Biology
Key Stage 4

Curriculum map

OAK NATIONAL ACADEMY

1. Philosophy

Six underlying attributes at the heart of Oak's curriculum and lessons.

Lessons and units are **knowledge and vocabulary rich** so that pupils build on what they already know to develop powerful knowledge.

Knowledge is **sequenced** and mapped in a **coherent** format so that pupils make meaningful connections.

Our **flexible** curriculum enables schools to tailor Oak's content to their curriculum and context.

Our curriculum is **evidence informed** through rigorous application of best practice and the science of learning.

We prioritise creating a **diverse** curriculum by committing to diversity in teaching and teachers, and the language, texts and media we use, so all pupils feel positively represented.

Creating an **accessible** curriculum that addresses the needs of all pupils is achieved to accessibility guidelines and requirements.

2. Units

KS4 Biology is formed of 7 units and this is the recommended sequence:

Unit Title	Recommended year group	Number of lessons
1 Cell biology	Year 10	21
2 Organisation	Year 10	23
3 Infection and response	Year 10	17
4 Bioenergetics	Year 10	15
5 Ecology	Year 10	17
6 Homeostasis and response	Year 11	25
7 Inheritance, variation and evolution	Year 11	26

3. Lessons

Unit 1 Cell biology

21 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Prokaryotic and Eukaryotic Cells**	• Describe the differences between eukaryotic and prokaryotic cells • Practice identifying eukaryotic and prokaryotic cells
2.	**Comparing of cells**	• Describe functions of subcellular structures • Compare the functions of different cells
3.	**Order of magnitude calculations**	• Convert mm to μm and vice versa • Express numbers in standard form

4.	**Microscopes, magnification and resolution**	• Describe the differences between images produced by light and electron microscopes • Explain how electron microscopes have enhanced our understanding of cell structures and processes • Explain what is meant by resolution and magnification
5.	**Using the microscope and magnification equation**	• Describe how to use a microscope to view plant cells in focus • Use the magnification equation to calculate the magnification, image or actual size • Change the units if necessary
6.	**Viewing animal cells under the microscope and calculating magnification**	• Find and view animal cells using a microscope • Use the equation M=I/A to calculate any value given the other two • Practice using scale to calculate magnification
7.	**Specialised cells**	• Describe specialised features of given cells • Explain the reason for the special features in terms of the cells function • Explain the importance of cell differentiation

8.	**Diffusion**	• Describe how substances move in and out of cells by diffusion, giving examples • Describe and explain factors that can affect the rate of diffusion
9.	**Exchange surfaces and surface area to volume ratio**	• Calculate surface area to volume ratios • Explain the need for internal surfaces and circulatory systems in larger organisms • Describe and explain adaptations in plants and animals for the exchange of materials
10.	**Osmosis**	• Define the term osmosis and give some examples in living things • Explain the changes to both animal and plant cells when placed in different solutions
11.	**Osmosis required practical (Part 1)**	• Identify variables to change, measure and control to test a hypothesis • Practice method writing and explain reasons for given method steps • Make and record accurate mass measurements

12.	**Osmosis required practical (Part 2)**	• Measure change in mass accurately and calculate percentage change • Display and interpret results appropriately • Describe and explain the patterns in the results
13.	**Active transport**	• Describe how substances are taken up by active transport • Compare diffusion, osmosis and active transport • Apply knowledge to exam questions
14.	**Cell cycle and mitosis**	• Identify DNA, genes, chromosomes on a diagram • Describe the main stages of the cell cycle • Use information provided to calculate time spent in different phases of the cell cycle
15.	**Aseptic techniques**	• Calculate the number of bacteria in a population given mean division time • Describe how to produce an uncontaminated culture of bacteria using aseptic technique • Identify variables to change, measure and control to test the action of disinfectants or antibiotics

16.	**Effectiveness of disinfectants**	• Make and record accurate measurements • Describe conclusions from the data and use data to support • Check for reproducibility in the conclusions • Calculate the area of the clear zone using πr^2
17.	**Stem cells and their uses**	• Name sources of stem cells and their uses • Describe some potential uses of stem cell technology • Evaluate different stem cell sources
18.	**Useful maths skills**	• Calculate mean values • Practice unit conversions, magnification calculation and percentage change
19.	**Cell biology review (Part 1)**	• Review and consolidate knowledge of cells from the cell biology unit
20.	**Cell biology review (Part 2)**	• Review and consolidate knowledge of cell transport from the cell biology unit

21. Case study and exam skills

- Practice applying knowledge to exam-style questions
- Learn about the work of Dr Stephanie dancer

Unit 2 Organisation

23 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Food tests**	• Describe how to test for starch, sugars, proteins and fats • Describe the positive and negative results of these tests • Describe the safety precautions needed for food testing
2.	**Digestive enzymes**	• Describe the structure and function of the digestive system • Describe the action of enzymes in digestion using the 'lock and key' model • Name the 3 main digestive enzymes, where they are produced, and the substrate and products of their action
3.	**Digestion**	• Describe the organs of the digestive system and their function • Describe the purpose and action of acid and bile in the digestive system

4.	**Absorption**	• Describe adaptations of digestive system for absorption • Explain how these adaptations aid absorption • Describe uses for the absorbed food particles
5.	**Investigating enzymes**	• Describe ways to measure the rate of enzyme action • Identify variables to change measure and control to test the effect of temperature on enzyme action • Describe and explain the effect of temperature on the rate of enzyme action
6.	**pH and enzymes (Part 1)**	• Identify variables to change, measure and control to test a hypothesis • Collect and record data accurately • Process and display results appropriately • Describe and explain the effect of pH on enzyme activity
7.	**pH and enzymes (Part 2)**	• Describe and explain the effect of pH on amylase activity • Suggest improvements to a method • Apply knowledge and understanding to secondary investigations

8.	**The lungs**	• Label the major structures in the lungs • Describe gaseous exchange • Describe and explain how the lungs are adapted for efficient gaseous exchange.
9.	**Blood and blood vessels**	• Describe the components of the blood and their function • Describe the structure and function of arteries and veins • Explain how blood components and blood vessels are adapted for their function
10.	**The heart**	• Label the major structures in the heart • Describe the path blood takes through the heart and around the body • Calculate blood flow using appropriate equations • Describe how heart rate is controlled
11.	**Heart rate**	• Review the structure of the heart • Describe the function of pacemaker cells • Describe the role of artificial pacemakers

12.	**Heart disease**	• Describe some of the causes of heart disease • Explain how coronary heart disease can lead to a heart attack • Evaluate treatments for heart disease
13.	**Non-communicable disease**	• Describe some risk factors for diseases • Explain the impacts of lifestyle choices and disease at local, national and global levels • Analyse and interpret secondary data on disease incidence rates
14.	**Cancer**	• Describe how cancer forms in the body • Describe the risk factors associated with cancer development • Explain the difference between 'benign' and 'malignant' tumours • Explain how malignant cancer can spread
15.	**Plant tissue**	In this lesson we will look at how the tissues of the leaf are adapted to photosynthesis.

16.	**Plant roots**	• Describe the structure of roots • Explain how roots are adapted for absorption of water and mineral ions
17.	**Transport in plants**	• Describe the movement of water around the plant by transpiration • Describe the movement of dissolved sugars around the plant by translocation • Explain the role of xylem, phloem and stomata in transport in plants
18.	**Investigating transpiration**	• Describe factors that can affect the rate at which water moves • Explain how rate of transpiration can be measured • Explain how changes in temperature, humidity, air movement and light intensity affect rates of water movement
19.	**Review (Part 1)**	• Review and consolidate knowledge of the digestive system, lungs and heart from the organisation unit

20.	**Review (Part 2)**	• Review and consolidate knowledge of non-communicable diseases and plant tissues from the organisation unit
21.	**Maud Leonora Menten**	• Introduction to the work of Maud Menten and her work on the Michaelis-Menten equation
22.	**Exam technique**	• Identifying the skills needed to answer describe, explain and evaluate questions • Practice answering describe, explain and evaluate questions
23.	**Maths skills**	• Describe the terms cardiac output, stroke volume and heart rate • Calculate cardiac output, stroke volume and heart rate • Use VESRAU to practice substitution and rearrangement (values, equation, substitute, rearrange, answer, units)

Unit 3 Infection and response

17 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Infectious disease**	• Name causes of some infectious diseases and describe how they make us ill • Describe how pathogens can be spread, and how this spread can be reduced • Describe the main defence mechanisms of the body
2.	**Viral and bacterial disease**	• Describe the symptoms, spread and prevention of viral measles, HIV and TMV • Describe the symptoms, spread and prevention of bacterial diseases salmonella and gonorrhoea • Explain why antibiotics can be used to treat bacterial infections but not viral ones. • Process secondary data related to infection rates

3.	**Fungal and protist disease**	• Describe the symptoms, spread and prevention of rose black spot • Describe the spread, symptoms and prevention of malaria • Explain what is meant by the term 'vector'
4.	**Immunity**	• Describe how white blood cells respond to destroy pathogens • Explain the difference between the primary and secondary immune response • Explain what is meant by immunity
5.	**Vaccines**	• Describe what is in a vaccine • Explain how vaccines prevent infection • Explain the advantages of large scale vaccination
6.	**Antibiotics**	• Explain the difference between antibiotics and over the counter medications • Collect data on the action of different antibiotics and process it appropriately • Use data collected to draw conclusions

7.	**Maths skills**	• Calculate a mean, the area of clear zones and percentage changes • Draw a conclusion from data
8.	**Testing drugs (Part 1)**	• Identify the source of digitalis, penicillin and aspirin • Describe the stages in developing new drugs to treat disease • Describe the use of placebos and explain why they are needed
9.	**Testing drugs (Part 2)**	• Recap on stages of drug development • Explain the importance of carrying out a double-blind trial
10.	**Monoclonal antibodies**	• Describe how monoclonal antibodies are made • Describe some uses of monoclonal antibodies • Explain why monoclonal antibodies are not as widely used as first hoped

11.	**Plant diseases and deficiencies (Part 1)**	• Describe physical and chemical defences in plants to prevent infectious disease • Describe the use of nitrate and magnesium ions by plants
12.	**Plant diseases and deficiencies (Part 2)**	• Describe the symptoms shown by plants deficient in nitrate and magnesium ions • Review TMV and Rose Black Spot, and describe how aphids can affect a plant • Describe how to identify and diagnose plant diseases
13.	**Review (Part 1)**	• Review and consolidate knowledge of pathogens from the infection and response unit
14.	**Review (Part 2)**	• Review and consolidate knowledge of drug development and treating infection from the infection and response unit
15.	**Review (BIO ONLY)**	• Review and consolidate knowledge of monoclonal antibodies and plant diseases from the infection and response unit

16.	**Exam Skills**	• Identify command verbs and respond appropriately • Apply knowledge to exam-style questions
17.	**Kelly Chibale: Drug production**	• Learn about the work of Kelly Chibale

Unit 4 Bioenergetics

15 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Photosynthesis**	• Name the reactants and products needed for photosynthesis and represent it using a word and symbol equation • Describe uses for the glucose made during photosynthesis • Carry out a test for starch and explain the results
2.	**Photosynthesis required practical**	• Identify variables to change, measure and control to test a hypothesis • Explain the steps in a given method to test a hypothesis • Collect and record data to test a hypothesis

3.	**Photosynthesis required practical results**	• Collect the data in a suitable table • Describe and explain the relationship between light intensity and rate of photosynthesis • Describe and explain the effect of carbon dioxide concentration and temperature on the rate of photosynthesis • (Higher tier & triple biology only) Calculate the inverse square law
4.	**Limiting factors of photosynthesis**	• Describe and explain the relationship between light intensity and rate of photosynthesis • Describe and explain the effect of carbon dioxide concentration and temperature on the rate of photosynthesis • Identify limiting factors from graphs
5.	**Manipulating factors of photosynthesis HT**	• Interpret graphs of photosynthesis rate with multiple factors and decide which is limiting • Describe some ways of manipulating conditions for plant growth • Evaluate these methods

6.	**Review photosynthesis**	• Review and consolidate knowledge of photosynthesis from the bioenergitics unit so far.
7.	**Respiration**	• Define respiration and explain its importance in the body • Describe some changes that occur in the body during exercise • Explain why these changes are necessary
8.	**Anaerobic respiration**	• Describe the consequences of anaerobic respiration • Explain the results of a simple experiment into anaerobic respiration • Compare aerobic respiration with anaerobic respiration
9.	**Consequences of anaerobic respiration**	• Describe how an oxygen debt occurs • Explain the problems with an oxygen debt and how the body compensates in response
10.	**Metabolism**	• Define the term metabolism • Give examples of reactions in metabolism • Describe the formation of lipids, amino acids and urea

11.	**Synoptic links**	• Explain the importance of the digestive, respiratory and circulatory systems in effective respiration
12.	**End of topic review**	• Review and consolidate knowledge of respiration and metabolism from the bioenergetics unit
13.	**Exam Skills**	• Apply knowledge of bioenergetics to exam style questions
14.	**Maths Skills**	• Practice calculating means, including identifying anomalies
15.	**Scientist case study-Ynes Mexia**	• (Higher tier & triple biology only) Calculate the inverse square law

Unit 5 Ecology

17 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Communities**	• Identify examples of interdependence within an ecosystem • Predict the impact of changes to one species on the rest of the community • Extract and interpret information from charts, tables and graphs relating to interaction of organisms in a community
2.	**Biotic and Abiotic factors**	• Identify biotic and abiotic factors within an ecosystem • Explain how a change in a biotic or abiotic factor can affect a community • Extract and interpret information from secondary data
3.	**Adaptations**	• Give examples of behavioural, structural or functional adaptations • Suggest factors that organisms are competing for given information • Identify and explain how organisms are adapted to live in their natural environment

4.	**Maths skills**	• Calculate surface area:volume ratio • Calculate means and uncertainties
5.	**Sampling required practical (Part 1)**	• Use a quadrat to collect valid data to estimate a population size • Describe how to make the data as accurate as possible • Calculate population estimates
6.	**Sampling required practical (Part 2)**	• Calculate percentage cover of organisms • Describe how to use a transect line to test a hypothesis • Process and interpret secondary data, identifying variables
7.	**Biomass**	• Construct pyramids of biomass from information given • Explain the loss of energy at each stage • Calculate the efficiency of organisms in turning food into new biomass

8.	**Food security and farming**	• Describe some of the biological factors that can affect levels of food security • Describe some of the ways farming methods can increase levels of efficiency of food production • Evaluate methods to improve efficiency of food production
9.	**Cycles**	• Describe the water cycle and explain its importance to living things • Describe the processes by which carbon is cycled through biotic and abiotic parts of ecosystems
10.	**Decay**	• Name the causes of decay and describe conditions that can speed it up • Describe and explain the effect of temperature on the rate of decay • Interpret secondary data to describe and explain the effect of oxygen on the rate of decay • Apply knowledge of decay to its uses

11.	**Decay required practical**	• Identify variables to change, measure and control to test a hypothesis involving the rate of decay • Collect and record data to test the hypothesis • Process and display the data appropriately
12.	**Global warming**	• Describe and explain ways in which humans affect ecosystems • Evaluate the data linking greenhouse gases to global warming • Describe some of the consequences of global warming
13.	**Biodiversity**	• Describe some impacts of humans on biodiversity • Explain the importance of biodiversity • Describe ways that humans have tried to restore or maintain biodiversity
14.	**Review (Part 1)**	• Review of communities, biotic and abiotic factors, adaptation, and sampling
15.	**Review (Part 2)**	• Review of cycles, global warming, and biodiversity

16.	**Review (Part 3)**	• Review of triple biology only content - biomass, food security and decay
17.	**Case Study: Dr Beth Penrose**	• Introduction to the work of Dr Beth Penrose

Unit 6 Homeostasis and response

25 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**The nervous system**	• Describe the role of receptors, neurons and effectors in responding to a stimulus • Describe an appropriate response pathway to any given stimulus
2.	**Reflex arcs**	• Describe what is meant by a reflex and give some examples • Explain the difference between a reflex and a conscious action • Label a diagram of a reflex arc, using key terms correctly • Describe how nerve cells communicate with each other in a simple reflex action
3.	**Required practical: Reaction time (Part 1)**	• Identify the hypothesis and variables from a given method • Collect and record data accurately • Process and display data collected (including uncertainties if appropriate)

4.	**Required practical: Reaction time (Part 2)**	• Decide on the reproducibility of class data • Evaluate the method • Describe and explain patterns in secondary data
5.	**The brain (Triple only)**	• Name the main parts of the brain and describe their function • Describe how knowledge of the brain has developed • Evaluate the benefits and risks of procedures carried out on the brain and nervous system
6.	**The eye (Triple only)**	• Label the parts of the eye and describe their functions • Describe how the eye responds to changes in light levels • Describe how the eye focuses on near and far objects
7.	**Correcting vision (Triple only)**	• Explain how defects of the eye can lead to short and long sightedness • Explain how treatments of long and shortsightedness work • Interpret ray diagrams that show long and short sightedness and how these are treated with lenses

8.	**Hormonal responses**	• Describe how the endocrine system brings about responses in the body • Label the main endocrine glands of the body • Compare hormonal responses with nervous responses
9.	**Negative feedback (Higher)**	• Describe the role of adrenaline and thyroxine in the body • Explain how negative feedback allows homeostasis to occur
10.	**Regulating body temperature (Triple only)**	• Describe how body temperature is monitored • Describe the responses to a rise or drop in core body temperature • Explain how these mechanisms restore body temperature
11.	**Controlling blood sugar levels (Higher)**	• Describe how blood glucose levels are monitored • Explain the response to an increase in blood glucose • Explain how insulin controls blood glucose levels in the body • Explain the role of glucagon in blood sugar level maintenance and how negative feedback is used

12.	**Diabetes**	• Compare Type 1 and Type 2 diabetes • Describe some treatments for both types of diabetes • Interpret data from graphs on the effect of insulin on blood glucose in people with diabetes
13.	**The nervous system and Homeostasis review lesson (Higher)**	• Review of nervous system and homeostasis
14.	**Water balance (Triple only)**	• Describe ways in which water is gained and lost by the body • Describe how water levels are monitored • Describe the response when water levels in the body vary
15.	**The kidney (Triple only)**	• Describe the function of the kidneys in producing urine • Describe and explain the differences in blood composition before and after filtration • Explain the role of ADH in water balance

16.	**Kidney failure (Triple only)**	• Interpret secondary data on blood composition before and after filtration • Describe how dialysis works • Evaluate the treatment of kidney failure by dialysis or transplant
17.	**Hormones in reproduction (Higher)**	• Describe the roles of male and female reproductive hormones • Describe the menstrual cycle and the hormones involved • Explain the interactions of FSH, LH, oestrogen and progesterone in the menstrual cycle • Extract and use information from graphs showing hormone levels
18.	**Artificial control of fertility (Higher)**	• Describe how fertility drugs and IVF work • Interpret secondary data on fertility treatments and IVF • Evaluate fertility treatments from the perspective of doctors and patients

19.	**Contraception**	• Describe how different methods of contraception prevent pregnancy • Interpret data on the effectiveness of contraception methods • Evaluate different hormonal and non-hormonal methods
20.	**Plant hormones**	• Describe the responses to light and gravity by plants • Describe how growth is achieved in roots and shoots • Investigate the effect of light or gravity on seedlings. • Describe the role of gibberellins and ethene
21.	**Osmoregulation review**	• A review of water balance and application to exam-style questions
22.	**Required practical: Plant hormones (Part 1)**	• Identify variables and design a hypothesis • Describe how to investigate how light and gravity affect plant growth • Display results appropriately • Draw conclusions consistent with results from the seedling practical

23.	**Required practical: Plant hormones (Part 2)**	• Interpret experimental data • Apply knowledge of plant hormones to exam-style questions • Interpret secondary data on the effect of hormones
24.	**Homeostasis review (Higher)**	• Review of homeostasis
25.	**Scientist case study**	• Outline the work of Kiran Mazumdar-Shaw

Unit 7 Inheritance, variation and evolution

26 Lessons

Lesson number	Lesson question	Pupils will learn
1.	**Meiosis and fertilisation**	• Describe the main features of meiosis • Compare mitosis with meiosis • Explain the importance of meiosis in sexual reproduction
2.	**Sexual vs. Asexual reproduction**	• Describe sexual and asexual reproduction in animals and plants • Explain why asexual reproduction leads to identical offspring • Explain why sexual reproduction leads to variation
3.	**Advantages and disadvantages of sexual and asexual reproduction**	• Describe the advantages and disadvantages of sexual and asexual reproduction • Give examples of organisms that can reproduce by both methods • Apply knowledge to novel organisms

4.	**Genes, DNA and chromosomes**	• Define and recognize diagrams of DNA, genes and chromosomes • Describe the structure and function of DNA • Describe the advantages of understanding the human genome
5.	**Nancy Chang**	• Outline the work of Nancy Chang, who sequenced the HIV genome
6.	**Protein synthesis**	• Describe how DNA bases code for proteins • Describe protein synthesis • Explain how mutations can affect the protein made
7.	**Genetic Inheritance (Higher)**	• Construct and interpret genetic diagrams • Calculate the probability of inheriting particular characteristics given information about the parents • Use genetic terms to describe parents & offspring characteristics

8.	**Inherited disorders (Part 1 - Higher)**	• Describe the symptoms of the genetic diseases cystic fibrosis & polydactyly • Use genetic cross diagrams to calculate probability of offspring inheriting these diseases
9.	**Inherited disorders (Part 2)**	• Interpret family tree diagrams • Use family tree to calculate ther probability of offspring inheriting diseases • Evaluate the use of embryo screening for detecting inherited disorders
10.	**Sex determination**	• Name and recognise the chromosomes that determine sex • Construct and interpret diagrams to show how sex is inherited • Interpret family tree diagrams to explain the pattern of inheritance
11.	**Mendel**	• Describe the work of Gregor Mendel • Interpret his results and describe how it furthered our understanding of genetics • Explain why Mendel's work was not accepted until after his death

12.	**Mid-Topic review**	• Review of meiosis, sexual and asexual reproduction, genes and inheritance
13.	**Variation and natural selection (Part 1)**	• Describe reasons for extensive variation within species • Describe the effects of mutations on variation
14.	**Variation and natural selection (Part 2)**	• Explain how variation can lead to evolution by natural selection
15.	**Evolution and extinction**	• Describe the theory of evolution by natural selection • Interpret evolutionary tree diagrams • Explain why some organisms are now extinct
16.	**Darwin and Wallace**	• Compare Lamarck's model for evolution with Darwin's • Describe the work of Darwin and Wallace in the development of evolutionary theory • Explain why many of these ideas were controversial

17.	**Speciation**	• Define the terms 'species' and 'speciation' • Describe how different species can arise from a common ancestor • Describe Wallace's work on speciation
18.	**Evidence for Evolution (Part 1)**	• Describe some of the ways fossils are produced • Explain how this and other evidence gives us information about the development of life on earth • Explain why we cannot be certain about how life on earth began
19.	**Evidence for Evolution (Part 2)**	• Describe how bacteria have evolved to become resistant to antibiotics • Describe ways of reducing the development of antibiotic resistant bacteria • Evaluate the use of antibiotics in agriculture
20.	**Selective breeding**	• Describe the process of selective breeding in plants and animals • Explain the impact of selective breeding • Evaluate the use of selective breeding in food plants and domesticated animals

21.	**Genetic engineering (Part 1)**	• Describe genetic engineering • Give examples of genetically modified organisms • Explain some potential benefits and risks of genetic engineering in agriculture and medicine
22.	**Genetic engineering (Part 2)**	• Describe the process of producing a genetically modified organism • Evaluate the use of genetic engineering
23.	**Cloning**	• Describe cloning techniques in plants and animals • Evaluate cloning methods for medicine and agriculture • Explain the ethical objections to animal cloning
24.	**Classification**	• Describe and apply the Linnaean system for classification • Explain why new models of classification have been proposed • Describe the 'three domain' classification system
25.	**End of topic review (Part 1)**	• Review of natural selection, selective breeding and genetic engineering

26. **End of topic review (Part 2 - Triple only)**

- Review of triple biology only content - protein synthesis, Mendel, evolution theories, speciation and cloning

4. Learn More

Contents

1. Introduction to Oak's Key stage 4 science curriculum principles

Below are a set of principles we have sought to apply in our curriculum planning within science. These are adapted for science from the generic principles guiding all Oak lessons.

2. Coherence and flexibility

We strive to support schools by giving them an online learning offer that can be flexible to fit alongside their existing curriculum. We need to balance this together with coherence, as complete flexibility would imply only standalone lessons, where none can build upon any other. In striking this balance, we will lean towards giving the maximum flexibility possible. All units will have revision lessons at the end to consolidate knowledge, which can be standalone if only that topic has been taught, and, where disciplinary knowledge is woven into the units, there will be reminders of previously used scaffolds and prompts.

3. Subjects first

The science curriculum is structured into biology, chemistry and physics units, with working scientifically skills taught in context throughout. This will be made explicit to the pupils within lessons. In terms of science's relationship and overlap with other subjects (e.g. geography and maths), we will not be able to create cross-curricular coherence as the units can be taught in multiple orders. Therefore, cross curricular topics (such as Earth science) will not cohere with other subjects (e.g. geography).

4. Knowledge organisation

The units in the science curriculum are grouped by key stage, with a suggested route through, organised within year groups. In Key Stage 4, units are sequenced according to the AQA specification (with two exceptions, P3 Particles and B7 Ecology). In most circumstances, the units within a given year can be sequenced flexibly, but there is an assumption in the creation of the units that knowledge in any given year is building on units from previous years (i.e. that units in year 5 are planned with the assumption that units in year 4 have been taught). If following a different exam board at KS4, we will provide a suggested route through at a later date.

As stated above, the substantive knowledge (i.e. the science content) will be taught in units, and the disciplinary knowledge (i.e. working scientifically) is taught in context. Hierarchical elements of working scientifically will be reflected in the units and therefore this will be built up accordingly. While this will take account of prior learning assumptions from the previous key stage, or units, there will also be reminders of prompts and scaffolds to help pupils.

5. Knowledge selection

We are seeking to support schools to deliver the National Curriculum to children who cannot attend school. Our choice of what to teach will primarily be guided by the content specified in the National Curriculum, but we have also chosen to broaden this to increase challenge and build aspiration (e.g. include more physics at KS1 and 2, introduce some KS4 concepts in KS3).

6. Inclusive and ambitious

We want Oak to be able to support all children. Our units will be pitched so that children with different starting points can access them. Pupils need to have a large amount of subject knowledge stored in their long-term memory in order to become competent at any subject, and this is especially true of science where application is often an application of knowledge. For this reason, these lessons are designed to teach science in a clear and deliberate fashion, emphasising secure content knowledge before moving onto tasks. In this approach the teacher is the subject expert and the emphasis is on instruction and explanation, followed by deliberate practice supported by modelling, guided practice and scaffolding. Models and analogies will be used where appropriate to allow pupils to visualise or contextualise abstract ideas.

7. Pupil engagement

We need pupils to be thinking during science lessons - both to engage with the subject and to strengthen memory of what is being learnt. Our lessons will not be video lectures. We seek to exercise pupils' minds throughout their lessons (based on the principles described in point 5 above). This will involve questions and tasks throughout instruction, just as we would with classroom teaching.

8. Motivation through learning

Like all teachers, we recognise that good presentation helps pupils keep participating in our lessons. However, we are teachers, not entertainers. We seek to motivate pupils through our subjects. We believe that science is inherently interesting, and we aim to build this interest through our teaching. In science, we will provide opportunities where possible for pupils to engage in home experimentation. We will begin each unit with a summary of the relevant careers for that unit, including those outside of science itself. Units will also include short case studies of work by current and past scientists that reflect the diversity of backgrounds of our pupils. Finally, we will try to be explicit about the real life relevance of each unit so that it is clear why this knowledge is important.

9. Additional information about sequence

The science curriculum has been planned on the following basis:

- Before KS3, pupils have been taught the latest KS2 National Curriculum (2014)

As a result of this work, the science curriculum has the following features:

- It takes a year-by-year approach to teaching the curriculum.
- The content of each year's units is based on the expectation that the relevant content for each given year is taught by the end of the previous year.
- In KS4, the units are based on the AQA specification, and are ordered to ensure that paper 1 content is taught first. In the suggested sequence, they appear in the same order as the specification, except for B7 Ecology and P3 Particles. (This is to allow for teaching of Ecology when weather conditions are more likely to be favourable for outdoor sampling work, and to teach Particles as the first physics topic as it contains content foundational to other units)
- There is no expectation that any given unit in one science (e.g. physics) is taught before any given unit in another (e.g. biology). Any crossover material (e.g. atoms in KS4 physics and chemistry) will only assume the previous key stage's knowledge
- Many topics within any given year can be taught in a different sequence if schools wish. However, the lesson by lesson materials have been written with the suggested route in mind, and schools will have to consider this in their decisions.
- Each year is divided into topics across biology, chemistry, and physics, but equally weighted across these three disciplines
- Working scientifically is integrated into all the topics and can be identified in the learning outcomes in the topic summaries where relevant.
- The working scientifically programme of study is covered throughout.
- The precise ordering between each science (as opposed to within it) is flexible, and a matter for schools to determine. It is expected that schools will alter this according to their staffing context and curriculum time allocation in year 10 and 11.
- We suggest teaching the first three units of KS4 science at the end of year 9 to support you in managing the large amount of content in KS4 science.