DHFS

AS and A Level Biology

Course Handbook

Contents

1. About the OCR Biology A Course

We chose OCR Biology A to teach DHFS students because:

- The content-led approach enables students to develop a logical academic understanding of biology
- As the course unfolds, fundamental biological concepts and skills are built on, applied and how they relate is synthesised into a unified whole
- Practical and mathematical skills are integrated into the course
- It is co-teachable with AS level

What is taught in the course?

The course starts with fundamental concepts, which are then applied more deeply in later modules in a variety of contexts. For example, study of the kidney in Y13 applies concepts about membranes, exchange surfaces and transport learnt in Y12. Practical and mathematical skills are developed throughout the programme of study. Each module is divided into topics, as follows:

First year (AS and A-level)

Module 2 – Foundations in biology

- 2.1.1 Cell structure
- 2.1.2 Biological molecules – water, carbohydrates, lipids and proteins
- 2.1.3 Nucleotides and nucleic acids
- 2.1.4 Enzymes
- 2.1.5 Biological membranes
- 2.1.6 Cell division, cell diversity and cellular organisation

Module 3 – Exchange and transport

- 3.1.1 Exchange surfaces
- 3.1.2 Transport in animals
- 3.1.3 Transport in plants

Module 4 – Biodiversity, evolution and disease

- 4.1.1 Communicable diseases, disease prevention and the immune system
- 4.2.1 Biodiversity
- 4.2.2 Classification and evolution

Second year (A level only)

Module 5 – Communication, homeostasis and energy

- 5.1.1 Communication and homeostasis
- 5.1.2 Excretion as an example of homeostatic control
- 5.1.3 Neuronal communication
- 5.1.4 Hormonal communication
- 5.1.5 Plant and animal responses
- 5.2.1 Photosynthesis
- 5.2.2 Respiration

Module 6 – Genetics, evolution and ecosystems

- 6.1.1 Cellular control
- 6.1.2 Patterns of inheritance
- 6.1.3 Manipulating genomes
- 6.2.1 Cloning and biotechnology
- 6.3.1 Ecosystems
- 6.3.2 Populations and sustainability

Throughout both years

The following are embedded throughout all the content of this programme of study.

- Practical skills
- 'How Science Works' – a wider view of science in context
- Mathematical Skills

Module 1 – Development of Practical Skills

- 1.1.1 Planning
- 1.1.2 Implementing
- 1.1.3 Analysis
- 1.1.4 Evaluation
- 1.2.1 Practical skills
    - Independent thinking
    - Use and application of scientific methods and practices
    - Research and referencing
    - Instruments and equipment
- 1.2.2 Use of apparatus and techniques

How Science Works

- **HSW1** Use theories, models and ideas to develop scientific explanations
- **HSW2** Use knowledge and understanding to pose scientific questions, define scientific problems, present scientific arguments and scientific ideas
- **HSW3** Use appropriate methodology, including information and communication technology (ICT), to answer scientific questions and solve scientific problems
- **HSW4** Carry out experimental and investigative activities, including appropriate risk management, in a range of contexts
- **HSW5** Analyse and interpret data to provide evidence, recognising correlations and causal relationships
- **HSW6** Evaluate methodology, evidence and data, and resolve conflicting evidence
- **HSW7** Know that scientific knowledge and understanding develops over time
- **HSW8** Communicate information and ideas in appropriate ways using appropriate terminology
- **HSW9** Consider applications and implications of science and evaluate their associated benefits and risks
- **HSW10** Consider ethical issues in the treatment of humans, other organisms and the environment
- **HSW11** Evaluate the role of the scientific community in validating new knowledge and ensuring integrity
- **HSW12** Evaluate the ways in which society uses science to inform decision making

Mathematical Skills

- M0 – Arithmetic and numerical computation
- M1 – Handling data
- M2 – Algebra
- M3 – Graphs
- M4 – Geometry and trigonometry

2. External Assessment

AS

For an AS level in Biology, students must sit two exams at the end of Y12. Each paper assesses content from modules 1-4

Component	Marks	Duration	Weighting
Breadth in Biology (01)	70	1 hour 30 mins	50%
Depth in Biology (02)	70	1 hour 30 mins	50%

Breadth assesses content from modules 1-4. **Section A** contains multiple choice questions. This section of the paper is worth 20 marks. **Section B** includes short answer question styles (structured questions, problem solving, calculations, practical).

Depth assesses content from modules 1-4. Question styles include short answer (structured questions, problem solving, calculations, practical) and extended response questions.

A-Level

For an A level in Biology, students must sit three exams at the end of Y13 and pass the 'practical endorsement', which is continually assessed throughout the 2-year programme of study.

Component	Marks	Duration	Weighting
Biological Processes (01)	100	2 hour 15 mins	37%
Biological Diversity (02)	100	2 hour 15 mins	37%
Unified Biology (03)	70	1 hour 30 mins	26%
Practical endorsement in Biology (04)	-	-	-

- **Biological Processes** assesses content from modules 1,2,3 and 5. Section A consists of 15 multiple choice questions. Section B includes short answer question styles (structured questions, problem solving, calculations, practical) and extended response questions.
- **Biological Diversity** assesses content from modules 1,2,4 and 6. Section A consists of 15 multiple choice questions. Section B includes short answer question styles (structured questions, problem solving, calculations, practical) and extended response questions.

- **Unified Biology** assesses content across teaching modules 1 to 6. Question styles include short answer (structured questions, problem solving, calculations, practical) and extended response questions.

Maths Skills and 'How Science Works'
Maths skills and 'How Science Works' understanding are assessed across all components.

Synoptic Assessment
All three externally assessed components contain some synoptic assessment. Synoptic assessment tests the learners' understanding of the connections between different elements of the subject. Synoptic assessment involves the explicit drawing together of knowledge, understanding and skills learned in different parts of the A level course. Synoptic assessment requires learners to make and use connections within and between different areas of biology, for example, by:

- applying knowledge and understanding of more than one area to a particular situation or context
- using knowledge and understanding of principles and concepts in planning experimental and investigative work and in the analysis and evaluation of data
- bringing together scientific knowledge and understanding from different areas of the subject and applying them

Assessment Objectives
There are three assessment objectives (AOs) in OCR AS Level in Biology A. Students are expected to:

- AO1 Demonstrate knowledge and understanding of scientific ideas, processes, techniques and procedures
- 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
- AO3 Analyse, interpret and evaluate scientific information, ideas and evidence, including in relation to issues, to:
    - make judgements and reach conclusions
    - develop and refine practical design and procedures

Component	**AO weighting in exams %**		
	AO1	**AO2**	**AO3**
Breadth in biology	22–24	19–20	7–9
Depth in biology	13–16	21–24	13–14
AS Total	**35–40**	**40–44**	**20–23**
Biological processes	13–14	15–16	8–9
Biological diversity	13–14	15–16	8–9
Unified biology	5–6	10–11	9–10
A-Level Total	**31-34**	**40-43**	**25-28**

3. Staff

There are five A-level biology teachers in the science faculty:

Mrs C Hollings (CHO) chollings@dronfield.derbyshire.sch.uk

Mr P Varley (PVA) pvarley@dronfield.derbyshire.sch.uk

Mrs R Horsfield (RHR) rhorsfield@dronfield.derbyshire.sch.uk

Mr S Hawkins (SHW) shawkins@dronfield.derbyshire.sch.uk

Mrs T Davies (TDA) tdavies@dronfield.derbyshire.sch.uk

Students are assigned two teachers. There are 5 lessons per week in a 2:3 teacher ratio.

Teachers are available for support and contactable by email, during lessons and during the school day. They are more than happy to help support your journey through the course! During the year, teachers may meet with students 1:1 or on small groups to address issues. They may also host catch-up or revision sessions that are advertised when available. During study leave, students can request to see teachers about particular problems they have. Teachers may also run a structured revision programme during Y13 study leave that they devise in with the students themselves. Teachers are not expected to check emails during holidays or weekends. However, teachers often make themselves available to some during the Easter and summer half-term holiday when students are revising for external exams.

4. Internal Assessment and Feedback

Students are given tests at the end of each topic using specimen and past exam questions. Tests last 45-60 minutes. There are 25 end of topic assessments over the two year course. Students also take part in trial exams in January of both Y12 and Y13. The Y12 trial exam assess module 2, which is covered in the autumn of Y12. The Y13 trial exam covers modules 1-4 and parts of modules 5 and 6. Both trial exams also include practical skills from module 1, maths skills and 'How Science Works' understanding.

Students are given a grade for each test and trial exam and are given detailed feedback. Students are given time to analyse and improve their understanding during 'Directed Improvement and Reflection Time' (DIRT). Students will be given further tasks to address areas of weakness. The science faculty also employs the use classroom visualizers to enable students to share and reflect on each other's answers.

During each topic, students are continually assessed and given feedback on verbal answers and written tasks. Students are expected to continually reflect and improve and deepen their understanding This is constant process and involves a mixture of self, peer and teacher assessment.

5. The Practical Endorsement

Students gain practical skills as they work through the modules. These are assessed in the written examinations and in the practical endorsement (component 04). Students will receive either a 'PASS' or 'FAIL' for their practical work. This is assessed internally (by teachers) and subject to random monitoring by external invigilators.

Students must complete a minimum of one practical activity from each of the 12 practical activity groups, resulting in a minimum of 12 practical activities during the 2-year course. In practice, students will do well in excess of the minimum of 12. **Evidence of this practical work must be recorded in the student lab book in order to PASS the practical endorsement (component 04).**

See table 1 below for the skills covered in each of the PAGs and table 2 for the PAG activities that we carry out.

Lab book expectations

- Bring your lab book with you every lesson, or store in E12.
- All practical work is dated. **This must match the teacher's records of when the practical activity was completed**
- Keep a clear record and space for any practical activity missed due to absence
- All practical work titled correctly *(eg. PAG 2 – Determining an enthalpy change)*
- Write-up practical work and complete all questions and extension opportunities
- When marked, DIRT must be completed in green pen in response to teacher feedback
- Keep neat, organised and continually updated. We recommend filing your PAG activity sheets in your lesson folders, separate to the lab book. Do not lose them!

Expectations before and during practical work

- Risk assessment completed
- Goggles worn when using chemicals
- Hair tied back when using Bunsen burners
- Stool tucked under and stood up at all times
- Sensible behaviour
- A level equipment is very expensive so extra care is necessary.
- Alert a teacher if glassware has broken or a chemical spillage has occurred. Do not attempt to clean up yourself unless your teacher allows.
- Be responsible for cleaning glassware you have used and putting it back in the appropriate places. The lab must look the way it did when you entered!
- **Failure to meet these expectations may result in you having to repeat a PAG in your own time or potentially a 'FAIL' for your practical endorsement**

Table 1 Practical activity requirements for the OCR Biology Practical Endorsement.

Practical activity group (PAG)	Techniques/skills covered (minimum)
1 Microscopy	• use of a light microscope at high power and low power, use of a graticule1, 1.2.2 (d) • production of scientific drawings from observations with annotations2, 1.2.2 (e)
2 Dissection	• safe use of instruments for dissection of an animal or plant organ, 1.2.2(j) • use of a light microscope at high power and low power, use of a graticule[1], 1.2.2 (d) • production of scientific drawings from observations with annotations[2], 1.2.2 (e)
3 Sampling techniques	• use of sampling techniques in fieldwork, 1.2.2 (k) • production of scientific drawings from observations with annotations[2], 1.2.2 (e)
4 Rates of enzyme controlled reactions	• use of appropriate apparatus to record a range of quantitative measurements (to include mass, time, volume, temperature, length and pH)[3], 1.2.2 (a) • use of laboratory glassware apparatus for a variety of experimental techniques to include serial dilutions[4], 1.2.2 (c) • use of ICT such as computer modelling, or data logger to collect data, or use of software to process data[5], 1.2.2 (l)
5 Colorimeter OR potometer	• use of appropriate apparatus to record quantitative measurements, such as a colorimeter or potometer, 1.2.2 (b) • use of laboratory glassware apparatus for a variety of experimental techniques to include serial dilutions[4], 1.2.2 (c)
6 Chromatography OR electrophoresis	• separation of biological compounds using thin layer / paper chromatography or electrophoresis, 1.2.2 (g)
7 Microbiological techniques	• use of laboratory glassware apparatus for a variety of experimental techniques to include serial dilutions[4], 1.2.2 (c) • use of microbiological aseptic techniques, including the use of agar plates and broth, 1.2.2 (i)
8 Transport in and out of cells	• use of appropriate apparatus to record a range of quantitative measurements (to include mass, time, volume, temperature, length and pH)[3], 1.2.2 (a) • use of laboratory glassware apparatus for a variety of experimental techniques to include serial dilutions[4], 1.2.2 (c) • use of ICT such as computer modelling, or data logger to collect data, or use of software to process data[5], 1.2.2 (l)
9 Qualitative testing	• use of laboratory glassware apparatus for a variety of experimental techniques to include serial dilutions[4], 1.2.2 (c) • use of qualitative reagents to identify biological molecules, 1.2.2 (f)
10 Investigation using a data logger OR computer modelling	• use of ICT such as computer modelling, or data logger to collect data, or use of software to process data[5], 1.2.2 (l) • apply investigative approaches, 1.2.1 (a)
11 Investigation into the measurement of plant or animal responses	• safe and ethical use of organisms to measure plant or animal responses and physiological functions, 1.2.2 (h) • apply investigative approaches, 1.2.1 (a)
12 Research skills	• apply investigative approaches, 1.2.1 (a) • use online and offline research skills, 1.2.1 (h) • correctly cite sources of information, 1.2.1 (i)

[1,2,3,4,5] These techniques/skills may be covered in *any* of the groups indicated.

Table 2 PAG activities provided by OCR

PAG1	PAG7
1. Using a light microscope to study mitosis 2. The examination and drawing of blood cells observed in blood smears 3. Using a light microscope to examine lung tissue	1. The effect of antibiotics on bacterial growth 2. Dilution plating to determine the density of microbes in liquid culture 3. Transformation of bacteria with plasmid DNA encoding Green Fluorescent Protein
PAG2	**PAG8**
1. Dissection of the mammalian heart 2. The dissection of a stem 3. Dissection of muscle fibres from chicken wings	1. An investigation into the water potential of potato 2. Investigating osmosis in an artificial cell 3. Investigating the rate of diffusion through a membrane
PAG3	**PAG9**
1. The calculation of species diversity 2. Measurement of the distribution and abundance of plants in a habitat 3. Investigating a correlation between a named species and the biotic and/or abiotic factors in their environment	1. Qualitative testing for biological molecules – proteins 2. Qualitative testing for biological molecules – lipids 3. Qualitative testing for biological molecules – glucose
PAG4	**PAG10**
1. The effect of substrate concentration on the rate of an enzyme controlled reaction 2. The effect of enzyme concentration on the rate of reaction 3. Investigating the effect of temperature on amylase activity	1. Investigating DNA structure using RasMol 2. Using a light sensor to measure changes in turbidity to monitor microbial growth in different sugars 3. Measuring pH change during yoghurt production
PAG5	**PAG11**
1. The effect of temperature on membrane permeability 2. Determining glucose concentration 3. Using a potometer	1. Investigation into the effect of exercise on pulse rate 2. Investigation into heart rate changes in *Daphnia* in response to environmental changes 3. Investigation into phototropism
PAG6	**PAG12**
1. Identification of the amino acids in a protein using paper chromatography 2. Electrophoresis of DNA fragments for analysis 3. Investigation using thin layer chromatography to separate photosynthetic pigments	1. Investigation into the respiration rate of *Saccharomyces cerevisiae* 2. Genetic crosses in fruit flies and their statistical analysis 3. Investigation into the rate of oxygen production in pondweed

DHFS have also devised other practical activities that augment our students practical experience. For example, students carry out a locust dissection and fish head dissection as part of PAG2 during module 3, exchange and transport.

Field Trip

PAG 3 is fulfilled as part of the biology field trip that takes place in the summer term of Y12. This takes place in the Lea Brook Valley in Dronfield, where we have links with a local biodiversity charity. (see below for more details)

6. Expectations

A wise teacher once commented, “A new year 12 is not an A-level student, they are an unleashed Y11!”

There is some truth in this as new Y12 students learn to deal with the increased academic demand and workload together with new freedoms and responsibilities. Being well organised greatly helps the learning process as time is not wasted dealing with disorganisation.

There is no denying that biology is a very challenging subject and that academic competition is intense. However, we have a strong track record of success and students succeed when they meet our high expectations. The earlier these expectations are met the better. Y13 students often reflect that they ‘wish’ had put these expectations into action as soon as they started the course.

Equipment

Every lesson requires:

- Pen, Green Pen, Pencil, Ruler, Eraser, Sharpener, Scientific calculator
- Coloured pens for diagrams
- Lab book
- Lined paper
- Folder (see section on folder)
- The textbook (see section on textbook)
- Also very useful is a stapler, hole-punch and glue-stick.

Attendance and catching up on missed lessons

Obviously, 100% attendance is our expectation in order to succeed. Every lesson includes new content that may not be visited again.

However, if lessons are missed, ***it is the responsibility of the student to ensure they catch up***.

If lessons are missed you should:

- Access ‘curriculum data’ to access the slides and tasks from the relevant lesson
- Check SIMS homework for any homework set
- Ask your classmates for notes and resources
- Try to attend an equivalent lessons delivered to another class if possible.
- Read the relevant sections in the text book and watch relevant ‘Bozeman’ videos

Try to avoid e-mailing your teacher in the first instance as teachers tend to be ‘bombarded’ by these e-mails. They may not answer your e-mail until the next day and then will simply send you the lesson slides that are accessible on curriculum data. However, if you are unsure, then you should still e-mail your teacher for clarification. Furthermore, if you are absent for a longer period of time, then you should be in dialogue with your teacher via e-mail.

Attitude

As an Arabic philosopher once said, “One who has not endured the discipline of study will not taste the joy of knowledge.” At the heart of our science faculty is a thirst for knowledge and love of learning, with an understanding that a true love of learning will involve hard work. We aim for all our students to buy into this, led by our sixth-formers.

- Commitment. Match the 5 hours a week in lesson with 5 hours of your own independent study, including homework. If you stick to this from the beginning, you are more likely to be successful.
- Curiosity. We try to encourage a friendly environment where students are comfortable enough to ask questions, no matter how silly they may think it is. Making mistakes is important for learning! Take part in discussions, be inquisitive, challenge ideas!
- Contribution. Students should expect to be asked questions regularly every lesson. It is important for you that your teachers can assess your understanding. This enables them to give you the best possible feedback and makes the learning process as effective as possible. Similarly, you will be expected to display your written work on a visualizer so that we can analyse and learn from answers as a class. We do this in a sensitive and celebratory way, but appreciate that it may be uncomfortable to begin with. However, we aim for students to take a professional attitude about this and ask you to recognise that exposing your answers to critique will actually benefit you as an individual most as you receive more feedback.
- We expect outstanding behaviour and total focus from our students from Y7 to Y13. The fact that you have chosen to study biology only increases this expectation! It is incredibly rare for this to be an issue, but sixth form students do need to separate the superb social atmosphere of ‘the Hub’ from lesson time and make sure they are disciplined with their personal study.

Classwork

We expect you to:

- Demonstrate your love of learning by coming to lessons with questions and ideas
- Relate what you are learning to your existing knowledge and experience
- Actively take notes during the lesson on lined paper
- Constantly review and refine your work using green pen
- Not to wait to be told to do these things

Homework and personal study

Studying A-levels is effectively a full time job. Lessons form only part of this and proper knowledge and understanding will only be achieved if lessons are supported by significant personal study. As a 'rule of thumb' you should spend just as much time doing personal study as you do in lessons. Being organised and disciplined about when you do this underpins success.

Your personal study should comprise the following:

- Pre-loading before the lesson
    - Read the relevant pages in the textbooks and make notes
    - Familiarise yourself with the lesson slides on curriculum data
    - For practical work read the method and extension questions in advance and where applicable prepare results tables etc.
- Consolidation
    - Review, summarise and supplement your lesson notes within 2 days of the lesson
- Application and Assessment
    - Do as many questions as possible on the topic
    - Do questions from other exam boards, particularly AQA
    - When marks schemes are available self-assess your work and be ready to share any difficulties you had by the time the work is handed in, or even before
    - These tasks will generally be set as **homework** by your teacher and assessment will be a mixture of self, peer and teacher assessment
- Revision and review
    - You are frequently assessed at the end of each topic, there are trial exams in January and external exams in the summer. If you are disciplined with revision and start early, you will increase your chances of success.
- Look for links between topics and how fundamental concepts repeat themselves
    - For example, the concept of polarity arises
- Maths skills
    - Devote around 20-30min per week to developing your maths skills, particularly if you are not studying A-level maths. (more details below)
- Wider reading and educational experiences for pleasure
    - This could involve: reading popular science books; a regular subscription to a magazine such as the New Scientist; watching documentaries; listening to podcasts; scientific YouTube channels; reading journal articles online; visiting museums; joining a conservation group

In the unlikely event that someone should hand in homework of poor quality, and you haven't approached your teacher beforehand, it may be rejected by your teacher unmarked and you will be asked to do it again.

7. Study-life balance

As the ancient biblical philosopher said, “Of making many books there is no end, and much study wearies the body.”

We are mindful that A-levels can be gruelling at times. We are also aware that students are learning to balance study with other commitments they may have. It is also vital for well-being that people have time to relax and pursue their hobbies. Organising your time so that there is time when you are **not** studying is therefore crucial! We would never advocate that you quit a sport you love for the sake of you’re A-levels, for example.

Sleep and relaxation is crucial to the learning process. Science is a subject that requires imagination. It’s worth remembering that: Mendeleev cracked the periodic table in a dream; Darwin developed his theories immersed in nature and Einstein daydreamed his way to the theory of relativity! Taking a break from something you are finding difficult to understand is sometimes the best way to understand it!

We are here to help and support. It is important that you approach either your teachers, parents/carers or the sixth form team if you are finding things tough. Our staff are experienced in supporting students through tough times and helping them find solutions.

8. Folders

Both classwork and homework need to be kept organised in order to succeed. You will not be required to bring your folder every day as they will get heavy. However, we carry out termly folder inspections to ensure students remain organised. So, keep it organised from day one!

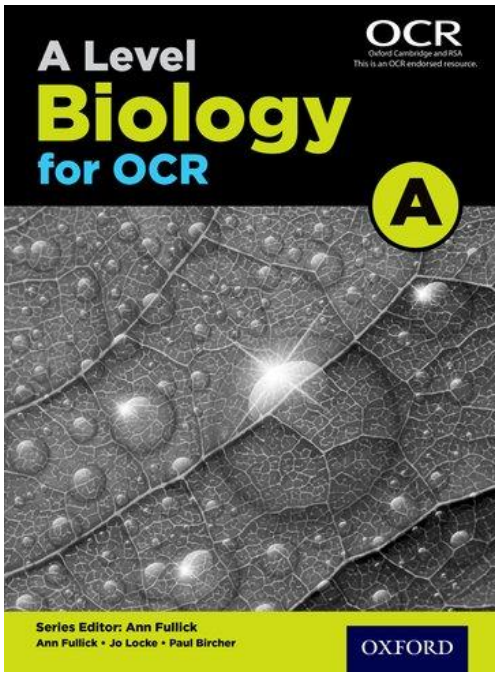
- Use a lever arch ring binder, file dividers, lined paper, a hole punch and plastic wallets
- Each file divider should be divided into each topic with the specification checklist at the front (this is set as summer work)
- Keep the checklist up-to-date by completing at the end of each lesson and at the end of the topic
- Complete your own notes during lesson time, giving a clear title using your green pen to tick, correct and improve your work as you go along. It is an expectation you complete DIRT work habitually.
- File certain topics (sub topics) within a module together in a plastic wallet and title this clearly with either a post-it or written in marker on the wallet
- At the end of each module, have a separate wallet for (a) assessments and (b) homework
- You may wish to keep your lab book in your ‘practical work’ section, alongside any relevant PAG work.

Ask your teacher to see good examples of folders of some of our students.

9. Resources

It is important to recognise at A-level that you will learn more effectively if you refer to more than one source.

Online Oxford 'Kerboodle' Textbook



https://www.kerboodle.com

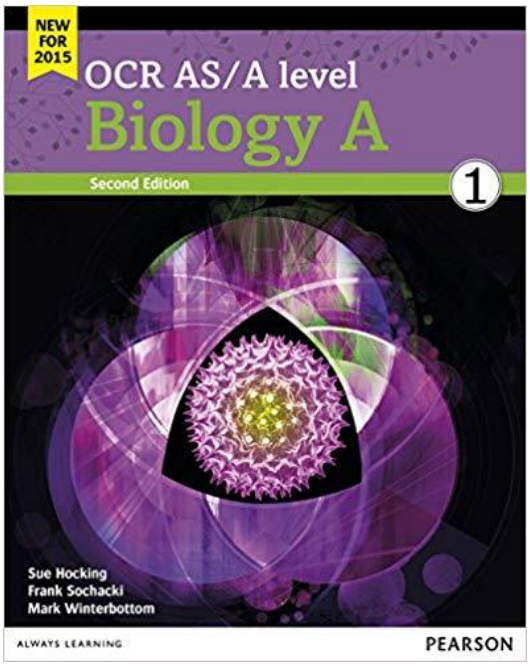
Students are given access to the online Kerboodle textbook. As well as the essential content, it contains many other resources such as summary questions, exam questions and other assessment tasks. It is an excellent resource and you are recommended to exploit it as much as possible. You will be provided you with your username and password. It will follow the format shown in an example below for a student called Charles Darwin:

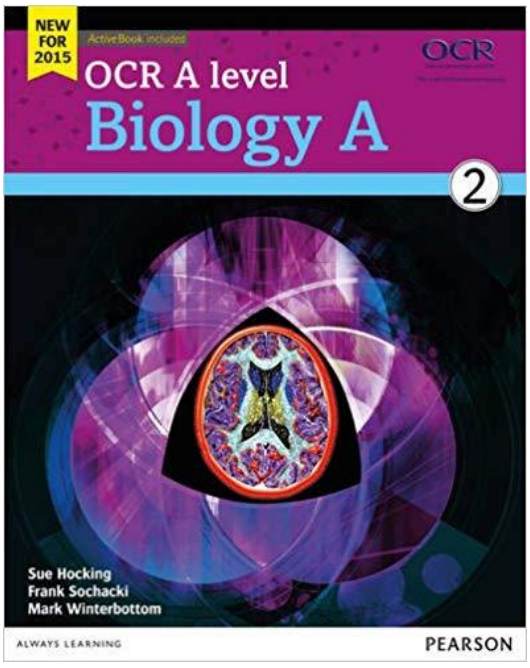
Username: cdarwin
Password: cdarwin (you will be asked to change this)
Institution code: ghx5

Some students also choose to buy the hard copy version, which can be purchased from the LRC at a discounted price. Alternatively cheaper second hand alternative can be purchased online or informally from Y13 leavers.

Other Recommended Textbooks

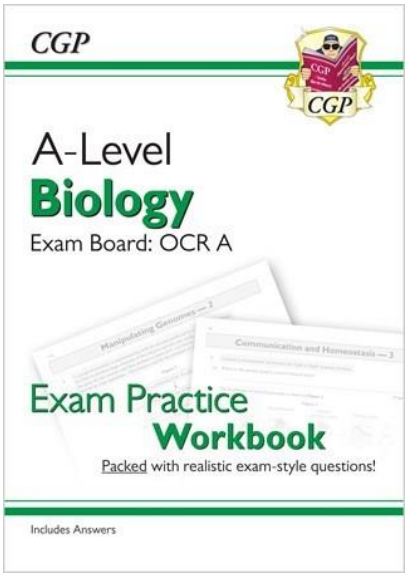
Other textbooks are also available, including the Pearson textbooks for the biology course. The textbooks contain essential content, summary questions, exam questions and 'How Science Works' extended tasks. Purchasing the book also gives you access to online resources.

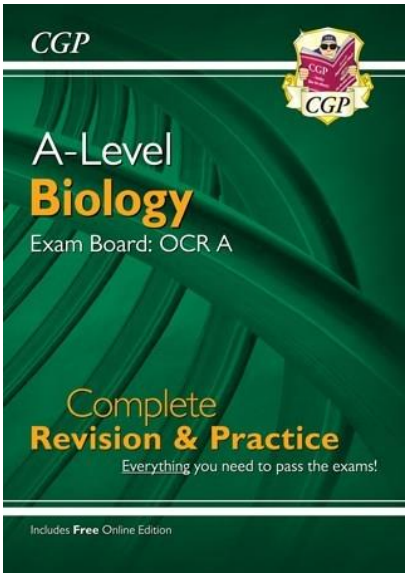


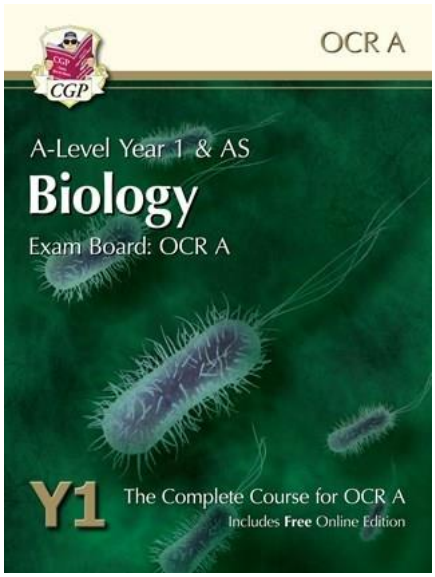


Revision Guides and Workbooks

CGP are an excellent source of revision guides, exam practice as well as textbooks







See CGP link for full details, but remember to purchase from LRC for discount!
https://www.cgpbooks.co.uk/secondary-books/as-and-a-level/science?sort=best_selling&quantity=36&page=1&view=grid&currentFilter=ExamBoard_512&filter_exam%20board=ExamBoard_511

VLE:

Every member of the DHFS school has access to the VLE from the school website. Here you will find:

- Videos explaining essential content
- Topic-based exam style questions and mark schemes

We recommend spending an hour of your first week exploring it and seeing what it has to offer!

Curriculum data

Curriculum data folders are accessible via the school website. The A-level biology section contains:

- All lesson resources
- All past papers going back over 10 years for OCR and AQA
- All relevant specifications and checklists
- Practical based questions
- All PAGs

Recommended Websites:

http://www.bozemanscience.com/biology-main-page – superb videos explaining the key concepts

https://www.rsb.org.uk/ 'The Royal Society of Biology' website. Lots of amazing resources including interactive practical tutorials. Must look!

https://www.yourgenome.org/ - a superb website on genetics

www.physicsandmathstutor.com – good for past paper resources, including biology

https://www.ocr.org.uk/qualifications/as-a-level-gce/biology-a-h020-h420-from-2015/- for to all relevant material related to the course from the exam board

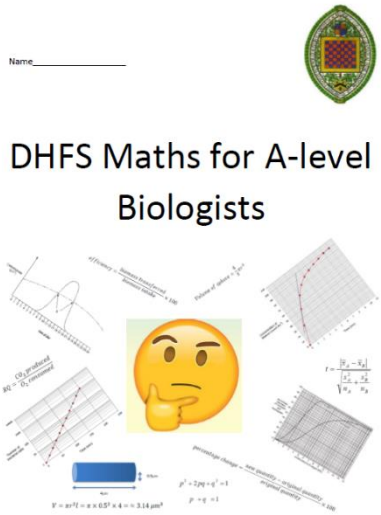
https://phet.colorado.edu/ - for simulations and models to help understand abstract ideas

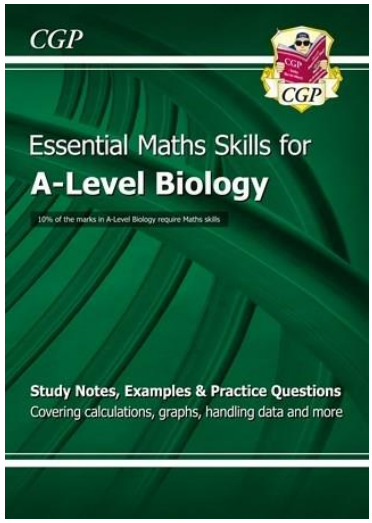
https://www.footprints-science.co.uk/ - for simulations and models to help understand abstract ideas

You Tube Channels

- Amoeba Sisters - https://www.youtube.com/user/AmoebaSisters
- Handwritten Tutorials - https://www.youtube.com/user/harpinmartin
- ASAP Science - https://www.youtube.com/user/AsapSCIENCE

10. Maths Skills





Maths skills are essential in all the sciences. 10% of your biology exams will be maths questions. Students who study A-level maths are at an advantage in these questions, since they spend around 10hours a week doing maths! But they do need to make themselves fully aware of the mathematical requirements of the course. Students who are not studying A-level maths on the other hand *must* therefore address this disadvantage and work hard to develop their maths skills. Students are required to spend an hour a week studying maths. The biology department has created online maths video tutorials for this purpose. Alternatively students can work through books aimed A-level Biologists.

11. Revision

Revision is vital for success, but students must know how to revise properly.

Here some principles and tips

1. Keep your folder organised from the outset.
2. Organise your time well.
3. Work in manageable chunks. Your concentration span will improve with time and these chunks may get longer.
4. Systematically revise the content.
    a. Use the specification tick list to ensure coverage.
    b. Condense notes into smaller revision cards.
5. Links! Spend time revising how all the different topics link together. For example, pick a big idea like ‘protein shape’ and think through all the areas this comes up.
6. Test yourself. Ensure you assess yourself on each area.
7. Practice past questions and use them to reveal areas to improve.
    a. start an exam paper blind (no revision materials with you) then mark it and correct your mistakes (roughly 2 hours).
    b. Make a list of the things you got wrong and why.
    c. Revise these things using your preferred methods
    d. Complete another exam paper (blind) and mark it to see whether these issues have been resolved. Then start the cycle again.
8. Refer to previous areas of weakness by reviewing DIRT from previous assessment.
9. Don’t forget to have explicit knowledge of the maths and practical skills
    a. Use the maths skills booklet provided
    b. Use the practical questions provided
10. Express yourself. Verbalising explanations to other students, family and friends can really help you remember information. It also helps structure answers clearly and methodically, using key terms. For example, try teaching something to a family member to make them understand!

12. ‘Reading around’ the subject

Biology makes much more sense when you ‘read around’ it and see various interpretations and applications of the same ideas. This not limited to reading!

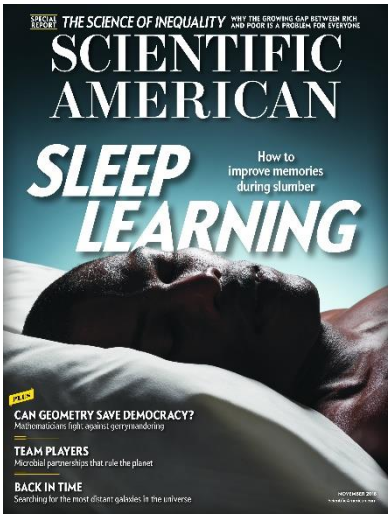
The more ways you learn about a biological idea, the better you learn. Therefore, we recommend lots of other materials to read to help embed these concepts. These are shown below and most can be loaned from the LRC or from websites:

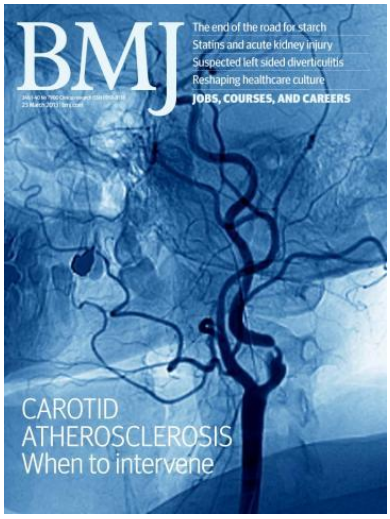
<u>Biological Sciences Review Magazine</u>

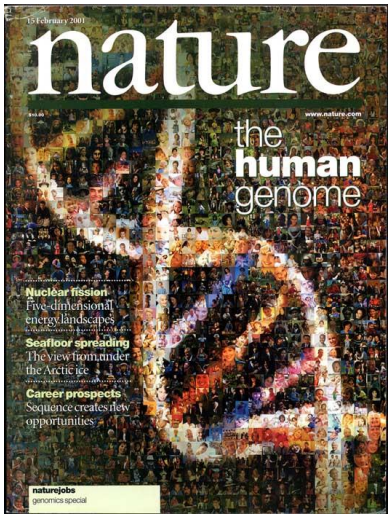
Written for A-level students and useful for research tasks, help with exams and broadening your knowledge around topics. Available through the VLE on the LRC area. Ask LRC for details.

- **Username:** fanshawelrc@dronfield.derbyshire.sch.uk
- **Password**: dhfslrc
- **Institute code:** 23162

<u>Other Magazines and Journals</u>







There are literally thousands of different scientific journals, with websites and newsletters etc.

The ‘New Scientist’ and ‘Scientific American’ are great ways to keep up to date with everything.

Prospective medical students should familiarise themselves with the ‘British Medical Journal’ too and the medical student version.

‘Nature’ is probably the most famous and prestigious journal. If you get published in ‘Nature’ one day, please remember your old school and come back and visit!

Books

There are many wonderful science books written. Please ask your teachers about their favourites!

Here are a few fantastic ones that we'd recommend, but there are many, many more!

1. 'Bad Science', by Ben Goldacre. This book is recommended for any science student. It is essential in this day and age that scientists work truthfully with evidence. Ben Goldacre also has written other science books and has a website.
2. 'The Language of the Genes', by Steve Jones. This book takes you through the fundamentals of genetics with some 'weird and wonderful' examples along the way. The material is also covered in the BBC Reith lectures (see podcasts section). Steve Jones is one of our favourite biologists. His books are great. Check out his lectures on YouTube too!
3. Genome: The Autobiography of a Species In 23 Chapters by Matt Ridley. This book takes you on a journey around the 23 human chromosomes.
4. 'The Ancestors Tale' and 'The Selfish Gene', by Richard Dawkins. Dawkins can be controversial at times for some people and is the voice of pure reason for others! What isn't in doubt is his biological explanations are astounding!
5. 'The Oxford Book of Modern Science Writing', edited by Richard Dawkins. This book introduces you to many different scientists and their writing. This book could introduce you to a lifetime of knowledge and discovery!
6. Science, a 4000 Year History, by Patricia Fara. This is as good as any introduction to the history of science, particularly as is goes right back to the dawn of history.
7. Science: A History, by John Gribbin. Another great introduction to the history of science.
8. This is Going to Hurt: Secret Diaries of a Junior Doctor, by Adam Kay. We recommend this if you are considering medicine. It certainly does not 'sugar-coat' it and it may even put you off. But, you'll be expected to know what a tough job it is in your interview.
9. The Ascent of Man, by Jacob Bronowski. You should watch the documentaries first.

Find the original paper

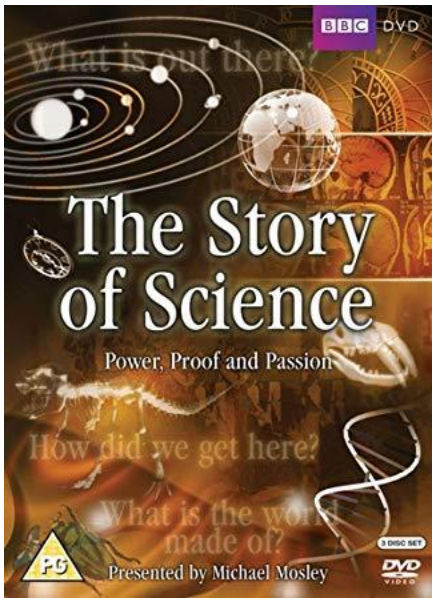
Much of the content in the A-specification is based on the pioneering work and the original paper is usually free to access online. Someone with a thirst for knowledge could have a field day here! Here are some examples:

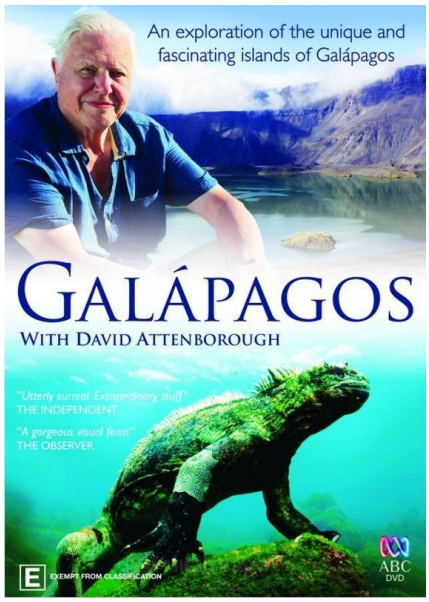
- Mitosis by Walther Fleming
  - http://llama.mshri.on.ca/courses/Biophysics205/Papers/Monod_Jacob.pdf
- Lac Operon, by Monod et. al.
  - http://llama.mshri.on.ca/courses/Biophysics205/Papers/Monod_Jacob.pdf
- Apoptosis, by JFR Kerr et. al.
  - https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2008650/?page=1
- Endosymbiosis, by Lynn Margulis (n. Sagan)
  - http://web.gps.caltech.edu/classes/ge246/endosymbiotictheory_marguli.pdf
- Evolution by Natural Selection, by Charles Darwin
  - http://darwin-online.org.uk/converted/pdf/1861_OriginNY_F382.pdf

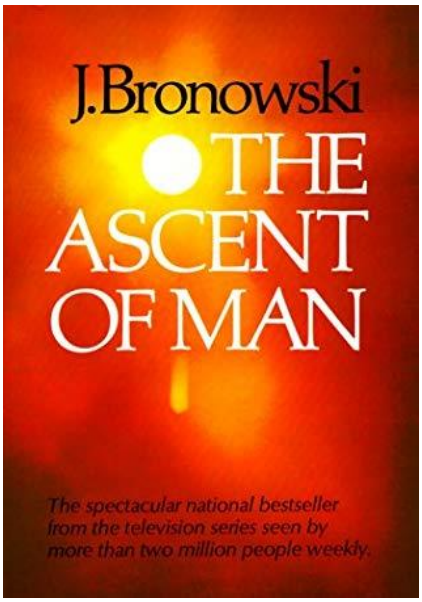
Documentaries

There are many great science documentaries. Here is a selection.

1. Anything by David Attenborough! A deep appreciation and broad knowledge of the diversity of life underpins a love of our subject. The Galapagos Islands are part of the syllabus too.
2. The Story of Science, by Michael Mosely. Wow, this documentary series is built around six fundamental questions. It's fantastic to see how the different sciences relate to each other and how they relate to politics, industry and the arts. The supplementary material on the history of cells theory is also essential viewing for biologists.
3. The Ascent of Man, by Jacob Bronowksi. This is probably the most thought provoking and greatest scientific documentary of all time!







Podcasts

BBC Radio 4 podcasts are a goldmine of scientific discussion, debate and comedy.

- 'In Our Time' is a discussion programme by leading scientists on a broad range of topics. It's not limited to science. Go here to educate yourself. There is 20 years' worth of stuff. It's amazing.
    - https://www.bbc.co.uk/programmes/p01gyd7j
- In 'Life Scientific', Professor Jim Al-Khalili talks to leading scientists about their life and work, finding out what inspires and motivates them and asking what their discoveries might do for mankind. Inspiring stuff.
    - https://www.bbc.co.uk/programmes/b015sqc7
- 'The Infinite Monkey Cage' is a witty, irreverent look at the world through scientists' eyes. With Brian Cox and Robin Ince.
    - https://www.bbc.co.uk/programmes/b00snr0w/episodes/downloads

13. Links and overlap with other subjects

Biology can open up many doors into further inquiry. It is a highly regarded A level and often a requirement for science degrees. As well as this, science degrees usually require a minimum of two science A-levels. Therefore, it is important students choose appropriate subjects to keep all options available. Below are our recommendations, including ideas for further study.

Maths

- Biology is a very mathematical subject and maths can support and develop this skill.
- 10-15% of A-level biology is maths
- Statistically, scientists who study maths at A level do better in science and mathematicians who study science do better in maths!

Physics and Chemistry

- Like biology, physics is the study of abstract ideas and phenomena and the application of models. Both require a similar set of skills.
- Biology involves applying physical concepts such as energy and particle theory
- A big part of the course is biochemistry which is applying chemical ideas to biological systems

Psychology

- Much of psychology is based on neuroscience, which is based on an understanding of the brain and nervous system. There is a lot of overlap in knowledge of synapses and neurotransmitters for example

P.E.

- P.E. applies biological ideas. Respiration and muscles are areas of overlap

Geography

- So far life has only been discovered on Earth! An understanding of the Earth is integral to understanding other subjects
- Also humans are part of the ecosystem and affect it a great deal
- Ecosystems and sustainability are areas of overlap

Other Subjects

Science and our understanding of our biological ourselves relates to many other areas of thought.

1. Pseudoscientific ideas about eugenics and race were used by Nazi Germany
2. Jewish scientist fled Nazi Germany and some were involved in the Manhattan project, most notably Einstein
3. Darwin got many of his ideas from Malthus who was an economist
4. Darwin's ideas are applied in 'Social Darwinism'
5. The theory of genetic mutation was informed by linguists investigating language change
6. The term DNA has come to mean much more than its basic biochemistry and has been used in the title of a play.

14. Biology for the Future

Biology can take you many places after A-levels. We recommend visiting UCAS.com and other university websites to get an idea of the degrees available for those studying biology at A-Level. Knowing where you want to be after Y13 can really motivate you! Biology supports applications to any other science based degree. Visiting universities can be really informative and inspiring. Students are often blown away by the laboratory facilities available!

Below are some courses that are specifically related to studying biology:

- **Biology**
- **Marine Biology**
- **Zoology**
- **Botany**
- **Ecology**
- **Molecular and Cellular Biology**
- **Plant Biology**
- **Genetics**
- **Microbiology**
- **Biochemistry**
- **Biophysics**
- **Medicine**
- **Dentistry**
- **Veterinary Science**
- **Sports Science**
- **Pharmacy**
- **Biomedical Sciences**
- **Medical Engineering**
- **Nutrition**
- **Psychology**

15. Summer Work

For new Y12s, summer work is accessible via the link on the website. It consists of introductory videos, reading and getting you all important folder organised!

Appendices

A. Course Outline

Y12

Week	(w/c)	3 lesson per week (SHW/TDA)	2 lesson per week (CHO/RHR)
1	**17/07/2023**	2.1.2 CHON and Polymers - Direct summer work, folder expectations and textbooks	2.1.1 Cell Structure PAG2 Celery Dissection PAG book expectations
	SumHols		
2	**04/09/2023**	2.1.2a Water	2.1.1 Cell Structure PAG1 skills Measuring and use of a graticule
3	**11/09/2023**	2.1.2 Carbohydrates Starch test and PAG9.3 Qual testing for glucose	2.1.1 Cell Structure
4	**18/09/2023**	2.1.2 Lipids PAG9.2 Qual Lipids	2.1.1 Cell Structure
5	**25/09/2023**	2.1.2 Lipids PAG9.2 Qual Lipids	2.1.1 Cell Structure
6	**02/10/2023**	2.1.2 Proteins PAG9.1 Qual Proteins/Kerboodle urine analysis	2.1.5 Biological Membranes PAG 8.3 Rates of Diffusion through membranes and PAG5.1 Effect of temperture on membrane permeability
7	**09/10/2023**	2.1.2 Proteins PAG6.1 Amino Acid Chromotography	2.1.5 Biological Membranes PAG 8.3 Rates of Diffusion through membranes and PAG5.1 Effect of temperture on membrane permeability
8	**16/10/2023**	2.1.2 Carbohydrates PAG5.2 Glucose Concentration with colorimeter	2.1.5 Biological Membranes PAG8.1 Osmosis in potatoes and 8.3 Osmosis in model cell
9	**23/10/2023**	2.1.3 Nucleotides/Nucleic Acids PAG9 DNA precipitation	2.1.5 Biological Membranes PAG8.1 Osmosis in potatoes and 8.3 Osmosis in model cell
10	**30/10/2023**	2.1.3 Nucleotides/Nucleic Acids PAG9 DNA precipitation	2.1.5 Biological Membranes PAG 8/1 Plasmolysis in Red Onion Cells
	Oct Half-term	**Oct Half-term**	**Oct Half-term**
11	**13/11/2023**	2.1.3 Nucleotides/Nucleic Acids PAG10.1 RasMol	2.1.5 Biological Membranes PAG 8/1 Plasmolysis in Red Onion Cells
12	**20/11/2023**	2.1.3 Nucleotides/Nucleic Acids	2.1.6 Cell Division, Diversity and Organisation
13	**27/11/2023**	Assessment	2.1.6 Cell Division, Diversity and Organisation
14	**04/12/2023**	2.1.4 Enzymes	2.1.6 Cell Division, Diversity and Organisation
15	**01/12/2023**	2.1.4 Enzymes PAG4.1-3 Factors affecting Enzymes	2.1.6 Cell Division, Diversity and Organisation
16	**18/12/2023**	2.1.4 Enzymes	3.1 Exchange PAG2 Locust Dissection
XMAS	**XMAS**	**XMAS**	**XMAS**

XMAS	XMAS	XMAS	XMAS
17	08/01/2024	4.1.1 Communicable Disease and Defence PAG 7.1 Antibiotic Discs	3.1 Exchange PAG1.3 Lung Tissue and PAG2 Fish Head Disecction/Locust Dissection
18	15/01/2024	4.1.1 Communicable Disease and Defence PAG 7.1 Antibiotic Discs	3.1 Exchange PAG10 Spirometry
19	22/01/2024	Trial Exams	Trial Exams
20	29/01/2024	Trial Exams	Trial Exams
21	05/02/2024	4.1.1 Communicable Disease and Defence	3.1 Exchange PAG1.3 Lung Tissue and PAG2 Fish Head Disecction/Locust Dissection
22	12/02/2024	4.1.1 Communicable Disease and Defence	3.1 Animal Transport PAG2.1 Heart Dissection
FEB HT	FEB HT	FEB HT	FEB HT
23	26/02/2024	Assessment	3.1 Animal Transport PAG2.1 Heart Dissection
24	04/03/2024	4.2.2 Classification and Evolution	3.1 Animal Transport PAG11.1 Effect of exercise on heart rate
25	11/03/2024	4.2.2 Classification and Evolution	3.1 Animal Transport
26	18/03/2024	4.2.2 Classification and Evolution	3.1a-d Plant Transport PAG2/1 Xylem and Phloem
27	25/03/2024	Assessment	3.1a-d Plant Transport PAG2/1 Xylem and Phloem
EASTER	EASTER	EASTER	EASTER
28	15/04/2024	4.2.1 Biodviersity PAG3.1 -3 skills (Simulation and Secondary Data)	3.1a-d Plant Transport PAG5/11 Use of potometers and different conditions
29	22/04/2024	4.2.1 Biodviersity	3.1a-d Plant Transport
30	29/04/2024	4.2.1 Biodviersity PAG3.1-2 Ecology Transect	3.1a-d Plant Transport
31	06/05/2024	Study Leave	Study Leave
32	13/05/2024	Study Leave	Study Leave
33	20/05/2024	Study Leave	Study Leave
SB HT	SB HT	SB HT	SB HT
34	03/06/2024	5.2.1 Photosynthesis PAG 12 Pond Weed	5.1.1 Communication and Homeostasis
35	10/06/2024	5.2.1 Photosynthesis	5.1.1 Communication and Homeostasis
36	17/06/2024	5.2.1 Photosynthesis	5.1.1 Communication and Homeostasis PAG11 Daphnia heart rate and Temperature
37	24/06/2024	5.2.1 Photosynthesis PAG 6.3 Thin Layer Chromotography	5.1.1 Communication and Homeostasis
38	01/07/2024	Work Experience	Work Experience
39	08/07/2024	5.2.1 Photosynthesis	5.1.1 Communication and Homeostasis
1	15/07/2024	5.2.1 Photosynthesis	5.1.1 Communication and Homeostasis PAG11 Daphnia heart rate and Temperature

Y13 (may alter slightly depending on calendar)

Week	(w/c)	3 lesson per week (SHW/RHR)	2 lesson per week (CHO)
1	**17/07/2023**	5.2.1 Photosynthesis	DIRT/Photosynthesis catch-up
	SumHols		
2	**04/09/2023**	5.2.1 Respiration	5.1.3 Neuronal Communication
3	**11/09/2023**	5.2.1 Respiration	5.1.3 Neuronal Communication
4	**18/09/2023**	5.2.1 Respiration	5.1.3 Neuronal Communication
5	**25/09/2023**	5.2.1 Respiration PAG12 Yeast	5.1.3 Neuronal Communication
6	**02/10/2023**	5.1.2 Liver	5.1.3 Neuronal Communication
7	**09/10/2023**	5.1.2 Liver	5.1.4 Hormonal Control
8	**16/10/2023**	5.1.2 Kidney Disection PAG2	5.1.4 Hormonal Control Adapted Pancrea
9	**23/10/2023**	5.1.2 Kidney	5.1.4 Hormonal Control
10	**30/10/2023**	5.1.2 Kidney	5.1.4 Hormonal Control
	Oct Half-terr	**Oct Half-term**	**Oct Half-term**
11	**13/11/2023**	5.1.5 a-f Plant Responses	5.1.4 Hormonal Control
12	**20/11/2023**	5.1.5 a-f Plant Responses	5.1.5 g-l Animal Responses
13	**27/11/2023**	5.1.5 a-f Plant Responses PAG11 Simulate	5.1.5 g-l Animal Responses
14	**04/12/2023**	6.1.1 Cellular Control	5.1.5 g-l Animal Responses PAG11 Heart
15	**01/12/2023**	6.1.1 Cellular Control	5.1.5 g-l Animal Responses
16	**18/12/2023**	6.1.1 Cellular Control	5.1.5 g-l Animal Responses
XMAS	**XMAS**	**XMAS**	**XMAS**
17	**08/01/2024**	6.2.1a-d Plant Cloning PAG2 Taking Cuttir	6.2.1a-d Animal Cloning
18	**15/01/2024**	6.2.1a-d Plant Cloning PAG2 Taking Cuttir	6.2.1a-d Animal Cloning
19	**22/01/2024**	Y13 Trial Exams	Y13 Trial Exam
20	**29/01/2024**	Y13 Trial Exams	Y13 Trial Exam
21	**05/02/2024**	6.1.2 Inheritance	6.2.1 e-h Biotechnology PAG7 Effect of ar
22	**12/02/2024**	6.1.2 Inheritance	6.2.1 e-h Biotechnology PAG7 Dilution Pla
FEB HT	**FEB HT**	**FEB HT**	**FEB HT**
23	**26/02/2024**	6.1.2 Inheritance	6.2.1 e-h Biotechnology PAG7 Bacterial Tr
24	**04/03/2024**	6.1.2 Evolution	6.2.1 e-h Biotechnology PAG7 Bacterial Tr
25	**11/03/2024**	6.1.3 Manipulating Genomes	6.3.2 Populations and Sustainability
26	**18/03/2024**	6.1.3 Manipulating Genomes PAG6 Electr	6.3.2 Populations and Sustainability
27	**25/03/2024**	6.1.3 Manipulating Genomes	6.3.2 Populations and Sustainability
EASTER	**EASTER**	**EASTER**	**EASTER**
28	**15/04/2024**	6.3.1 Ecosystems PAG 3.1-3 Ecology	6.3.1 Ecosystems
29	**22/04/2024**	6.3.1 Ecosystems	6.3.1 Ecosystems
30	**29/04/2024**	Revision	Revision
31	**06/05/2024**	Revision	Revision
32	**13/05/2024**	Study Leave	Study Leave
33	**20/05/2024**	Study Leave	Study Leave
SB HT	**SB HT**	**SB HT**	**SB HT**
34	**03/06/2024**	Study Leave	Study Leave
35	**10/06/2024**	Study Leave	Study Leave
36	**17/06/2024**	Study Leave	Study Leave

B. Year 1 and AS Checklist

2.1.1 Cell Structure *Learners should be able to demonstrate and apply their knowledge and understanding of:*	Notes	☺	😐	☹	Revised
(a) the use of microscopy to observe and investigate different types of cell and cell structure in a range of eukaryotic organisms. *To include an appreciation of the images produced by a range of microscopes: light microscope, transmission electron microscope, scanning electron microscope and laser scanning confocal microscope*					
(b) the preparation and examination of microscope slides for use in light microscopy *Including the use of an eyepiece graticule and stage micrometer PAG1*					
(c) the use of staining in light microscopy. *To include the use of differential staining to identify different cellular components and cell types PAG1*					
(d) the representation of cell structure as seen under the light microscope using drawings and annotated diagrams of whole cells or cells in sections of tissue *PAG1*					
(e) the use and manipulation of the magnification formula *magnification = image size ÷ object size M0.1, M0.2, M0.3, M1.1, M1.8, M2.2, M2.3, M2.4*					
(f) the difference between magnification and resolution. *To include an appreciation of the differences in resolution and magnification that can be achieved by a light microscope, a transmission electron microscope and a scanning electron microscope M0.2, M0.3*					
(g) the ultrastructure of eukaryotic cells and the functions of the different cellular components. *To include the following cellular components and an outline of their functions: nucleus, nucleolus, nuclear envelope, rough and smooth endoplasmic reticulum (ER), Golgi apparatus, ribosomes, mitochondria, lysosomes, chloroplasts, plasma membrane, centrioles, cell wall, flagella and cilia. M0.2*					
(h) photomicrographs of cellular components in a range of eukaryotic cells. *To include interpretation of transmission and scanning electron microscope images.*					
(i) the interrelationship between the organelles involved in the production and secretion of proteins. *No detail of protein synthesis is required.*					
(j) the importance of the cytoskeleton. *To include providing mechanical strength to cells, aiding transport within cells and enabling cell movement.*					
(k) the similarities and differences in the structure and ultrastructure of prokaryotic and eukaryotic cells. *PAG1*					
2.1.2 Biological Molecules – Water, CHONP, and Carbohydrates *Learners should be able to demonstrate and apply their knowledge and understanding of:*	Notes	☺	😐	☹	Revised
(a) how hydrogen bonding occurs between water molecules, and relate this, and other properties of water, to the roles of water for living organisms. *A range of roles that relate to the properties of water, including solvent, transport medium, coolant and as a habitat **AND** roles illustrated using examples of prokaryotes and eukaryotes.*					
(b) the concept of monomers and polymers and the importance of condensation and hydrolysis reactions in a range of biological molecules					
(c) the chemical elements that make up biological molecules. *To include: C, H and O for carbohydrates C, H and O for lipids C, H, O, N and S for proteins C, H, O, N and P for nucleic acids*					
(d) the ring structure and properties of glucose as an example of a hexose monosaccharide and the structure of ribose as an example of a pentose monosaccharide. *To include the structural difference between an α- and a β-glucose molecule AND the difference between a hexose and a pentose monosaccharide.*					
(e) the synthesis and breakdown of a disaccharide and polysaccharide by the formation and breakage of glycosidic bonds. *To include the disaccharides sucrose, lactose and maltose.*					
(f) the structure of starch (amylose and amylopectin), glycogen and cellulose molecules					

(g) how the structures and properties of glucose, starch, glycogen and cellulose molecules relate to their functions in living organisms					
2.1.2 Biological Molecules – Lipids and Phospholipids *Learners should be able to demonstrate and apply their knowledge and understanding of:*	Notes	☺	😐	☹	Revised
(h) the structure of a triglyceride and a phospholipid as examples of macromolecules. *To include an outline of saturated and unsaturated fatty acids.*					
(i) the synthesis and breakdown of triglycerides by the formation (esterification) and breakage of ester bonds between fatty acids and glycerol					
(j) how the properties of triglyceride, phospholipid and cholesterol molecules relate to their functions in living organisms. *To include hydrophobic and hydrophilic regions and energy content AND illustrated using examples of prokaryotes and eukaryotes.*					
2.1.2 Biological Molecules – Proteins *Learners should be able to demonstrate and apply their knowledge and understanding of:*	Notes	☺	😐	☹	Revised
(k) the general structure of an amino acid					
(l) the synthesis and breakdown of dipeptides and polypeptides, by the formation and breakage of peptide bonds					
(m) the levels of protein structure. *To include primary, secondary, tertiary and quaternary structure AND hydrogen bonding, hydrophobic and hydrophilic interactions, disulfide bonds and ionic bonds.*					
(n) the structure and function of globular proteins including a conjugated protein *To include haemoglobin as an example of a conjugated protein (globular protein with a prosthetic group), a named enzyme and insulin. An opportunity to use computer modelling to investigate the levels of protein structure within the molecule. PAG10*					
(o) the properties and functions of fibrous proteins *To include collagen, keratin and elastin (no details of structure are required).*					
2.1.2 Biological Molecules – Ions and Chemical Tests *Learners should be able to demonstrate and apply their knowledge and understanding of:*	Notes	☺	😐	☹	Revised
(p) the key inorganic ions that are involved in biological processes *including: cations: calcium ions (Ca^{2+}), sodium ions (Na^{+}), potassium ions (K^{+}), hydrogen ions (H^{+}), ammonium ions (NH_4^{+}); anions: nitrate (NO_3^{-}), hydrogencarbonate (HCO_3^{-}), chloride (Cl^{-}), phosphate (PO_4^{3-}), hydroxide, (OH^{-}).*					
(q) how to carry out and interpret the results of the following chemical tests: • biuret test for proteins • Benedict's test for reducing and non-reducing sugars • reagent test strips for reducing sugars • iodine test for starch • emulsion test for lipids *PAG9*					
(r) quantitative methods to determine the concentration of a chemical substance in a solution *To include colorimetry and the use of biosensors (an outline only of the mechanism is required). PAG5*					
(s) (i) the principles and uses of paper and thin layer chromatography to separate biological molecules / compounds *To include calculation of retention (Rf) values.* (ii) practical investigations to analyse biological solutions using paper or thin layer chromatography. *For example the separation of proteins, carbohydrates, vitamins or nucleic acids. M0.1, M0.2, M1.1, M1.3, M2.2, M2.3, M2.4 PAG6*					
2.1.3 Nucleotides and Nucleic Acids *Learners should be able to demonstrate and apply their knowledge and understanding of:*	Notes	☺	😐	☹	Revised
(a) the structure of a nucleotide as the monomer from which nucleic acids are made					

To include the differences between RNA and DNA nucleotides, the identification of the purines and pyrimidines and the type of pentose sugar. An opportunity to use computer modelling to investigate nucleic acid structure. PAG10					
(b) the synthesis and breakdown of polynucleotides by the formation and breakage of phosphodiester bonds					
(c) the structure of ADP and ATP as phosphorylated Nucleotides *Comprising a pentose sugar (ribose), a nitrogenous base (adenine) and inorganic phosphates.*					
(d) (i) the structure of DNA (deoxyribonucleic acid) (ii) practical investigations into the purification of DNA by precipitation *To include how hydrogen bonding between complementary base pairs (A to T, G to C) on two antiparallel DNA polynucleotides leads to the formation of a DNA molecule, and how the twisting of DNA produces its 'double-helix' shape. PAG9*					
(e) semi-conservative DNA replication *To include the roles of the enzymes helicase and DNA polymerase, the importance of replication in conserving genetic information with accuracy and the occurrence of random, spontaneous mutations.*					
(f) the nature of the genetic code *To include the triplet, non-overlapping, degenerate and universal nature of the code and how a gene determines the sequence of amino acids in a polypeptide (the primary structure of a protein).*					
(g) transcription and translation of genes resulting in the synthesis of polypeptides. *To include, the roles of RNA polymerase, messenger (m)RNA, transfer (t)RNA, ribosomal (r)RNA.*					
2.1.4 Enzymes *Learners should be able to demonstrate and apply their knowledge and understanding of:*	Notes	☺	😐	☹	Revised
(a) the role of enzymes in catalysing reactions that affect metabolism at a cellular and whole organism level *To include the idea that enzymes affect both structure and function.*					
(b) the role of enzymes in catalysing both intracellular and extracellular reactions *To include catalase as an example of an enzyme that catalyses intracellular reactions and amylase and trypsin as examples of enzymes that catalyse extracellular reactions.*					
(c) the mechanism of enzyme action *To include the tertiary structure, specificity, active site, lock and key hypothesis, induced-fit hypothesis, enzyme-substrate complex, enzyme product complex, product formation and lowering of activation energy.*					
(d) (i) the effects of pH, temperature, enzyme concentration and substrate concentration on enzyme activity *To include reference to the temperature coefficient (Q10).* (ii) practical investigations into the effects of pH, temperature, enzyme concentration and substrate concentration on enzyme activity *M0.1, M0.2, M0.3, M1.1, M1.3, M1.11, M3.1, M3.2, M3.3, M3.5, M3.6 PAG4*					
(e) the need for coenzymes, cofactors and prosthetic groups in some enzyme-controlled reactions *To include Cl^- as a cofactor for amylase, Zn^{2+} as a prosthetic group for carbonic anhydrase and vitamins as a source of coenzymes. PAG4*					
(f) the effects of inhibitors on the rate of enzyme controlled reactions. *To include competitive and non-competitive and reversible and non-reversible inhibitors with reference to the action of metabolic poisons and some medicinal drugs, and the role of product inhibition AND inactive precursors in metabolic pathways (covered at A level only). M0.1, M0.2, M0.3, M1.1, M1.3, M1.11, M3.1, M3.2, M3.3, M3.5, M3.6 PAG4*					
2.1.5 Biological membranes *Learners should be able to demonstrate and apply their knowledge and understanding of:*	Notes	☺	😐	☹	Revised
(a) the roles of membranes within cells and at the surface of cells *To include the roles of membranes as,* *• partially permeable barriers between the cell and its environment, between organelles and the cytoplasm and within organelles* *•sites of chemical reactions* *•sites of cell communication (cell signalling).*					
(b) the fluid mosaic model of membrane structure and the roles of its components *To include phospholipids, cholesterol, glycolipids, proteins and glycoproteins AND the role of membrane-bound receptors as sites where hormones and drugs can bind. M0.2*					
(c) (i) factors affecting membrane structure and permeability					

(ii) practical investigations into factors affecting membrane structure and permeability *To include the effects of temperature and solvents. M0.1, M0.2, M1.1, M1.2, M1.3, M1.6, M1.11, M3.1, M3.2, M3.3, M3.5, M3.6 PAG8*					
(d) (i) the movement of molecules across membranes (ii) practical investigations into the factors affecting diffusion rates in model cells *To include diffusion and facilitated diffusion as passive methods AND active transport, endocytosis and exocytosis as processes requiring adenosine triphosphate (ATP) as an immediate source of energy.* *M0.1, M0.2, M0.3, M1.1, M1.2, M1.3, M1.6, M1.11, M2.1, M3.1, M3.2, M3.3, M3.5, M3.6, M4.1 PAG8*					
(e) (i) the movement of water across membranes by osmosis and the effects that solutions of different water potential can have on plant and animal cells (ii) practical investigations into the effects of solutions of different water potential on plant and animal cells. *Osmosis to be explained in terms of a water potential gradient across a partially-permeable membrane.* *M0.1, M0.2, M0.3, M1.1, M1.2, M1.3, M1.6, M1.10, M1.11, M2.1, M3.1, M3.2, M4.1 PAG8*					
2.1.6 Cell division, cell diversity and cellular organisation *Learners should be able to demonstrate and apply their knowledge and understanding of:*	Notes	☺	😐	☹	Revised
(a) the cell cycle *To include the processes taking place during interphase (G_1, S and G_2), mitosis and cytokinesis, leading to genetically identical cells.*					
(b) how the cell cycle is regulated *To include an outline of the use of checkpoints to control the cycle.*					
(c) the main stages of mitosis *To include the changes in the nuclear envelope, chromosomes, chromatids, centromere, centrioles, spindle fibres and cell membrane.*					
(d) sections of plant tissue showing the cell cycle and stages of mitosis *To include the examination of stained sections and squashes of plant tissue and the production of labelled diagrams to show the stages observed. PAG1*					
(e) the significance of mitosis in life cycles *To include growth, tissue repair and asexual reproduction in plants, animals and fungi.*					
(f) the significance of meiosis in life cycles *To include the production of haploid cells and genetic variation by independent assortment and crossing over.*					
(g) the main stages of meiosis *To include interphase, prophase 1, metaphase 1, anaphase 1, telophase 1, prophase 2, metaphase 2, anaphase 2, telophase 2 (no details of the names of the stages within prophase 1 are required) and the term homologous chromosomes. PAG1*					
(h) how cells of multicellular organisms are specialised for particular functions *To include erythrocytes, neutrophils, squamous and ciliated epithelial cells, sperm cells, palisade cells, root hair cells and guard cells.*					
(i) the organisation of cells into tissues, organs and organ systems *To include squamous and ciliated epithelia, cartilage, muscle, xylem and phloem as examples of tissues.*					
(j) the features and differentiation of stem cells *To include stem cells as a renewing source of undifferentiated cells.*					
(k) the production of erythrocytes and neutrophils derived from stem cells in bone marrow					
(l) the production of xylem vessels and phloem sieve tubes from meristems					
(m) the potential uses of stem cells in research and medicine. *To include the repair of damaged tissues, the treatment of neurological conditions such as Alzheimer's and Parkinson's, and research into developmental biology.*					
3.1.1 Exchange surfaces *Learners should be able to demonstrate and apply their knowledge and understanding of:*	Notes	☺	😐	☹	Revised
(a) the need for specialised exchange surfaces *To include surface area to volume ratio (SA:V), metabolic activity, single-celled and multicellular organisms. M0.1, M0.3, M0.4, M1.1, M2.1, M4.1*					
(b) the features of an efficient exchange surface *To include,* *•increased surface area – root hair cells* *•thin layer – alveoli*					

•good blood supply/ventilation to maintain gradient – gills/alveolus.					
(c) the structures and functions of the components of the mammalian gaseous exchange system *To include the distribution and functions of cartilage, ciliated epithelium, goblet cells, smooth muscle and elastic fibres in the trachea, bronchi, bronchioles and alveoli. PAG1*					
(d) the mechanism of ventilation in mammals *To include the function of the rib cage, intercostal muscles (internal and external) and diaphragm.*					
(e) the relationship between vital capacity, tidal volume, breathing rate and oxygen uptake *To include analysis and interpretation of primary and secondary data e.g. from a data logger or spirometer. M0.1, M0.2, M0.4, M1.3 PAG10*					
(f) the mechanisms of ventilation and gas exchange in bony fish and insects *To include:* *•bony fish – changes in volume of the buccal cavity and the functions of the operculum, gill filaments and gill lamellae (gill plates); countercurrent flow* *•insects – spiracles, trachea, thoracic and abdominal movement to change body volume, exchange with tracheal fluid.*					
(g) the dissection, examination and drawing of the gaseous exchange system of a bony fish and/or insect trachea *PAG2*					
(h) the examination of microscope slides to show the histology of exchange surfaces. *PAG1*					
3.1.2 Transport in animals *Learners should be able to demonstrate and apply their knowledge and understanding of:*	Notes	☺	😐	☹	Revised
(a) the need for transport systems in multicellular animals *To include an appreciation of size, metabolic rate and surface area to volume ratio (SA:V). M0.1, M0.3, M0.4, M1.1, M2.1, M4.1*					
(b) the different types of circulatory systems *To include single, double, open and closed circulatory systems in insects, fish and mammals.*					
(c) the structure and functions of arteries, arterioles, capillaries, venules and veins *To include the distribution of different tissues within the vessel walls. PAG2*					
(d) the formation of tissue fluid from plasma *To include reference to hydrostatic pressure, oncotic pressure and an explanation of the differences in the composition of blood, tissue fluid and lymph.*					
(e) (i) the external and internal structure of the mammalian heart *PAG2* (ii) the dissection, examination and drawing of the external and internal structure of the mammalian heart					
(f) the cardiac cycle To include the role of the valves and the pressure changes occurring in the heart and associated vessels.					
(g) how heart action is initiated and coordinated *To include the roles of the sino-atrial node (SAN), atrio-ventricular node (AVN), purkyne tissue and the myogenic nature of cardiac muscle (no detail of hormonal and nervous control is required at AS level).*					
(h) the use and interpretation of electrocardiogram (ECG) traces *To include normal and abnormal heart activity e.g. tachycardia, bradycardia, fibrillation and ectopic heartbeat. M0.1, M1.1, M1.3, M2.4*					
(i) the role of haemoglobin in transporting oxygen and carbon dioxide *To include the reversible binding of oxygen molecules, carbonic anhydrase, haemoglobinic acid, HCO_3^- and the chloride shift.*					
(j) the oxygen dissociation curve for fetal and adult human haemoglobin. *To include the significance of the different affinities for oxygen AND the changes to the dissociation curve at different carbon dioxide concentrations (the Bohr effect). M3.1*					
3.1.3 Transport in plants *Learners should be able to demonstrate and apply their knowledge and understanding of:*	Notes	☺	😐	☹	Revised
(a) the need for transport systems in multicellular plants *To include an appreciation of size, metabolic rate and surface area to volume ratio (SA:V). M0.1, M0.3, M0.4, M1.1, M2.1, M4.1*					

(b) (i) the structure and function of the vascular system in the roots, stems and leaves of herbaceous dicotyledonous plants (ii) the examination and drawing of stained sections of plant tissue to show the distribution of xylem and phloem *PAG1* (iii) the dissection of stems, both longitudinally and transversely, and their examination to demonstrate the position and structure of xylem vessels *To include xylem vessels, sieve tube elements and companion cells. PAG2*					
(c) (i) the process of transpiration and the environmental factors that affect transpiration rate (ii) practical investigations to estimate transpiration rates *To include an appreciation that transpiration is a consequence of gaseous exchange.* *To include the use of a potometer. M0.1, M0.2, M1.1, M1.2, M1.3, M1.6, M1.11, M3.1, M3.2, M3.3, M3.5, M3.6, M4.1 PAG5, PAG11*					
(d) the transport of water into the plant, through the plant and to the air surrounding the leaves *To include details of the pathways taken by water AND the mechanisms of movement, in terms of water potential, adhesion, cohesion and the transpiration stream.*					
(e) adaptations of plants to the availability of water in their environment *To include xerophytes (cacti and marram grass) and hydrophytes (water lilies).*					
(f) the mechanism of translocation. *To include translocation as an energy-requiring process transporting assimilates, especially sucrose, in the phloem between sources (e.g. leaves) and sinks (e.g. roots, meristem) AND details of active loading at the source and removal at the sink.*					
4.1.1 Communicable diseases, disease prevention and the immune system *Learners should be able to demonstrate and apply their knowledge and understanding of:*	Notes	☺	😐	☹	Revised
(a) the different types of pathogen that can cause communicable diseases in plants and animals *To include,* *•bacteria – tuberculosis (TB), bacterial meningitis, ring rot (potatoes, tomatoes)* *•virus – HIV/AIDS (human), influenza (animals), Tobacco Mosaic Virus (plants)* *•protoctista – malaria, potato/tomato late blight* *•fungi – black sigatoka (bananas), ring worm (cattle), athlete's foot (humans).*					
(b) the means of transmission of animal and plant communicable pathogens *To include direct and indirect transmission, reference to vectors, spores and living conditions – e.g. climate, social factors (no detail of the symptoms of specific diseases is required). M0.1, M0.2, M0.3, M1.1, M1.2, M1.3, M1.5, M1.7, M3.1, M3.2*					
(c) plant defences against pathogens *To include production of chemicals AND plant responses that limit the spread of the pathogen (e.g. callose deposition).*					
(d) the primary non-specific defences against pathogens in animals *Non-specific defences to include skin, blood clotting, wound repair, inflammation, expulsive reflexes and mucous membranes (no detail of skin structure is required).*					
(e) (i) the structure and mode of action of phagocytes (ii) examination and drawing of cells observed in blood smears *To include neutrophils and antigen-presenting cells AND the roles of cytokines, opsonins, phagosomes and lysosomes. PAG1*					
(f) the structure, different roles and modes of action of B and T lymphocytes in the specific immune response *To include the significance of cell signalling (reference to interleukins), clonal selection and clonal expansion, plasma cells, T helper cells, T killer cells and T regulator cells.*					
(g) the primary and secondary immune responses *To include T memory cells and B memory cells. M1.3*					
(h) the structure and general functions of antibodies *To include the general structure of an antibody molecule.*					
(i) an outline of the action of opsonins, agglutinins and anti-toxins					
(j) the differences between active and passive immunity, and between natural and artificial immunity *To include examples of each type of immunity.*					
(k) autoimmune diseases					

To include an appreciation of the term autoimmune disease and a named example e.g. arthritis, lupus.					
(l) the principles of vaccination and the role of vaccination programmes in the prevention of epidemics *To include routine vaccinations AND reasons for changes to vaccines and vaccination programmes (including global issues). M0.1, M0.2, M0.3, M1.1, M1.2, M1.3, M1.5, M1.7, M3.1, M3.2*					
(m) possible sources of medicines *To include examples of microorganisms and plants (and so the need to maintain biodiversity) AND the potential for personalised medicines and synthetic biology.*					
(n) the benefits and risks of using antibiotics to manage bacterial infection. *To include the wide use of antibiotics following the discovery of penicillin in the mid-20th century AND the increase in bacterial resistance to antibiotics (examples to include Clostridium difficile and MRSA) and its implications.*					
4.2.1 Biodiversity *Learners should be able to demonstrate and apply their knowledge and understanding of:*	Notes	☺	😐	☹	Revised
(a) how biodiversity may be considered at different levels *To include habitat biodiversity (e.g. sand dunes, woodland, meadows, streams), species biodiversity (species richness and species evenness) and genetic biodiversity (e.g. different breeds within a species).*					
(b) (i) how sampling is used in measuring the biodiversity of a habitat and the importance of sampling (ii) practical investigations collecting random and non-random samples in the field *To include how sampling can be carried out i.e. random sampling and non-random sampling (e.g. opportunistic, stratified and systematic) and the importance of sampling the range of organisms in a habitat. M0.2, M1.3, M1.5, M1.4, M1.6, M1.7, M1.9, M1.10, M3.2 PAG3*					
(c) how to measure species richness and species evenness in a habitat *M1.1, M1.5, M2.3, M2.4*					
(d) the use and interpretation of Simpson's Index of Diversity (D) to calculate the biodiversity of a habitat *To include the formula: $D = 1 - (\Sigma(n/N)^2)$ AND the interpretation of both high and low values of Simpson's Index of Diversity (D). M1.1, M1.5, M2.3, M2.4*					
(e) how genetic biodiversity may be assessed, including calculations *To include calculations of genetic diversity within isolated populations, for example the percentage of gene variants (alleles) in a genome.* *proportion of polymorphic gene loci = number of polymorphic gene loci/total number of loci* *Suitable populations include zoos (captive breeding), rare breeds and pedigree animals. M1.1, M1.5, M2.3, M2.4*					
(f) the factors affecting biodiversity *To include human population growth, agriculture (monoculture) and climate change. M1.3, M1.7, M3.1*					
(g) the ecological, economic and aesthetic reasons for maintaining biodiversity *Ecological, including protecting keystone species (interdependence of organisms) and maintaining genetic resource* *•economic, including reducing soil depletion (continuous monoculture)* *•aesthetic, including protecting* *•landscapes.*					
(h) in situ and ex situ methods of maintaining biodiversity *•In situ conservation including marine conservation zones and wildlife reserves* *•ex situ conservation including seed banks, botanic gardens and zoos.*					
(i) international and local conservation agreements made to protect species and habitats. *Historic and/or current agreements, including the Convention on International Trade in Endangered Species (CITES), the Rio Convention on Biological Diversity (CBD) and the Countryside Stewardship Scheme (CSS).*					
4.2.2 Classification and evolution *Learners should be able to demonstrate and apply their knowledge and understanding of:*	Notes	☺	😐	☹	Revised
(a) the biological classification of species *To include the taxonomic hierarchy of kingdom, phylum, class, order, family, genus and species AND domain.*					
(b) the binomial system of naming species and the advantage of such a system					

(c) (i) the features used to classify organisms into the five kingdoms: Prokaryotae, Protoctista, Fungi, Plantae, Animalia (ii) the evidence that has led to new classification systems, such as the three domains of life, which clarifies relationships *To include the use of similarities in observable features in original classification.* *To include the more recent use of similarities in biological molecules and other genetic evidence AND details of the three domains and a comparison of the kingdom and domain classification systems.*					
(d) the relationship between classification and Phylogeny *(covered in outline only at AS level)*					
(e) the evidence for the theory of evolution by natural selection *To include the contribution of Darwin and Wallace in formulating the theory of evolution by natural selection AND fossil, DNA (only genomic DNA at AS level) and molecular evidence.*					
(f) the different types of variation *To include intraspecific and interspecific variation AND the differences between continuous and discontinuous variation, using examples of a range of characteristics found in plants, animals and microorganisms AND both genetic and environmental causes of variation. An opportunity to use standard deviation to measure the spread of a set of data and/or Student's t-test to compare means of data values of two populations and/or the Spearman's rank correlation coefficient to consider the relationship of the data. M1.2, M1.3, M1.6, M1.7, M1.10*					
(g) the different types of adaptations of organisms to their environment *Anatomical, physiological and behavioural adaptations AND why organisms from different taxonomic groups may show similar anatomical features, including the marsupial mole and placental mole.*					
(h) the mechanism by which natural selection can affect the characteristics of a population over time *To include an appreciation that genetic variation, selection pressure and reproductive success (or failure) results in an increased proportion of the population possessing the advantageous characteristic(s). M0.3*					
(i) how evolution in some species has implications for human populations. *To include the evolution of pesticide resistance in insects and drug resistance in microorganisms.*					

C. Year 2 Checklist

A Level Biology Checklist	Notes	☺	😐	☹	Revised
Module 5: Communication, homeostasis and energy					
5.1.1 Communication and homeostasis *Learners should be able to demonstrate and apply their knowledge and understanding of:*					
(a) the need for communication systems in multicellular organisms *To include the need for animals and plants to respond to changes in the internal and external environment and to coordinate the activities of different organs.*					
(b) the communication between cells by cell signalling *To include signalling between adjacent cells and signalling between distant cells.*					
(c) the principles of homeostasis *To include the differences between receptors and effectors, and the differences between negative feedback and positive feedback.*					
(d) the physiological and behavioural responses involved in temperature control in ectotherms and endotherms. *To include:* *• endotherms – peripheral temperature receptors, the role of the hypothalamus and effectors in skin and muscles; behavioural responses* *• ectotherms – behavioural responses.* *An opportunity to monitor physiological functions in ectotherms and/or endotherms. PAG11*					
5.1.2 Excretion as an example of homeostatic control *Learners should be able to demonstrate and apply their knowledge and understanding of:*					
(a) the term excretion and its importance in maintaining metabolism and homeostasis					

To include reference to the importance of removing metabolic wastes, including carbon dioxide and nitrogenous waste, from the body.					
(b) (i) the structure and functions of the mammalian liver (ii) the examination and drawing of stained sections to show the histology of liver tissue *To include the gross structure and histology of the liver AND the roles of the liver in storage of glycogen, detoxification and the formation of urea (the ornithine cycle covered in outline only). PAG1*					
(c) (i) the structure, mechanisms of action and functions of the mammalian kidney (ii) the dissection, examination and drawing of the external and internal structure of the kidney (iii) the examination and drawing of stained sections to show the histology of nephrons *To include the gross structure and histology of the kidney including the detailed structure of a nephron and its associated blood vessels AND the processes of ultrafiltration, selective reabsorption and the production of urine.* *M0.1, M0.3, M1.1, M1.3, M2.1, M3.1 PAG1, PAG2*					
(d) the control of the water potential of the blood To include the role of osmoreceptors in the hypothalamus, the posterior pituitary gland, ADH and its effect on the walls of the collecting ducts.					
(e) the effects of kidney failure and its potential treatments *To include the problems that arise from kidney failure including the effect on glomerular filtration rate (GFR) and electrolyte balance AND the use of renal dialysis and transplants for the treatment of kidney failure.*					
(f) how excretory products can be used in medical diagnosis. *To include the use of urine samples in diagnostic tests, with reference to the use of monoclonal antibodies in pregnancy testing and testing for anabolic steroids and drugs.* *PAG9*					
	N	☺	😐	☹	R
5.1.3 Neuronal communication *Learners should be able to demonstrate and apply their knowledge and understanding of:*					
(a) the roles of mammalian sensory receptors in converting different types of stimuli into nerve impulses *To include an outline of the roles of sensory receptors (e.g. Pacinian corpuscle) in responding to specific types of stimuli and their roles as transducers.*					
(b) the structure and functions of sensory, relay and motor neurones *To include differences between the structure and function of myelinated and non-myelinated neurones.*					
(c) the generation and transmission of nerve impulses in mammals *To include how the resting potential is established and maintained and how an action potential is generated (including reference to positive feedback) and transmitted in a myelinated neurone AND the significance of the frequency of impulse transmission. M1.3, M3.1*					
(d) the structure and roles of synapses in neurotransmission. *To include the structure of a cholinergic synapse AND the action of neurotransmitters at the synapse and the importance of synapses in summation and control.*					
5.1.4 Hormonal communication *Learners should be able to demonstrate and apply their knowledge and understanding of:*					
(a) endocrine communication by hormones To include secretion of hormones into the blood, transport by the blood, and detection by target cells or tissues.					
(b) the structure and functions of the adrenal glands *Adrenal glands as an example of endocrine glands, to include the hormones secreted by the cortex and medulla and their functions.*					
(c) (i) the histology of the pancreas (ii) the examination and drawing of stained sections of the pancreas to show the histology of the endocrine tissues *To include the endocrine tissues. PAG1*					
(d) how blood glucose concentration is regulated					

To include the action of insulin and glucagon as an example of negative feedback, and the role of the Liver AND the control of insulin secretion, with reference to potassium channels and calcium channels in the beta cells of the pancreas.					
(e) the differences between Type 1 and Type 2 diabetes mellitus *To include the causes of Type 1 and Type 2 diabetes and the treatments used for each.*					
(f) the potential treatments for diabetes mellitus. *To include the use of insulin produced by genetically modified bacteria and the potential use of stem cells to treat diabetes mellitus.*					
5.1.5 Plant and animal responses *Learners should be able to demonstrate and apply their knowledge and understanding of:*					
(a) (i) the types of plant responses (ii) practical investigations into phototropism and geotropism *To include the response to abiotic stress and herbivory e.g. chemical defences (such as tannins, alkaloids and pheromones), folding in response to touch (Mimosa pudica) AND the range of tropisms in plants. M1.3, M1.6 PAG11*					
(b) the roles of plant hormones To include the role of hormones in leaf loss in deciduous plants, seed germination and stomatal closure.					
(c) the experimental evidence for the role of auxins in the control of apical dominance					
(d) the experimental evidence for the role of gibberellin in the control of stem elongation and seed germination					
(e) practical investigations into the effect of plant hormones on growth *An opportunity for serial dilution. An opportunity to use standard deviation to measure the spread of a set of data. M0.2, M1.1, M1.2, M1.3, M1.4, M1.6, M1.9, M1.10, M3.1, M3.2 PAG11*					
(f) the commercial use of plant hormones *To include the use of hormones to control ripening, the use of rooting powders and hormonal weed killers.*					
(g) the organisation of the mammalian nervous system *To include the structural organisation of the nervous system into the central and peripheral systems AND the functional organisation into the somatic and autonomic nervous systems.*					
(h) the structure of the human brain and the functions of its parts *To include the gross structure of the human brain AND the functions of the cerebrum, cerebellum, medulla oblongata, hypothalamus and pituitary gland.*					
(i) reflex actions *To include knee jerk reflex and blinking reflex, with reference to the survival value of reflex actions. M0.1, M0.2, M1.1, M1.2, M1.3, M1.6 PAG11*					
(j) the coordination of responses by the nervous and endocrine systems *To include the 'fight or flight' response to environmental stimuli in mammals AND the action of hormones in cell signalling (studied in outline only) with reference to adrenaline (first messenger), activation of adenylyl cyclase, and cyclic AMP (second messenger).*					
(k) the effects of hormones and nervous mechanisms on heart rate *An opportunity to monitor physiological functions, for example with pulse rate measurements before, during and after exercise or sensors to record electrical activity in the heart. An opportunity to use standard deviation to measure the spread of a set of data and/or Student's t-test to compare means of data values of two sets of data. M0.1, M0.2, M0.3, M1.1, M1.2, M1.3, M1.6, M1.10, M3.1 PAG10, PAG11*					
(l) (i) the structure of mammalian muscle and the mechanism of muscular contraction (ii) the examination of stained sections or photomicrographs of skeletal muscle. *To include the structural and functional differences between skeletal, involuntary and cardiac muscle AND the action of neuromuscular junctions AND the sliding filament model of muscular contraction and the role of ATP, and how the supply of ATP is maintained in muscles by creatine phosphate. An opportunity to monitor muscle contraction and fatigue using sensors to record electrical activity. PAG1, PAG10, PAG11*					
5.2.1 Photosynthesis *Learners should be able to demonstrate and apply their knowledge and understanding of:*					
(a) the interrelationship between the process of photosynthesis and respiration					

To include the relationship between the raw materials and products of the two processes. M0.1, M0.3, M0.4, M3.4					
(b) the structure of a chloroplast and the sites of the two main stages of photosynthesis *The components of a chloroplast including outer membrane, lamellae, grana, thylakoid, stroma and DNA.*					
(c) (i) the importance of photosynthetic pigments in photosynthesis (ii) practical investigations using thin layer chromatography (TLC) to separate photosynthetic pigments *To include reference to light harvesting systems and photosystems. M0.1, M0.2, M1.1, M1.3, M2.2, M2.3, M2.4 PAG6*					
(d) the light-dependent stage of photosynthesis *To include how energy from light is harvested and used to drive the production of chemicals which can be used as a source of energy for other metabolic processes (ATP and reduced NADP) with reference to electron carriers and cyclic and non-cyclic photophosphorylation AND the role of water.*					
(e) the fixation of carbon dioxide and the light independent stage of photosynthesis *To include how the products of the light-dependent stage are used in the light-independent stage (Calvin cycle) to produce triose phosphate (TP) with reference to ribulose bisphosphate (RuBP), ribulose bisphosphate carboxylase (RuBisCO) and glycerate 3-phosphate (GP) – no other biochemical detail is required.*					
(f) the uses of triose phosphate (TP) *To include the use of TP as a starting material for the synthesis of carbohydrates, lipids and amino acids AND the recycling of TP to regenerate the supply of RuBP.*					
(g) (i) factors affecting photosynthesis (ii) practical investigations into factors affecting the rate of photosynthesis. *To include limiting factors in photosynthesis with reference to carbon dioxide concentration, light intensity and temperature, and the implications of water stress (stomatal closure) AND the effect on the rate of photosynthesis, and on levels of GP, RuBP and TP, of changing carbon dioxide concentration, light intensity and temperature. An opportunity to use sensors, data loggers and software to process data. M0.1, M0.2, M0.3, M1.1, M1.3, M1.11, M3.1, M3.2, M3.4, M3.5, M3.6, M4.1 PAG4, PAG10, PAG11*					
5.2.2 Respiration *Learners should be able to demonstrate and apply their knowledge and understanding of:*					
(a) the need for cellular respiration *To include examples of why plants, animals and microorganisms need to respire (suitable examples could include active transport and an outline of named metabolic reactions).*					
(b) the structure of the mitochondrion *The components of a mitochondrion including inner and outer michondrial membranes, cristae, matrix and mitochondrial DNA.*					
(c) the process and site of glycolysis *To include the phosphorylation of glucose to hexose bisphosphate, the splitting of hexose bisphosphate into two triose phosphate molecules and further oxidation to pyruvate AND the production of a small yield of ATP and reduced NAD.*					
(d) the link reaction and its site in the cell *To include the decarboxylation of pyruvate to acetate, the reduction of NAD, and the combination of acetate with coenzyme A.*					
(e) the process and site of the Krebs cycle To include the formation of citrate from acetate *and oxaloacetate and the reconversion of citrate to oxaloacetate (names of intermediate compounds are not required) AND the importance of decarboxylation, dehydrogenation, the reduction of NAD and FAD, and substrate level phosphorylation.*					
(f) the importance of coenzymes in cellular respiration *With reference to NAD, FAD and coenzyme A.*					
(g) the process and site of oxidative phosphorylation *To include the roles of electron carriers, oxygen and the mitochondrial cristae.*					
(h) the chemiosmotic theory *To include the electron transport chain, proton gradients and ATP synthase in oxidative phosphorylation and photophosphorylation.*					
(i) (i) the process of anaerobic respiration in eukaryotes					

(ii) practical investigations into respiration rates in yeast, under aerobic and anaerobic Conditions *To include anaerobic respiration in mammals and yeast and the benefits of being able to respire anaerobically AND why anaerobic respiration produces a much lower yield of ATP than aerobic respiration. An opportunity to use sensors, data loggers and software to process data. M0.1, M0.2, M1.1, M1.3, M2.4, M3.1, M3.2 PAG4, PAG10, PAG11*					
(j) the difference in relative energy values of carbohydrates, lipids and proteins as respiratory substrates					
(k) the use and interpretation of the respiratory quotient (RQ) *To include calculating the respiratory quotient (RQ) using the formula:* *$RQ = CO_2$ produced÷ O_2 consumed* *M0.1, M0.2, M1.1, M1.3, M2.3*					
(l) practical investigations into the effect of factors such as temperature, substrate concentration and different respiratory substrates on the rate of respiration. For example the use of respirometers. *An opportunity to use sensors, data loggers and software to process data. An opportunity to use standard deviation to measure the spread of a set of data and/or Student's t-test to compare means of data values of two sets of data. M0.1, M0.2, M1.1, M1.2, M1.3, M1.6, M1.10, M2.4, M3.2, M3.3, M3.5, M3.6 PAG4, PAG10, PAG11*					
Module 6: Genetics, evolution and ecosystems					
6.1.1 Cellular control *Learners should be able to demonstrate and apply their knowledge and understanding of:*					
(a) types of gene mutations and their possible effects on protein production and function *To include substitution, insertion or deletion of one or more nucleotides AND the possible effects of these gene mutations (i.e. beneficial, neutral or harmful).*					
(b) the regulatory mechanisms that control gene expression at the transcriptional level, posttranscriptional level and post-translational level *To include control at the,* *• transcriptional level: lac operon, and transcription factors in eukaryotes.* *• post-transcriptional level: the editing of primary mRNA and the removal of introns to produce mature mRNA.* *• post-translational level: the activation of proteins by cyclic AMP.*					
(c) the genetic control of the development of body plans in different organisms *Homeobox gene sequences in plants, animals and fungi are similar and highly conserved AND the role of Hox genes in controlling body plan development.*					
(d) the importance of mitosis and apoptosis as mechanisms controlling the development of body form. *To include an appreciation that the genes which regulate the cell cycle and apoptosis are able to respond to internal and external cell stimuli e.g. stress.*					
6.1.2 Patterns of inheritance *Learners should be able to demonstrate and apply their knowledge and understanding of:*					
(a) (i) the contribution of both environmental and genetic factors to phenotypic variation (ii) how sexual reproduction can lead to genetic variation within a species *To include examples of both genetic and environmental contributions – environmental examples could include diet in animals and etiolation or chlorosis in plants. Meiosis and the random fusion of gametes at fertilisation.*					
(b) (i) genetic diagrams to show patterns of inheritance *To include monogenic inheritance, dihybrid inheritance, multiple alleles, sex linkage and codominance.* (ii) the use of phenotypic ratios to identify linkage (autosomal and sex linkage) and Epistasis *To include explanations of linkage and epistasis. M0.3, M1.4*					
(c) using the chi-squared (χ2) test to determine the significance of the difference between observed and expected results *The formula for the chi-squared (χ2) test will be provided. M0.3, M1.4, M1.9, M2.1*					
(d) the genetic basis of continuous and discontinuous variation *To include reference to the number of genes that influence each type of variation.*					
(e) the factors that can affect the evolution of a species					

To include stabilising selection and directional selection, genetic drift, genetic bottleneck and founder effect.					
(f) the use of the Hardy–Weinberg principle to calculate allele frequencies in populations *The equations for the Hardy–Weinberg principle will be provided.*					
(g) the role of isolating mechanisms in the evolution of new species *To include geographical mechanisms (allopatric speciation) and reproductive mechanisms (sympatric speciation).*					
(h) (i) the principles of artificial selection and its uses *To include examples of selective breeding in plants and animals AND an appreciation of the importance of maintaining a resource of genetic material for use in selective breeding including wild types.* (ii) the ethical considerations surrounding the use of artificial selection. *To include a consideration of the more extreme examples of the use of artificial selection to 'improve' domestic species e.g. dog breeds.*					
6.1.3 Manipulating genomes *Learners should be able to demonstrate and apply their knowledge and understanding of:*					
(a) the principles of DNA sequencing and the development of new DNA sequencing techniques *To include the rapid advancements of the techniques used in sequencing, which have increased the speed of sequencing and allowed whole genome*					
(b) (i) how gene sequencing has allowed for genome-wide comparisons between individuals and between species (ii) how gene sequencing has allowed for the sequences of amino acids in polypeptides to be predicted (iii) how gene sequencing has allowed for the development of synthetic biology *With reference to bioinformatics and computational biology and how these fields are contributing to biological research into genotype–phenotype relationships, epidemiology and searching for evolutionary relationships. PAG10*					
(c) the principles of DNA profiling and its uses *To include forensics and analysis of disease risk.*					
(d) the principles of the polymerase chain reaction (PCR) and its application in DNA analysis					
(e) the principles and uses of electrophoresis for separating nucleic acid fragments or proteins *Opportunity for practical use of electrophoresis. PAG6*					
(f) (i) the principles of genetic engineering *To include the isolation of genes from one organism and the placing of these genes into another organism using suitable vectors.* (ii) the techniques used in genetic engineering *To include the use of restriction enzymes, plasmids and DNA ligase to form recombinant DNA with the desired gene and electroporation.*					
(g) the ethical issues (both positive and negative) relating to the genetic manipulation of animals (including humans), plants and microorganisms *To include insect resistance in genetically modified soya, genetically modified pathogens for research and 'pharming' i.e. genetically modified animals to produce pharmaceuticals AND issues relating to patenting and technology transfer e.g. making genetically modified seed available to poor farmers.*					
(h) the principles of, and potential for, gene therapy in medicine. *To include the differences between somatic cell gene therapy and germ line cell gene therapy.*					
6.2.1 Cloning and biotechnology *Learners should be able to demonstrate and apply their knowledge and understanding of:*					
(a) (i) natural clones in plants and the production of natural clones for use in horticulture (ii) how to take plant cuttings as an example of a simple cloning technique *To include examples of natural cloning and the methods used to produce clone (various forms of vegetative propagation). Dissection of a selection of plant material to produce cuttings. PAG2*					
(b) (i) the production of artificial clones of plants by micropropagation and tissue culture (ii) the arguments for and against artificial cloning in plants *To include an evaluation of the uses of plant cloning in horticulture and agriculture.*					
(c) natural clones in animal species					

To include examples of natural clones (twins formed by embryo splitting).					
(d) (i) how artificial clones in animals can be produced by artificial embryo twinning or by enucleation and somatic cell nuclear transfer (SCNT) (ii) the arguments for and against artificial cloning in animals *To include an evaluation of the uses of animal cloning (examples including in agriculture and medicine, and issues of longevity of cloned animals).*					
(e) the use of microorganisms in biotechnological processes *To include reasons why microorganisms are used e.g. economic considerations, short life cycle, growth requirements AND processes including brewing, baking, cheese making, yoghurt production, penicillin production, insulin production and bioremediation.*					
(f) the advantages and disadvantages of using microorganisms to make food for human consumption *To include bacterial and fungal sources.*					
(g) (i) how to culture microorganisms effectively, using aseptic techniques (ii) the importance of manipulating the growing conditions in batch and continuous fermentation in order to maximise the yield of product required *An opportunity for serial dilutions and culturing on agar plates. PAG7*					
(h) (i) the standard growth curve of a microorganism in a closed culture (ii) practical investigations into the factors affecting the growth of microorganisms *An opportunity for serial dilutions and the use of broth. M0.1, M0.3, M0.5, M1.1, M1.3, M2.5, M3.1, M3.2, M3.4, M3.5, M3.6 PAG7*					
(i) the uses of immobilised enzymes in biotechnology and the different methods of immobilisation. *To include methods of enzyme immobilisation AND an evaluation of the use of immobilised enzymes in Biotechnology examples could include:* *• glucose isomerase for the conversion of glucose to fructose* *• penicillin acyclase for the formation of semisynthetic penicillins (to which some penicillin resistant organisms are not resistant)* *• lactase for the hydrolysis of lactose to glucose and galactose* *• aminoacyclase for production of pure samples of L-amino acids* *• glucoamylase for the conversion of dextrins to glucose* *• nitrilase for the conversion of acrylonitrile to acrylamide (for use in the plastics industry).* *M0.2, M0.3, M1.2, M1.3, M1.4, M1.6, M1.10, M3.2, M4.1 PAG4*					
6.3.1 Ecosystems *Learners should be able to demonstrate and apply their knowledge and understanding of:*					
(a) ecosystems, which range in size, are dynamic and are influenced by both biotic and abiotic factors *To include reference to a variety of ecosystems of different sizes (e.g. a rock pool, a playing field, a large tree) and named examples of biotic and abiotic factors.*					
(b) biomass transfers through ecosystems *To include how biomass transfers between trophic levels can be measured AND the efficiency of biomass transfers between trophic levels AND how human activities can manipulate the transfer of biomass through ecosystems. M0.1, M0.2, M0.3, M0.4, M1.1, M1.3, M1.6*					
(c) recycling within ecosystems *To include the role of decomposers and the roles of microorganisms in recycling nitrogen within ecosystems (including Nitrosomonas, Nitrobacter, Azotobacter and Rhizobium) AND the importance of the carbon cycle to include the role of organisms (decomposition, respiration and photosynthesis) and physical and chemical effects in the cycling of carbon within ecosystems.*					
(d) the process of primary succession in the development of an ecosystem *To include succession from pioneer species to a climax community AND deflected succession.*					
(e) (i) how the distribution and abundance of organisms in an ecosystem can be measured (ii) the use of sampling and recording methods to determine the distribution and abundance of organisms in a variety of ecosystems. *M1.3, M1.4, M1.5, M1.7, M1.9, M1.10, M3.1, M3.2 PAG3*					
6.3.2 Populations and sustainability *Learners should be able to demonstrate and apply their knowledge and understanding of:*					
(a) the factors that determine size of a population *To include the significance of limiting factors in determining the carrying capacity of a given environment and the impact of these factors on final population size.* *M0.1, M0.2, M0.3, M0.4, M0.5, M1.3, M2.5, M3.1, M3.2*					
(b) interactions between populations					

To include predator–prey relationships considering the effects on both predator and prey populations AND interspecific and intraspecific competition.					
(c) the reasons for, and differences between, conservation and preservation *To include the economic, social and ethical reasons for conservation of biological resources.*					
(d) how the management of an ecosystem can provide resources in a sustainable way *Examples to include timber production and fishing.*					
(e) the management of environmental resources and the effects of human activities. *To include how ecosystems can be managed to balance the conflict between conservation/ preservation and human needs e.g. the Masai Mara region in Kenya and the Terai region of Nepal, peat bogs AND the effects of human activities on the animal and plant populations and how these are controlled in environmentally sensitive ecosystems e.g. the Galapagos Islands, Antarctica, Snowdonia National Park, the Lake District.*					

Forms of assessment

All three externally assessed components (01–03) contain some synoptic assessment, some extended response questions and some stretch and challenge questions.
Stretch and challenge questions are designed to allow the most able learners the opportunity to demonstrate the full extent of their knowledge and skills.
Stretch and challenge questions will support the awarding of A* grade at A level, addressing the need for greater differentiation between the most able learners.

Biological processes (Component 01)

This component is worth **100 marks**, is split into two sections and assesses content from teaching modules **1, 2, 3** and **5**. Learners answer all the questions.
Section A contains **multiple choice** questions. This section of the paper is worth **15 marks**.
Section B includes **short answer** question styles (structured questions, problem solving, calculations, practical) and **extended response** questions. This section of the paper is worth **85 marks**.

Biological diversity (Component 02)

This component is worth **100 marks**, is split into two sections and assesses content from teaching modules **1, 2, 4** and **6**. Learners answer all the questions.
Section A contains **multiple choice** questions. This section of the paper is worth **15 marks.**
Section B includes **short answer** question styles (structured questions, problem solving, calculations, practical) and **extended response** questions. This section of the paper is worth **85 marks.**

Unified biology (Component 03)

This component assesses content from across all teaching modules **1 to 6**. Learners answer all the questions. This component is worth **70 marks**. Question styles include **short answer** (structured questions, problem solving, calculations, practical) and **extended response** questions**.**

Practical endorsement in biology (Component 04)

Performance in this component is reported separately to the performance in the A level as measured through externally assessed components 01 to 03. This non-exam assessment component rewards the development of practical competency for biology and is teacher assessed.
Learners complete a minimum of 12 assessed experiments covering the technical skills (together with the use of apparatus and practical techniques) specified in Section 5g.
Learners may work in groups but must be able to demonstrate and record independent evidence of their competency.
Teachers who award a pass to their learners need to be confident that the learner consistently and routinely exhibits the competencies listed in Section 5g before completion of the A level course.

D. Practical Skills Checklist

Practical Skills in A Level Biology

Module 1: Development of Practical Skills in Biology

1.1.1 Planning
Learners should be able to demonstrate and apply their knowledge and understanding of:

(a) experimental design, including to solve problems set in a practical context
Including selection of suitable apparatus, equipment and techniques for the proposed experiment.
Learners should be able to apply scientific knowledge based on the content of the specification to the practical context.

(b) identification of variables that must be controlled, where appropriate

(c) evaluation that an experimental method is appropriate to meet the expected outcomes.

1.1.2 Implementing *Learners should be able to demonstrate and apply their knowledge and understanding of:*
(a) how to use a wide range of practical apparatus and techniques correctly
(b) appropriate units for measurements
(c) presenting observations and data in an appropriate format.
1.1.3 Analysis *Learners should be able to demonstrate and apply their knowledge and understanding of:*
(a) processing, analysing and interpreting qualitative and quantitative experimental results Including reaching valid conclusions, where appropriate.
(b) use of appropriate mathematical skills for analysis of quantitative data
(c) appropriate use of significant figures M1.1
(d) plotting and interpreting suitable graphs from experimental results, including: (i) selection and labelling of axes with appropriate scales, quantities and units M3.2 (ii) measurement of gradients and intercepts. M3.3, M3.4, M3.5
1.1.4 Evaluation *Learners should be able to demonstrate and apply their knowledge and understanding of:*
(a) how to evaluate results and draw conclusions
(b) the identification of anomalies in experimental measurements
(c) the limitations in experimental procedures
(d) precision and accuracy of measurements and data, including margins of error, percentage errors and uncertainties in apparatus M1.11
(e) the refining of experimental design by suggestion of improvements to the procedures and apparatus.

Practical Endorsement			
Practical Activity Group (PAG)	Techniques and Skills covered	Specification references	Activity Covered
1 Microscopy	- Use of a light microscope at high power and low power, use of a graticule - Production of scientific drawings from observations with annotations	2.1.1(b), 2.1.1(c), 2.1.1(d), 2.1.1(k), 2.1.6(d), 2.1.6(g), 2.1.6(h), 3.1.1(c), 3.1.1(h), 3.1.3(b), 4.1.1(e),5.1.2(b), 5.1.2(c), 5.1.4(c), 5.1.5(l)	
2 Dissection	- Safe use of instruments for dissection of an animal or plant organ - Use of a light microscope at high power and low power, use of a graticule Production of scientific drawings from observations with annotations	3.1.1(g), 3.1.2(c), 3.1.2(e), 3.1.3(b), 5.1.2(c), 6.2.1(a)	
3 Sampling techniques	- Use of sampling techniques in fieldwork - Production of scientific drawings from observations with annotations	4.2.1(b), 6.3.1(e)	
4 Rates of enzyme controlled reactions	- Use of appropriate apparatus to record a range of quantitative measurements (to include mass, time, volume, temperature, length and pH) - Use of laboratory glassware apparatus for a variety of experimental techniques to include serial dilutions - Use of ICT such as computer modelling, or data logger to collect data, or use of software to process data	2.1.4(d), 2.1.4(e), 2.1.4(f), 5.2.1(g), 5.2.2(i), 5.2.2(l)	
5 Colorimeter or potometer	- Use of appropriate instrumentation to record quantitative measurements, such as a colorimeter - Use of laboratory glassware apparatus for a variety of experimental techniques to include serial dilutions	2.1.2(r), 3.1.3(c)	
6 Chromatography OR electrophoresis	- Separation of biological compounds using thin layer / paper chromatography or electrophoresis	2.1.2(s), 5.2.1(c), 6.1.3(e)	
7 Microbiological techniques	- Use of laboratory glassware apparatus for a variety of experimental techniques to include serial dilutions	6.2.1(g), 6.2.1(h)	

	- Use of microbiological aseptic techniques, including the use of agar plates and broth		
8 Transport in and out of cells	- Use of appropriate apparatus to record a range of quantitative measurements (to include mass, time, volume, temperature, length and pH) - Use of laboratory glassware apparatus for a variety of experimental techniques to include serial dilutions - Use of ICT such as computer modelling, or data logger to collect data, or use of software to process data	2.1.5(c), 2.1.5(d), 2.1.5(e)	
9 Qualitative testing	- Use of laboratory glassware apparatus for a variety of experimental techniques to include serial dilutions - Use of qualitative reagents to identify biological molecules	2.1.2(q), 2.1.3(d), 5.1.2(f)	
10 Investigation using a data logger OR computer modelling	- Use of ICT such as computer modelling, or data logger to collect data, or use of software to process data	2.1.2(n), 2.1.3(a), 3.1.1(e), 5.1.5(k), 5.1.5(l), 5.2.1(g), 5.2.2(i), 5.2.2(l), 6.1.3(b)	
11 Investigation into the measurement of plant or animal responses	- Safe and ethical use of organisms to measure plant or animal responses and physiological functions	3.1.3(c), 5.1.1(d), 5.1.5(a), 5.1.5(e), 5.1.5(i), 5.1.5(k), 5.1.5(l), 5.2.1(g), 5.2.2(i), 5.2.2(l)	
12 Research skills	*- Apply investigative approaches* *- Use online and offline research skills* *- Correctly cite sources of information*		
It is expected that the following skills will be developed across all activities, regardless of the exact selection of activities. The ability to: •safely and correctly use a range of practical equipment and materials (1.2.1 b) •follow written instructions (1.2.1 c) •keep appropriate records of experimental activities (1.2.1 e) •make and record observations/measurements (1.2.1 d) •present information and data in a scientific way (1.2.1 f) •use a wide range of experimental and practical instruments, equipment and techniques (1.2.1 j).			

E. Maths Skills Checklist

A Level Biology Mathematical Skills Checklist

M0 – Arithmetic and numerical computation			
Skill Code	**Skill**	**You may be tested on your ability to:**	**Skill appears in the following parts of the specification:**
M0.1	Recognise and make use of appropriate units in calculations	- 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	2.1.1(e), 2.1.2(s), 2.1.4(d), 2.1.4(f), 2.1.5(c), 2.1.5(d), 2.1.5(e), 3.1.1(a), 3.1.1(e), 3.1.2(a), 3.1.2(h), 3.1.3(a), 3.1.3(c), 4.1.1(b), 4.1.1(l), 5.1.2(c), 5.1.5(i), 5.1.5(k), 5.2.1(a), 5.2.1(c), 5.2.1(g), 5.2.2(i), 5.2.2(k), 5.2.2(l), 6.2.1(h), 6.3.1(b), 6.3.2(a)
M0.2	Recognise and use	- use an appropriate number of decimal places in calculations, e.g. for a mean	2.1.1(e), 2.1.1(f), 2.1.1(g), 2.1.2(s), 2.1.4(d), 2.1.4(f), 2.1.5(b), 2.1.5(c), 2.1.5(d),

	expressions in decimal and standard form	- 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 5.0×10^{-3} mol dm^{-3}.	2.1.5(e), 3.1.1(e), 3.1.3(c), 4.1.1(b), 4.1.1(l), 4.2.1(b), 5.1.5(e), 5.1.5(i), 5.1.5(k), 5.2.1(c), 5.2.1(g), 5.2.2(i), 5.2.2(k), 5.2.2(l), 6.1.2(f), 6.2.1(i), 6.3.1(b), 6.3.2(a)
M0.3	Use ratios, fractions and percentages	-calculate percentage yields -calculate surface area to volume ratio -use scales for measuring represent phenotypic ratios (monohybrid and dihybrid crosses).	2.1.1(e), 2.1.1(f), 2.1.4(d), 2.1.4(f), 2.1.5(d), 2.1.5(e), 3.1.1(a), 3.1.2(a), 3.1.3(a), 4.1.1(b), 4.1.1(l), 4.2.2(h), 5.1.2(c), 5.1.5(k), 5.2.1(a), 5.2.1(g), 6.1.2(b), 6.1.2(c), 6.2.1(h), 6.2.1(i), 6.3.1(b), 6.3.2(a)
M0.4	Estimate results	-estimate results to sense check that the calculated values are appropriate.	3.1.1(a), 3.1.1(e), 3.1.2(a), 3.1.3(a), 5.2.1(a), 6.3.1(b), 6.3.2(a)
M0.5 (full A Level only)	Use calculators to find and use power, exponential and logarithmic functions	-estimate the number of bacteria grown over a certain length of time.	6.2.1(h), 6.3.2(a)
	M1 - Handling Data		
M1.1	Use an appropriate number of significant figures	-report calculations to an appropriate number of significant figures given raw data quoted to varying numbers of significant figures -understand that calculated results can only be reported to the limits of the least accurate measurement.	2.1.1(e), 2.1.2(s), 2.1.4(d), 2.1.4(f), 2.1.5(c), 2.1.5(d), 2.1.5(e), 3.1.1(a), 3.1.2(a), 3.1.2(h), 3.1.3(a), 3.1.3(c), 4.1.1(b), 4.1.1(l), 4.2.1(c), 4.2.1(d), 4.2.1(e), 5.1.2(c), 5.1.5(e), 5.1.5(i), 5.1.5(k), 5.2.1(c), 5.2.1(g), 5.2.2(i), 5.2.2(k), 5.2.2(l), 6.2.1(h), 6.3.1(b)
M1.2	Find arithmetic means	-find the mean of a range of data, e.g. the mean number of stomata in the leaves of a plant.	2.1.5(c), 2.1.5(d), 2.1.5(e), 3.1.3(c), 4.1.1(b), 4.1.1(l), 4.2.2(f), 5.1.5(e), 5.1.5(i), 5.1.5(k), 5.2.2(l), 6.2.1(i)
M1.3	Construct and interpret frequency tables and diagrams, bar charts and histograms	-represent a range of data in a table with clear headings, units and consistent decimal places -interpret data from a variety of tables, e.g. data relating to organ function -plot a range of data in an appropriate format, e.g. enzyme activity over time represented on a graph -interpret data for a variety of graphs, e.g. explain electrocardiogram traces.	2.1.2(s), 2.1.4(d), 2.1.4(f), 2.1.5(c), 2.1.5(d), 2.1.5(e), 3.1.1(e), 3.1.2(h), 3.1.3(c), 4.1.1(b), 4.1.1(g), 4.1.1(l), 4.2.1(b), 4.2.1(f), 4.2.2(f), 5.1.2(c), 5.1.3(c), 5.1.5(a), 5.1.5(e), 5.1.5(i), 5.1.5(k), 5.2.1(c), 5.2.1(g), 5.2.2(i), 5.2.2(k), 5.2.2(l), 6.2.1(h), 6.2.1(i), 6.3.1(b), 6.3.1(e), 6.3.2(a)
M1.4	Understand simple probability	-use the terms probability and chance appropriately -understand the probability associated with genetic inheritance.	4.2.1(b), 5.1.5(e), 6.1.2(b), 6.1.2(c), 6.2.1(i), 6.3.1(e)
M1.5	Understand the principles of sampling as applied to scientific data	-analyse random data collected by an appropriate means, e.g. use Simpson's index of diversity to calculate the biodiversity of a habitat.	4.1.1(b), 4.1.1(l), 4.2.1(b), 4.2.1(c), 4.2.1(d), 4.2.1(e), 6.3.1(e)
M1.6	Understand the terms mean, median and mode	-calculate or compare the mean, median and mode of a set of data, e.g. height/mass/ size of a group of organisms.	2.1.5(c), 2.1.5(d), 2.1.5(e), 3.1.3(c), 4.2.1(b), 4.2.2(f), 5.1.5(a), 5.1.5(e), 5.1.5(i), 5.1.5(k), 5.2.2(l), 6.2.1(i), 6.3.1(b)
M1.7	Use a scatter diagram to identify a correlation	-interpret a scattergram, e.g. the effect of lifestyle factors on health.	4.1.1(b), 4.1.1(l), 4.2.1(b), 4.2.1(f), 4.2.2(f), 6.3.1(e)

	between two variables		
M1.8	Make order of magnitude calculations	-use and manipulate the magnification formula magnification = size of image/size of real object	2.1.1(e)
M1.9	Select and use a statistical test	-the chi squared test (χ2) to test the significance of the difference between observed and expected results -the Student's t-test -the Spearman's rank correlation coefficient.	4.2.1(b), 5.1.5(e), 6.1.2(c), 6.3.1(e)
M1.10	Understand measures of dispersion, including standard deviation and range	-calculate the standard deviation -understand why standard deviation might be a more useful measure of dispersion for a given set of data e.g. where there is an outlying result.	2.1.5(e), 4.2.1(b), 4.2.2(f), 5.1.5(e), 5.1.5(k), 5.2.2(l), 6.2.1(i), 6.3.1(e)
M1.11	Identify uncertainties in measurements and use simple techniques to determine uncertainty when data are combined	-calculate percentage error where there are uncertainties in measurement.	2.1.4(d), 2.1.4(f), 2.1.5(c), 2.1.5(d), 2.1.5(e), 3.1.3(c), 5.2.1(g)
M2 – Algebra			
M2.1	Understand and use the symbols: =,1, <, «, », >, ~, α		2.1.5(d), 2.1.5(e), 3.1.1(a), 3.1.2(a), 3.1.3(a), 5.1.2(c), 6.1.2(c)
M2.2	Change the subject of an equation	-use and manipulate equations, e.g. magnification.	2.1.1(e), 2.1.2(s), 5.2.1(c), 6.1.2(f)
M2.3	Substitute numerical values algebraic equations using appropriate units for physical quantities	-use a given equation e.g. Simpson's-index of diversity	2.1.1(e), 2.1.2(s), 4.2.1(c), 4.2.1(d), 4.2.1(e), 5.2.1(c), 5.2.2(k), 6.1.2(f)
M2.4	Solve algebraic equations	-solve equations in a biological context, e.g. cardiac output = stroke volume × heart rate	2.1.1(e), 2.1.2(s), 3.1.2(h), 4.2.1(c), 4.2.1(d), 4.2.1(e), 5.2.1(c), 5.2.2(i), 5.2.2(l)
M2.5 (full A Level only)	Use logarithms in relation to quantities that range over several orders of magnitude	-use a logarithmic scale in the context of microbiology, e.g. growth rate of a microorganism such as yeast.	6.2.1(h), 6.3.2(a)
M3 - Graphs			
M3.1	Translate information between graphical, numerical and algebraic forms	-understand that data may be presented in a number of formats and be able to use these data, e.g. dissociation curves.	2.1.4(d), 2.1.4(f), 2.1.5(c), 2.1.5(d), 2.1.5(e), 3.1.2(j), 3.1.3(c), 4.1.1(b), 4.1.1(l), 4.2.1(f), 5.1.2(c), 5.1.3(c), 5.1.5(e), 5.1.5(k), 5.2.1(g), 5.2.2(i), 6.2.1(h), 6.3.1(e), 6.3.2(a)
M3.2	Plot two variables from experimental or other data	-select an appropriate format for presenting data, bar charts, histograms, graphs and scattergrams.	2.1.4(d), 2.1.4(f), 2.1.5(c), 2.1.5(d), 2.1.5(e), 3.1.3(c), 4.1.1(b), 4.1.1(l), 4.2.1(b), 5.1.5(e), 5.2.1(g), 5.2.2(i), 5.2.2(l), 6.2.1(h), 6.2.1(i), 6.3.1(e), 6.3.2(a)
M3.3	Understand that $y = mx + c$ represents a linear relationship	-predict/sketch the shape of a graph with a linear relationship, e.g. the effect of substrate concentration on the rate of an enzyme controlled reaction with excess enzyme.	2.1.4(d), 2.1.4(f), 2.1.5(c), 2.1.5(d), 3.1.3(c), 5.2.2(l)
M3.4 (full A Level only)	Determine the intercept of a graph	-read off an intercept point from a graph, e.g. compensation point in plants.	5.2.1(a), 5.2.1(g), 6.2.1(h)

M3.5	Calculate rate of change from a graph showing a linear relationship	-calculate a rate from a graph, e.g. rate of transpiration.	2.1.4(d), 2.1.4(f), 2.1.5(c), 2.1.5(d), 3.1.3(c), 5.2.1(g), 5.2.2(l), 6.2.1(h)
M3.6	Draw and use the slope of a tangent to a curve as a measure of rate of change	-use this method to measure the gradient of a point on a curve, e.g. amount of product formed plotted against time when the concentration of enzyme is fixed.	2.1.4(d), 2.1.4(f), 2.1.5(c), 2.1.5(d), 3.1.3(c), 5.2.1(g), 5.2.2(l), 6.2.1(h)
M4 – Geometry and Trigonometry			
M4.1	Calculate the circumferences, surface areas and volumes of regular shapes	-calculate the circumference and area of a circle -calculate the surface area and volume of rectangular prisms, of cylindrical prisms and of spheres -e.g. calculate the surface area or volume of a cell.	2.1.5(d), 2.1.5(e), 3.1.1(a), 3.1.2(a), 3.1.3(a), 3.1.3(c), 5.2.1(g), 6.2.1(i)

F. Graphs, Tables and Drawings Checklists

Graphs

The following practical Learning Outcomes relate to graph drawing:

Module 1: Development of practical skills in biology

1.1.2(c) presenting observations and data in an appropriate format

1.1.3(d) plotting and interpreting suitable graphs from experimental results, including: (i) selection and labelling of axes with appropriate scales, quantities and units (ii) measurement of gradients and intercepts.

1.2.1(f) present information and data in a scientific way (Practical Endorsement).

Graphs must also be covered under the biology mathematical skills requirements, See maths skills M1.3, M1.7, M3.1, M3.2, M3.3, ***M3.4****, M3.5, M3.6.*

Here is a checklist you can use for your graphs,

S	**S**ize of the graph: does the bit with actual plotted points in take up at least half the paper?	
P	**P**lotting: is every data point within half a little square of where it should be?	
L	**L**ine of best fit: if there's a trend in your data, is it indicated with a smooth curve or straight line?	
A	**A**xes right way round: the thing you changed (independent variable) along the bottom; the thing you measured (dependent variable) up the side.	
T	**T**itle: have you included a title that tells you what this graph shows?	
A	**A**xis labels: name of each variable with the right unit symbol.	

Tables

The following practical Learning Outcomes relate to tables:

Module 1: Development of practical skills in biology

1.1.2(c) presenting observations and data in an appropriate format
1.2.1(d) make and record observations/ measurements (Practical Endorsement) 1.2.1(f) present information and data in a scientific way (Practical Endorsement).

Tables must also be covered under the biology mathematical skills requirements, See maths skills M1.3, M3.1.

Here is a checklist you can use for your tables,

1	All raw data in a single table with ruled lines and border.	
2	Independent variable (IV) in the first column; dependent variable (DV) in columns to the right (for quantitative observations) OR descriptive comments in columns to the right (for qualitative observations).	
3	Processed data (e.g. means, rates, standard deviations) in columns to the far right.	
4	No calculations in the table, only calculated values.	
5	Each column headed with informative description (for qualitative data) or physical quantity **and** correct units (for quantitative data); units separated from physical quantity using either brackets or a solidus (slash).	
6	No units in the body of the table, only in the column headings.	
7	Raw data recorded to a number of decimal places appropriate to the resolution of the measuring equipment.	
8	All raw data of the same type recorded to the same number of decimal places.	
9	Processed data recorded to up to one significant figure more than the raw data.	

Drawings

The following practical Learning Outcomes relate to biological drawing:

Module 1: Development of practical skills in biology (Biology A and Biology B),
1.1.2(c) presenting observations and data in an appropriate format
1.2.1(f) present information and data in a scientific way (Practical Endorsement) 1.2.2(e) production of scientific drawings from observations with annotations (Practical Endorsement).

Drawing skills are also part of many of the Learning Outcomes throughout the biological content e.g.:
2.1.1(d), 3.1.1(g), 3.1.2(e)(ii), 3.1.3(b)(ii), 4.1.1(e)(ii), 5.1.2(b)(ii), 5.1.2(c)(ii), 5.1.2(c)(iii), 5.1.4(c)(ii) (Biology A).

2.1.1(c)(ii), 2.2.1(b)(ii), 2.2.4(c)(i), 3.1.1(b)(ii) (Biology B).

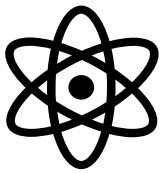
Here is a checklist you can use for your drawings,

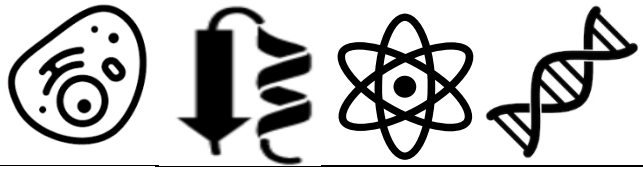
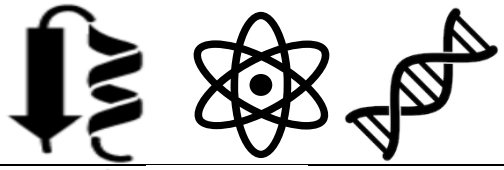
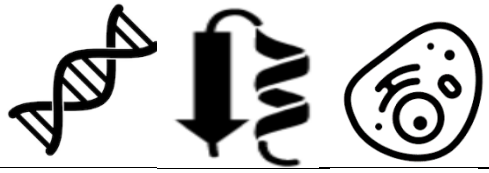
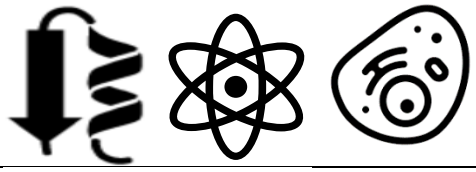
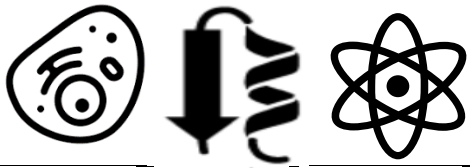
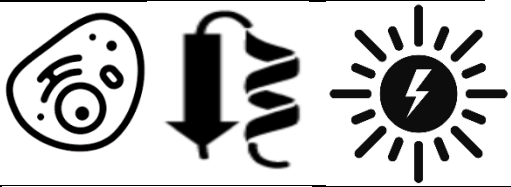
1	Your drawing and its label lines must be done with a really sharp pencil (not a pen).	
2	Your drawing should take up at least half the page / space available.	
3	Lines need to be clear and continuous – not ragged or broken – and no shading or colouring is allowed.	
4	Ensure the proportions are correct, i.e. different areas are the right size relative to each other, and that your drawing is a true likeness of the specimen that you are drawing.	
5	Label all the different areas of tissue that you have shown, writing the words in pencil or pen.	
6	Rule the label lines (in pencil). Don't let the label lines cross each other and do not write on the label lines.	
7	Make sure the label lines touch the part you are labelling.	
8	Annotations - add concise notes about the structures/features labelled on your drawing.	
9	Include a scale - add a scale bar immediately below the drawing if necessary.	
10	Include a title stating what the specimen is.	

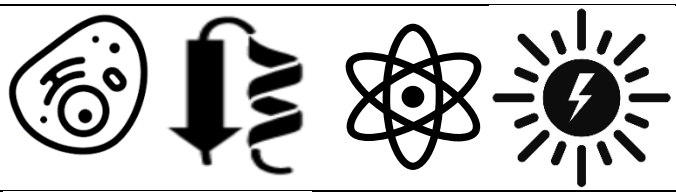
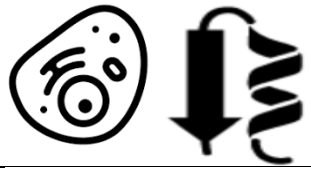
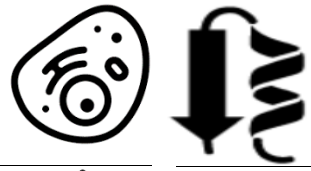
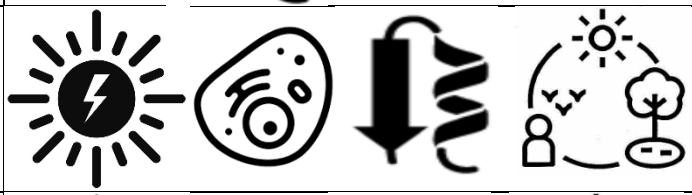
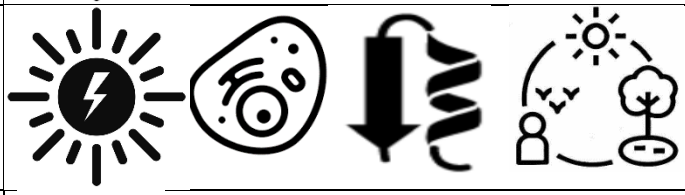
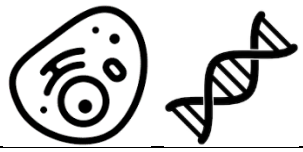
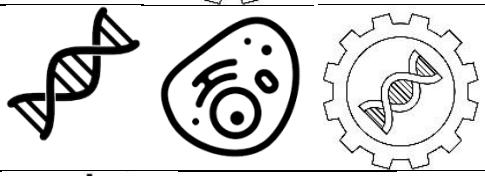
LOW POWER TISSUE PLAN

Remember: A low power tissue plan defines the extent of areas of different tissues but does NOT show any individual cells.

G. Big Ideas and Sequencing

Big Idea	Icon	Summary	Description
Cells		**Organisms are organised on a cellular basis**	All organisms are constituted of one or more cells. Multi-cellular organisms have cells that are differentiated according to their function. Life at is most fundamental consists of chemical reactions within cells controlled by enzymes. Growth is the result of multiple cell divisions.
Energy Transfer		**The total amount of energy in the Universe is always the same but energy can transformed when things change or are made to happen**	Many processes or events involve changes and require energy to make them happen. Energy can be transferred from one body to another in various ways. In these processes some energy is changed to a form that is less easy to use. Energy cannot be created or destroyed. Energy obtained from fossil fuels is no longer available in a convenient form for use.
Particles		**All material in the Universe is made of very small particles**	Atoms are the building blocks of all materials, living and non-living. The behaviour of the atoms explains the properties of different materials. Chemical reactions involve rearrangement of atoms in substances to form new substances. Each atom has a nucleus containing neutrons and protons, surrounded by electrons. The opposite electric charges of protons and electrons attract each other, keeping atoms together and accounting for the formation of some compounds.
Structure and function		**The structure and properties of biological molecules and the larger structures they form relate to their function in living organisms.**	This idea builds on the big idea of particles. The behaviour of the atoms and molecules explains their properties and roles in living organisms. The structure and shape of biological molecules, particularly proteins, determine the vast array of biological functions in living organisms. Molecules build up into larger structures. Structure then relates to function the level of cells, tissues, organs and organisms as a whole.
Genes		**Genetic information is passed down from one generation of organisms to another. Genes code for proteins.**	Genetic information in a cell is held in the chemical DNA in the form of a four letter code. Genes code for proteins, which determine the development and structure of organisms. In asexual reproduction all the genes in the offspring come from one parent. In sexual reproduction half of the genes come from each parent. Central Dogma: DNA → mRNA → Protein
Evolution		**The diversity of organisms, living and extinct, is the result of evolution**	All life today is directly descended from a universal common ancestor that was a simple one-celled organism. Over countless generations changes resulted from natural diversity within a species which makes possible the selection of those individuals' best suited to survive under certain conditions. Organisms not able to respond sufficiently to changes in their environment become extinct. Modification and descent becomes DNA and time.
Ecosystems		**Organisms require a supply of energy and materials for which they are often dependent on or in competition with other organisms**	Energy is transferred through an Ecosystem whereas elements are recycled. Autotrophs harness energy to build organic molecules from inorganic ones. Heterotrophs obtain organic molecules from other organisms. In any ecosystem there is competition among species for the energy and materials they need to live and reproduce.
Earth		**The composition of the Earth and its atmosphere and the processes occurring within them shape the Earth's surface and its climate**	Organisms are made from the elements that form the Earth, mainly C, H, O, N, P and S and common ions such as Ca2+ and Na+. Organisms are dependent on energy from the sun which is the main source of energy for ecosystems. The conditions on the Earth, such as the presence of liquid water, create the ecological niches that drive natural selection.
Biology, Technology and Medicine		**Biology has a vast and rapidly growing array of applications in technology, industry and medicine.**	Humans have learnt to manipulate a vast array of biological processes that they then use in technology, industry and medicine. Biotechnology and Gene Technology are two rapidly growing areas.

Module*	Section	Main Big Ideas
Module 2 – Foundations in Biology	2.1.1 Cell structure	
	2.1.2 Biological molecules	
	2.1.3 Nucleotides and nucleic acids	
	2.1.4 Enzymes	
	2.1.5 Biological membranes	
	2.1.6 Cell division, cell diversity and cellular organisation	
Module 3 – Exchange and transport	3.1.1 Exchange surfaces	
	3.1.2 Transport in animals	
	3.1.3 Transport in plants	
Module 4 – Biodiversity, evolution and disease	4.1.1 Communicable diseases, disease prevention and the immune system	
	4.2.1 Biodiversity	
	4.2.2 Classification and evolution	
Module 5 – Communication, homeostasis and energy	5.1.1 Communication and homeostasis	
	5.1.2 Excretion as an example of homeostatic control	

	5.1.3 Neuronal communication	
	5.1.4 Hormonal communication	
	5.1.5 Plant and animal responses	
	5.2.1 Photosynthesis	
	5.2.2 Respiration	
Module 6 – Genetics, evolution and ecosystems	6.1.1 Cellular control	
	6.1.2 Patterns of inheritance	
	6.1.3 Manipulating genomes	
	6.2.1 Cloning and biotechnology	
	6.3.1 Ecosystems	
	6.3.2 Populations and sustainability