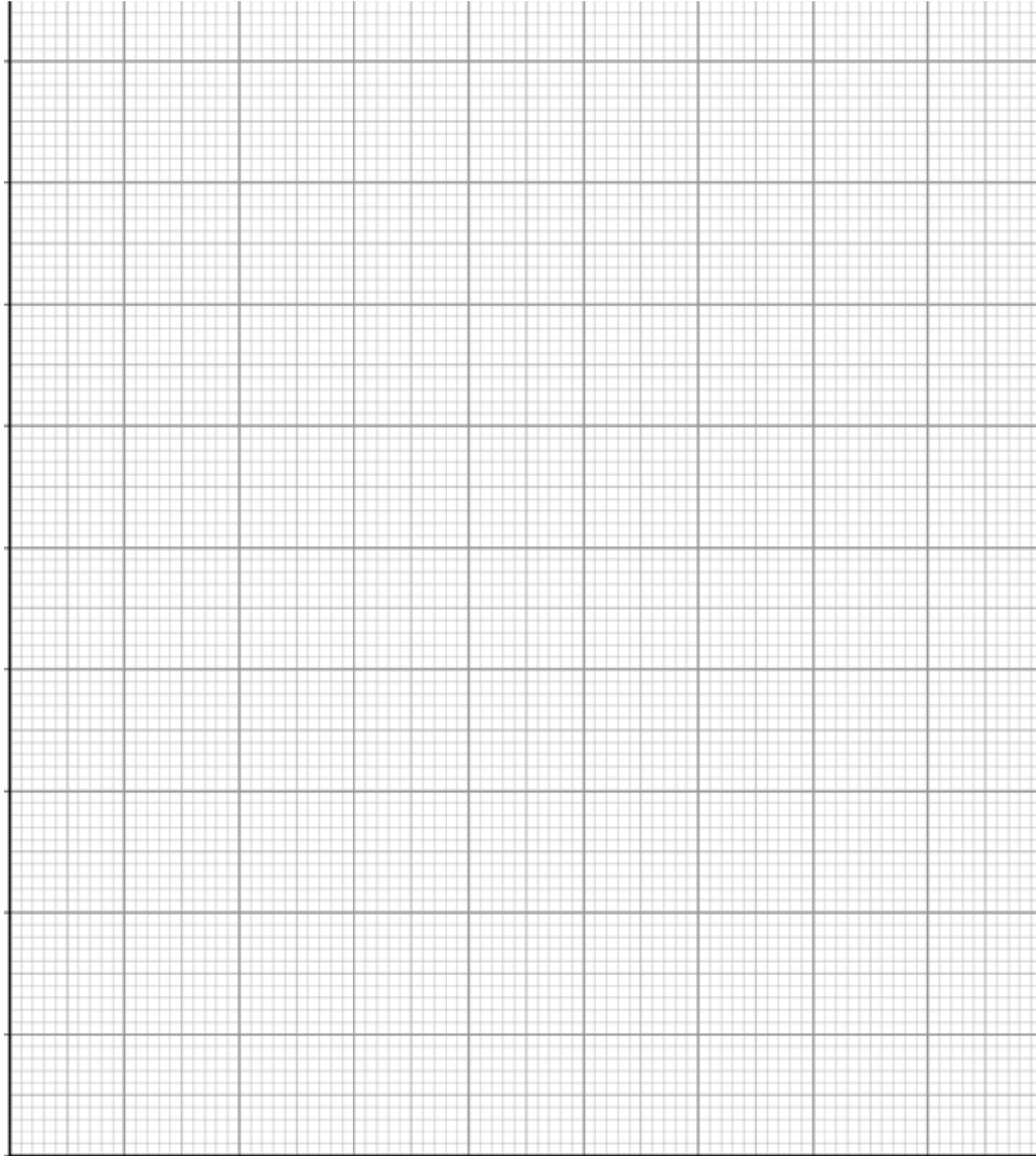
6. Suggest how to improve the validity of these conclusions.

Activity 9 Data in tables

A patient with a leaking heart valve may have the valve replaced. A study compared two different types of replacement heart valve:

- mechanical valves
- biological valves from pigs.

The data used in the study was collected from female patients aged 50–69. **Table 4** shows the data

Table 4

	Type of replacement heart valve	
	Mechanical	**Biological**
Number of patients given the valve	2852	1754
Number of patients who died from heart-related problems after valve replacement	180	178
Percentage of patients alive after 5 years	91	89
Percentage of patients needing a second valve replacement within 6 years	2.2	5.2
Percentage of patients who had a blood clot on the brain after surgery	5.8	0.1

1. Give **one** conclusion about the death of patients from heart-related problems after a valve replacement. Include calculations to support your answer.

2. Evaluate the use of mechanical replacement heart valves and biological replacement heart valves.
Use information from **Table 4**.

Activity 10 Analysing complex graphs

The volume of air breathed in and out of the lungs during each breath is called the tidal volume. The breathing rate and tidal volume were measured for a cyclist pedaling at different speeds. The graph shows the results
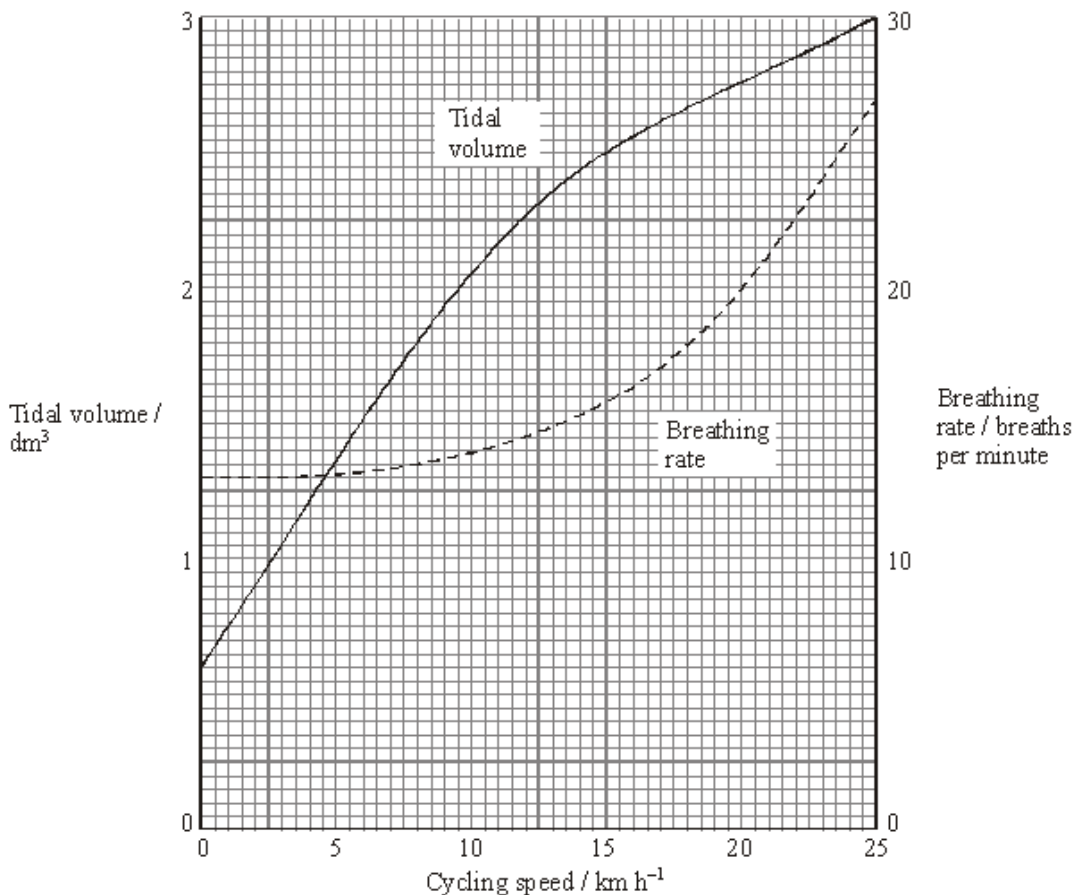
1. State the tidal volume when the cycling speed was 17 km h^{-1}.

2. State the breathing rate when the cycling speed was 8 km h^{-1}.

3. Calculate the change in breathing rate when the cyclist speed changed from 10 to 20 km h^{1}.
   Express this as a percentage.

4. State the speed at which the breathing rate starts to increase.

5. The tidal volume increased linearly with the cycling speed up to about 10 km h^{-1}.
   Calculate the increase in volume for each increase in speed of 1 km h^{-1}.