KS4 Science Curriculum

Year 9 Biology

Students revisit the building blocks of organisms from KS3, studying cell structure and function in more detail and how the role of specialist cells is achieved using their adapted cell structure. They should be able to use their knowledge to then compare and contrast prokaryotic and eukaryotic cell structure. Students learn how we study cells using light and electron microscopes and develop the maths skills to calculate how much an image has been magnified by and how to manipulate the formula to calculate image or object size, which involves unit conversion skills. Students will also study how cells divide by mitosis as it's part in the cell cycle. There is an opportunity during the learning on stem cells, to evaluate the risks and benefits to society of using these cells and the ethical considerations that arise.

They then study the different transport processes that cells use to move substances in and out across their cell membrane. From simple diffusion to active transport which requires energy from respiration to move substances against their concentration gradient. Students will be able to determine Osmosis taking place using potato pieces by measuring change in mass to indicate the amount of water moving into or out of cells, calculating % change and then graphing their data. They will revisit active transport again when studying plants and how they move ions into root hair cells (linking with specialised cells from their 1st topic in yr9) and in the next topic of digestion to see how glucose is moved into the epithelial cells from the small intestine.

Lastly, they start the topic of organisation by looking at digestion where students study the structure of the digestive system, identifying the major organs involved. They will study the nature of chemical digestion, involving enzymes and what factors affect the rate of enzyme reactions. Enzyme practicals require teamwork, communication and coordination to get the data and again gives students the opportunity to graph that data and draw conclusions.

Year 9 Chemistry

In year 9, students begin the GCSE Chemistry course. They build on their understanding of the structure of the atom and begin linking ideas from KS3 about different groups and chemical reactions. Students will learn about the arrangement of elements in the modern periodic table and begin to make sense of their physical and chemical properties. They will learn about the historical development of the periodic table and the models of atomic structure which provide good examples of how scientific ideas and explanations develop over time as new evidence emerges.

Next, students will explore how atoms are held together in different structures; ionic, covalent, and metallic. Students will then apply their knowledge of atomic structure and bonding to the physical and chemical properties of materials. They will learn how this knowledge of structure and bonding can be used in everyday life to engineer new materials with desirable properties.

Students continue to develop their knowledge and understanding in Science through opportunities for working scientifically. These include investigating, observing, experimenting, and testing out ideas. Students' practical skills are developed in year 9 with a range of separating techniques studied including distillation and chromatography.

Year 9 Physics

Year 9 is where pupils start applying their understanding of Key Stage 3 Physics to GCSE content. The first year focuses on energy.

In terms 1 and 2, pupils investigate the different types of energy, how they can be transferred from one form to another, and how energy can never be destroyed. Students are then introduced to the ideas that differing energy forms can be used to generate electricity, the advantages, and disadvantages of each process.

In terms 3 and 4, students examine the processes by which energy can be transferred, via radiation and conduction, and what can be done to reduce heat losses from the home by these processes. The first equations of Key Stage 4 are introduced and applied to energy transfer, and the first required practicals, linked to energy processes, are completed during these terms.

In term 5, additional energy equations are introduced and applied to real life situations. These equations utilise their mathematical skills and help with the student's understanding of energy transfers and heat transfer processes.

At the end the school year, year 9s engage in a longer-term project in Biology, Chemistry and Physics, where they can practise and improve their scientific skills. The students will plan, risk assess, carry out and report on how their chosen factors affect the flight of paper planes. This engages their natural curiosity and uses higher cognitive processing to make decisions on dependent, independent and control variables as well as suggesting how to improve their method. They will experience the value of a trial to address any unanticipated issues with their methodology prior to data collection. Maths skills, data analysis and drawing conclusions will be needed to scientifically report their findings. Alongside this, students will be conducting research into scientific process and discovery in a field of their choice, working on their presentation skills as a team and starting to think about the relevance of science in the modern world. To help inspire them, they will be learning about forensic science, which supports future GCSE content such as DNA and chemical analysis. By the end of Year 9, students will have the essential foundational content and skills to thrive at GCSE and be thinking about where their scientific careers could take them.

Year 10 Biology

Students continue the topic of Organisation by recapping digestion from yr9 and then looking at other organ systems like the gas exchange system and the cardiovascular system. This extends to plant systems, which albeit more simple builds on the specialised cells in yr9 and focuses on transport which will underpin the later topics of plant diseases and photosynthesis. Within the organ system topic, students will learn about non-communicable disease like heart disease and cancer.

The area of disease in then widened in the next area of study "Infection and Control", where students discover the cause and symptoms of a number of specified diseases across humans and plants, caused by either viruses, bacteria or protists. Vaccination is studied as to how it's effect on the immune system, can prevent disease or the use of antibiotics when infection by bacteria does occur. They will study the work of Semmelweis and his discovery of how hand washing can prevent microbes being passed on. This unit gives plenty of opportunity for maths and graphing skills and there is a required practical, using antibiotic assays to determine the effectiveness of a soap or disinfectant to kill bacteria. Students use measuring skills and then manipulate their data to calculate an area of no growth to use as their comparative factor in their conclusions.

Before revising for their End of Year exams, students start the topic of Bioenergetics, where they look at photosynthesis and respiration and the relationship between them. An opportunity for plenty of practical work, investigating the effects of different variables on the

rate of photosynthesis and even proving photosynthesis does not take place in the absence of light.

Post exams, students start the Ecology topic, so there is plenty of good weather to get out of the lab and take measurements in the local environment. Students will learn to use quadrats and how to treat the data collected, to apply it to calculating populations or determining distribution of named organisms. They will also look at factors affecting a habitat and the organisms in it, as well as how evolutionary biologists like Carl Woese classify organisms, and the effect recent DNA sequencing has had on how previous evolutionary trees were organised. This topic is continued in yr11.

Year 10 Chemistry

In year 10, students begin Chemistry with an introduction to quantitative chemistry. Calculations of relative atomic mass and relative formula mass make use of students' strong knowledge of the periodic table from KS3. Students learn the concept of 'the mole' and apply this to several calculations used throughout GCSE Chemistry. In this topic, students will learn to use chemical equations as a way of communicating chemical ideas.

Next, students apply their knowledge of reactivity and displacement from Year 9 to the topic of metal reactions. Students will explore the reactivity series and learn how it impacts the choices Scientists make when undertaken industrial processes such as metal extraction.

Students will then apply their knowledge of ions, ionic equations, and reactivity from Year 9 to the topic of electrolysis. In this topic, students will learn how elements are separated from ionic compounds using electricity.

Next, students will learn about energy changes. They will be able to answer complex questions such as what is an endothermic and an exothermic reaction? Why do reactions fall into these two categories?

Students will explore the fundamental concept of the rate of a reaction. They will learn what is required for reaction to start; the activation energy, as well as the factors which affect the rate of chemical reactions. Students will gain an understanding of how these chemical concepts relate to real world examples, for example, why we cut potatoes up before boiling them.

In the last term of year 10, time is given to allow for revision and mastery in the lead up to GCSE mock exams.

Throughout year 10, students' practical skills are developed through practicals including making salts, electrolysis, measuring energy changes, and a variety of ways to measure the rate of a reaction.

Year 10 Physics

In Year 10, students begin their investigation into the smallest realm of physics – particles.

In terms 1 and 2, students are introduced to the arrangement of particles in solids, liquids, and gases, and how these patterns alter during changes of state. These skills are then applied to gas pressure and temperature. The particle model is then used to explain one of the most misunderstood area of physics – radioactivity. Students learn the types, properties, and uses of radioactive decay. The particle model is then applied to the twin processes of nuclear fission and fusion.

In terms 3 and 4, students are introduced to the mysteries of waves, learning about their nature and properties, and investigating this nature using wave generators. This understanding is strengthened when investigating electromagnetic waves – what are they, what role do they play in the universe, and how we can use them in everyday life. The origin of electromagnetic waves is then explored when they delve into the beauty of space physics, looking at the formation of the solar system, the life cycle of stars and the fate of the universe.

Terms 5 and 6 are spent applying the principles of particles to the most challenging branch of physics – electricity.

Students will investigate electrical currents and electrical energies and utilise these concepts in understanding series and parallel circuits. The skills learnt will be reinforced when completing experiments on the behaviour of electrical components, and the relationship between resistance and size.

All students follow the separate science ('triple') curriculum until end of yr10. As a result of the end of year 10 exams, students will either continue triple or switch to the 'double' syllabus (combined science trilogy). They all continue to be taught Biology, Chemistry and Physics but the pace of work and amount of content increases for the triples and so is not suitable for all students. Irrespective of the course, all students can still access A'level Science subjects if they achieve the correct grade or higher (see 6th form prospectus). Double students will receive a combined double GCSE grade (worth 2 GCSEs) and the triples will receive individual grades in Biology, Chemistry and Physics (3 GCSEs).

Year 11 Biology

The topic of Ecology from yr 10 is briefly recapped then knowledge is built upon to look at the larger concepts like the water and carbon cycle, the role of the environment and organisms in those processes and the importance of recycling those molecules. Then the focus returns to humans and their homeostatic mechanisms to affect tight controls on body parameters.

Lastly, students study the strategies of sexual and asexual reproduction which leads on to the 2nd cell division process, meiosis. They then study the exciting topic of inheritance, looking at the structure of DNA and how the rules of Mendelian genetics can be applied using genetic diagrams like punnet squares to make predictions on offspring genotypes and phenotypes. Finally, they study fossils as evidence of evolution and the ideas of Darwin as to how natural selection drives evolution. Bringing in their knowledge from the Ecology topic they learn how being less well adapted for the environment than a competitor and the big events like climate change/disasters has led to past extinctions.

The Biology syllabus in year 11 is shorter to allow for review and consolidation of previous topics to help students see how these topics fit in together as well as mastery and time for revision.

Year 11 Chemistry

In their final year of Chemistry education at GCSE level, students are introduced to the world of organic chemistry; the chemistry of carbon compounds. They will learn how these compounds are used in everyday life and some of the issues that come with this.

Next, students will apply their knowledge of elements and compounds to the topic of chemical analysis. They will learn how substances can be analysed using melting point data and chromatography. Students will also learn the significance of the 'squeaky pop' in identifying gases!

Finally, students bring together many ideas taught throughout the course to look at how Chemistry affects our environment and the part we as human beings are playing. How can we reduce our carbon footprint? How can we produce clean drinking water? How do we extract metals from the Earth? And how can we do all of these things better to protect our environment?

Throughout year 11, students' practical skills will continue to be developed through practicals including chromatography and water purification.

Year 11 Chemistry is designed to be shorter in length than the other years in order to maximise time for revision and mastery in the lead up to GCSE exams.

Year 11 Physics

In Year 11, students complete their studies into electricity, and cover the last remaining major topic – forces.

In terms 1 and 2, electricity is revisited and applied to electricity in the home. This reinforces previously taught content by placing electricity into a familiar setting. Once electricity has been mastered, students investigate forces, motion and Newton's Laws of Motion. This revisits and expands many of the ideas first introduced at Key Stage 3, such as speed and velocity, developing these and expanding to include accelerated motion, explaining how these concepts can be described, represented graphically, and calculated mathematically.

In terms 3 and 4, the ideas from the module on motion are applied to momentum and elasticity. Students studying Physics as a separate science will also link forces to the particle model and look at pressures in fluids, as well as finishing the waves module when developing their skills in light and applying to lenses. Finally, the last foray into electricity is made when it is combined with magnetism from Key Stage 3 and applied to electromagnetism and the motor effect.