A-Level Biology

Xaverian College

Preparing for Year 12

Introduction

The biology department are very pleased you have chosen to study biology at Xaverian College. The A-Level biology department is a large department, with typically around 420 students studying A-level Biology.

There are currently 10 teaching staff and one laboratory technician.

Your lessons will take place in both laboratories and traditional classrooms, with a mixture of practical and theoretical biology.

You will find that A-level biology includes many of the topics you studied at GCSE level, but that they are studied in quite a lot more detail. The work and the skills expected of you are also more demanding.

Is Biology Difficult?

A-level biology is difficult! Ask around amongst students who have studied the subject, and they will tell you that it is one of the most difficult A-levels you can choose.

It will require a lot of hard work. But then, everything in life that is worth having is hard work!

Every year approximately 50% of our students get A* to B grades, which enable them to progress to prestigious universities.

You can start your journey to a high grade in biology by following this guide and preparing well for year 12.

Why study A-level Biology?

Biology A-level will give you the skills to make connections and associations with all living things around you. Biology literally means the study of life - and if that's not important, what is? Being such a broad topic, you're bound to find a specific area of interest, plus it opens the door to a fantastic range of interesting careers.

Many people use an AS or A-level in Biology in their future studies or work. Even if you don't decide to work in biology, studying it still develops useful and transferable skills for other careers. You'll develop research, problem-solving and analytical skills, alongside teamwork and communication. Universities and business regard all of these very highly.

Possible degree options

According to bestcourse4me.com, the top five degree courses taken by students who have A-level Biology are:

- Biology
- Psychology
- Sport and exercise science
- Medicine
- Anatomy

This list is by no means exhaustive. Biology can prove useful for a wide variety of degree courses.

Which career appeals to you?

Studying Biology at A-level or degree opens up all sorts of career opportunities, such as:

- A number of healthcare professions, including medicine
- Molecular geneticist
- Nature conservation
- Pharmacology
- Research science
- Veterinary science
- Teaching
- Marine biology
- Dentistry

If you think of some of the biggest problems currently faced by humanity – the Covid19 pandemic and global warming, for example – it is clear that the world needs talented biologists more than ever.

Structure of the Course

A-level biology is a two-year course. You study for two years, and then sit three exams at the end of the second year.

Your results from these three exams are your final grade.

In common with other A-levels, biology results are graded from A* to U. A* to E is a pass; U is ungraded.

Practical Skills Certificate

You will also study for a Practical Skills Certificate. This is awarded separately to your A-level grade. Your teachers will assess your practical work over the two years of study and award this certificate if you demonstrate competence in a set of criteria for practical work.

Resources

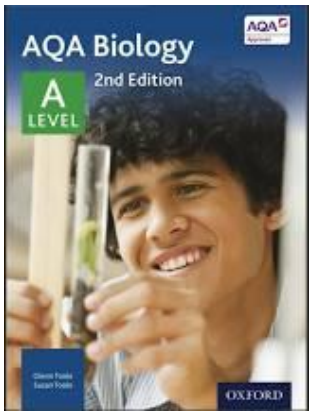
We follow the **AQA** biology specification.

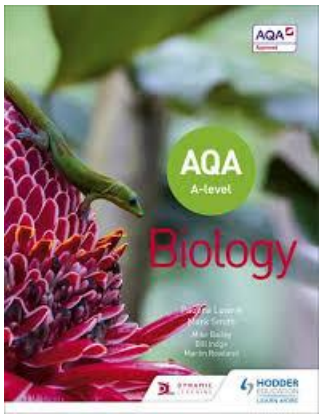
You can see this, and many other relevant resources on the AQA Website.

We give our students all the notes they require, plus booklets of past-paper questions and many other resources.

We do not require students to have or buy a text-book. However, if you want to buy or borrow one, make sure it is for the correct specification.

These are both good:





How to get a good grade in biology

There are several aspects to getting a good grade:

Have excellent **recall** of all the facts	This requires you to study all of the biology in the specification, and have a good long term memory of it. Learn thoroughly and revise effectively.
Be able to **apply** your knowledge	This means being able to use your knowledge to solve new and unfamiliar problems. You need good problem-solving skills. These can be developed with practice.
Maths skills	10% of the marks in biology exams come from questions involving maths.
Practical work	15% of the marks in biology exams come from questions involving practical work you will do during your course. You will carry out many practical experiments and need to make sure you understand how they work. You need to have a good understanding of the scientific method.

Topics

At Xaverian, we have divided the content in A-level Biology into 14 topics. 8 are covered in Year 12 and the other 6 in Year 13. Students are also provided with notes on maths skills and practical investigation.

A summary of the 8 topics studied in Year 12 is given below:

Topic	Content	Practical Work
1. Biological Molecules	Carbohydrates, Lipids, Proteins, Enzymes, DNA, RNA, ATP, Ions and Water.	Identification of Molecules Quantitative Biochemistry Enzymes and factors affecting rate of reaction
2. Cells and Cell Transport	Structure of prokaryotic and eukaryotic cells. The Cell Membrane and Transport across it.	Effect of factors on permeability of cell membranes. Investigations of osmosis. Microscopy.
3. Gas Exchange and Digestion	Structure and adaptations of lungs, fish gills, gas exchange in insects and in leaves. Digestion of food and absorption of nutrients.	Dissections. Biological drawings. Microscopy.
4. Transport in Animals	Structure and function of mammalian circulatory systems. Haemoglobin and transport of oxygen.	Dissections. Biological drawings. Microscopy.
5. Immunology	Defence against pathogenic disease. Life cycles of viruses including HIV & Influenza. Functions of the immune system.	Effect of antimicrobials on growth of bacteria.
6. Transport in Plants	Transport in xylem and phloem in plants.	Potometer and rate of transpiration in plants. Estimating density of stomata in leaves.
7. DNA & Genetic Diversity	Structure and function of DNA and RNA. DNA replication. Genes and alleles. Protein synthesis. Cell division by mitosis and meiosis.	Root tip squash and stages of mitosis.
8. Variation & Diversity	Evolution of species and taxonomic classification of organisms. Species and biological diversity.	Investigations of ecological diversity.

The most effective things you can do to prepare for year 12 biology are:

- Make a start on Topic 1, Biological Molecules.
- Develop your Maths Skills.
- Work on your understanding of Practical Experiments and the Scientific Method.

Preparatory Work

In preparation for the start of your studies we have provided the following questions and activities. By independently researching and working through them you will develop a firm foundation of knowledge, skills and, ultimately, confidence in your ability to succeed on the course.

Practical science key terms:

Learn the answers to the questions below then cover the answers column with a piece of paper and write as many answers as you can. Check and repeat.

When is a measurement valid?	when it measures what it is supposed to be measuring
When is a result accurate?	when it is close to the true value
What are precise results?	when repeat measurements are consistent/agree closely with each other
What is repeatability?	how precise repeated measurements are when they are taken by the *same* person, using the *same* equipment, under the *same* conditions
What is reproducibility?	how precise repeated measurements are when they are taken by *different* people, using *different* equipment
What is the uncertainty of a measurement?	the interval within which the true value is expected to lie
Define measurement error	the difference between a measured value and the true value
What type of error is caused by results varying around the true value in an unpredictable way?	random error
What is a systematic error?	a consistent difference between the measured values and true values
What does zero error mean?	a measuring instrument gives a false reading when the true value should be zero
Which variable is changed or selected by the investigator?	independent variable
What is a dependent variable?	a variable that is measured every time the independent variable is changed
Define a fair test	a test in which only the independent variable is allowed to affect the dependent variable
What are control variables?	variables that should be kept constant to avoid them affecting the dependent variable

Key term definitions:

Give the definitions for the following key terms

Key term	Definition
Accurate	
Data	
Precise	
Prediction	
Range	
Repeatable	
Reproducible	
Resolution	
Uncertainty	
Variable	
Control variable	
Dependent variable	

Biological Molecules

Use your prior knowledge and research to answer the following:

1. What are monomers?

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2. What are polymers?

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3. What is a condensation reaction?

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4. What is a hydrolysis reaction?

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5. What is a monosaccharide?

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6. How is a glycosidic bond formed?

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7. Name three examples of polysaccharides

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8. Describe the Benedict's test for reducing sugars

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9. Name the two main groups of lipids

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10. Give four roles of lipids

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11. What is an ester bond?

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12. Describe the emulsion test for lipids

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13. What are the monomers that make up proteins?

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14. Draw the general structure of an amino acid:

15. How is a peptide bond formed?

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16. What is a polypeptide?

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17. Describe the biuret test for proteins

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18. How does an enzyme affect a reaction?

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19. Give five factors which can affect enzyme action:

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Maths Skills

Numbers and Units:

A key criterion for success in biological maths lies in the use of correct units and the management of numbers. The units scientists use are from the *Système Internationale* – the SI units. In biology, the most commonly used SI base units are metre (m), kilogram (kg), second (s), and mole (mol). Biologists also use SI derived units, such as square metre (m^2), cubic metre (m^3), degree Celsius (°C), and litre (l).

To accommodate the huge range of dimensions in our measurements they may be further modified using appropriate prefixes. For example, one thousandth of a second is a millisecond (ms). Some of these prefixes are illustrated in the table below.

Multiplication factor	Prefix	Symbol
10^9	giga	G
10^6	mega	M
10^3	kilo	k
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n

Practice questions

1 A burger contains 4 500 000 J of energy. Write this in:
a) kilojoules
b) megajoules.

2 HIV is a virus with a diameter of between 9.0×10^{-8} m and 1.20×10^{-7} m.
Write this range in nanometres.

Powers and indices:

Ten squared = 10 × 10 = 100 and can be written as 10^2. This is also called 'ten to the power of 2'.

Ten cubed is 'ten to the power of three' and can be written as 10^3 = 1000.

The power is also called the index.

Fractions have negative indices:
one tenth = 10^{-1} = 1/10 = 0.1
one hundredth = 10^{-2} = 1/100 = 0.01

Any number to the power of 0 is equal to 1, for example, 29^0 = 1.
If the index is 1, the value is unchanged, for example, 17^1 = 17.

When multiplying powers of ten, you must *add* the indices.
So $100 \times 1000 = 100\,000$ is the same as $10^2 \times 10^3 = 10^{2+3} = 10^5$

When dividing powers of ten, you must *subtract* the indices.
So $100/1000 = 1/10 = 10^{-1}$ is the same as $10^2/10^3 = 10^{2-3} = 10^{-1}$

But you can only do this when the numbers with the indices are the same.
So $10^2 \times 2^3 = 100 \times 8 = 800$

And you can't do this when adding or subtracting.
$10^2 + 10^3 = 100 + 1000 = 1100$
$10^2 - 10^3 = 100 - 1000 = -900$

Remember: You can only add and subtract the indices when you are multiplying or dividing the numbers, not adding or subtracting them.

Practice questions

3 Calculate the following values. Give your answers using indices.
a) $10^8 \times 10^3$ **b)** $10^7 \times 10^2 \times 10^3$
c) $10^3 + 10^3$ **d)** $10^2 - 10^{-2}$

4 Calculate the following values. Give your answers with and without using indices.
a) $10^5 \div 10^4$ **b)** $10^3 \div 10^6$
c) $10^2 \div 10^{-4}$ **d)** $100^2 \div 10^2$

Converting units:

When doing calculations, it is important to express your answer using sensible numbers.
For example, an answer of 6230 µm would have been more meaningful expressed as 6.2 mm.

If you convert between units and round numbers properly, it allows quoted measurements to be understood within the scale of the observations.

To convert 488 889 m into km:
A kilo is 10^3 so you need to divide by this **number, or** move the decimal point three places to the left.
$488\,889 \div 10^3 = 488.889$ km

However, suppose you are converting from mm to km: you need to go from 10^3 to 10^{-3}, or move the decimal point six places to the left.

333 mm is 0.000 333 km

Alternatively, if you want to convert from 333 mm to nm, you **would** have to go from 10^{-9} to 10^{-3}, or move the decimal point six places to the right.

333 mm is 333 000 000 nm

Practice questions

5 Calculate the following conversions:

a) 0.004 **m** into **mm** **b)** 130 000 **ms** into **s**
c) 31.3 **ml** into **µl** **d)** 104 **ng** into **mg**

6 Give the following values in a different unit so they make more sense to the reader.
Choose the final units yourself. (Hint: make the final number as close in magnitude to zero as you can. For example, you would convert 1000 m into 1 km.)

a) 0.000 057 **m** **b)** 8 600 000 **µl**
c) 68 000 **ms** **d)** 0.009 **cm**

Decimal numbers:

A decimal number has a decimal point.
Each figure *before* the point is a whole number, and the figures *after* the point represent fractions.

The number of decimal places is the number of figures *after* the decimal point.

For example, the number 47.38 has 2 decimal places, and 47.380 is the same number to 3 decimal places.
In science, you must write your answer to a sensible number of decimal places.

Practice questions

7 New antibiotics are being tested. A student calculates the area of clear zones in Petri dishes in which the antibiotics have been used.
List these in order from smallest to largest.
0.0214 cm^2 0.03 cm^2 0.0218 cm^2 0.034 cm^2

8 A student measures the heights of **a number of** different plants.
List these in order from smallest to largest.

22.003 cm 22.25 cm 12.901 cm 12.03 cm 22 cm

Standard form:

Sometimes biologists need to work with numbers that are very small, such as dimensions of organelles, or very large, such as populations of bacteria.

In such cases, the use of scientific notation or standard form is very useful, because it allows the numbers to be written easily.

Standard form is expressing numbers in powers of ten, for example, 1.5×10^7 microorganisms.

Look at this worked example. The number of cells in the human body is approximately 37 200 000 000 000.

To write this in standard form, follow these steps:

Step 1: Write down the smallest number between 1 and 10 that can be derived from the number to be converted. In this case it would be 3.72

Step 2: Write the number of times the decimal place will have to shift to expand this to the original number as powers of ten. On paper this can be done by hopping the decimal over each number like this:

until the end of the number is reached.

In this example that requires 13 shifts, so the standard form should be written as 3.72×10^{13}.

For very small numbers the same rules apply, except that the decimal point **has to** hop backwards. For example, 0.000 000 45 would be written as 4.5×10^{-7}.

Practice questions

9 Change the following values to standard form.
a) 3060 kJ **b)** 140 000 kg **c)** 0.000 18 m **d)** 0.000 004 m

10 Give the following numbers in standard form.
a) 100 **b)** 10 000 **c)** 0.01 **d)** 21 000 000

11 Give the following as decimals.
a) 10^{6} **b)** 4.7×10^{9} **c)** 1.2×10^{12} **d)** 7.96×10^{-4}

Other Suggested Activities

Reading

There are a great many really good biology books. Textbooks are obviously good for learning the actual specification theory.

'Popular science' books are much easier and enjoyable to read, and can give you a wonderful sense of the wider themes of biology. Any of the books below would be great reading before starting A level biology, and there are many more!

The Gene: An Intimate History by Siddhartha Mukherjee

The Wasp That Brainwashed the Caterpillar: Evolution's Most Unbelievable Solutions to Life's Biggest Problems by Matt Simon

The Immortal Life of Henrietta Lacks: by Rebecca Skloot

The Epigenetics Revolution: How Modern Biology Is Rewriting Our Understanding of Genetics, Disease, and Inheritance: Nessa Carey

Anything by Richard Dawkins is good. He's controversial because he's very outspoken on religion, but he's written some excellent books on evolution - particularly The Selfish Gene and The Blind Watchmaker.

Sapiens by Yuval Harari is amazing. It's not only about biology - there's history and anthropology too but it's a great (if long) read.

The Third Chimpanzee by Jared Diamond is good on human biology and evolution.

TV / Film

The Immortal Life of Henrietta Lacks (above) has been made into a film.

Brian Cox made a fantastic series called 'The Wonders of Life' which is at a perfect level as an introduction to A-level biology. You might be able to find it free online, or it's available on Amazon Prime.

Any of the series made by David Attenborough.

Manchester Museum

The museum has a fabulous exhibition on evolution.