Science

The Science curriculum is designed to build knowledge, to inspire curiosity in students so that they actively seek to be able to explain phenomena in the world around them, using discoveries made by scientists past and present. Within the teaching of Science, the ALNS Teaching and Learning principles are embedded alongside pedagogy distilled from evidence-based research.

What do we want science students to get from ALNS?

Have a strong knowledge and understanding of scientific phenomena

Be able to apply their knowledge to a range of scenarios

Be able to effectively use their oracy skills to communicate their understanding or science

Be able to read and comprehend a range of scientific texts for meaning

Have the choice of studying science beyond GCSE

Have a strong base of knowledge in regards to the role of science at a local and global level

How is the curriculum planned?

Through learning science, students are given a broad understanding of; the fundamentals of science, how influential scientists discover things, and their discoveries and how science seeks to explain the world around us.This will prepare them for adult life and further studies. The knowledge and skills required from the Science National Curriculum (NC) are broken down into distinct units at both Key Stage 3 and Key Stage 4 but we try to look at the secondary Science curriculum as a 5-year journey. In years 7 and 8, students cover the Key Stage 3 NC, introducing the main areas of biology, chemistry and physics at a level that is suitable for them based on their prior attainment. Year 10 is the first year where students then begin to study Combined Science or the three separate Sciences. Throughout, the key concepts in each Science are revisited and emphasised so that these are firmly known and memorised so they can be applied to unfamiliar contexts readily. For example, key concepts in biology such as cells, transport, respiration and surface area are revisited many times in different contexts that are progressively more demanding. Where the science learning compliments the learning in other subjects, key vocabulary and approaches are used to explicitly build links in the students' schemas. This leads to the learning in both areas reinforcing each other, improving stickability. With Science this is most apparent in areas such as Geography (earth structure, pollution, population effects, limited resources), Maths (ensuring common approaches to work covered), PSHEE (development, reproduction and fertility control).

To ensure that all students (and especially the disadvantaged) acquire the cultural capital to help them be more successful in the future, we ensure that they acquire the relevant scientific vocabulary and are aware of the scientists involved in some of the biggest scientific discoveries such as Darwin, Newton, and Curie. We also recognise the work done by famous women and people of colour.

How is the curriculum delivered/taught?

Adaptive (Responsive) teaching: We use a range of evidence-based techniques which underpins our pedagogical approach to teaching Science. Questioning and quizzing is used to unpick preconceptions and then time is spent highlighting and challenging misconceptions to ensure that students have a solid foundation upon which they can construct their new learning. The link to prior learning and experiences not only ensures that students' misconceptions are cleared up but it also reinforces the prior learning in long term memory. Dynamic teachers respond appropriately to class needs over short and long periods of time building a greater understanding of learning barriers. Staff actively seek opportunities to develop their own practice against specified areas of the Teaching and Learning principles.

Stickability: During the sequences of learning students are given the opportunity to practise skills and use their knowledge in a multitude of ways ranging from 'Shed load of practice' to practical skill tasks. Throughout lessons teachers are constantly questioning students, enabling them to interrogate and develop their schema. This means that teachers do not race through content but build lasting memory and move learning from the working memory into their long term memory. Fluency in tasks reduces cognitive load and allows for greater sequencing of information leading to greater development of knowledge.

Literacy for life: Throughout the five year journey students are exposed to a huge number of subject specific vocabulary and they are expected to use, scrutinise and define these words. In order to access scientific texts and literature students need to be able to understand and use a wide range of subject-specific language. This is introduced gradually and the teachers will draw attention to new vocabulary and explore with students the component parts of words and how they link to other words (for example, photo meaning light from the Greek phos/photos – in photosynthesis, photograph, photon, photobiotic). In their books students keep a glossary of terms, referring to them when necessary. Students are expected to read scientific texts and with the teacher's support, unpick the key parts and address any areas they are confused about.

Feedback for learning and Modelling: Lessons begin with a short quiz that assesses prior content knowledge as we believe interleaving supports stickability. Teachers constantly assess students' understanding through questioning, as described above, but also through the process of marked reviews and other forms of summative assessment. A marked review involves the teacher deliberately choosing a set of examination and retrieval questions for students to complete. The questions themselves are given a score which despite increasing stakes is productive as it enables students to judge their understanding of a topic and also enables Science staff to highlight key misconceptions at an individual and whole class level. The teacher can then respond by corrective teaching and targeted support. The use of marked reviews also then enables the teacher to repeat areas of weakness through contextual changes in questions to identify and correct misconceptions and build schema.

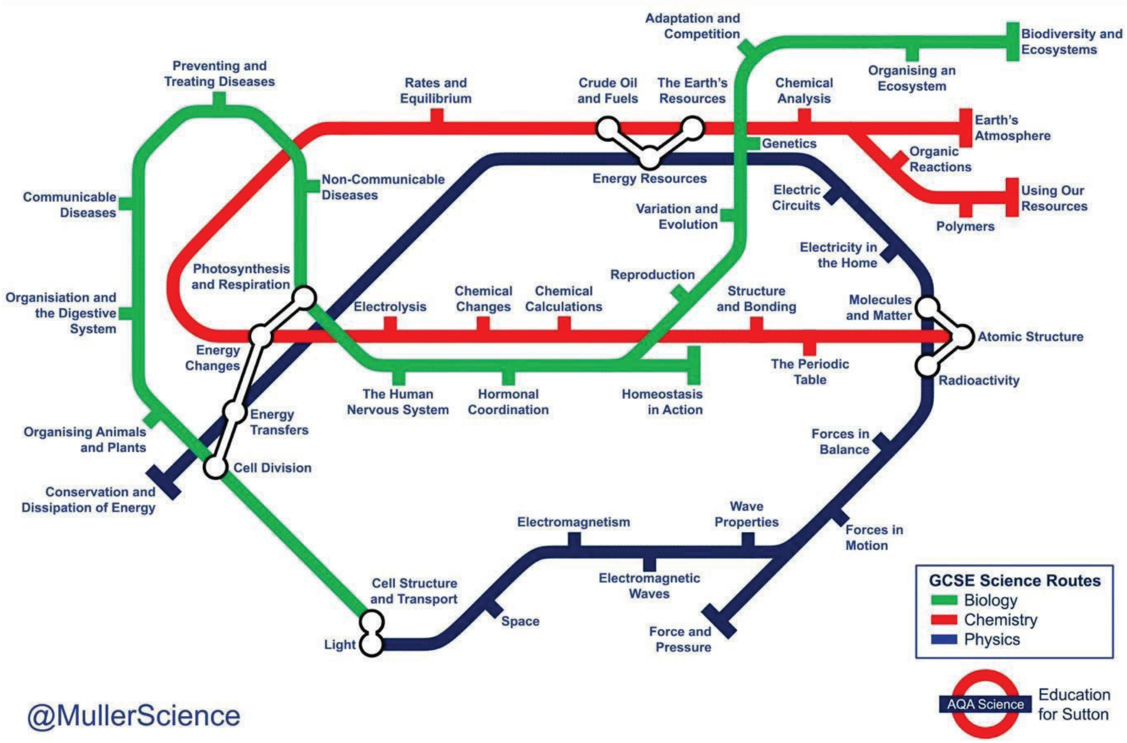
Students are given constructive feedback that celebrates strengths but that is focused on the next steps in learning. Within lessons, students are given time to act upon this feedback in line with research. Throughout lessons teachers question individuals and give constructive verbal feedback – again focused on the next steps. Independent learning is used alongside the teaching sequence so that it compliments and reinforces the work covered in lessons or is used to act as a retrieval aid.

Challenge for all: Within our schemes of work, tasks are scaffolded to support or challenge students appropriately. This means that teachers do not race ahead to complete prescribed schemes of work but are reactive and use the techniques outlined in the 6 Ps of science pedagogy diagram to ensure students develop understanding throughout the learning sequence. Task design is prioritised in planning so that all students can accelerate independently whilst being supported. The need for spacing the practice of core skills is supported through independent learning and marked reviews so that students are exposed to the key concepts throughout the learning sequence. This is also the gateway to a high challenge high support environment where challenge is not implicit but is explicit. Students who struggle to complete tasks or write are encouraged to create google documents on their chromebooks and use these instead of writing in their exercise books.

Foster a love of learning: The ability to think critically and to identify areas of development is the cornerstone of the scientific method. The need for students to reflect and to develop is naturally built into the 5 year journey through revisiting skills regularly. A range of activities and styles are used so that, where appropriate, practical activities and the use of models are built into the learning sequence. This enables our students to experience scientific processes, use models to access challenging concepts and embed them in their long-term memory. All of which is underpinned by independent learning.

The tube map summary from STEM learning shows how topics can be sequenced and where there is commonality. In the intent document for each area, this has been developed to a much greater level. This is simply a model to promote discussion of commonality.

Curriculum Map



<u>How is the curriculum assessed?</u>

Science assessment is focused on students taking feedback and then having the skills to act upon it in a timely fashion so knowledge is embedded and can be linked to other areas of the curriculum. Science teachers are aware that effective feedback can only be built upon effective learning. The bi-modular approach to summative assessments also enables students to link and build their learning whilst supporting teachers in identifying misconceptions. During Science lessons, standard practice is to carry out multiple levels of formative assessment to ascertain the conceptual understanding of students. This ranges from the use of examination questions to verbal questioning and finally the summative assessments. Teaching and learning across the department is aided by regular assessment of students' progress through the use of marked reviews. The key concepts are shared with staff so that knowledge is interleaved and through retrieval practice students develop a deeper understanding due to pedagogical approaches such as fortnightly reviews. At the end of the learning sequences teachers produce a marked review. (process described above)

The infographic below shows how the learning sequences have the key characteristics of retrieval practice, deliberate practice, corrective teaching, interleaving of key concepts, fortnight reviews and marked reviews enables students to progress.

6 Ps of science pedagogy

Prior

Check Prior knowledge

- 5 question recall starter quiz
- Questioning throughout
- Marked reviews which include relevant prior knowledge

Practice

Deliberate Practice

- I go, you go
- SLOP
- 5 question recall starter quiz
- My GCSE Science
- Independent learning

Progress

Regular progress assessment

- Google forms assessment
- Marked reviews
- End of topic tests
- KS3 skills assessments
- Mocks (standardisation and moderation)

Pacing

Reactive pacing

- Fortnightly reviews allow teachers to decelerate and work on fluency
- The lessons allow challenge levels meaning the pacing can be fluctuated for individuals.
- Adaptive teaching
- Regular routines across the department.
- Technology used to support lesson transition

Present

Present ideas like a scientist

- No hands up questioning
- Scaffolding questions to build collective answers from small building blocks.
- Start lesson with bigger questions to encourage students to think like scientists.
- Focus on keywords and etymology with glossaries throughout the department.
- Acknowledging famous scientists

Possession

Possession of their learning

- Student choosing words for their glossary.
- Pink penning allows students to identify the areas to strengthen in the own learning.
- Modelling our thought processes to help frame thinking via I go, you go for example.

Five year science learning pathway

As stated earlier, key concepts are revisited during the five years and explicit links are made through teaching and retrieval practice between topics. The diagram below shows an example of when content is taught.

Year 7	Year 8	Year 9	Year 10	Year 11
Organisms - the key concepts covered are cell structure and function, surface area to volume ratio and the uses of glucose **Chemical reactions** - the key concepts covered are atomic structure, particle model, particle theory, interactions based on charge, conservation of mass, use of periodic table, and separating mixtures.. **Earth, genes and evolution** - the key concepts covered are human reproduction, inheritance, natural selection, evolution, Earth structure and the evolution of the atmosphere and Earth's resources.	**Universe, forces and waves** - the key concepts covered are forces (including gravity), speed, magnets, light and sound, the Solar system and beyond. **Photosynthesis, plants and ecology** - the key concepts covered are plant organs and tissues, photosynthesis, uses of glucose, plant reproduction and pollination, food chains and ecosystems. **Energy and electricity** - the key concepts are the types of energy, efficiency, energy resources, power, and electrical circuits.	**Energy and electricity** - the key concepts covered are electrical circuits, resistance and Ohm's Law, types of energy, energy resources and equations. **Cell biology and bioenergetics** - the key concepts are cell structure and function, magnification, method of substance exchange, surface area to volume ratio, plant organs and tissues, photosynthesis, uses of glucose, and types of respiration. **Atomic structure and the periodic table** - the key concepts are atomic structure, periodic table, separating mixtures, and interactions based on charge. **Chemical and energy changes** - the key concepts are interactions based on charge, reactivity of metals, pH, neutralisation and enthalpy change.	**Bonding, structure and properties** - key concepts are interactions based on charge, the atomic structure, the periodic table and its uses, reactivity of metals.. **Atomic structure and particle model** - key concepts are atomic structure, interactions based on charge, radioactivity, particle theory, density and changes of state. **Organisation, infection and response** - the key concepts are organ structure, function and diseases, surface area to volume ratio, specialised cells, enzymes as a biological catalyst, development of medicines. **Forces** - key concepts are Newton's laws, types of forces, speed, momentum. **Waves and magnets** - key concepts are magnetic fields, induced magnets, properties and uses of waves, including the electromagnetic spectrum, global warming.	**Using resources, chemical analysis and chemistry of the atmosphere** - the key concepts are Earth's resources and sustainability, reactivity of metals, the evolution of the atmosphere, global warming, separation mixtures and gas tests. **Organic chemistry and rates of reaction** - key concepts are atomic structure, separating mixtures, changes of state, sustainability, particle theory, enthalpy change and Le Chatelier's principle. **Homeostasis and inheritance** - organs and their function, specialised cells and tissues, hormones, negative feedback, reproduction methods, inheritance, natural selection, evolution and extinction **Ecology** - the key concepts are food chains, ecosystems, sustainability, natural recycling, global warming and pollutants.