Halesowen College

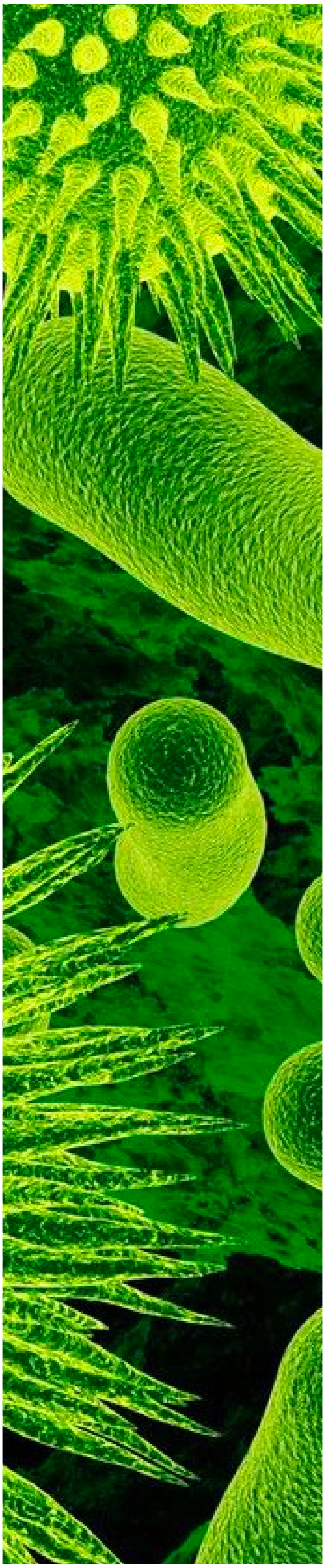
Be College Ready

A LEVEL BIOLOGY

INTRODUCTION AND PREPARATION WORK

This document will tell you a little about the structure of the Biology course at Halesowen College, hopefully answer some of your questions and contains the summer/induction preparation work which will form part of your induction assessments in September.

Please read through the contents carefully



PROBLEMS / QUERIES?

If you need any guidance, help or have any queries you can contact the course leader Catherine Hailes via email any time at ***chailes@halesowen.ac.uk*** She will endeavour to get back to you asap but please allow reasonable time for a reply.

We look forward to seeing you in September!

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SO YOU'RE THINKING OF STUDYING BIOLOGY AT A LEVEL?

It's a good idea to ask yourself why and make sure your reasons make good sense. Some of the common reasons we hear are:

- ***You like Biology*** **-** It's an advantage to like the subject but liking it at GCSE can often vanish at A level due to its difficulty
- ***Biology is easy*** **-** It is not easy at all – mostly due to complex processes and huge amounts of new terminology and content to memorise
- ***It's the easiest science*** **-** It may come across as the easiest science at GSCE but increased Maths demand and larger content make it just as hard as Chemistry, Physics and Geology
- ***I need it for my career*** **-** Will Biology give you the career options you want? What if you don't like it? Do you have an alternative? It may be hard to stay motivated on such a hard course if you know you don't need it for your degree choice!
- ***I couldn't think of anything else*** **-** I couldn't think of anything else is not a good enough reason to take it, this is a very hard course and you need to be fully motivated to put in the work required to do well
- ***It's practical-based*** **-** It does have a practical element but there is a large amount of theory lessons (would an Applied Science course suit you better?)

WHAT DOES IT TAKE TO SUCCEED?

- A strong ability AND passion for Biology and biological processes
- You will need to study Maths at some level alongside your Biology
- You will need to complete independent reading and comprehension tasks BEFORE and AFTER every lesson and track your progress - Independent Study Guide (ISG)
- At least 6 HOURS of independent study (including set work) every week
- You take an active role in lessons – regularly contribute to lessons and question what you are learning
- You are prepared to work harder than you have done before (consistently)

ENTRY REQUIREMENTS

- GCSE double award science (or 2 single award) grades A*, A or B (or equivalent).
- A minimum of five other GCSE grade 5/C or above (including English)
- A minimum of grade 5 in Maths
- You will be expected to study some form of Maths alongside AS Biology, either a full Maths A level or Functional Maths AS
- If you studied Applied Science (Btec) at school you should continue on to an Applied Science course and will not be able to join the A Level Biology course

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THE IMPORTANCE OF MATHS

- Maths content in Biology A levels has been increased by the government, 10% of your final exam is just Maths.
- Although it is level 2 Maths this is HARDER level 2 Maths than at GCSE, this will include magnification calculations, rates of reaction, % increase/decrease and statistical analysis of data.
- Without additional Maths input your grade is likely to suffer.
- If you are not taking a full Maths A level alongside you Biology you will be automatically enrolled on Functional Maths AS to improve your Maths skills and numerical confidence
- There will be a Maths assessment in your induction period - Prep work for this is outlined in the Summer/ Induction Prep. work!

COURSE COMBINATIONS

- It is really important you have a good combination of A Levels that work alongside each other
- Effective combinations will help make you more competitive when applying for university places
- Courses that combine well together will also support your learning e.g. Chemistry and Biology have a number of links and overlaps so what you learn in one will support and strengthen your knowledge in the other

WHAT DO GOOD COURSE COMBINATIONS LOOK LIKE

DEGREE COURSE	L3 COMBINATION OPTIONS	KEY POINTS
Medical Science, Vet, Doctor, Dentist, BioChemistry, Pharmacist	Biology, Chemistry, Maths	In competitive medical degrees this is by far the best combination you can have. You must do Chemistry AS along with Biology if you want to apply for these courses at uni. Maths is an excellent combination as it supports both the sciences and is a desired A Level for completive universities.
General Science but Biology based	Biology, Another science, Another science or Maths	If you know you want to study science at university but are not sure exactly what type of degree you want to do yet, having a range of sciences keeps your options open and again Maths is a highly desirable A Level so will make you more competitive. Other sciences could include Chemistry, Geology, and Physics (you must do Maths with this).
Midwifery, Nursing, Radiographer, Optometrist:	Biology/Chemistry, Ext Cert in Applied science Another science/social science Ext dip Health and Social Care or Medical Science	Many science-based courses do not need an A Level in Biology, you may do better with an Ext Dip either in Medical Science or even Health and Social care or 2 A Levels and an equivalent vocational qualification. Although any science course still needs a high level of commitment with less formal assessments many students perform better on these courses.

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WHAT DO GOOD COURSE COMBINATIONS LOOK LIKE

DEGREE COURSE	L3 COMBINATION OPTIONS	KEY POINTS
Unsure but probably not a Science Degree	Not A Levels in Science	All the science A Levels are very challenging and require a great deal of commitment and focus to do well in. If you are not thinking of studying science at university, they may not be the right choice for you.
Primary School Teaching	Maths, English, Ext Cert in Applied Science	This is a degree where science is not a necessity but may offer you an advantage, if you are committed you should be able to get a Distinction in a vocational science course while still being able to focus your efforts in getting good grades in other A Levels.
Psychology	Psychology, Sociology/ Maths/English, Ext Cert in Applied Science	Again this is a degree where science is not a necessity but may offer you an advantage, but it is most important that you do well in Psychology so by doing a Applied Science Extended Certificate this will relieve some of the strain to allow you to focus on your other A Levels at examination time.

REMEMBER:

- These are just examples - YOU NEED to research the courses and universities you are interested in NOW to make sure you make the right choices
- Your combinations make up a portfolio that universities will look at when deciding to offer you a place
- Psychology and sociology are social sciences, they do combine well with Biology and Maths but are not ‘true’ sciences
- Some of our vocational courses are equal to an A Level in UCAS points and are a good option if an A level is not a necessity or you are not predicted a high grade e.g. to study midwifery at Wolverhampton you do not need an A Level in Biology, they accept an Extended Certificate in Applied Science BUT some universities are more competitive and so may not accept a this sort of course in place of an A Level i.e. for midwifery at Birmingham you must have A Level Biology
- Don’t forget Geology – it’s a true science and if you enjoyed physical Geography it could be a good choice for you, it also overlaps with topics in Biology and Chemistry
- It is better to have 3 good grades (or equal UCAS points) that combine well than to choose a combination that is not right for you or not matched well and get 3 OK grades

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ASSESSMENT SUMMARY FOR A LEVEL BIOLOGY

In the 1st year will study 4 modules:

1. Development of practical skills in Biology
2. Foundations in Biology
3. Exchange and transport
4. Biodiversity evolution and disease

In the 2nd year you will study and additional 2 modules in the 2nd year:

5. Communication, homeostasis and energy
6. Genetics, evolution and ecosystems

AS Biology - Although we no longer put students in for the AS exams this may be considered on an individual basis. If this is the case the content of the 4 AS modules will be examined in 2 internal exams at the end of the 1st year:

- Breath in Biology (70 marks) 50%
- Depth in Biology (70 marks) 50%

All students will complete an Assessment at the end of the 1st year covering the content covered to date and the grades achieved will determine if you are able to continue onto the 2nd year of the course.

A Level Biology - the content of the 6 modules taught over the 2 years will be externally examined in 3 exams at the end of the 2nd year:

- Biological processes (100 marks) 37%
- Biological diversity (100 marks) 37%
- Unified Biology (70 marks) 26%

- A2 pass rates are outstanding (100% for last 2 years)
- You will need to achieve a D or higher in the 1st year internal exams AND have good levels of attendance and behaviour to go on to the 2nd year of the course to achieve the full A level
- Your practical endorsement will be reported separately – so you will receive a grade for your A Level accompanied with a Pass or Fail for your practical skills

PRACTICAL ENDORSEMENT

- A level Biology no longer has any assessed practical examinations/coursework.
- Instead you will need to complete a number of practical activities in class in order to develop your practical investigation skills for your Practical Endorsement which will be awarded alongside your A Level grade.
- These skills will be informally assessed during the lessons (so good attendance is even more important as you cannot 'catch up' on practical's) and then examined in a practical based exam questions in the papers at the end of the course.
- As well as staff keeping a record of attendance and progress during practical activities you will be required to keep a log book.
- Offers from universities will include a statement of whether or not you need a Pass or Fail in the Practical

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HAVE YOU CONSIDERED… BTEC EXTENDED CERTIFICATE IN HUMAN BIOLOGY

- Contains coursework as well as external examinations so all the pressure is not on the final exams
- Will be taught alongside 2 other A levels
- 1st year includes an exam on key biological principals (very similar to what is taught in the A Level Biology) and an Internally Assessed Assignment based Unit, last year this was on Microbial Biology.
- A minimum of five GCSE grades at C or above including Double Science, and Grade D or more in Maths and English
- Ideal if you studied Applied Science at school

KEY POINTS

- Biology at A Level is a hard subject and the Ext Cert is still challenging but.....
- If you work and get involved in lessons....
- Do regular independent research and seek help often
- YOU WILL SUCCEED!
- Make sure you have selected the right combination of courses for your future plans by researching your options!

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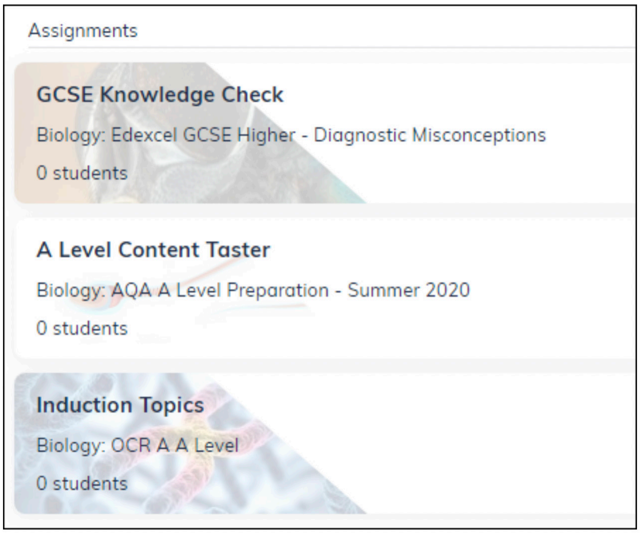
SUMMER/INDUCTION PREPARATORY WORK

The Summer/Induction Preparation work is split in to 2 sections.

PART A: BIOLOGICAL CONTENT

- We have selected some online Biology work for you to start over the summer/during induction.
- In order to complete the work you need to follow this link: *https://app.senecalearning.com/dashboard/join-class/pv4q64auyd*
- The link will take you to the: Halesowen College A Level Biology 20/21 class
- When you join the class if you click on Assignments you will see a number of assessments have been set on here already:



- Each of these Assignment has been chosen for a different reason:
    - **GCSE Knowledge Check:** this covers you GSCE knowledge and will help us to see how prepared you are for A Level content.
    - **A Level Content Taster:** this will allow you to see the sort of level and topics you will be covering in the A Level (although we are on OCR not AQA the topics that are covered are shared across the exam boards) to give you an idea of what to expect.
    - **Induction Topics:** this covers the topics that you will cover in the 1st few weeks of teaching so will form part of your Induction Assessments and help you to revise/review and learn the topics you will be tested on in the Induction Assessment.
- We would like you to **complete all of the Assessments set,** you will have until approximately week 3 of the Induction Period to complete this work so the more you can cover over the summer will leave more time for focusing on other tasks set and allow you to ‘get ahead’ and prepare for the learning to come.
- You can complete the activities as many times as you like, we will take the most recent scores. Every time you complete an assessment it will change to help you work on the questions you did not get right in previous attempts so you won’t just be doing the same thing again. It would be great seeing you repeating the Assessments to get 100% and to improve you memory score (each time you repeat a section of learning this increases).

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The marks obtained, number of attempts, memory score and time spent learning for these assessments will feed through to us and will be used to help us determine your commitment levels, ability and suitability for the course along with other assessments and information gathered in the induction period so it is vital they are completed, preferably before teaching starts as additional work will be set in the first lesson.

PART B: MATHS SKILLS

In preparation for your Induction Maths Assessment we want you to work on your Maths skills. As discussed in this document Maths now forms a significant part of your course and it is important that you work on your Maths skills throughout the course. With this in mind we will be assessing your Maths skills in the induction period.

The assessment will be based on skills covered in the following pages. The documents making up Part B are titled:

- **M0 Arithmetic and numerical computation content Tutorials**
- **M0 Arithmetic and numerical computation Practice Questions Document**
- **M0 Arithmetic and numerical computation Mark Scheme Document**

Instructions of what you need to do are in the Tutorials document so read this first

Skills covered in these documents will be assessed in a separate unseen test paper during the induction period AND you will be expected to hand in a copy of the marked Practice Questions pages for review in the 1st week of lessons.

MATHS SKILLS – M0 ARITHMETIC AND NUMERICAL COMPUTATION TUTORIALS

There are 5 areas covered in this section of Maths skills:

- **M0.1 – Recognise and make use of appropriate units in calculations**
- **M0.2 – Recognise and use expressions in decimal and standard form**
- **M0.3 – Use ratios, fractions and percentage**
- **M0.4 – Estimate results**
- **M0.5 – Use calculators to find and use power, exponential and logarithm functions**

In this document each area has its own section with a tutorial explaining and giving examples of the skills. You will also need to complete the **Practice questions document** and mark it using **Mark schemes document.**

You need to work through each of the tutorial sections and then complete and mark the practice questions to improve and develop your Maths skills in this area (remember this is only 1 of 5 areas of Maths skills in the A Level).

In the induction period you will be asked to hand in your marked copy of the **Practice questions document** for review by your teacher AND you will be given a **M0 Maths Skills** Test to assess your progress with this work. Therefore, we are not only testing your Maths skills but your ability to learn independently and prepare for a known assessment in advance.

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M0.1 – RECOGNISE AND MAKE USE OF APPROPRIATE UNITS IN CALCULATIONS

Section M0.1 explains the importance of using appropriate units in calculations and being able to convert between them. If your measurement is getting larger, for example from nm to mm, then you need to divide by the appropriate factor. If your measurement is getting smaller, for example from cm to mm then you need to multiply. There are many typical measures including distance (or length), mass, time etc. each with multiple units to convert between, and it is important for learners to choose the most appropriate unit to use.

Rates of change show a quantity per a unit of time, with the unit of time always expressed as "to the minus 1". Other examples have rate of change measured as quantity per length, again with the unit of length being made into negative powers. In some cases learners will need to combine two or more units.

TUTORIALS

Learners may be tested on their ability to:

- convert between units e.g. mm^3 to cm^3 as part of volumetric calculations
- work out the unit for a rate e.g. breathing rate.

UNITS

Units indicate what a given quantity is measured in. Generally, a measured quantity without units is meaningless, although there are some exceptions, like pH for example.

In an exam, you would be expected to be able to convert between different metric units, such as between mm and cm without being given the information about how many mm there are in a cm.

Converting between units involves multiplying or dividing by an appropriate factor. The factor is determined by how many of one unit there are in the other unit. For example, there are 1000 m in a km, so in this case, converting between metres and km your conversion factor would be 1000.

If your measurement is getting larger, for example from mm to m, then you need to divide by your factor. If your measurement is getting smaller, for example from m to mm then you need to multiply by your factor.

Just remember that if the unit gets bigger the number should get smaller, and if the unit gets smaller then the number should get bigger.

For example, say we are converting 7 µm to mm. There are 1000 µm in one mm, so the conversion factor is 1000 or 10^3.

As the measurement is getting larger, you divide your number by the factor.

Therefore, we divide 7 µm by 10^3 which equals 0.007 mm which in standard form (see section M0.2 for this) is 7×10^{-3} mm.

Let's look at units of length you may encounter and how they relate to the metre.

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We have kilometres which are 1000 m, decimetres are a tenth of a metre, centimetres a hundredth, millimetres a thousandth of a metre, micrometres are 10^{-6} metres and nanometres are 10^{-9} metres.

Units of length	Abbreviation	Number of metres	
kilometre	km	1000 m	10^3 m
metre	m	m	m
decimetre	dm	1/10 m	10^{-1} m
centimetre	cm	1/100 m	10^{-2} m
millimetre	mm	1/1000 m	10^{-3} m
micrometre	µm	1/1000000 m	10^{-6} m
nanometre	nm	1/1000000000 m	10^{-9} m

These units of length are also used when dealing with area and volume.

Area is expressed as length squared, such as square centimetres.

You may need to work out how many square centimetres there are in a square metre. There are 100 cm in a metre, so if you were to convert cm to metres the conversion factor would be 100. But you are dealing with squares, so there are 100 times 100 cm^2 in a m^2. So here your conversion factor would be 100 times 100, which is 10,000, or 10^4.

So 4 m^2 expressed in square centimetres would be 4 x 10,000 cm^2. Remember that here the units are getting smaller – metres to centimetres – so the number gets bigger – you multiply by your factor.

Likewise, volume is expressed as length cubed.

So 4 m3 expressed in cm3 would have a conversion factor of 100 x 100 x 100, which is 106. So there are 106 cm3 in one m^3 and 4 m^3 expressed in cm^3 would be 4 x 10^6 cm^3.

The main units of volume are mm^3, cm^3 and dm^3. However, if we are dealing with liquids we often use the unit 'litre' (l) instead. Here are the more commonly used units of volume for liquids. Note that a litre is equivalent to dm3 and a millilitre is equivalent to cm3.

Units of volume	Abbreviation	How it relates to the litre		Equivalence in length measurements
litre	*l*	*l*	*l*	dm^3
millilitre	m*l*	10^{-3} *l*	1/1000 *l*	cm^3
microlitre	µ*l*	10^{-6} *l*	1/1000000 *l*	mm^3
nanolitre	n*l*	10^{-9} *l*	1/1000000000 *l*	

You will encounter units of mass and here are common units of mass and how they relate to the gram. For example, the microgram is a millionth of a gram.

Units of mass	Abbreviation	How it relates to the gram	
kilogram	kg	10^3 g	1000 g
gram	g	g	g
milligram	mg	10^{-3} g	1/1000 g
microgram	µg	10^{-6} g	1/1000000 g
nanogram	ng	10^{-9} g	1/1000000000 g

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And here are units of time and how they relate to the standard unit of the second.

Units of time	Abbreviation	How they relate to the second	
second	s	s	s
millisecond	ms	10^{-3} s	1/1000 s
microsecond	µs	10^{-6} s	1/1000000 s
nanosecond	ns	10^{-9} s	1/1000000000 s

If we are dealing with times greater than a second, we use minutes, hours, days, etc.

You must always think about which unit you are using when communicating a measurement. For example, although it is true that an average mitochondrion has a length of 0.0000055 m, it is more appropriate to state the measurement as 5.5 µm. Likewise, if the volume of a liquid is 56000 ml it would be better to refer to it as 56 l or 56 dm^3.

It is the clear communication of the number and its unit which is the most important thing to consider.

RATES OF CHANGE

A rate of change is the quantity being measured per unit of time. Now this per means 'divided by'. So quantity measured divided by the unit of time equals the rate of change.

An important mathematical notation to remember is that whatever is underneath the division line (the denominator) can also be written to the negative power. So the rate of change would be equal to the quantity being measured times the unit of time to the minus one.

So remember, whenever you see the term 'per' it means 'divided by' and you need to write the units with the correct mathematical notation, with the denominator expressed to its negative power.

For example, a woodlouse might crawl at 10 cm per second.

This would be written as 10 cm s^{-1}.

If a patient is on a drip, the number of drips per minute would be drips min^{-1}.

There are other examples where the rate of change is measured as quantity per length, area or volume. Here the same principle applies, with, for example, the unit volume being made into its negative power:

For example, as a slime mould develops the number of cells per unit volume might increase, so you would be looking at the number of cells per mm^3 or cells mm^{-3}. The power stays the same, but the negative sign in front of it tells you that you divide by mm^3. So the rate of change of the slime mould colony would be measured in number of cells per cubic mm per s, written as cells mm^{-3} s^{-1}.

There are other examples where you would need to combine two or more units, for example, light energy is measured in photons per square metre per second – the number of photons that hit a square metre every second and you would express your data in photons m^{-2} s^{-1}. The rate of change would be measured in a change in the number of these photons hitting a square metre every second over a period of time. So if you were to measure the rate of change in light intensity you would express your data in photons per square metre per second per second: photons m^{-2} s^{-1} s^{-1} which is written as photons m^{-2} s^{-2}

Rates of change are used in many areas of Biology: For example:

Bacterial growth rates are measured as the number of bacteria per hour expressed as bacteria h^{-1}

Breathing rate would be expressed as breaths min^{-1}

Rate of change in temperature would be ^{o}C s^{-1}.

You just need to remember that the minus sign is simply a notation that tells you the unit is the denominator.

So if we return to the example of light energy, measured in photons m^{-2} s^{-2}, this tells you that you take the change in the number of photons hitting each square metre each second and divide that by the time over which the change took place.

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M0.2 – RECOGNISE AND USE EXPRESSIONS IN DECIMAL AND STANDARD FORM

You are usually expected to record raw data to the same number of decimal places, which is simply how many digits come after the decimal point. When adding and subtracting decimals the answer should be given using the lowest number of decimal places used in the calculation. This involves rounding off the number to a certain point depending on how many decimal places you are recording, with rounding up being required if the next number is 5 or above.

Many numbers in Biology, particularly with calculations involving large or small numbers, will be written in standard form, in the format: $a \times 10^n$

where *n* is a whole number (also known as an integer)

and a is between the values of 1 and 10.

You need to remember the "power laws" in order to deal with the value of n.

You are expected to be able to express results in standard form and to also convert between standard and decimal forms.

TUTORIALS

Learners may be tested on their ability to:

- use an appropriate number of decimal places in calculations, e.g. for a mean
- carry out calculations using numbers in standard and ordinary form, e.g. use of magnification
- understand standard form when applied to areas such as size of organelles
- convert between numbers in standard and ordinary form
- understand that significant figures need retaining when making conversions between standard and ordinary form, e.g. 0.0050 mol dm^{-3} is equivalent to 5.0 x 10-3 mol dm^{-3}

DECIMAL PLACES

You need to understand and use the appropriate number of decimal places or significant figures in calculations.

Decimal places are simply how many digits come after the decimal point.

For example, all of these numbers have the same number of decimal places but may have a different number of significant figures.

Number	Decimal places	Significant figures
11.37	2	4
105.82	2	5
5.69	2	3
0.02	2	1

Significant figures (covered in detail in section M1.1) are numbers with meaning, starting from the first non-zero digit. For example.... now these numbers have the same number of significant figures but differ in the number of decimal places.

Number	Decimal places	Significant figures
11.3	1	3
105	0	3
5.69	2	3
0.0200	4	3

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When you are carrying out an experiment, you will be expected to record raw data to the same number of decimal places (rather than the same number of significant figures). These decimal places are used to tell the reader the accuracy of your data collection. For example when measuring volumes 5.0, 5.5, 6.0 and 6.5 ml half a ml would be about right if you were using a 10 ml measuring cylinder. However, if you used a Gilson pipette you may be justified in using two decimal places.

Measurement	Volume (m*l*) X	Volume (m*l*) ✓
1	9	9.0
2	9.5	9.5
3	10	10.0
4	10.5	10.5

Processed data (i.e. what has been calculated), can be recorded up to one decimal place more than the raw data. For example, if you were asked to calculate the mean for the above example, from the data using a measuring cylinder the answer could be recorded as 9.75 ml. If you were using the data from the Gilson pipette, you could express the mean as 9.750 ml.

Measurement	Volume (m*l*) X	Volume (m*l*) ✓
1	9	9.0
2	9.5	9.5
3	10	10.0
4	10.5	10.5
		Mean = 9.75

When adding and subtracting decimals the answer should be given using the lowest number of decimal places used in the calculation. This is because you can't claim your degree of accuracy to be any higher than what your data say. This involves rounding off the number to a certain point depending on how many decimal places you are recording, with rounding up being required if the next number is 5 or above. For example, 25.5 – 8.31 = 17.19. The lowest number of decimal places in the calculation is one decimal place so the answer would therefore be 17.2.

This is particularly important when measuring quantities by difference such as mass, temperature and volume. The measurements made should be recorded to a specific number of decimal places, and when calculating the difference between the measurements, this number of decimal places should be maintained.

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For example, if the following temperature measurements were recorded:

Initial temperature **22.5 °C**

Final temperature **29.5 °C**

The temperature difference would be 29.5 – 22.5 = 7.0 °C. This is given to 1 decimal place, to match the resolution of the measured values as this is the degree of accuracy of our data. The '0' is significant, so must be included.

The number of decimal places you show in your collection of raw data or in your answer at the end of a calculation is communicating information about the degree of accuracy you are claiming, and this is important information in a scientific context.

STANDARD FORM

Many numbers in Biology, particularly with calculations involving large or small numbers, will be written in a scientific notation known as standard form. A number written in standard form is: $\mathbf{a \times 10^n}$

where n is a whole number (also known as an integer)

and a is between the values of 1 and 10

Standard form makes writing and reading long numbers easier. For example, 1 million in standard form is 1×10^6.

2 million would be 2×10^6.

You need to remember the "power laws" in order to deal with the value of n.

The multiplicative rule is where you add the powers

The division rule is where you subtract one power from the other

The power rule is where the powers are multiplied

The reciprocal rule is where the negative sign tells you it is the denominator

And the root rule is where the power is divided by the root

For example, for $2 \times 10^4 \times 8 \times 10^3$, we know that 2 x 8 = 16 so our a value is 16. For the n value we need to apply the multiplicative rule and add the powers, so $10^4 \times 10^3$ equals 10^7. Therefore the whole answer is 16×10^7.

However, be careful that you don't make a mistake by forgetting that a must be between 1 and 10.

So here the multiplicative power rule has been applied and there is the correct numerical answer, the answer is not in standard form because the a value is not between 1 and 10. Therefore, 16 needs to be 'scaled' down by dividing by 10. Importantly - if we divide the numerical answer by 10, we have to increase the power by 1 in order to keep the numerical value the same. Therefore 16×10^7 becomes 1.6×10^8.

Here are some other examples of numbers written using standard form:

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Number	Standard form
456000	4.56×10^5
2068567	2.068567×10^6
46	4.6×10^1
3789	3.789×10^3
4	4×10^0
0.0005	5×10^{-4}
0.4678	4.678×10^{-1}
0.000030006	3.0006×10^{-5}
0.3040506	3.040506×10^{-1}

You are expected to be able to express results in standard form and to also convert between standard and decimal forms. For example, the size of a cell may be 0.0001 m in ordinary (decimal) form. This would be written in standard form as 1×10^{-4} m.

In Biology raw data is usually reported to the same number of decimal places rather than the same number of significant figures including when converting between standard and decimal forms.

By applying this to the data from the previous table, we get this third column:

Number	Standard form	Standard form to 1 decimal place
456000	4.56×10^5	4.6×10^5
2068567	2.068567×10^6	2.1×10^6
46	4.6×10^1	4.6×10^1
3789	3.789×10^3	3.8×10^3
4	4×10^0	4.0×10^0
0.0005	5×10^{-4}	5.0×10^{-4}
0.4678	4.678×10^{-1}	4.7×10^{-1}
0.000030006	3.0006×10^{-5}	3.0×10^{-5}
0.3040506	3.040506×10^{-1}	3.0×10^{-1}

You have to be careful though because, by reducing the number of significant figures, you are altering your communication about the degree of accuracy you are claiming to have.

In M0.1 we looked at converting between units to express a measurement clearly. An alternative is to keep units the same but use standard form. This is most useful in Biology when you want to make a clear comparison between two things. You might want to show that a bacterium was 2 µm long and that an Amoeba was 1 mm. It would be better to communicate this as the bacterium being 2×10^{-3} mm and the Amoeba being 1 mm. Or you could say that the bacterium is 2 µm and the Amoeba is 1×10^3 µm. In this way you are using standard form to communicate clearly the difference in length.

A LEVEL BIOLOGY

M0.3 – USE RATIOS, FRACTIONS AND PERCENTAGE

Section M0.3 explains the use of ratios, fractions and percentages in calculating percentage yields and percentage change, surface area to volume ratios and phenotypic ratios as well as using scales for measuring.

A percentage is simply a fraction out of 100 and is used to calculate what quantity a "part" is out of a "whole". By dividing the "part" by the "whole" and multiplying by 100, it is converted into a percentage. Percentages can be used to determine how much a quantity has increased or decreased by (percentage change) as well as calculating the efficiency of reactions using how much product is formed (percentage yield).

Ratios are used to describe the relationship between values and is reported as "x : 1". Ratios are most commonly used to describe the relationship between surface area and volume (surface area to volume ratios) or in genetics in comparing offspring (phenotypic ratios).

TUTORIALS

Learners may be tested on their ability to:

- **Calculate percentage yields**
- **Calculate surface area to volume ratio**
- **Use scales for measuring**
- **Represent phenotypic ratios (monohybrid and dihybrid crosses)**

PERCENTAGE

'Percentage' means 'out of 100'

x percent means x divided by 100.

$$x\% = \frac{x}{100}$$

So a percentage is a fraction of 100. For example, 30 percent as a fraction is 30 out of 100

$$30\ \% = \frac{30}{100}$$

Let's look at how you convert 30/100 into a percentage. First you work out 30/100 as a decimal, which is 0.3, and then you multiply this by 100. Remember that percent means 'out of 100'.

Let's convert 30/110 into a percentage. Firstly work out 30/110 as a decimal – you might need a calculator to do this. And then multiply your answer by 100, which gives you 27 %. Working backwards, 27 % means 27 out of 100. And this is equivalent, or equal to, 30/110.

In Biology you may be required to find a percentage of a quantity. For example in studying populations you might want to know the gender distribution in a population. To work out the percentage you need to divide the 'part' (the specific data you are looking at) by the 'whole' (the total number). To convert this into a percentage you multiply your answer by 100 %.

$$\frac{part}{whole} \times 100\% = \ \%$$

For example, in a population of 2200 rabbits there are 1000 males and 1200 females. You want to know the percentage that is female. Here 1200 is the 'part' and 2200 is the 'whole'. So we divide 1200 by 2200, and multiply by 100 % to express the answer as a percentage. The answer is 54.5 %.

$$\%\ \text{female} - \frac{1200}{2200} \times 100\ \% = 54.5\ \%$$

A LEVEL BIOLOGY

PERCENTAGE CHANGE

Percentage change is a useful calculation to compare values and determine how much a quantity has increased or decreased by.

In percentage change the 'part' is the increase and the 'whole' is the original quantity.

For example, you might subtract the initial mass from the final mass to find the increase. Then divide this by the initial mass. This is then multiplied by 100 to give the answer as a percentage. Doing it this way, you have to keep an eye on whether it is an increase or a decrease and make it clear in your answer.

For example, if the initial mass of some cellular tissue in an osmosis investigation is 5.6 g and after a day it is 4.7 g. You might want to find out the percentage change.

The percentage change is 4.7 – 5.6 divided by 5.6 and then multiplied by 100% which gives you a percentage change of -16 %. You could refer to this as a 16% decrease.

$$\frac{(4.7-5.6)}{5.6} = -0.16$$

0.16 x 100 = - 16 % = 16 % decrease

Another way to calculate percentage change uses the idea of a multiplier.

Percentage change is calculated using this formula:

The original quantity times a multiplier equals the new quantity

The key point to remember is that a multiplier of 1 represents a change of 0 %, because if you substitute 1 for the multiplier in the equation, then the Original quantity equals the new quantity

The difference between the multiplier and 1, multiplied by 100 %, is the % change.

So a multiplier of 1.43 represents an increase of 43 % because 1.43 minus one, multiplied by 100 % equals 43 %, whilst a multiplier of 0.83 represents a decrease of 17 % because 1 minus 0.83 = 0.17, multiplied by 100 % equals 17 %.

Let's return to the previous example where the initial mass of some cellular tissue in an osmosis investigation is 5.6 g and after a day it is 4.7 g

Then to work out the percentage change we have to work out the value of the multiplier:

The initial mass is 5.6 g, the final mass is 4.7 g.

Remember that the original quantity times the multiplier equals the new quantity.

Rearranging this equation to calculate the multiplier, gives you the new quantity divided by the original quantity, which is 4.7 divided by 5.6, which is 0.84.

Initial mass = 5.6 g, Final mass = 4.7 g

Original quantity x *Multiplier* = New Quantity

$$5.6 \times \mathit{Multiplier} = 4.7$$

$$\mathit{Multiplier} = \frac{4.7}{5.6} = 0.84$$

This represents a decrease of 1 - 0.84 which equals 0.16. To express this as a percentage you need to multiply by 100 % which gives you a 16 % decrease.

It doesn't matter which method you use as long as you understand the principles behind the method you adopt.

A LEVEL BIOLOGY

PERCENTAGE YIELD

The percentage yield is a way of looking at the limitations of a process.

You can work out mathematically what goes in and what comes out, but there are many steps in a biological process and the actual yield is rarely the same as the theoretical yield.

The percentage yield is a measure of the limitations of a biological or chemical process. You are essentially saying what percentage of the theoretical yield am I ending up with at the end of this process?

One area where percentage yield is relevant is in scientific experiments where yield can be limited by the amount of a reagent that is present. In these situations it is important to be able to work out how efficient a reaction is under certain conditions. This is where it helps to calculate a percentage yield.

For percentage yield calculations, the actual yield – the amount of product actually obtained in a chemical reaction – is divided by the theoretical yield – the amount of product that could possibly be produced according to the starting amount of the limiting reagent. To convert this into a percentage you then multiply by 100 %.

For example, imagine a scenario where you were producing insulin from genetically modified bacteria. You calculated that with everything you started with at the beginning you had a theoretical yield of 120 mg of insulin. However, when you carried out the procedure you only ended up with 90 mg – the actual yield.

The percentage yield is the actual yield, 90 mg, divided by the theoretical yield, 120 mg, multiplied by 100 %, which equals 75 %

In a big manufacturing process these calculations are very important as getting the highest possible percentage yield might be the difference between a process being financially viable or not.

RATIO

A ratio is a relationship between two numbers and is used to compare values, with the quantities being in direct proportion.

When presenting the ratio of one quantity to another it is reported in the form x : 1,

x is found by dividing the first quantity by the second. So, expressing 40 to 5 as a ratio, 40 would be divided by 5. This would be expressed as a ratio of 8 to 1.

x= 40= $\frac{8}{5}$ ratio = 8:1

Surface area to volume ratio is important in understanding processes such as gas exchange, heat loss and diffusion rates. Surface area to volume ratio is affected by size and shape. So keeping the volume of an object the same, but changing its shape, changes its surface area to volume ratio. Keeping the shape the same, such as a sphere, but changing the volume will also affect its surface area to volume ratio.

The surface area to volume ratio is calculated by dividing the surface area by the volume.

For example, a cube has sides of 1 cm. The total surface area is the sum of the areas of each side. A cube has 6 equal sides, each side of this cube has an area of 1 cm2. Therefore the surface area is 1 cm2, multiplied by 6. So the surface area of the cube is 6 cm2.

The volume of the cube is calculated by multiplying the length of each side:

1 cm x 1 cm x 1 cm = 1 cm3

The surface area to volume ratio is 6 divided by 1 which equals 6. Note that ratios have no units.

The ratio is 6:1 but in this scenario it is normally expressed as a single number

Ratios are commonly used in genetics to represent, for example, phenotypic ratios for monohybrid and dihybrid crosses.

A LEVEL BIOLOGY

For example, in a fruit fly genetics experiment the offspring were counted; 78 fruit fly offspring had red eyes and 20 had brown eyes

Phenotype	Number of offspring
Red eyes	78
Brown eyes	20

To calculate the ratio of Red-eyed flies to Brown-eyed flies 78 is divided by 20, which equals 3.9.

So the ratio of Red to Brown is 3.9:1

If we now look at the ratio of brown-eyed flies to red-eyed flies, we would divide 20 by 78 which equals 0.256. This can be rounded up to 0.3. So the ratio is 0.3:1

When more than two quantities are all being compared the order in which the ratio is given follows the order in which the different quantities are named and the last one will always be given as 1, with the other numbers all relative to that.

For example, imagine there were four options for eye colour in flies: red, purple, scarlet and white, and the numbers of offspring are 127, 50, 32 and 8 respectively. The respective ratios are all relative to the last number. Therefore you divide each by the last number, which here is 8.

Phenotype	Red eyes	Purple eyes	Scarlet eyes	White eyes
Number of offspring	127	50	32	8
Calculating the ratio of offspring	$\frac{127}{8} = 15.9$	$\frac{50}{8} = 6.3$	$\frac{32}{8} = 4.0$	$\frac{8}{8} = 1$

The ratios of Red to Purple to scarlet to White is therefore 15.9 : 6.3 : 4.0 : 1

Again remember that with ratios there are no units.

SCALES FOR MEASURING

NB: This topic is covered thoroughly in sections M0.1 and M1.8.

Units show what a quantity is measured in, and generally a measured quantity without units is meaningless.

Learners would be expected to be able to convert between different units, as detailed in section M0.1, with respect to the scale they are measuring in.

For example, bacteria would generally be measured in micrometres (µm), whereas an elephant would be measured in metres (m). As bacteria and elephants are nowhere near the same size, this example shows why understanding scales for measurements and the corresponding units are so important.

Being able to accurately label diagrams and pictures according to scale is essential, as detailed in section M1.8, and can be denoted by a sentence, ratio or scale bar.

A LEVEL BIOLOGY

M0.4 – ESTIMATE RESULTS

Estimating allows you to see whether the answer you've calculated makes sense or whether you may have made a mistake. Sometimes this may involve working out an answer based on an already known quantity, such as the average weight of a human being 70 kg. Other times you need to round a value up or down to create nicer numbers to work with. Estimating is very useful for spotting mistakes made with units, decimal points or general mistakes with putting in the wrong number.

TUTORIALS

Learners may be tested on their ability to:

- Estimate results to sense check that the calculated values are appropriate.

It's very easy to write the wrong number or to press the wrong number on a calculator. Without having an estimation, your result can clearly be wrong but go unnoticed. You need to ask yourself, "Does that look right?". By comparing your calculated answer with your estimation it is easier to spot whether you have made a mistake.

For example, say we surveyed a small area of woodland and found 8 mice in 10 m2. And we wanted a rough estimate of how many there might be in the woodland which was 1 km2. We know that 1 km2 is equal to 106 m2 (see M0.1 if you are unsure about this bit) so we know that the answer will be many orders of magnitude higher than the number of 8 mice in 10 m2. The sum is 8 mice x 106 m2 divided by 10 m2. Which is 800,000 mice in 1 km2. If you put the numbers into the calculator in the wrong order, or divide when you should be multiplying, you know that a number that has not got five or six zeros after it, is wrong.

In this example you could work out the number without a calculator but what if you found 8 mice in 14 m2 and the woodland had an area of 2.3 km2.

Knowing that there are 106 m2 in a km2 tells you that the answer will be around 106 mice.

The calculation is 8 mice x 2.3 x 106 m2, divided by 14 m2. The answer is 1,314,286, rounded to the nearest whole mouse. This is better communicated in standard form (see M0.2 if you are not sure about this) which gives 1.3 x 106 mice.

The key message is to think about your answer, and have a rough idea of its order of magnitude before you get out your calculator.

Sometimes the best way to make estimations in calculations is to round numbers (particularly decimals) up or down to a number you're happier working with. For example, the calculation: 4.9/11.2 could be estimated as 5/10 = 0.5

If you get the answer 54.88 then the estimate shows that you have done something wrong – in this case you would have pressed the multiply key instead of the divide key on your calculator.

Estimating is a useful skill for any biologist and can be used in all sorts of contexts – from the working out the number of bacteria in a dilution, to measuring lengths when using a microscope, to ecological sampling.

Think about your answer, and ask yourself, "Does this answer make sense?". I cannot stress enough how important this is, in all calculations you do..

A LEVEL BIOLOGY

M0.5 – USE CALCULATORS TO FIND AND USE POWER, EXPONENTIAL AND LOGARITHM FUNCTIONS

Different models of calculators have different buttons to enter powers and logarithms. Some examples of different calculator symbols for powers include: ‘xy’, ‘10x’, ‘^’ and ‘exp’.

The two most useful logarithm bases are base-10 (common logs) or base-e (natural logs). Common logs are written as “log(x)” and have the calculator button “log”. Natural logs are written as “ln(x)” and have the calculator button “ln”.

You will be expected to be able to estimate the number of bacteria grown over a certain length of time. Bacterial cells multiply exponentially. The formula to find the number of cells after n generations is:

$$N=N_0\times 2^n$$

where N_0 = initial number and n = division number.

TUTORIALS

Learners may be tested on their ability to:

- estimate the number of bacteria grown over a certain length of time.

Note: this is an A Level mathematical skill, not assessed at AS Level

Different models of calculators have different ways of entering powers and using them. Some examples of different calculator symbols include: ‘xy’, ‘10x’, ‘^’ and ‘exp’.

But let’s look at logs first. Logarithms (or logs) can have any positive value as their base, but the two bases used in Biology are 10, referred to as common logs, and the base 2.71828…etc , the value for e, referred to as natural logs. On a calculator, log to the base 10 is the button with log written on it, which can be written as “log(x)”. Log to the base e has the calculator button ln and is written as “ln(x)”

Common log	Natural log
Base-10	Base-e
log(x)	*ln(x)*
log	ln

You need to know how to use the natural log and common log buttons.

Have a go at working out both the natural and common logs of 3 x 10^5.

You should end up with 5.477 for common logs and 12.611 for natural logs.

A LEVEL BIOLOGY

You also need to know how to use the exponential function on your calculator. You may be expected to estimate the number of bacteria grown over a certain length of time. Bacterial cells multiply exponentially. If a culture of bacteria increases by a factor of 2 (which means the population doubles) in one generation, then the formula to find the number of cells, N, after n generations is:

$N=N_0\times 2^n$ **N_0 = initial number** **n = number of divisions, or generations**

N_0, the initial number at time zero, multiplied by 2 to the power little n where little n is the number of divisions, or generations..

For example, one bacterial cell will divide about every 20 min under standard conditions.

The cells produced will form a sequence of numbers:

Division 0	Division 1	Division 2	Division 3	Division 4	Division 5	Division 6	Division 7
1	2	4	8	16	32	64	128

For example, after the 6th division there will be 64 cells. The formula to calculate the number in the nth generation is given by the formula $N = N_0 \times 2^n$ where n is the number of generations.

So, how many cells will there be after 4 hours?

You have to work out how many divisions there have been in 4 hours. The bacteria divide once every 20 minutes, which is three times an hour. Therefore, in 4 hours the bacteria will divide 12 times. Little n will be equal to 12. You then put this into the original equation.

You started with one bacterial cell, so $N_0=1$

So the number of cells, capital N, is equal to 1 x 2 to the power 12. Which means there are 4096 bacterial cells after 4 hours

60 minutes / 20 minutes = 3 divisions an hour

4 x 3 = 12 divisions

$N=N_0\times 2^n = 1 \times 2^{12} = 4096$ bacterial cells

To do this calculation successfully you need to know how to enter exponential powers into your calculator.

It is important for you to get to know how to put numbers into your calculator to get the right answers out of it.

Halesowen College

Be College Ready

A LEVEL BIOLOGY

NAME:

MATHS SKILLS – M0 ARITHMETIC AND NUMERICAL COMPUTATION PRACTICE QUESTIONS

This part of this document needs to be printed out, completed and marked for handing in during the induction period, this will be at the end of your 1st week of teaching. If you do not have access to a printer, you can write it out on paper and hand this in. This is so we can see you have completed the activity set. Please mark your work in a different colour and add up the marks for each section and complete the table below

Use the tutorial document to practice and go through the skills to help you complete this work.

This is NOT a test and you can use the Tutorial document to help you complete it, and the Mark scheme Document to check through your answers. This is a practice document to help you prepare for the test you will be given on these topics in Induction. You may complete it more than once.

The questions are split into the 5 areas covered in this section of Maths skills. Please add up the marks for each section and complete the table below:

Section Title	Mark	Percentage
M0.1 – Recognise and make use of appropriate units in calculations	______/42	
M0.2 – Recognise and use expressions in decimal and standard form	______/12	
M0.3 – Use ratios, fractions and percentage	______/18	
M0.4 – Estimate results	______/9	
M0.5 – Use calculators to find and use power, exponential and logarithm functions	______/6	

Remember: in the induction period you will be asked to hand in your marked copy of the Practice questions document for review by your teacher AND you will be given a M0 Maths Skills Test to assess your progress with this work. Therefore, we are not only testing your Maths skills but your ability to learn independently and prepare for a known assessment in advance.

A LEVEL BIOLOGY

M0.1 RECOGNISE AND MAKE USE OF APPROPRIATE UNITS IN CALCULATIONS

QUIZ – CONVERTING BETWEEN UNITS

Answers to all of these questions should use standard form e.g. use 5.6×10^3 rather than 5600, use 4.2×10^{-2} rather than 0.042.

1. How many?

mm in a m		μm in a mm	
μm in a m		nm in a μm	
nm in a mm		nm in a m	
mm in a μm		m in a μm	
μm in a nm		mm in a nm	
μ*l* in a litre		m*l* in a litre	
μ*l* in a m*l*		ms in a s	
μs in a ms			

[15]

2. Convert each of the following into metres.

(a)	70 nm	
(b)	5 μm	
(c)	1 mm	
(d)	0.2 mm	

[4]

3. Convert each of the following into μm.

(a)	4 m	
(b)	200 nm	
(c)	17 mm	
(d)	0.3 nm	

[4]

A LEVEL BIOLOGY

4. Areas. How many?

(a) μm^2 in a m^2	
(b) μm^2 in a mm^2	

[2]

5. Volumes. How many?

(a) mm^3 in a cm^3	
(b) μm^3 in a mm^3	

[2]

6. Convert each of these into more sensible units using standard form to express your answers if appropriate.

(a) 0.0003 µm	
(b) 0.004 km	
(c) 4500000 nm	
(d) 0.0007 s	

[4]

QUIZ- RATES OF CHANGE

1. Express these rates of change with the correct units:

(a) 2 µg per cm^3	
(b) 200 kJ per m^2 per year	
(c) 10 g per dm^3	
(d) 15 cm^3 per minute	

[4]

2. In an experiment you were measuring the growth rate of *Salmonella*. You started with 100 *Salmonella* and after 2 hours you had 6500 *Salmonella*. What is the bacterial growth rate?

[1]

A LEVEL BIOLOGY

3. In an experiment you were measuring the growth rate of *Salmonella*. You started with 80 *Salmonella* and after 4 hours you had 5000 *Salmonella*. What is the bacterial growth rate?

[1]

4. How would you express the following in numbers and units?

a) A woodlouse crawled 5 cm in 10 min.

[1]

b) A patient's drip flowed with 10 drips every 30 s.

[1]

c) The growth of a slime mould colony was 40 cells per millimetre cubed per hour.

[1]

d) A breathing rate of 20 breaths in 30 s.

[1]

e) A change in temperature of 1.2 degrees over three years.

[1]

A LEVEL BIOLOGY

QUIZ - M0.2 RECOGNISE AND USE EXPRESSIONS IN DECIMAL AND STANDARD FORM

1. Convert each of these into standard form, to one decimal place.

1)	40000000	
2)	8567	
3)	0.0000007	
4)	0.07607	
5)	4500067	
6)	93	
7)	7	
8)	62545	

[8]

2. Multiply these numbers, giving your answer in standard form to one decimal place:

1)	$(1 \times 10^4) \times (6 \times 10^3)$	
2)	$(3 \times 10^4) \times (3 \times 10^{-1})$	
3)	$(2 \times 10^{-2}) \times (3 \times 10^{-3})$	
4)	$(4 \times 10^2) \times (5 \times 10^3)$	

[4]

M0.3 USE RATIOS, FRACTIONS AND PERCENTAGES

QUIZ – PERCENTAGES: PRACTICE CALCULATIONS

Learners may be tested on their ability to:

- Calculate percentage yields
- Calculate surface area to volume ratio
- Use scales for measuring
- Represent phenotypic ratios (monohybrid and dihybrid crosses)

1. Ventricular systole lasts for 0.3 s. The cardiac cycle lasts for 0.8 s. What percentage of the cardiac cycle is ventricular systole?

[1]

A LEVEL BIOLOGY

2. In an onion root tip squash, 200 cells were observed, and each cell was assigned to a stage of the cell cycle. Here are the results:

Stage	Number of cells
Interphase	150
Prophase	20
Metaphase	12
Anaphase	4
Telophase	8
Cytokinesis	6

What percentage of cells were at each stage of the cell cycle?

[1]

3. A soil sample weighed 2.4 g. After heating at 100 ^{0}C in an oven to evaporate the water, it weighed 1.8 g. What percentage of the soil sample was water?

[1]

4. Stearic acid has the formula $C_{17}H_{35}COOH$. What percentage of the atoms in stearic acid are:

(a) carbon?

(b) hydrogen?

(c) oxygen?

[3]

A LEVEL BIOLOGY

QUIZ – PERCENTAGE YIELD: PRACTICE CALCULATIONS

1. In the following examples you are given the actual yield and the theoretical yield. Calculate the percentage yield.

(a)	Actual yield = 40 g	Theoretical yield = 60 g	
(b)	Actual yield = 60 g	Theoretical yield = 100 g	
(c)	Actual yield = 90 g	Theoretical yield = 130 g	
(d)	Actual yield = 23 g	Theoretical yield = 60 g	

[4]

2. In the hydrolysis of a sample of triglycerides, the theoretical yield of fatty acids is 9.0 g. The actual yield was 7.2 g. What was the percentage yield for this synthesis?

[1]

QUIZ – RATIO: PRACTICE CALCULATIONS

1. Calculate the surface area-to-volume ratios of the following cuboids:

(a)	A cuboid with sides: 2 cm x 2 cm x 2 cm	
(b)	A cuboid with sides: 1 m x 2 m x 4 m	
(c)	A cuboid with sides: 1 mm x 1 mm x 8 mm	

[3]

A LEVEL BIOLOGY

QUIZ – PHENOTYPIC RATIO: PRACTICE CALCULATIONS

1. Plants were grown either in the light or the dark and the length of the stem was measured.

Growing conditions	Stem length (cm)
Light	10
Dark	25

a) What was the ratio of stem length, light to dark?

[1]

b) What was the ratio of stem length, dark to light?

[1]

2. The stem length experiment was repeated by growing plants under four different coloured lights:

Light used for growth	Stem length (cm)
Blue	25
Green	3
Yellow	10
Red	15

What was the ratio of stem length blue to green to yellow to red?

[1]

3. Let's say colour of naked mole rats is determined by a single gene and brown colour (B) is dominant to white colour (b). If two heterozygous (Bb) naked mole rats were mated, what is the expected ratio of brown naked mole rats to white naked mole rats?

[1]

A LEVEL BIOLOGY

QUIZ – M0.4 ESTIMATE RESULTS

1. Estimate these and check your approximations using a calculator

a)	15.6 x 24.4	
b)	8.8 x 32.3	
c)	15.6/24.4	
d)	8.8/32.3	

[4]

2. Here's an example from ecological sampling. A 0.5 m x 0.5 m quadrat was used to count plants. Ten samples were taken and the plants in each quadrat counted.

The values were: 7, 3, 6, 12, 4, 8, 8, 9, 10, 2

Make an estimate of the density of plants per m^2.

Now calculate the density of plants per m^2.

[1]

3. Estimate whether the following calculations will give an answer that is greater than, or less than, one.

a) $\frac{3.872}{5 \times 10.2}$

b) $\frac{3}{6 \times 0.2}$

c) $\frac{452 \times 7}{84 \times 113}$

d) $\frac{0.5 \times 0.2}{0.01}$

[4]

A LEVEL BIOLOGY

QUIZ – M0.5 USE CALCULATORS TO FIND AND USE POWER, EXPONENTIAL AND LOGARITHM FUNCTIONS

1. Use your calculator to determine the value of:

a) 12^3

b) 10^5

c) Log (4)

d) Ln(7)

[4]

2. A bacterial cell divides (doubles) every 45 minutes under standard conditions. There is initially one bacterium in the culture. How many cells will there be after 6 hours?

[1]

3. A bacterial cell divides (doubles) every 35 minutes under standard conditions. There is initially one bacterium in the culture. How many cells will there be after 8 hours?

[1]

A LEVEL BIOLOGY

MATHS SKILLS – M0 ARITHMETIC AND NUMERICAL COMPUTATION MARK SCHEME

Use these pages to mark your practice questions for handing in during the induction period.

M0.1 RECOGNISE AND MAKE USE OF APPROPRIATE UNITS IN CALCULATIONS

MARK SCHEME – CONVERTING BETWEEN UNITS

Answers to all of these questions should use standard form e.g. use 5.6×10^3 rather than 5600, use 4.2×10^{-2} rather than 0.042.

7. How many?

mm in a m	1×10^3	µm in a mm	1×10^3
µm in a m	1×10^6	nm in a µm	1×10^3
nm in a mm	1×10^6	nm in a m	1×10^9
mm in a µm	1×10^{-3}	m in a µm	1×10^{-6}
µm in a nm	1×10^{-3}	mm in a nm	1×10^{-6}
µ*l* in a litre	1×10^6	m*l* in a litre	1×10^3
µ*l* in a m*l*	1×10^3	ms in a s	1×10^3
µs in a ms	1×10^3		

8. Convert each of the following into metres.

(a)	70 nm	70 nm = 7×10^{-8} m
(b)	5 µm	5 µm = 5×10^{-6} m
(c)	1 mm	1 mm = 1×10^{-3} m
(d)	0.2 mm	0.2 mm = 2×10^{-4} m

9. Convert each of the following into µm.

(a)	4 m	4 m = 4×10^6 µm
(b)	200 nm	200 nm = 2×10^{-1} µm
(c)	17 mm	17 mm = 1.7×10^4 µm
(d)	0.3 nm	0.3 nm = 3×10^{-4} µm

A LEVEL BIOLOGY

10. Areas. How many?

(a)	μm^2 in a m^2	1×10^{12}
(b)	μm^2 in a mm^2	1×10^{6}

11. Volumes. How many?

(a)	mm^3 in a cm^3	1×10^{3}
(b)	μm^3 in a mm^3	1×10^{9}

12. Convert each of these into more sensible units using standard form to express your answers if appropriate.

(a)	0.0003 µm	0.3 nm or 3×10^{-1} nm
(b)	0.004 km	4 m
(c)	4500000 nm	4.5 mm
(d)	0.0007 s	0.7 ms or 7×10^{-1} ms

MARK SCHEME – RATES OF CHANGE

5. Express these rates of change with the correct units:

(a)	2 µg per cm^3	2 µg cm^{-3}
(b)	200 kJ per m^2 per year	200 kJ m^{-2} yr^{-1}
(c)	10 g per dm^3	10 g dm^{-3}
(d)	15 cm^3 per minute	15 cm^3 min^{-1}

6. In an experiment you were measuring the growth rate of *Salmonella*. You started with 100 *Salmonella* and after 2 hours you had 6500 *Salmonella*. What is the bacterial growth rate?

6500 – 100 = 6400 bacteria in 2 hours

$\frac{6400}{2}$ = 3200 bacteria per hour

= 3200 bacteria h^{-1}

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7. In an experiment you were measuring the growth rate of *Salmonella*. You started with 80 *Salmonella* and after 4 hours you had 5000 *Salmonella*. What is the bacterial growth rate?

> 5000 – 80 = 4920 bacteria in 4 hours
>
> $\frac{4920}{4}$ = 1230 bacteria per hour
>
> = 1230 bacteria h^{-1}

8. How would you express the following in numbers and units?

f) A woodlouse crawled 5 cm in 10 min.

> 5 mm min^{-1} or 0.5 cm min^{-1} or 30 cm h^{-1}

g) A patient's drip flowed with 10 drips every 30 s.

> 20 drips min^{-1} or 0.3 drips s^{-1}

h) The growth of a slime mould colony was 40 cells per millimetre cubed per hour.

> 40 mm^{-3} h^{-1}

i) A breathing rate of 20 breaths in 30 s.

> 40 breaths min^{-1} or 0.7 breaths s^{-1}

j) A change in temperature of 1.2 degrees over three years.

> 0.4 °C yr^{-1}

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MARK SCHEME –M0.2 RECOGNISE AND USE EXPRESSIONS IN DECIMAL AND STANDARD FORM

3. Convert each of these into standard form, to one decimal place.

1)	40000000	4.0×10^7
2)	8567	8.6×10^3
3)	0.0000007	7.0×10^{-7}
4)	0.07607	7.6×10^{-2}
5)	4500067	4.5×10^6
6)	93	9.3×10^1
7)	7	7.0×10^0
8)	62545	6.3×10^4

4. Multiply these numbers, giving your answer in standard form to one decimal place:

1)	$(1 \times 10^4) \times (6 \times 10^3)$	$= 6.0 \times 10^7$
2)	$(3 \times 10^4) \times (3 \times 10^{-1})$	$= 9.0 \times 10^3$
3)	$(2 \times 10^{-2}) \times (3 \times 10^{-3})$	$= 6.0 \times 10^{-5}$
4)	$(4 \times 10^2) \times (5 \times 10^3)$	$= 20 \times 10^5 = 2.0 \times 10^6$

M0.3 USE RATIOS, FRACTIONS AND PERCENTAGES

MARK SCHEME – PERCENTAGES: PRACTICE CALCULATIONS

Learners may be tested on their ability to:

- Calculate percentage yields
- Calculate surface area to volume ratio
- Use scales for measuring
- Represent phenotypic ratios (monohybrid and dihybrid crosses

1. Ventricular systole lasts for 0.3 s. The cardiac cycle lasts for 0.8 s. What percentage of the cardiac cycle is ventricular systole?

The part is 0.3 s
The whole is 0.8 s

$$\frac{0.3\ s}{0.8\ s} \times 100 = 37.5\ \%$$

So 37.5% of the cardiac cycle is ventricular systole

A LEVEL BIOLOGY

2. In an onion root tip squash, 200 cells were observed, and each cell was assigned to a stage of the cell cycle. Here are the results:

Stage	Number of cells
Interphase	150
Prophase	20
Metaphase	12
Anaphase	4
Telophase	8
Cytokinesis	6

What percentage of cells were at each stage of the cell cycle?

Using Interphase as an example, 150 is the part, 200 is the whole.

$$\frac{150}{200} \times 100 = 75\ \%$$

Interphase	75%
Prophase	10%
Metaphase	6%
Anaphase	2%
Telophase	4%
Cytokinesis	3%

3. A soil sample weighed 2.4 g. After heating at 100 ^{0}C in an oven to evaporate the water, it weighed 1.8 g. What percentage of the soil sample was water?

$$\frac{1.8}{2.4} \times 100 = 75\ \%$$

$$100 - 75 = 25\ \%$$

Or you can do this another way: $\frac{2.4-1.8}{2.4} \times 100 = 25\ \%$

4. Stearic acid has the formula $C_{17}H_{35}COOH$. What percentage of the atoms in stearic acid are?

Stearic acid has 56 atoms (18 carbons, 36 hydrogens and 2 oxygens)

So, for carbon, 18 is the part, 56 is the whole.

$$\frac{18}{56} \times 100 = 32\ \%$$

(a)	carbon?	32%
(b)	hydrogen?	64%
(c)	oxygen?	4%

A LEVEL BIOLOGY

MARK SCHEME – PERCENTAGE YIELD: PRACTICE CALCULATIONS

3. In the following examples you are given the actual yield and the theoretical yield. Calculate the percentage yield.

$$\frac{actual\ yield}{theoretical\ yield} \text{ x } 100$$

(a)	Actual yield = 40 g	Theoretical yield = 60 g	67%
(b)	Actual yield = 60 g	Theoretical yield = 100 g	60%
(c)	Actual yield = 90 g	Theoretical yield = 130 g	69%
(d)	Actual yield = 23 g	Theoretical yield = 60 g	38%

4. In the hydrolysis of a sample of triglycerides, the theoretical yield of fatty acids is 9.0 g. The actual yield was 7.2 g. What was the percentage yield for this synthesis?

$$\frac{actual\ yield}{theoretical\ yield} \text{ x } 100 = \frac{7.2}{9.0} \text{ x } 100 = 80\ \%$$

MARK SCHEME – RATIO: PRACTICE CALCULATIONS

1. Calculate the surface area-to-volume ratios of the following cuboids:

a) Sum of the sides: one side = 2 x 2 = 4 cm^2 There are six sides, so 4 x 6 = 24 cm^2

The volume is 2 x 2 x 2 = 8 cm^3

The surface area divided by volume = $\frac{24}{8} = 3$ So the ratio is 3:1

b) Two sides are 1 x 2 m, two are 2 x 4 m and two are 1 x 4 m. So 4 m^2 + 16 m^2 + 8 m^2 = 28 m^2

The volume is 1 x 2 x 4 = 8 m^3

$\frac{28}{8} = 3.5$ The ratio is 3.5:1

c) Two sides are 1 x 1 mm, and four are 1 x 8 mm. So 2 mm^2 + 32 mm^2 = 34 mm^2
The volume is 1 x 1 x 8 = 8 mm^3

Surface area divided by volume = $\frac{34}{8} = 4.25$ The ratio is 4.25:1

(a)	A cuboid with sides: 2 cm x 2 cm x 2 cm	3:1
(b)	A cuboid with sides: 1 m x 2 m x 4 m	3.5:1
(c)	A cuboid with sides: 1 mm x 1 mm x 8 mm	4.25:1

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MARK SCHEME – PHENOTYPIC RATIO: PRACTICE CALCULATIONS

3. Plants were grown either in the light or the dark and the length of the stem was measured.

Growing conditions	Stem length (cm)
Light	10
Dark	25

c) What was the ratio of stem length, light to dark?

$\frac{Length\ in\ the\ light}{Length\ in\ the\ dark} = \frac{10}{25} = 0.4$ So the ratio is 0.4:1

d) What was the ratio of stem length, dark to light?

$\frac{Length\ in\ the\ dark}{Length\ in\ the\ light} = \frac{25}{10} = 2.5$ So the ratio is 2.5:1

4. The stem length experiment was repeated by growing plants under four different coloured lights:

Light used for growth	Stem length (cm)
Blue	25
Green	3
Yellow	10
Red	15

What was the ratio of blue to green to yellow to red?

If the last in the ratio must be 1, then divide all the others by 15 (the value for the last one)

For blue $\frac{25}{15} = 1.7$

For green $\frac{3}{15} = 0.2$

For yellow $\frac{10}{15} = 0.67$

So the answer is 1.7 : 0.2 : 0.7 :1

A LEVEL BIOLOGY

5. Let's say colour of naked mole rats is determined by a single gene and brown colour (B) is dominant to white colour (b). If two heterozygous (Bb) naked mole rats were mated, what is the expected ratio of brown naked mole rats to white naked mole rats?

A standard genetic cross will give the following:

	B	**b**
B	BB	Bb
b	Bb	bb

B is dominant to b. Therefore, both BB and Bb genotype will produce a brown naked mole rat phenotype, whereas bb will produce a white phenotype. So, there are three browns to each white, so the ratio will be 3:1.

MARK SCHEME – M0.4 ESTIMATE RESULTSS

1. Estimate these and check your approximations using a calculator

a)	15.6 x 24.4	→ 15 x 25 = 375	→ 380.64
b)	8.8 x 32.3	→ 10 x 30 = 300	→ 284.24
c)	15.6/24.4	→ 15/25 = 3/5 = 6/10 = 0.6	→ 0.64
d)	8.8/32.3	→ 8/32 = ¼ = 0.25	→ 0.27

2. Here's an example from ecological sampling. A 0.5 m x 0.5 m quadrat was used to count plants. Ten samples were taken and the plants in each quadrat counted.

The values were: 7, 3, 6, 12, 4, 8, 8, 9, 10, 2

Make an estimate of the density of plants per m^2.

Now calculate the density of plants per m^2.

~ 70 plants in total → Calculated as 69

Area of 1 quadrat = 0.5 x 0.5 = 0.25 m^2.

Total area sampled of 10 x 0.25 = 2.5 m^2.

To get density per m^2, divide number of plants by area sampled

= ~70/2.5 = 28 plants per m^2 = 28 plants m^{-2}

The actual calculated value is 69/2.5 = 27.6 plants m^{-2} or 2.76 x 10 plants m^{-2}.

A LEVEL BIOLOGY

3. Estimate whether the following calculations will give an answer that is greater than, or less than, one.

a) $\frac{3.872}{5 \times 10.2}$

less than 1

b) $\frac{3}{6 \times 0.2}$

more than 1

c) $\frac{452 \times 7}{84 \times 113}$

less than 1

d) $\frac{0.5 \times 0.2}{0.01}$

more than 1

MARK SCHEME – M0.5 USE CALCULATORS TO FIND AND USE POWER, EXPONENTIAL AND

1. Use your calculator to determine the value of:

e) 12^3

f) 10^5

g) Log (4)

h) Ln(7)

a) 1728
b) 100,000
c) 0.602
d) 1.946

2. A bacterial cell divides (doubles) every 45 minutes under standard conditions. There is initially one bacterium in the culture. How many cells will there be after 6 hours?

6 hours = 360 minutes

360/45 = 8 divisions

$N = N_0 \times 2^n$ = 1 x 2^8 = 256 bacterial cells

A bacterial cell divides (doubles) every 35 minutes under standard conditions. There is initially one bacterium in the culture. How many cells will there be after 8h

8 hours = 480 minutes 480/35 = 13.7 divisions

Since divisions will not be strictly synchronous students might legitimately use 13.7 or reason that only 13 complete divisions have occurred

$N = N_0 \times 2^n$ = 1 x $2^{13.7}$ = 13308 bacterial cells = 1.3 x 10^4 bacterial cells

$N = N_0 \times 2^n$ = 1 x 2^{13} = 8192 bacterial cells = 8.2 x 10^3 bacterial cells