Curriculum Overview - Science

The Science Curriculum at Sheffield Park Academy

The intent of our Science curriculum

Our core intent in our science curriculum is that:

Students should improve and develop fluency in working scientifically, mathematical, and practical skills.

They will also deepen their knowledge and understanding of a broad range of Biology, Chemistry and Physics concepts, enabling them to become influential young leaders in STEM fields.

At KS3 students will:

- Gain a broad understanding of the core concepts of Biology, Chemistry and Physics.
- At a minimum cover all topics specified in the National Curriculum.
- Develop fluency in working scientifically, mathematical, and practical skills, building on knowledge from Primary education.
- Develop resilience, the ability to learn from mistakes and respond to feedback to improve their knowledge.
- Be able to access KS4 qualifications by the end of KS3, including Combined Science and Triple Science.
- Have the opportunity to participate in Science-related trips or extracurricular activities and link their understanding of Science to the wider world

At KS4 students will:

- Gain a deeper understanding of the core concepts of Biology, Chemistry and Physics.
- At a minimum cover all topics specified in the National Curriculum and the relevant exam board specification.
- Continue to improve and develop fluency in working scientifically, mathematical, and practical skills.
- Improve resilience, the ability to learn from mistakes and respond to feedback to improve their knowledge.
- Have the opportunity to participate in Science-related trips or extracurricular activities and link their understanding of Science to the wider world.
- Be able to access KS5 qualifications or STEM jobs that require Level 2 qualifications by the end of KS4, including A-level Sciences and BTEC Applied Science.

At KS5 students will:

- Gain a thorough understanding of the core concepts of subjects they have chosen – either Applied Science, or A-level Sciences.
- Cover at a minimum all content specified in the relevant exam board specification.
- Develop high-level skills in working scientifically, mathematical, and practical skills.
- Show increasing independence in practical skills and achieve practical endorsements in any A-level Sciences.
- Become highly resilient and reflective learners ready for future study, employment or training.
- Link curriculum content to STEM careers (Gatsby criteria).
- Be able to make cross-curricular links with other Level 3 subjects they are taking.

- Be able to access university-level or other Level 4+ qualifications or STEM jobs that require Level 3 qualifications by the end of KS5 including degrees, foundation degrees and apprenticeships.
- Have the opportunity to participate in Science-related trips or extracurricular activities and link their understanding of Science to the wider world.

How we implement our science curriculum

We broadly follow the principles outlined the in the United Learning Science curriculum, an overview of which is attached as an appendix to this document. However, the United Learning Science curriculum is adapted for our context and teaching and learning strategies.

Our teaching sequence is a:

- A hierarchical, spiral progression of knowledge that revisits key concepts with increasing complexity throughout KS3 and KS4
- Supports development of working scientifically, mathematical, and practical skills through regular lesson activities with a specific focus on these
- Supports development of scientific vocabulary over time through a gradual but consistent introduction of new terminology
- Contains practical lessons to encourage engagement and working scientifically skills
- Contains adequate time for formative assessment, feedback and revision
- Give a clear structure to out of lesson activities including homework (structured around Seneca learning) and (for exam year groups) exam question practice

Our lessons will:

- Be delivered by staff with strong subject knowledge. They will be delivered by the most appropriate subject specialist where possible. Where this is not possible, staff will be supported to ensure strong subject knowledge.
- Will follow Rosenshine's principles of instruction.
- Consistently begin with review of previous material – either through:

1) An AO1 recall-focused do now activity **(memory platform)** focusing on curriculum links (interleaving), including use of the school knowledge organizer **(powerful knowledge)** to build literacy, as part of our whole school disciplinary **literacy** approach
2) A fluency test focusing on repeated iterations of the same mathematical or working scientifically skill
3) Feedback from one page-marking/whole class **feedback**

- Have clearly defined outcomes, shared with students, and activities will be structured around these
- Be appropriately chunked to deliver knowledge in small steps
- Contain clear expositions, checking for understanding, and independent practice, using an I do, We do, You do **(guided practice)** approach
- Contain targeted questioning of students through the We Do phase
- Contain opportunities for students to self-assess their work in green pen
- At KS4 give students regular review through exam-style questions
- Use exam style command words for written questioning as part of our whole school disciplinary literacy approach
- Focus on delivering 3 key terms per lesson to introduce scientific vocabulary in a steady progression
- Contain opportunities for formative assessment through topic tests
- Contain opportunities to review this formative assessment to close gaps in knowledge

- Link to a progressive scheme of online home learning, using the Seneca home learning package
- For Year 11: be supported by additional intervention for exam years including Saturday school and intervention sessions

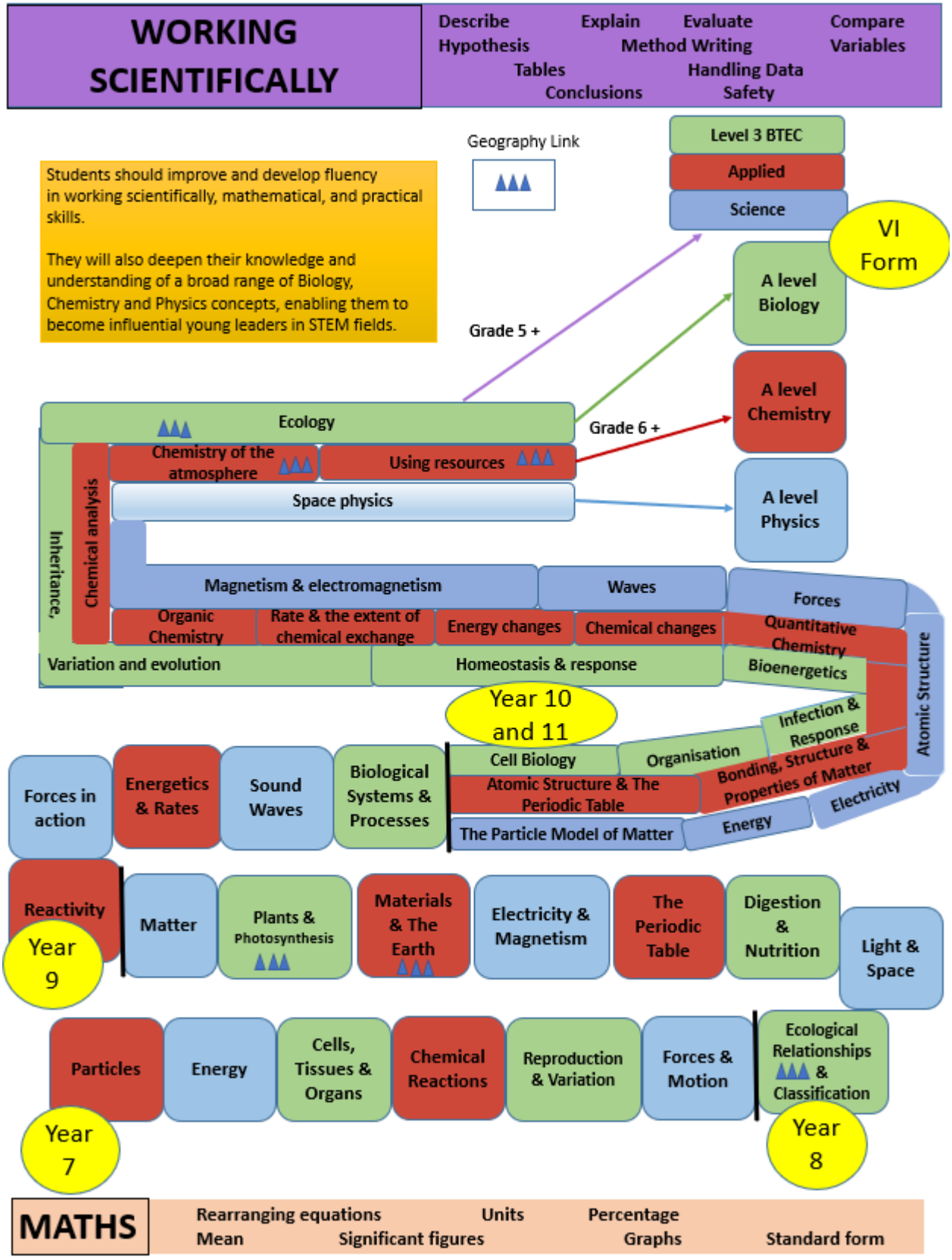
Science Roadmap - the hierarchical progression of the Science Curriculum

The progression through the Science curriculum is laid out in our Science Roadmap, which is shared with all students in their books. The relevant section of the roadmap, and the lesson outcomes that link to this, will be shared with students after the Do Now task of each lesson.

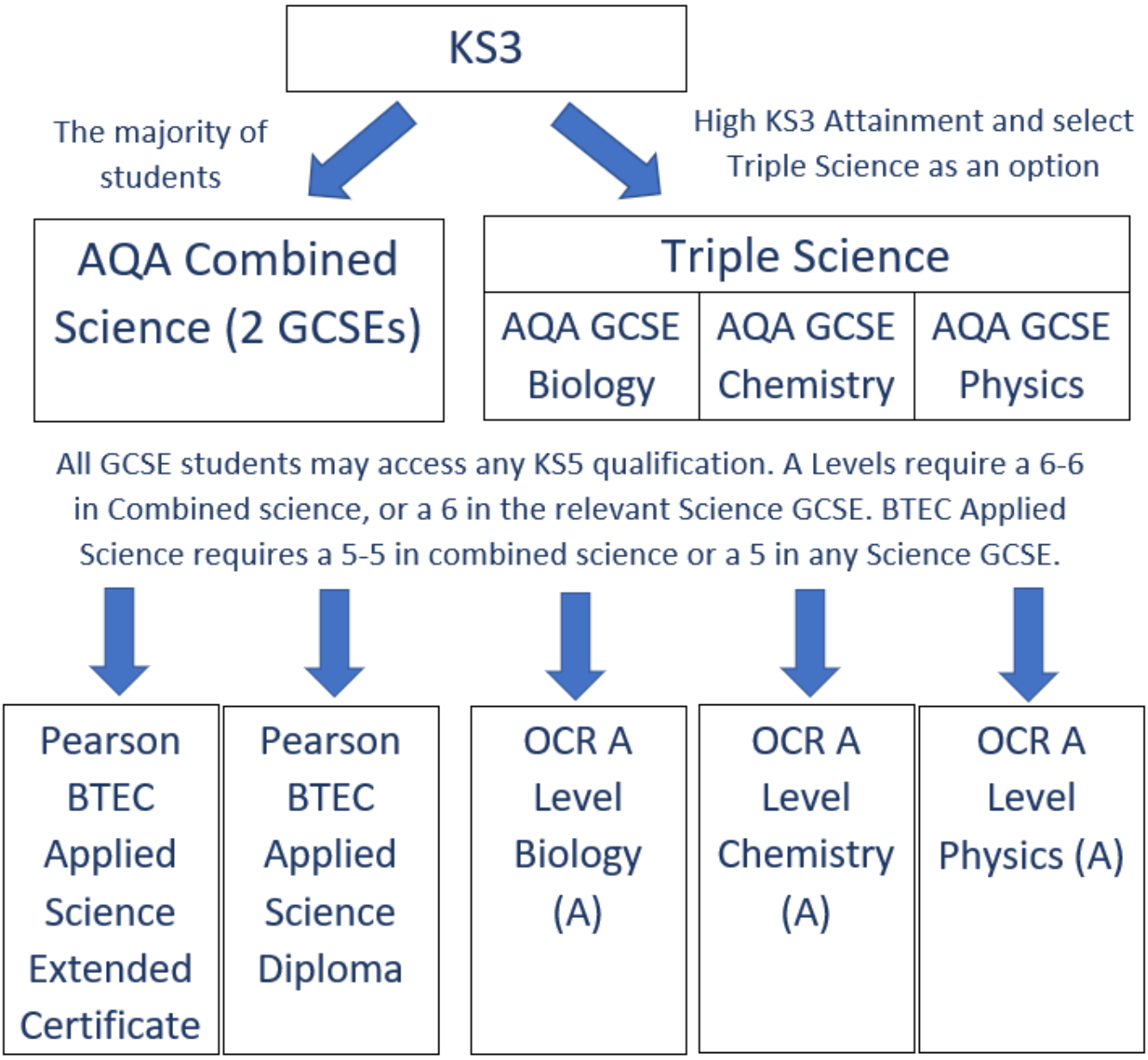
The Roadmap also outlines the core mathematical and working scientifically skills we expect students to develop fluency in throughout our curriculum.

It also illustrates how we implement the hierarchical development of knowledge outlined in the United Learning Science curriculum in our context.

Please note where split classes exist the order of topics may very – but topics from each Science discipline will always be taught in sequence to ensure strong prior knowledge.


WORKING SCIENTIFICALLY
Describe
Explain
Evaluate
Compare
Hypothesis
Method Writing
Variables
Tables
Handling Data
Conclusions
Safety
Students should improve and develop fluency in working scientifically, mathematical, and practical skills.
They will also deepen their knowledge and understanding of a broad range of Biology, Chemistry and Physics concepts, enabling them to become influential young leaders in STEM fields.
Geography Link
Level 3 BTEC
Applied
Science
VI Form
A level Biology
A level Chemistry
A level Physics
Grade 5 +
Grade 6 +
Ecology
Chemistry of the atmosphere
Using resources
Space physics
Inheritance,
Chemical analysis
Magnetism & electromagnetism
Waves
Forces
Organic Chemistry
Rate & the extent of chemical exchange
Energy changes
Chemical changes
Quantitative Chemistry
Variation and evolution
Homeostasis & response
Bioenergetics
Atomic Structure
Year 10 and 11
Infection & Response
Cell Biology
Organisation
Bonding, Structure & Properties of Matter
Forces in action
Energetics & Rates
Sound Waves
Biological Systems & Processes
Atomic Structure & The Periodic Table
Electricity
The Particle Model of Matter
Energy
Reactivity
Matter
Plants & Photosynthesis
Materials & The Earth
Electricity & Magnetism
The Periodic Table
Digestion & Nutrition
Light & Space
Year 9
Particles
Energy
Cells, Tissues & Organs
Chemical Reactions
Reproduction & Variation
Forces & Motion
Ecological Relationships & Classification
Year 7
Year 8
MATHS
Rearranging equations
Units
Percentage
Mean
Significant figures
Graphs
Standard form

We offer a variety of qualifications at GCSE and Level 3. The progression through these qualifications depending on student attainment is outlined below.



We expect all students sitting “Triple” Science to take higher tier as these students will have a strong track record of KS3 attainment.

For Combined Science, students who show regular evidence at KS3 and through KS4 of securely achieving a grade 5 or higher will be entered for higher tier. All other students will be entered for foundation tier.

Summative Assessment in Science

In Science we regularly summatively assess students and generate "age-related grades". These aim to support tracking of progress, setting, directing students to the most appropriate KS4 and KS5 qualifications, and act as a motivational tool so students can compare their own attainment against target. An overview of assessment in Science is shown below:

Year group	Assessment(s)/End of Year Exams
7	Topic tests at the end of each topic. End of Year exams in June/July – United Learning exams, typically 60 marks.
8	Topic tests at the end of each topic. End of Year exams in June/July – United Learning exams, typically 60 marks.
9	Topic tests at the end of each topic. End of Year exams in June/July – United Learning exams, typically 60 marks.
10	Topic tests at the end of each topic. End of Year exams in June/July – Paper 1 for Biology, Chemistry, Physics. 70 marks, 1hr 15 mins (combined); 100 marks, 1 hr 45 mins (triple).
11	Topic tests at the end of the majority of topics. PPEs in Nov – Paper 1 for Biology, Chemistry, Physics. 70 marks, 1hr 15 mins (combined); 100 marks, 1 hr 45 mins (triple). PPEs in Feb/Mar – Paper 2 for Biology, Chemistry, Physics. 70 marks, 1hr 15 mins (combined); 100 marks, 1 hr 45 mins (triple). Final GCSE exams will be Papers 1 and 2 for each of Biology, Chemistry and Physics – 70 marks, 1 hr 15 mins each worth 1/6th of the double GCSE grade (combined). For triple science – each GCSE (Biology, Chemistry, Physics) has Papers 1 and 2 – 100 marks, 1 hr 45 mins each, each paper worth ½ of the respective GCSE.

Appendix A - Principles and Purpose of the United Learning Science Curriculum

The Appendix below outlines the principles behind the United Learning Science Curriculum. Please note, although we follow the broad principles of the United Learning Science Curriculum, they are adapted for the school teaching and learning approaches and our context.

The purpose of the United Learning Science curriculum is to develop children's scientific understanding so they can be scientifically informed citizens and, if they wish, pursue careers in science, or in careers which require some scientific understanding. To be scientifically informed requires a broad knowledge of scientific ideas, an appreciation of how experimentation and observation develop this knowledge, and an ability to think rationally and analytically when applying this knowledge in new contexts.

The following principles have informed the planning of the United Learning curriculum across all subjects.

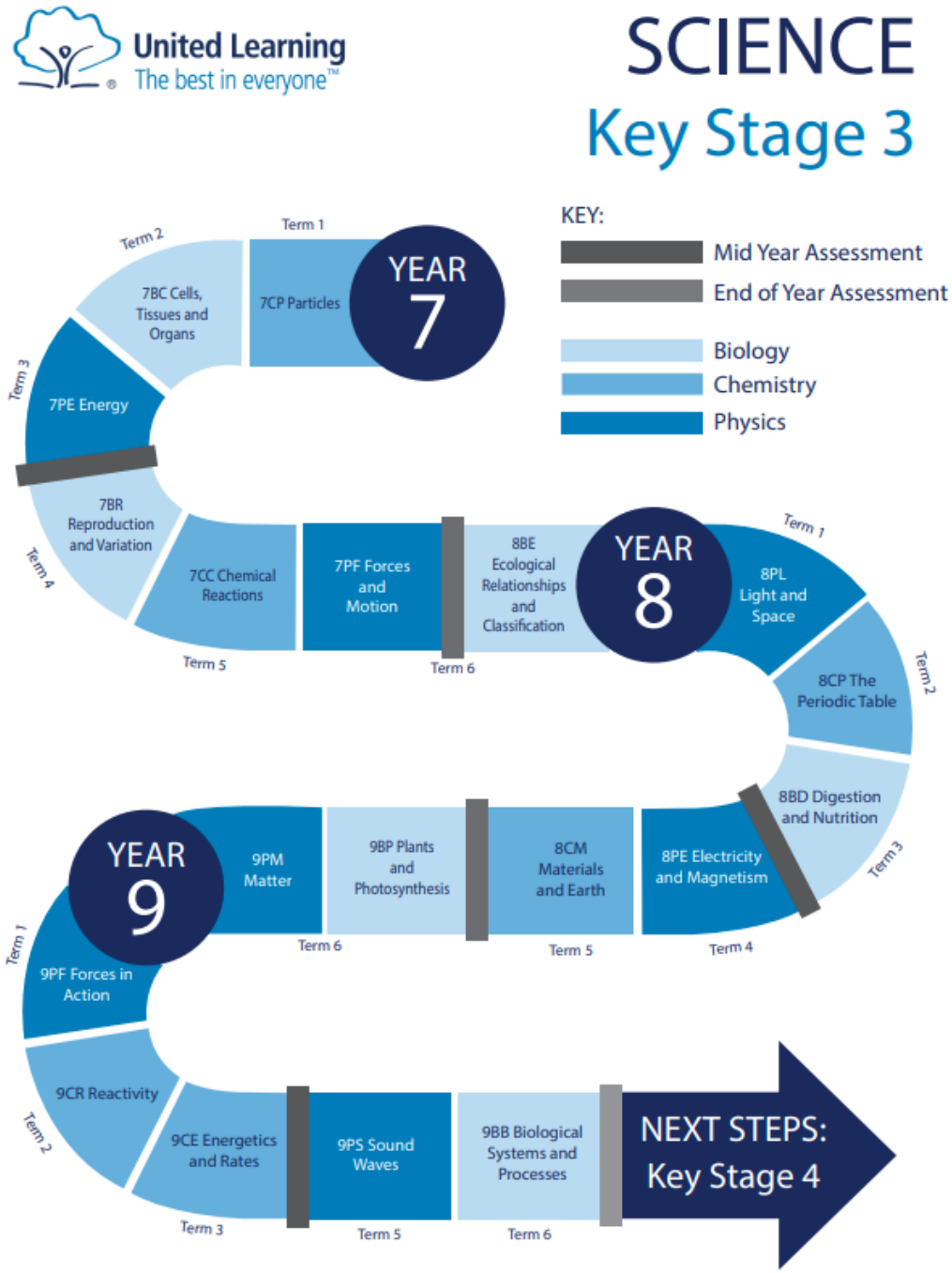
- **Entitlement:** All pupils have the right to learn what is in the United Learning curriculum, and schools have a duty to ensure that all pupils are taught the whole of it.
- **Coherence:** Taking the National Curriculum as its starting point, our curriculum is carefully sequenced so that powerful knowledge builds term by term and year by year. We make meaningful connections within subjects and between subjects.
- **Mastery:** We ensure that foundational knowledge, skills and concepts are secure before moving on. Pupils revisit prior learning and apply their understanding in new contexts.
- **Adaptability:** The core content – the 'what' – of the curriculum is stable, but schools will bring it to life in their own local context, and teachers will adapt lessons – the 'how' – to meet the needs of their own classes.
- **Representation:** All pupils see themselves in our curriculum, and our curriculum takes all pupils beyond their immediate experience.
- **Education with character:** Our curriculum - which includes the taught subject timetable as well as spiritual, moral, social and cultural development, our co-curricular provision and the ethos and 'hidden curriculum' of the school – is intended to spark curiosity and to nourish both the head and the heart.

Here we explore these principles in the context of the United Learning Science Curriculum:

- **Entitlement:** The United Learning Science Curriculum covers the National Curriculum. We have added to the content covered by the National Curriculum, but we have not removed any content specified in the National Curriculum.
- **Coherence:** We sequence our units to introduce knowledge and new ideas in a way that begins with the simplest and builds to the more complex, including a range of vertical concepts developed over time in variety of contexts.
- **Mastery:** Reviewing prior knowledge is threaded throughout all units, with concepts and skills revisited, built upon, and developed in new contexts.
- **Adaptability:** All lesson materials are editable, with advice included to help teachers adapt lessons to suit their context, including scaffolding examples and assessment tools to identify gaps in learning.
- **Representation:** A diverse range of names, images and scientists are used in resources throughout the curriculum, so that students from all backgrounds recognise the relevance of science.
- **Education with character:** The science curriculum raises a number of ethical, culturally significant, or sensitive questions which students will want to explore in ways that go beyond the curriculum. We encourage teachers to respond sensitively to these and use their professional judgement to help students to reflect and have informed opinions on these.

How the United Learning curriculum is sequenced

- The roadmap diagram below sets out the route that we expect pupils to take through the KS3 curriculum. The roadmap shows the suggested route-through of topics in the curriculum, all of which must be taught.



In our planning we have asked ourselves 'why this, why now?' In the science curriculum, we have several vertical concepts (see Appendix B) that appear in different units over the course of both KS3 and 4. Below we provide some examples of the curriculum choices we have made, based on these concepts, and why the units have been placed in the order we've chosen:

- **Example 1:**

- Year 7 starts with 7CP Particles, in which we introduce the concept of diffusion. We have placed this unit here as an understanding of particle behaviour is fundamental to all three sciences, and that movement in and out of cells requires an understanding of diffusion, which is taught in the next topic, 7BC Cells, Tissues and Organs. The idea is developed later in 9PM Matter and will be revisited in a range of topics at KS4, including Organisation.

- **Example 2:**
  - In 7PE Energy we introduce the idea that energy is transferred between stores. This concept is applied in 8PE Electricity and Magnetism and developed further in KS4 in Energy, where energy is also quantified, using energy formulae. Energy is also linked to Forces via work done, which is introduced in 9PF Forces in Action, as well as Forces and Motion in KS4.
- **Example 3:**
  - In year 8, we introduce the Bohr Model of the atom. This is an important part of the vertical concept, 'reactions rearrange particles', which begins in year 7 with 7CC Chemical Reactions. The Bohr model is revisited in Atomic structure and Periodic Table in KS4 chemistry, as well as Atomic Structure in physics, and is prerequisite knowledge for the next chemistry topic, Bonding, which in turn is foundational to many of the remaining Chemistry units.
- **Example 4:**
  - 'Forces affect motion' is a fundamental idea in physics and is explored at length in year 11 when Newton's Laws of motion are introduced formally for the first time. The fundamentals to this concept are first introduced in 7PF Forces, built upon in 9PF Forces in Action before simple Newtonian mechanics are explored in depth in Forces and Motion in year 11
- **Example 5:**
  - In biology, the idea that 'species show variation' is central to understanding how organisms have evolved over time. This idea is introduced in year 7 with 7BR Reproduction and Variation, with Darwinian natural selection introduced in year 8, with 8BE Ecological Relationships & Classification. The genetic underpinning of variation is introduced in 9BB Biological Systems and Processes and developed further, alongside evolution and speciation in KS4 in Inheritance and Selection.

United Learning guidance on teaching the Science Curriculum

When we walk into a science lesson, what should we expect to see?

- In **all** science lessons we expect to see:
  - A low stakes knowledge Do Now quiz
  - A short review of any prior knowledge essential for that lesson (this may be included in the Do Now, or follow from it)
  - Lesson activities that relate clearly to each learning outcome and no activities that do not relate to them (excepting the Do Now).
  - Student self-assessment against success criteria/mark scheme/model answer for all written work carried out in the lesson.
  - Lesson activities which are *authentic*, by which we mean:
    - activities are both scientifically valid and;
    - representative of what students will be expected to do in exams (eg labelling organelles in cells rather than drawing cells, no poster work).
  - Written work that is always the product of a student's own thinking. There should be no copying of notes (any notes should be printed for students when required).

- Over the course of several science lessons we would expect to see:

- Explicit command verb skills development (eg ‘evaluate’ ‘compare’ ‘describe’ ‘explain’ with appropriate modelling via ‘I, we, you’, **this should be particularly frequent in KS4**).
- Maths skills & working scientifically skills are taught in context and gaps assessed and addressed via fluency quizzes.
- Independent practice that includes application activities, including core exam command verb practice, maths skills and WS skills where applicable.
- Homework set that is based on self-quizzing of core knowledge, topic question packs and further exam question practice.

- In Sixth Form Science lessons we would not expect to see anything fundamentally different to the above, and all the features of KS3 & 4 lessons apply to KS5. However, some differences may be as follows:
  - Checks for understanding are likely to look different to those found in KS3 or 4, given the greater likelihood of smaller classes at KS5, but they should still be regular.
  - It is likely that more new material can delivered in larger chunks (given the ability and age of the students) before, for example, any guided practice.
  - Teacher modelling will likely involve more complex concepts which cannot easily be broken up without losing meaning, therefore we may expect to see longer direct instruction. Lessons should not become long lectures, and students should still get the opportunity to consolidate new material before moving on.
  - Do nows may be more complex at KS5 but will still involve regular retrieval practice.
  - The length and complexity of independent activities will be greater at KS5, as will the nature of any scaffolding, which will more likely be scientifically focused and will be less likely to guide students’ general literacy.

Our curriculum is designed to provide challenge for all learners. The general principle is that the outcomes are the same for all students, but that the scaffolding is targeted to different students’ needs.

Working scientifically skills are embedded in lessons, and always taught within a science context.

Fluency quizzes (see Assessment section below) are used in both KS3 & 4 and are intended to provide regular practice of the skills and core knowledge, as well as being a simple tool for teachers to identify gaps, informing future in-lesson interventions.

In KS4, we have taken the approach of assigning two lessons to each required practical activity, where appropriate, so that there is a lesson to complete the practical and one further lesson consolidating working scientifically skills in the context of that practical.

In KS3 many topics have a ‘required’ practical task, to mimic the approach at KS4 (outlined in Appendix C).

In both KS3 and 4, it is not intended that these practicals constitute the only experience of working scientifically for students. Elements of working scientifically should be included in most lessons, and that these should be responsive to assessed gaps in students’ knowledge or understanding.

United Learning guidance on assessing the Science Curriculum

Formative Assessment in Science

Whole class feedback should be used when formatively assessing students’ written work.

Weekly fluency quizzes are an effective method of identifying and consolidating core knowledge and skills.

All lessons have Do Nows, and these are mostly made of knowledge retrieval questions selected to cover relevant prior knowledge for the lesson. Do Nows should be used as an opportunity to assess gaps in knowledge.

Students should self-assess against mark schemes, model answers or success criteria for all written work.

The KS3 curriculum has been divided into a series of statements to support formative assessment, called Key Performance indicators (KPIs). KPIs are a summary of what a student should be able to do by the end of a topic, having been taught the curriculum content. There are also KPIs for working scientifically, which are intended to be assessed throughout the key stage.

Summative Assessment in Science

Summative assessment provided includes two types of assessment: optional topic tests and compulsory end of year exams.

Topic tests have been produced for each topic – all are approximately 50 marks and include the elements of working scientifically that have been developed during the unit, in addition to the specified content for that unit.

End of year exams are written for each of year 7, 8 and 9 and are compulsory for all students.

Progression in the Science Curriculum

Progression between key stages

Primary to secondary:

- The United Learning KS3 curriculum is planned on basis that students will arrive in year 7 having been taught the National Curriculum in their primary school.
- The relevant prior knowledge for each unit in year 8 (and where relevant in subsequent years) is outlined in the relevant schemes of work.
- Teachers should assess this on a unit-by-unit basis and address any gaps in required prior knowledge accordingly.

KS3 to KS4:

- The United Learning KS3 curriculum is an essential foundation to KS4, and GCSE exams assume knowledge of the KS3 curriculum.
- Careers in science and using science are referenced regularly in lessons and students should be made aware about separate science and further KS5 study from year 7 onwards.
- Students should be made aware about the importance of science, and its relevance to their lives, regardless of their potential future choices at KS5.

KS4 to KS5

- Separate science GCSE is the preferred pathway to KS5 study of science, and beyond. Separate science will be taught within an option block, to higher attaining students.
- A range of evidence from KS3 should be used to target the highest attaining students towards separate science.
- Students studying science beyond KS5 should be supported with suitable transition materials that consolidate the fundamentals from KS4.
- Studying any of the three sciences at KS5 can lead to a wide variety of careers and further study, further details of which can be found via the UCAS links below.

- Students studying science at A level, and particularly those with aspirations of studying science at university should be encouraged to consider doing maths at A level. This is particularly important for students doing physics at A level where the study of maths at A level should be a requirement.

Progression to university and careers

KS5 to university

- Studying science at KS5 opens a huge range of possible degree choices, from aerospace engineering to zoology. Each will require a different transition from KS5 to degree and a range of reasons to study, depending on the ambitions of individual students. The UCAS website is a good source of information on the different destinations for KS5 scientists and can be used as a reference point for students.

- The table below has links to each of these pages:

Aerospace engineering	Agriculture	Biological sciences	Chemistry	Civil engineering
Dentistry	Electrical and electronic engineering	Engineering and technology	Game design	Geology
Mathematical sciences	Mechanical engineering	Medicine	Midwifery	Molecular biology, biophysics and biochemistry
Nursing	Optometry	Paramedic science	Pharmacology	Physical sciences
Physiology, physiotherapy and pathology	Psychology	Radiography	Veterinary science	Zoology

Appendix B – Vertical Concepts

KS3

Vertical Concept	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
Cells carry out life processes	Cells, tissues and organs	Reproduction & Variation	Plants & photosynthesis	Biological Systems & Processes	
Multicellular organisms act as systems	Cells, tissues and organs	Reproduction & Variation	Digestion & Nutrition	Plants & Photosynthesis	Biological Systems & Processes
Genes are inherited	Cells, tissues and organs	Reproduction & Variation	Biological Systems & Processes		
Species show variation	Reproduction & Variation	Ecological Relationships & Classification			
Organisms are interdependent	Ecological Relationships & Classification	Plants & Photosynthesis			
Matter and energy are cycled in ecosystems	Ecological Relationships & Classification	Plants & Photosynthesis			
Properties are determined by structure	Particles	Atoms & the Periodic Table	Matter		
Reactions rearrange particles	Chemical Reactions	Atoms & the Periodic Table	Reactivity	Energetics & Rates	
Reactions involve energy	Chemical Reactions	Atoms & the Periodic Table	Reactivity	Energetics & Rates	
Earth as a dynamic system & source of raw materials	Materials & the Earth	Plants & Photosynthesis			
Energy is transferred between stores	Energy	Light & Space			
Energy is transferred by different mechanisms	Energy	Light & Space	Electricity & Magnetism	Sound waves	
Forces act through fields	Light & Space	Electricity & Magnetism			
Forces affect motion	Forces & Motion	Light & Space	Forces in Action	Matter	
Mass and energy are conserved	Energy	Particles	Chemical Reactions	Atoms and Periodic Table	Matter

KS4

Vertical Concept	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7
Cells carry out life processes	Cell Biology	Organisation	Infection & Response	Bioenergetics	Homeostasis & Response		
Multicellular organisms act as systems	Organisation	Infection & Response	Bioenergetics	Homeostasis & Response			
Genes are inherited	Cell Biology	Inheritance, Variation & evolution					
Species show variation	Ecology	Inheritance, Variation & evolution					
Organisms are interdependent	Ecology	Inheritance, Variation & evolution					
Matter and energy are cycled in ecosystems	Bioenergetics	Ecology					
Properties are determined by structure	Atomic Structure & the Periodic Table	Bonding, Structure & Properties of Matter	Chemical Changes	Particle Model of Matter			
Reactions rearrange particles	Bonding, Structure & Properties of Matter	Chemical Changes	Quantitative Chemistry	Organic Chemistry			
Reactions involve energy	Chemical Changes	Energy Changes	Rates of Reaction	Organic Chemistry			
Earth as a dynamic system & source of raw materials	Chemical Changes	Organic Chemistry	Chemistry of the Atmosphere	Using Resources			
Energy is transferred between stores	Energy	Electricity	Atomic Structure	Forces			
Energy is transferred by different mechanisms	Energy	Electricity	Particle Model of Matter	Forces	Waves		
Forces act through fields	Electricity	Forces	Magnetism & electromagnetism				
Forces affect motion	Forces	Magnetism & electromagnetism					
Mass and energy are conserved	Energy	Quantitative Chemistry	Chemical Changes	Ecology	Rates of reaction	Particle Model of Matter	Magnetism & Electromagnetism

Appendix C – KS3 'Required' practicals

Year 7

Topic	Practical	Skills covered
7BC	Microscope	7BC1, WSME1
7BC	Diffusion	WSSK2, WSAN2
7CP	Distillation	WSAT2, WSAN 4
7CC	Acid & alkali titration	WSAN 1, WSAN 2
7PE	Energy in food	WSAT 2, WSSK 2
7PE	Cooling down	WSSK1, WSAN 3
7PF	The relationship between mass & weight	WSAN 2, WSME1

Year 8

Topic	Practical	Skills covered
8BD	Food tests	WSAT 2, WSAN 1
8BD	Digestion of starch	WSSK1, WSAN 3
8BE	Sampling	WSSK4, WSAN2
8CP	Conservation of mass - MgO	8CP2, WSAN3
8PL	Law of reflection	WSSK2, WSAN2
8PE	Series and parallel circuits	8PE1, WSSK3
8PE	Ohms Law	8PE1, WSME1, WSAN 1

Year 9

Topic	Practical	Skills covered
9BP	Observing stomata	WSAN1, 9BP3
9BP	Testing a leaf for starch	WSAT2, 9BP2
9BB	Building a DNA model	WSAT1, 9BB5
9CE	Measuring rates of reaction	WSSK2, WSAN 2
9CR	Displacement reactions	WSAN3, 9CR1
9PF	Hooke's law	WSAN1, WSAN2
9PF	Balance	WMSE1, 9PF1