Science Curriculum III

Ambition

- Subject sentence – What is the quest of your discipline?

  "The Science Department ensured all students were equipped with the powerful scientific knowledge that will enable them to explain the world around them, to understand the scientific process and to develop an appreciation of the value of science in their everyday lives."

- How does your subject address social disadvantage by equipping students with powerful knowledge?
  - The Science curriculum has been constructed so that all students have access to the powerful knowledge and qualifications they need to succeed at good universities or real alternatives. In addition to knowledge, we aim to equip students with the skills to question the world around them, to analyse and synthesise information and to develop the practical skills necessary to lead to future scientific careers.
  - In the Science Department, teachers prioritise disadvantaged students when creating and implementing their Intervention Prevention plans. Disadvantaged and SEN students are targeted through in-class intervention (questioning, one-to-one teaching, and small break-out groups) or out-of-class intervention such as Prep or revision classes. This allows for rapid identification of any misconceptions and errors.
  - Students with special educational needs or disabilities are given extra support using Double Staffing. Students are taught in small group settings so that individual needs can be catered for. Students with profound barriers to learning will receive additional teaching and practice of core concepts so that they can achieve mastery. Students who are new to English receive extra support with vocabulary and literacy.
- What skills and cultural capital do students acquire in your subject?
  - We teach beyond the specification requirements, to the wider domain, whilst also ensuring students are well prepared to be successful in GCSE examinations. We think hard about how learning in our lessons relates to current developments in the world whether that is the coronavirus, global warming, or attempts to send humans back to the moon. The schemes of work ensure topical issues such as fracking, plastics, use of fossil fuels. are covered in detail to allow students to have an educated and informed opinion on global issues.
  - We want our students to be scientifically literate and to have the critical thinking skills to question a news article or a social media post that could contain misleading or false information. To do this we ensure that lessons contextualise science to the world around them. This increases our students' confidence in discussing science and in thinking critically about information presented to them online or in the media.
  - Students take part in co-curricular STEM. Students undertake a project and carry out research, experiments and make conclusions. They present back their STEM projects and discuss their findings. Links are made to areas such as biodiversity, human impact on the environment or alternative fuels.
- How do you make Careers education explicit in your curriculum?
  - We ensure students gain a deeper understanding of the diverse range of careers available to those with scientific knowledge and how to access these careers. Careers education is made explicit in our curriculum through the inclusion of Careers Spotlights, linked specifically to the discipline of science. Careers Spotlights are presented to students at key points within the SOW, to ensure that students are not only exposed to a variety of careers but can make explicit links between these careers and the content they are studying.
- How does your curriculum support Civic Responsibility for the local community?
  - Science topics across all stages encourage reflection on progression and change of scientific ideas over time, encouraging students to think about how this could apply to their communities. We encourage intellectual development within students that will provide them with the skills needed to become change agents.
- How does your curriculum approach issues surrounding race?
  - Science education has historically often overlooked figures who contributed to our modern scientific understanding of our world including women, ethnic minorities, and those with disabilities. A significant amount of time has been spent researching both a more diverse range of scientists to spotlight in our lessons and integrating those scientists into our SOW, so they become a core part of the story of scientific development. In addition, we aim for students to be taught about why science benefits from a diverse range of ideas to progress. We do this both through our science lectures and through specific lessons in the curriculum.

- What additional experiences (including expeditions) do your students access in your subject?
    - Typically all year groups have had a trip or an in-school event. These range from a planetarium event or a Crime Scene Investigation event in school to expeditions to the Natural History Museum and The Science Museum to name a few. We also have plans to organise an annual trip to the National Space Centre. We truly believe in teaching and learning outside the classroom to contextualize their current learning and to enhance their love of the subject by seeing how science is manifested in society.
    - A whole week is dedicated to 'National Science Week' where students take part in special activities or events on that year's theme. During DEAR students read about a famous scientist and their discoveries.
- Where does your curriculum link with the PDS curriculum?
    - Y7 C1 - Science Skills (hazards and risks) - Safety
    - Y7 C1 - Forces and Space - World
    - Y7 C1 - Diversity in Science Lecture - Community: Discrimination
    - Y7 C2 - Reproduction - Relationships
    - Y7 C3 - Acids and alkalis (hazards and risks) - Safety
    - Y8 C1 - Electricity and magnetism (electrical safety) - Safety
    - Y8 C2 - Environmental Chemistry – World: Global warming, acid rain, alternative fuels, pollution
    - Y8 C2 - Science Skills (hazards and risks) - Safety
    - Y8 C3 - Genetics – Who am I?
    - Y9 C1 - Cell Biology (stem cells) - World
    - Y9 C1 - Energy - World: Global warming, acid rain, alternative fuels, pollution, The Nuclear Question
    - Y9 C2 - The Body, The heart, the lungs - Who am I?
    - Y9 C3 - Infection and Response - Safety
    - Y9 C3 - Chemistry of the Atmosphere - World: Global warming, acid rain, alternative fuels, pollution
    - Y10 C1 - Infection and Response - Safety: Peoples health
    - Y10 C1 - Radioactivity - (The dangers of ionising radiation) - Safety and The World: The Nuclear Question
    - Y10 C2 - Homeostasis - Safety
    - Y10 C2 - Inheritance - Who am I?
    - Y10 C2 - Electricity (electrical safety) - safety
    - Y10 C3 - Ecology - The World
    - Y10 C3 - Waves (Ultraviolet rays and the dangers of ionising radiation) - Safety
    - Y11 C1 - Ecology - The World: animals and plants
    - Y11 C1 - Inheritance: (inherited and environmental characteristics) - Who am I?
    - Y11 C2 - Practical skills (safety in science) - Safety
- How do you support personal development through House and Stretch?
    - We work with the House leaders in order to contribute to the personal development of our students. Within STEM we have our students work on STEM projects such as how to tackle global warming, how to increase recycling or other important issues. We support House when there are key science related issues to cover such as Climate Change or the Coronavirus.
    - We also ensure that wider school environment is grounded in an understanding in science. This supports stretch projects, for example in helping out students to understand 'Who am I?' we teach about genetics and inheritance. We help our students to understand important issues and debates facing the world such as how to tackle global warming, the nuclear question, and ethical questions on stem cells, genetic engineering or IVF. We also try to ensure all sure students build a good understanding on important topical topics such as the coronavirus or vaccinations so that they know the science behind them. By doing this we aim to help students think critically about what they read in social media or the news and avoid misinformation.

Rationale

- How is your curriculum designed?

  We consider the curriculum design both vertically and horizontally:

  - We consider it vertically from year to year because we know scientific knowledge is learnt in a hierarchical nature – students must have a secure understanding of the basic knowledge before they can build on to the more complex ideas. To support this, the science curriculum has been broken down into two key stages, considering the prior knowledge of earlier stages. In Y7 and Y8, students learn about the basic phenomena in biology, chemistry and physics and then start deepening their knowledge in Y9 and Y10. Topics have been planned and interleaved to ensure that students are always building on their previous learning. What students have learnt at primary schools is considered carefully to ensure Y7 content is built on what students have learnt before.
  - We consider the curriculum horizontally by taking into account what students will be learning in other subjects such as maths, English or PE. For example, we link together with the maths department so that both science and maths teachers use similar language in both subjects to describe the same concepts such as when teaching how to rearrange equations. Or we consider when certain topics such as the circulatory system are taught in both PE and biology and how learning in both subjects can build from each other.
  - We intelligently sequence learning over time so that more challenging topics such as the physics electricity topic is saved until later in year 10 when students can better access its more abstract nature as they will possess a higher level of prior knowledge.

- What content do you cover and how is this delivered over time?

  - For Biology, primary students are introduced to different animals (including humans) and plants and their life processes in KS1 and this is then revisited in more depth at KS2. At KS3 the students are introduced to the basic building blocks of all living organisms, cells. Students learn some of the key cells in organisms and they are specialised to carry out different functions. It is important for students to learn about microscopy and how the development of a microscope allowed us to see an organism's makeup beyond what the eye can see, therefore all students complete a required practical where they use a microscope to look at different cells. KS4 sees the students developing into scientists, deepening their knowledge by examining the finer detail of subject knowledge e.g. how the biological systems within the body work such as the circulatory system, linking this to students' lives by teaching them how to live a healthy life and what risk factors for diseases such as CHD. Students are also taught about the origins of life and the theory of evolution to help them understand where they came from and why they are here. Given the intake of our students, we encourage them to ponder and debate about science vs religion and the flaws within each theory.
  - At KS3, students start with a rigorous grounding in the fundamentals of chemistry: by looking at the states of matter, elements, compounds and mixtures, the periodic table, chemical reactions and the behaviour of different materials. Students learn how different elements come together and make up the world around us. To ensure our students have cultural capital when they study the chemistry of the atmosphere students are exposed to current world issues such as global warming, the use of plastics, recycling etc. so that they can start to understand the wider world around them. Having mastered the foundation knowledge, students are fully equipped with the necessary knowledge and skills to tackle the more challenging KS4 content. Students' further study on the atom and its finer structures and bonding in chemistry allows students to visualise how substances are made up beyond what the eye can see.
  - In physics, students learn everyday phenomena such as the forces in effect when they are sitting or walking as well as learning about the miracles of the solar system to put into perspective how small our world is in comparison to the galaxies and universe. They can then articulate why we have day and night, why there are four seasons and can explain this. At KS4 the focus shifts to a more quantitative appreciation of the subject matter, which allows students to apply skills that have already been introduced in their Mathematics lessons. The study of electromagnetic waves allows students to understand the physics behind things as common as how they communicate using mobile phones to treating cancer using radiotherapy.

- Which content don't you cover (that others might)? Why?

  - Diversifying our scheme is a work in progress but is a priority.

- How many lessons do students have per week, for each year group?

  - Y7 - 5, Y8 - 5, Y9 – 5.

- Y10 - 6, Y11 – 6. In Y10 and Y11 we aim for subject specialists to teach their classes, so these lessons would be 2x biology, 2x chemistry and 2x physics.
- In addition in year 11 students will receive 2x Academic Morning Meetings or Academic Dear lectures.

- Which exam board do you use? Why?
  - We study AQA Combined Science – Trilogy. This choice is based on being able to share teaching resource across the Academy Trust (all schools in the Trust use AQA in science), the relevance of the required practicals that AQA set and the supporting resources that AQA offer.

Concepts

- How is your subject curriculum designed and delivered in a way that allows pupils to transfer key knowledge to long-term memory?
  - There is an expectation for every science lesson to begin with low stakes retrieval practice, usually deployed in the form of a 'Do Now' quiz or a 'Brain Dump' based on key information. Retrieval practice may be based on the previous lesson, or it may be interleaved knowledge, based on information learned in a previous cycle or year. Students then self-assess this and can identify gaps in their knowledge.
  - In addition our assessments strategy helps to embed ideas into students long term memories. Our assessments are a mixture of individual topic assessments and cumulative assessments that can assess knowledge across different topics or years of learning.
- How do you intelligently sequence your curriculum so that new knowledge and skills build on what has been taught before?
  - Our curriculum is designed to be remembered in detail and to be built on prior knowledge. Both spaced practice and interleaving is used to inform it's design. At KS3 we prioritise teaching core scientific knowledge that we then revisit and build on into KS4. Concepts are encountered multiple times throughout the curriculum, with each encounter adding another layer of meaning.
  - We have examined the primary National Curriculum carefully and worked with DAT Primary schools. We have done this both to understand what is taught in Primary and to help support Primary teachers in better teaching science in KS1 and KS2.
  - During Year 7 and Year 8 we base much of what we teach on the National Curriculum. During Year 7 we have ten topics that cover the core knowledge of biology, chemistry, physics and science skills. In Year 8 there are ten more topics that each build on topics from Year 7. At the start of each topic in Year 8 students will spend a lesson reviewing key ideas from the previous year's linked topic. We explicitly save more abstract topics until Year 8 such as Waves and Electricity so that students will have greater prior knowledge by the time they start studying them. No one topic is studied in complete isolation from another, and a plethora of links can be identified across the subject. Sometimes we will include GCSE content at this stage where we know students will be able to access it so that our most able are stretched.
  - During Year 9 and 10 students study a mixture of the National Curriculum and GCSE content. We will intelligently sequence it so that more abstract or challenging content is taught to students later in their learning journey. For example instead of teaching the P2 electricity topic in Year 9, we save it until towards the end of Year 10. We do this because we know by then students will have more prior knowledge from both science and maths and so they will be better able to access this topic.
  - By Year 11 we are finishing off GCSE content then will go back and assessment data to inform targeted revision of key challenging concepts. We plan time in Year 11 for application practice, developing exam skills and revisiting earlier concepts.
- How do you use spaced practice / retrieval practice?
  - Low-stakes quizzing is embedded in science. Students from all year groups are quizzed during Morning Meeting at least once a week using a central bank of science questions, as well as tier 2 vocabulary that links to the domain. These questions have been made more specific and adapted heavily. They have become more focused on the specific knowledge needed for the GCSE exams.
  - In our assessments we use a mixture of end of topic assessments and cumulative assessments. For example a Year 8 Cycle 3 Assessment may assess content from any topic from Year 7 or Year 8 to benefit from the spacing effect.

- At the start of each science lesson, all students complete a Do Now either in the back of their books or on Mini White Boards. The Do Now will consist of retrieval practice questions that will include a mixture of questions based on last lesson, what was covered last week, in the last month or in a previous topic entirely. There will then be a Review Now where students will receive feedback and self-assess their Do Now answers.
- Within Schemes of Work certain parts of the year will focus on revising previously taught topics rather than pushing ahead with new content.

- How does your subject use homework to support learning?

  We believe that homework should be:

  - Interleaved-revision of powerful knowledge that has been modelled and taught in lessons, Morning Meetings and intervention sessions.
  - Used in retrieval practice. Knowledge from homework is retrieved in low-stakes quizzing which takes place both through Morning Meeting and Do Now activities in lessons. These activities are sequenced to interrupt forgetting, and strengthening the students' ability to take knowledge from their working memory into their long term memory.
  - Allow opportunities to practice extended writing. Each cycle at KS4 students will complete extended history homework, practising their skills in summarisation, explanation, analysis and judgement.
  - Homework's are often revision based so that they cover a topic that is not currently being taught to benefit from spaced practice. Students use the knowledge organisers for retrieval practice from each topic where they are to look, cover write and check the key knowledge from different sections of the KOs. In addition to this students are set weekly online homework using the Seneca platform or questions from homework booklets.

- How is reading and mathematical fluency prioritised in your subject?

  - Reading is prioritised in science by allowing students to do their own research around a concept or theory, in many of the SoW the strategy of "reading reconsidered" is encouraged to allow students to read aloud in class.
  - The science and maths departments have worked closely to ensure there is consistency in the way the departments teach key skills e.g. rearranging equations.

Implementation

- Subject leadership – What are the roles and responsibilities for staff in your department?

  - SPA (HOD) - Creating LTPs and SOW and ensuring these are up to date with the most recent research into pedagogy. Lead on physics for the department. Planning intervention for Y11. Contributions to Cross-Cutting teams meetings. Creating resources to be used within school and in the event of home learning. Lead on subject-specific CPD for the department. Lead on H&S. Planning revision lectures for Y11. Mentor to LMI.
  - RMO (SLT) - Planning intervention for Y11. Planning revision lectures for Y11. SLT role – Data and Curriculum. Line manager and coach to SPA
  - HMU (Deputy HOD) - Creating resources to be used school-wide (Brain Dumps and quizzing for MM, 100% sheets). Create and deliver subject-specific CPD and practice. Mentor to FSU. Planning intervention for Y11.
  - EEM (Pioneer of Science) Creating resources to be used school-wide (Brain Dumps and quizzing for MM, 100% sheets). Create and deliver subject-specific CPD and practice to the department. Lead on biology for the department. Lead on biology LTP and SOW.
  - AAK (HoY) - Lead on chemistry for the department. Mentor to EEM. Create and deliver subject-specific CPD and practice to the department. Planning revision lectures for Y11. HoY role – Oversee Y8-9.
  - LMI (TF – ECF 1) - Planning/adapting lessons for individual science classes. House Leader.
  - FSU (ECF 1) - Planning/adapting lessons for individual science classes. STEM lead.
  - APE (Lab technician) – Providing technical support, ensuring that equipment is functioning properly and is ready to use, and that the right materials are available for particular lessons, Leading on H&S documentation.

In addition, we assign responsibility to different parts of the curriculum in the following areas:

	Staff	Responsibilities
Y7 Science	LMI with support from SPA	☐ Creation and printing of mini assessments ☐ Creation and printing of revision lists ☐ Organising Schemes of Work ☐ Creation / adaption / QA of lesson PowerPoints for different groups ☐ Setting home-learning work
Y8 Science	FSU with support from HMU	
Y9 Science	HMU	
Y10 and Y11 Biology	EEM	
Y10 and Y11 Chemistry	AAK	
Y10 and Y11 Physics	SPA	

We do this to reduce teacher workload and to ensure best practice is shared around the department.

- Subject knowledge – What are the staff specialisms? What has been the impact of staff training?
    - The Science department is staffed two physics specialists (SPA and RMO), one biology specialist (EEM) and four chemistry specialists (FSU, LMI, AAK and HMU).
    - To support biology teaching, EEM delivers additional subject-specific CPD on teaching biology and creates lesson and revision resources to be used by the wider department.
    - To support physics teaching SPA delivers additional subject-specific CPD on teaching physics and creates lesson and revision resources to be used by the wider department.
    - To support chemistry teaching AAK delivers additional subject-specific CPD on teaching chemistry and creates lesson and revision resources to be used by the wider department.
    - In addition we sign-post Trust wide subject-specific CPD to the determine based on need as determined by Learning Walks, or from Coaching conversations.
- Equitable delivery – How do you support disadvantaged students and students with SEND?
    - Disadvantaged students are always a priority for staff and disadvantaged students who are not making enough progress are identified on intervention and prevention documents. These documents inform daily planning and tailored interventions. All expeditions in science expand the cultural capital of students and social disadvantage has no impact on the range of experiences they gain from the Science department.
    - SEND students to learn the full science curriculum and are not disadvantaged by a lack of access to the powerful knowledge we impart. We do not change the content we teach for SEND students or the groups they occupy. We ensure SEND access to the curriculum is unimpaired - we deconstruct the complex abstract scientific concepts to their component parts, before applying and building on this knowledge to make it accessible to all.
    - We use subject-specific CDP to support the teaching of students with SEND along with all students. For example, we use techniques to reduce cognitive load such as Dual coding and worked-example pairs or Concrete vs abstract representations when teaching some of the more abstract concepts in science.
    - All members of the department understand the necessity of ensuring that all content is accessible for all students. Staff are knowledgeable in the strengths and weaknesses of all students and lessons and lesson resources are tailored for individual classes.
- Planning the progression model – How does a certain topic (e.g. algebra / language analysis) progress across the key stage(s)?
    - We ensure that in each year students build on their prior knowledge. The following is an example of the Progression in How Science Works in the context of the atomic model changing with time.
    - Y7 – introduce core knowledge to students such as concepts of substances and mixtures, elements and compounds and the periodic table

- Y8 – Build on core knowledge from year 7 introducing more complex concepts such as physical and chemical changes and the atomic model
- Y9 – Examine specific examples of how scientific ideas have changed. E.g. present different models of the atom and how they have changed with time – from Aristotle's idea of the Atom to J.J. Thompson's Plum Pudding model, then how the work of Rutherford, Bohr and Chadwick changed the atomic model through experimentation and examining data.
- Y10 – Explore in detail how scientific models can be changed through gathering experimental evidence and data e.g. through examining the Alpha Particle experiment. Compare and contrast different models and interpretations and identify links between them. Establish how important collecting data is to inform scientific theory.
- Y11 – Learn to evaluate scientific experiments and their limitations. How science changes with time as new technologies developed or experimental methods improve. Establish what scientific data can tell us, but also what they cannot tell us and why the missing information is important to explore.

- Breadth and depth – How do your LTPs / SoW demonstrate extent of knowledge and skills coverage and depth?
  - The curriculum at KS3 is designed to give students a wide range of core knowledge across a variety of scientific domains. It has been informed by the National Curriculum including what students learn in primary school so that at year 7 we consider prior knowledge gained in KS1 and KS2. It is also designed to develop key scientific skills such as practical skills, writing experimental methods, identifying hazards and risks, collecting, and analysing data, drawing graphs and starting to build skills at evaluating experimental design.
  - At KS4 the assessments from the AQA Combined Science Trilogy specification are used as a guide, however, we also look for opportunities to go beyond this to promote a deeper understanding of science and ensure our students understand the subject domain in detail. The current KS4 curriculum prepares our students rigorously for their GCSE examinations at the end of KS4 and beyond for those who may want to study sciences at A level.
  - There is extensive intervention at KS4 including break-out teaching groups, Prep, Morning Mastery, and extra revision sessions. The intervention for each group is tailored to the specific needs of these students.
  - To stretch the most able, students are invited to a Trust-wide 'Getting to Grade 9 Conference'. For students looking to study science beyond their GCSE's, specific extra support is provided, for example through packs of A level questions.

- Assessment – How do teachers assess across the unit / term / cycle / year / key stage?
  - Formative assessment is incorporated within every science lesson. We use on-going informal assessment based on observation, discussion, questioning and written work. This provides us with the means to continuously adjust our teaching to benefit student progress. We use questioning both to assess and to advance children's learning. At KS4, exam-style questions are a common aspect of each lesson and in homework. We continuously provide feedback and use DIRT to encourage students to improve on these.
  - Summative assessment is applied on a cyclical basis. At KS3, students will conduct a summative assessment twice a year, one of which will be based on a trust-wide common assessment.
  - At KS4, students will be formally assessed at the end of each cycle to allow us to gain an accurate measure of the progress being made as students are exposed to the different styles of exam questions within each GCSE unit. The assessments used at KS4 reflect AQA Combined Science Trilogy specification but also attempt to deepen science understanding for students.