United Curriculum

Primary Science

United Curriculum Principles

Building on the Framework for Excellence, The United Learning Primary Curriculum has six core principles:

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

Subject-specific rationales are built on these six principles.

United Curriculum Principles: Science

The United Curriculum for science provides all pupils, regardless of their background, with:

Substantive knowledge:

- Ensuring pupils **master** core content through the development of key concepts and **timely revisiting** of key knowledge
- Sequencing the curriculum to allow for gradual development of **vertical concepts** – the 'big ideas' in science – to provide firm foundations for KS3 and KS4
- **Preventing common misconceptions** that are often formed at an early age and prove problematic at the later stages of pupils' science education
- Purposefully teaching appropriate knowledge that **goes beyond the KS1 and KS2 national curriculum**, to aid current and future understanding, and to smooth the transition to KS3
- Encouraging pupils to apply and **make connections** between the disciplines of science, the wider curriculum and the wider world

Disciplinary knowledge:

- Sequencing Working Scientifically elements so that they are **explicitly taught** and practised alongside the substantive knowledge, and regularly reviewed and built upon across the years and key stages
- Making deliberate and **explicit links to other curriculum areas** – particularly geography and mathematics – to ensure there is a consistent approach to teaching content, and that pupils are always **first taught content in the most relevant subject**. For example, pupils are taught how to construct bar charts or calculate the mean in mathematics before they are applied in science
- Planning practical tasks that have a **clear purpose**: to demonstrate or prove substantive concepts, or to allow pupils to deliberately practice working scientifically skills in a relevant context

Curiosity and excitement about science:

- Selecting examples and applications of science that **inspires pupils' curiosity** about the world and natural phenomena
- Ensuring that all pupils **can see themselves reflected** in the science curriculum, by highlighting present-day role models and the contributions of scientists from a wide range of backgrounds; and considering social and cultural values around scientific ideas

Understanding the World: The Natural World

<table>
<tr><th></th><th colspan="3">Science</th></tr>
<tr><td>Development Matters N3/4</td><td colspan="2">Use all their senses in hands-on exploration of natural materials.
Talk about what they see, using a wide vocabulary.
Plant seeds and care for growing plants.</td><td>Understand the key features of the life cycle of a plant and an animal.
Begin to understand the need to respect and care for the natural environment and all living things.</td></tr>
<tr><td>Development Matters Reception</td><td colspan="2">Understand the effect of changing seasons on the natural world around them.</td><td>Explore the natural world around them.
Describe what they see, hear and feel whilst outside.</td></tr>
<tr><td>ELG</td><td colspan="3">- Explore the natural world around them, making observations and drawing pictures of animals and plants;
- Understand some important processes and changes in the natural world around them, including the seasons and changing states of matter.</td></tr>
<tr><td>Nursery</td><td>On the Move
On the Farm
Plant and care for vegetables.
Life cycles / animals and their young.
Once Upon a Time
Observe changes through baking.
All Creatures Great and Small
African animals and their young.</td><td>Bears
Explore the natural materials linked to the bear stories.
Special Days
Explore Christmas themed materials using the 5 senses..</td><td>Milestones
Children will:
• Use their senses in hands on exploration.
• Sort clothing to wear in different climates/ types of weather.
• Dress appropriately to go outside in wet, cold and windy weather.
• Match animals to their young.
• Plant seeds and look after growing plants with support.
• Identify that certain animals live in different environments.</td></tr>
<tr><td>Reception</td><td colspan="2">It’s Getting Cold Outside
Explore the weather using their senses. Find out about hibernation.
Spring in Our Step
Spring/ nature walks. Bean dairy
Science Detectives
Seasons and weather</td><td>Milestones
Children will:
• Identify some key signs of each season.
• Can talk about what a plant needs to survive
• Care for the natural world and living things.
• Sequences and talk about the life cycles of living things.
• Talk about changes they observe e.g. melting and freezing, cooking.
• Describe some the effects of changing seasons on the natural world.
• Begin to understand what they can do to help the environment.</td></tr>
<tr><td>Y1 Links</td><td colspan="2">Year 1 Autumn 1 Biology
Plants
Identifying and naming common plants and describing basic structures
Year 1 Autumn 2 Biology / Physics
Seasonal changes
Observing changes across four seasons and describing associated weather</td><td>Curriculum Goals
Explore, make observations, and ask questions about the natural world, gaining a developing understanding of important processes and changes they observe.</td></tr>
</table>

Understanding the World: Forces and Materials

<table>
<tr><th></th><th colspan="3">Science</th></tr>
<tr><td>Development Matters N3/4</td><td colspan="3">Use all their senses in hands-on exploration of natural materials.
Explore collections of materials with similar and/or different properties.
Talk about what they see, using a wide vocabulary.
Explore and talk about different forces they can feel.
Talk about the differences between materials and changes they notice.
Explore how things work.</td></tr>
<tr><td>Development Matters Reception</td><td colspan="3">Explore the natural world around them.
Describe what they see, hear and feel whilst outside.</td></tr>
<tr><td>ELG</td><td colspan="3">- Understand some important processes and changes in the natural world around them, including the seasons and changing states of matter.</td></tr>
<tr><td>Nursery</td><td>On the Move
Explore the forces. Sort toy vehicles.
Once Upon a Time 1
Observe changes through baking.
Sort materials according to their properties.</td><td>Bears
Explore the natural materials linked to the bear stories.
Special Days
Explore Christmas themed materials using the 5 senses.</td><td>Milestones
Children will:
• Use their senses in hands on exploration.
• Explore and talk about different forces they can feel.
• Sort collections of materials with similar and/or different properties
• Begin to use vocabulary such as hard, soft, rough, smooth, heavy, light, springy, firm, shiny or dull to describe materials.</td></tr>
<tr><td>Reception</td><td colspan="2">Science Detectives
Changing materials.</td><td>Milestones
Children will:
• Describe what they see, hear and feel when exploring forces and materials.
• Talk about changes they observe e.g. melting and freezing, cooking.</td></tr>
<tr><td>Y1 Links</td><td colspan="2">Year 1 Spring 1 Chemistry
Everyday materials
Distinguishing objects from the material it's made from, and describing simple properties</td><td>Curriculum Goals
Use accurate vocabulary to describe the properties of materials and talk about forces they have experienced.</td></tr>
</table>

Year 1: Autumn 1

Biology: Plants

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• Recognise differences between two seasons: spring and winter (EYFS, Spr)	• A **plant** is a **living** thing that usually grows in one place • **Coniferous** plants keep their leaves all year round (e.g. pine, yew, juniper in UK) • **Deciduous** plants lose their leaves in winter (e.g. oak, silver birch, horse chestnut, sycamore, ash) • **Trees** are a type of plant that have a tall **stem** made of **wood** • The basic parts of a plant are **leaves**, **flowers**, **roots**, **stem/trunk/branch**	• Plant growth from germination (Y2) • Requirements for plant life (Y2, Y3) • Purpose of leaves, stem/trunk, roots and flowers (Y3) • Coniferous trees transport their seeds in cones; deciduous trees use seeds and flowers/fruit (Yr3 Spr) • Classifying plants (Y4)
Disciplinary Knowledge	• M&O: Measure/observe using senses (EYFS, Spr)	***Draw and label a scientific diagram of a plant*** • R&P: Draw a diagram, a simple scientific drawing that explains or informs ***Classify trees as deciduous or coniferous using images of them at different times in the year*** • R&P: Use a table to classify items based on properties	• R&P: Use Carroll diagrams (Y1 Spr), Venn diagrams (Y1 Sum), and a pair of axes (Y2) to classify items based on properties
Vertical concepts		• 5: Plants grow in soil • 8: There is a wide variety of living things • 10: There are many different kinds of plants and animals in the world today.	• 5: Much of the solid surface of the Earth is covered in soil, which is a mixture of pieces of rock of various sizes and the remains of organisms. Some soil also contains air, water and some nutrients (Y3)

Year 1: Autumn 2 Biology & Physics: Seasonal changes

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• Recognise differences between two seasons: spring and winter (EYFS) • Types of weather include sunny, rainy, and windy (EYFS) • Coniferous plants keep their leaves all year round (e.g. pine, yew, juniper in UK) (Y1 Aut) • Deciduous plants lose their leaves in winter (e.g. oak, silver birch, horse chestnut, sycamore, ash) (Y1 Aut) • **Geography**: We live on the Earth (Y1 Aut)	• There are four **seasons**: **spring**, **summer**, **autumn** and **winter** • The **weather** changes gradually as we move from season to season • The weather can change rapidly in one day (e.g. sunny morning and rainy afternoon) • Recognise differences between four seasons in terms of living things (trees lose leaves; flowers drop and we see different animals, such as butterflies in the summer) • **Daytime** is when the **Earth** is facing the **Sun**; nighttime is when the Earth is facing away from the Sun • In the **summer** that there are more hours of **daylight** and in **winter** there are fewer hours of daylight • In the summer, we face the sun for more of the day and so it is lighter/darker when we travel to school in summer/winter • The **Moon** is more visible at night	• **Geography:** Observing weather patterns (Y2 Aut) • Earth rotates in 24 hours, meaning that only half of the Earth is facing the Sun at any one time; this creates night and day (Y5 Sum) • The Moon orbits the Earth in 28 days and, during this time, the sun shines on different parts (Y5 Sum) • Seasons are caused by the Earth's tilt (KS3)
Disciplinary Knowledge		***Use information from images of four seasons to identify and record differences in wildlife and weather in four seasons*** • A&P: Scientists look for patterns in the world around them • M&O: Gather information from text/books/images • R&P: Record numerical or descriptive observations in a table	• A&P: Scientists look for patterns in data to try to identify correlations (Y5) • M&O: Gather information from the internet (Y3)
Vertical concepts		• 5: The weather can change rapidly. Different seasons have different weather patterns • 6: Daytime is when the Earth is facing the Sun; nighttime is when the Earth is facing away from the Sun.	• 5: The air is all around us on Earth (Y2) • 5: Weather is determined by conditions of the air. The temperature, pressure, direction and speed of the movement and the amount of water vapour in the air combine to create the weather (KS3) • 6: The Moon reflects light from the Sun (Y3)

Year 1: Spring

Chemistry: Everyday materials

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• Materials melt when it is hot and freeze when it is cold (EYFS)	• An **object** is a 'thing' that can be seen and touched • Objects have a name and often have a **purpose.** For example a cup is the object, and its purpose is for drinking from. • The **material** is what an object is made of, for example a cup can be made of paper or plastic • Common materials include **wood**, **paper**, **metal**, **glass**, **water**, **rock** • Materials have different **physical properties**, some materials are **hard** whilst others are **soft**, some can be described as **rough** whilst others are **smooth**, some are **dull** whereas others are **shiny**. • Materials can be grouped in a number of ways based on their physical properties • The material that we choose to make an object from depends on its purpose (e.g. no chocolate kettle)	• Materials have physical properties that make them better or worse for certain uses, such as waterproof, absorbent, windproof, heatproof, malleable (r2 Spr) • Materials such as wood, metal, plastic, brick, rock, paper and cardboard have these physical properties to different extents (Y2 Spr) • Different combinations of materials could be used to create different object, including a wall, a mop and a saucepan (Y2 Spr)
Disciplinary knowledge	• Use a table to classify items based on properties (Y1 Aut)	***Sort materials into a Carroll diagram based on their characteristics*** • A&P: Scientists group objects or living things based on their properties • R&P: Use a Carroll diagram to classify items based on properties ***Find the best material for a dog bed (waterproof and soft)*** • A&P: It is important that we keep as much as we can the same, apart from the thing we measure and the one thing we change • A&E: Make simple statements about the results of an enquiry	• A&P: The thing that we measure is called the dependent variable; the thing we change is the independent variable (Y3)
Vertical concepts		• 4: Things around us can be made to change or happen. We can pull objects behind us or push them across the table	• 4: All living things need food to give them energy (Y2) • 4: The arrows in a food chain show where energy is being transferred from and to (Y2)

Year 1: Summer 1

Biology: Animals

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• A plant is a living thing that usually grows in one place (Y1 Aut) • Coniferous plants keep their leaves all year round (e.g. pine, yew, juniper in UK) (YA Aut) • Deciduous plants lose their leaves in winter (e.g. oak, silver birch, horse chestnut, sycamore, ash) (Y1 Aut)	• **Animals** are different to **plants** because they usually move around, rather than stay in the same place • Animals can be placed into different groups (**carnivores**, **herbivores** and **omnivores**) based the foods they eat. • Animals have different features, including **fins**, **wings**, **scales**, **legs**, **feathers**, **claws**, **paws** etc. • Animals can be grouped into **fish**, **amphibians, reptiles**, **birds** and **mammals** (name common examples)	• Classification refers to a method used to place all living things into groups.(Yr4 Aut) • Organisms can be classified in a number of ways • A species is a group of one type of organism, individuals in this group can breed with each other to produce offspring that can go on to breed(Yr4 Aut) • Early classification from Aristotle placed animals into groups based on land, water and air, plants were grouped according to size, small, medium and large(Yr4 Aut) • Fish, amphibians, reptiles, birds and mammals are all vertebrates (Yr4 Aut) • Vertebrates have endoskeletons (Yr4 Aut) • Vertebrates can be grouped in a number of ways based on their characteristics, e.g. warm/cold blooded; or physical features like fur, beak, wings etc.(Yr4 Aut) • Invertebrates can be grouped based on their characteristics as snails and slugs; worms; spiders and insects (Yr4 Aut)
Disciplinary Knowledge	• A&P: Scientists group objects or living things based on their properties (Y1 Spr) • M&O: Gather information from text/books/images (Y1 Aut) • R&P: Use a Carroll diagram to classify items based on properties (Y1 Spr)	***Research different animals and use images and text to classify the animals as herbivores, carnivores or omnivores, and based on their physical characteristics*** • A&P: Scientists conduct secondary research to learn from what other scientists have already learned • R&P: Use a Venn diagram to classify items into two or three sets based on properties	• A&E: Science is never 'complete' and scientists are always working to make models more accurate or to discover new explanations (Y5)
Vertical concepts		• 8: There is a wide variety of living things, including plants and animals	• 8: Plants and animals are dependent on each other (Y2)

Year 1: Summer 2

Biology: Humans

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• Animals can be grouped into fish, amphibians, reptiles, birds and mammals (name common examples) (Y1 Sum) • Animals can be placed into different groups (carnivores, herbivores and omnivores) based the foods they eat (Y1 Sum)	• Humans are **omnivores**, but some choose to eat only plants • Humans are made of many different body parts including head, neck, back, ears, eyes, nose, mouth, arms, shoulders, elbows, hands, fingers, legs, knees, feet, toes, face, ears, eyes, nose, mouth, arms, legs, hands, feet, toes. • Humans have five **senses**, smell, taste, touch, sight and hearing. • The five senses are each associated with different body parts (eyes, ears, nose, tongue)	• The main food groups are carbohydrates (starch and sugars), proteins, fats, dairy, fruit and vegetables(Y3 Spr) • Humans need a balanced diet which is made of main food groups (Y3 Spr) • Our skeleton is made up of bones that grow as we grow (Y3 Spr) • Humans and some other animals have skeletons (Y3 Spr) • Organs are parts of the body that do a particular job, the heart pumps blood around the body and the lungs are used for breathing which gets air into your body. (Y3 Spr) • The skeleton protects organs, e.g. the skull protects the brain; and the ribcage protects the lungs, heart and other important organs (Y3 Spr) • The skeleton supports the body, e.g. the spine helps the body stand (Y3 Spr) • The skeleton helps the body move, e.g. pelvis and knee joints (Y3 Spr) • The muscles and skeleton are required to help the body move. When muscles contract they pull the bone (Y3 Spr)
Disciplinary Knowledge	• Draw a diagram, a simple scientific drawing that explains or informs (Y1 Spr)	***Draw a scientific diagram, labelling key human body parts***	
Vertical concepts		• 7: Living things, including humans, react to their surroundings with their senses	• 7: Living things grow, need, water, air and food, react to their surroundings, move, get rid of their waste, reproduce (Y2)

Year 2: Autumn 1

Biology: Plant growth

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• The basic parts of a plant are leaves, flowers, roots, stem/trunk/branch (Y1 Aut) • **Plants** are classed as **living things** because they **grow**, **move**, **reproduce**, and need **nutrition** (food) (Y1 Aut)	• A seed is **living** • A seed is the **embryonic** stage of the plant life cycle. • A seed consists of three parts, the **seed coat**, the **endosperm** and the **embryo** • **Germination** is the development of a plant from a **seed**. During germination **roots** and **shoots** emerge and grow • To **germinate** a seed needs water and a certain temperature • **Temperature** is a measure of how hot or cold something is • Some plants grow from **bulbs**. A bulb is a resting stage for certain plants. They have a large underground food store, short **stems** and fleshy leaves. • When a plant grows it gets bigger. • Plants need **water**, **light** and a suitable **temperature** to grow • Many plants make **fruits** or **vegetables**; some of these grow below ground	• The four main stages of the plant's life cycle include germination, pollination, fertilisation and seed dispersal (Y3 Spr) • Pollination and fertilisation usually takes place in flowers. Dispersal is important to make sure there is enough space for seeds to germinate and plants to grow.(Y3 Spr) • Seeds can be dispersed in a variety of ways (Y3 Spr) • Plants need air (oxygen and carbon dioxide), water, light, nutrients from the soil, space, and a suitable temperature to grow (Y3 Spr) • Requirements for life vary from plant to plant and they adapt to their environment (e.g. some plants need less space, a lower temperature, fewer nutrients etc.) (Y3 Spr) • Roots absorb nutrients from the soil and help anchor the plant (Y3 Spr) • The stem/trunk supports the plant and transports water up the plant. The xylem transports water and nutrients from the roots, and the phloem transports food from the leaves to the all parts of the plant (Y3 Spr) • Leaves use sunlight, carbon dioxide from the air and water to make their own food (Y3 Spr)
Disciplinary Knowledge	• **Maths**: Use words to describe lengths and heights (Y1) • A&P: It is important that we keep as much as we can the same, apart from the thing we measure and the one thing we change (Y1 Spr) • M&O: Measure/observe using senses (EYFS) • R&P: Record numerical or descriptive observations in a table (Y1 Aut) • A&E: Make simple statements about the results of an enquiry (Y1 Spr)	***Investigate the conditions required for germination*** • A&P: Make a prediction based on substantive knowledge ***Investigate how light affects the growth of plants*** • M&O: Make systematic observations of an object	• Explain findings using scientific knowledge (Y3) • The thing that we measure is called the dependent variable; the thing we change is the independent variable (Y3)
VCs		• 9: Plants and animals reproduce (have offspring)	• 9: Organisms produce offspring of the same kind, but in many cases offspring are not identical with each other or with their parents (Y5)

Year 2: Autumn 2

Biology: Needs of animals

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• Animals can be grouped into fish, amphibians, reptiles, birds and mammals (name common examples) (Y1 Sum) • Temperature is a measure of how hot or cold something is (Y2 Aut) • Plants need water, light and a suitable temperature to grow (Y2 Aut) • **Plants** are classed as **living things** because they **grow**, **move**, **reproduce**, and need **nutrition** (food) (Y1 Aut)	• Animals, including humans, **reproduce**. This means they have **offspring** that grow into adults • As animals **grow** they get bigger. • Some animals change during their life cycle as the mature (e.g. tadpole to frog) • Animals, including humans, need **water**, **food**, **air**, and the **right temperature** to survive • Humans need **exercise** to stay healthy • Humans need to eat a healthy and **balanced diet** • Humans need to practice **hygiene** to stay healthy	• Life cycles of hedgehogs, peregrine falcons, frog and ladybird, including metamorphosis (Y5) • Living things grow, need air and nutrients, react to their surroundings, move, get rid of their waste, reproduce (Y2 Spr) • Living things are adapted to their environment. This means they may not be able to survive in other habitats (Y2 Spr) • The main food groups are carbohydrates (starch and sugars), proteins, fats, dairy, fruit and vegetables (Yr3 Spr) • Humans need a balanced diet which is made of main food groups (Y2 Spr) • Vitamins, minerals and fibre are needed and being deficient in these causes diseases (Y2 Spr) • Different animals have different nutritional needs (Y2 Spr)
Disciplinary Knowledge	• A&P: Scientists conduct secondary research to learn from what other scientists have already learned (Y1 Sum) • A&P: Scientists group objects or living things based on their properties (Y1 Spr) • M&O: Gather information from text/books/images (Y1 Aut) • R&P: Use a Carroll diagram to classify items based on properties (Y1 Spr)	***Gather information from images and text and sort images into a Carroll diagram based on the animal kingdom and extent of change***	• Using and drawing a classification key to classify organisms (Y4)
Vertical concepts	• 7: Living things, including humans, react to their surroundings with their senses (Y1) • 9: Plants and animals reproduce (have offspring) (Y1)	• 5: The air is all around us on Earth • 7: Living things grow, need, water, air and food, react to their surroundings, move, get rid of their waste, reproduce • 8: All living things need energy for food, as well as air, water and certain temperature conditions.	• 5: There is less and less air further away from the Earth's surface; space is a vacuum (Y5) • 7: Living things need water, air, food, a way of getting rid of water and an environment that stays within a particular temperature range (Y3)

Year 2: Spring 1 Chemistry: Uses of everyday materials

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• An object is a 'thing' that can be seen and touched (Y1 Spr) • Objects have a name and often have a purpose for example a cup is the object and its purpose is for drinking from.(Y1 Spr) • The material is what an object is made of, for example a cup can be made of paper or plastic. Common materials include wood, paper, metal, glass, water, rock (Y1 Spr) • Materials have different physical properties, some materials are hard whilst others are soft, some can be described as rough whilst others are smooth, some are dull whereas others are shiny. (Y1 Spr) • Materials can be grouped in a number of ways based on their physical properties (Y1 Spr) • The material that we choose to make an object from depends on its purpose (e.g. no chocolate kettle) (Y1)	• **Matter** is all the 'stuff' that we experience in everyday life, including air, water, tables and us! • Materials have different **physical properties** such as **malleable**, **waterproof**, **heatproof**, **windproof** and **absorbent**. • These physical properties make the materials more suitable for certain uses • Everyday materials such as **wood**, **metal**, **plastic**, **brick**, **rock**, **paper** and **cardboard** have these physical properties but to different extents • Different combinations of materials can be used to create different objects, for example a saucepan or a mop. • The shape of some solid objects made from some materials can be changed by **squashing**, **bending**, **twisting** or **stretching** the material.	• There are three states of matter: solid, liquid and gas (Y2 Sum) • Physical properties include being malleable, windproof, hard/soft, opaque/transparent, magnetic, electrical conductivity, thermal conductivity, and boiling and melting points (Y5 Sum) • Chemical properties are properties that scientists need specialist equipment to measure (Y5 Sum)
Disciplinary knowledge	• A&P: It is important that we keep as much as we can the same, apart from the thing we measure and the one thing we change (Y1 Spr) • M&O: Make systematic observations of an object (Y2 Aut) • R&P: Use a Carroll diagram to classify items based on properties (Y1 Spr) • A&E: Make simple statements about the results of an enquiry (Y1 Spr)	***Classify materials based on the extent of its properties by using a pair of axes*** • R&P: Use a pair of axes to classify items based on the extent to which it displays two properties ***Investigate the best material to use to make an umbrella that is waterproof and windproof*** • A&P: There are four main stages of enquiry (A&P, M&O, R&P, A&E) • A&P: Scientists identify potential hazards in their experiments and plan ways to reduce them • A&E: Ask further questions that could be explored to extend findings	
Vertical concepts		• 1: All the 'stuff' encountered in everyday life, including air, water and different kinds of solid substances is called matter • 1: Different materials are recognisable by their properties	• 1: The amount of material does not change when a solid melts or a liquid evaporates (Y4) • 1: If a material could be divided into smaller and smaller pieces it would be found to be made of pieces, particles, smaller than can be seen even with a microscope. These particles are not in a material; they are the material (Y4)

Year 2: Spring 2 Biology: Living things & their habitats

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• **Geography**: Deserts are places where there is very little precipitation (Y2 Spr) • **Geography**: Hot deserts have a very hot and dry climate (Y2 Spr) • **Geography**: Cold deserts have a very cold and dry climate (Y2 Spr) • Temperature is a measure of how hot or cold something is (Y2 Aut) • Plants need water, light and a suitable temperature to grow (Y2 Aut) • Animals, including humans, need water, food, air, and the right temperature to survive (Y2 Aut)	• Everything in the world can be categorised as either **alive**, used to be alive or has never been alive. • Living things are called **organisms** • Living things grow, need air and **nutrients**, react to their surroundings, move, get rid of their **waste**, **reproduce** • Animals move from place to place, while plants move on the spot • **Habitats** are the places that living things live, a very small habitat is called a **micro-habitat**, these can be found within larger habitats • Animals and plants in a habitat depend on each other e.g. for food or shelter • Animals get their food from plants and other animals, this food provides the **energy** animals need. • Most plants produce their own food and are called **producers**. • In a **food chain**, the arrows show where the **energy** is being transferred from and to • Living things are **adapted** to their **environment**. This means they may not be able to survive in other habitats • Some animals and plants have adapted to life in a **hot desert**: **camels** and **cacti.** Some animals and plants have adapted to life in a **cold desert**: **Arctic fox** and **shrubs**	• The main food groups are carbohydrates (starch and sugars), proteins, fats, dairy, fruit and vegetables. Humans need a balanced diet of these (Y3 Spr). Vitamins, minerals and fibre are needed and being deficient in these causes diseases (Y3 Spr) • Different animals have different nutritional needs (Y4 Spr) • A food chain starts with a producer (usually a plant) who can produce its own food. Organisms that eat producers are called consumers (Y4 Aut) • A predator hunts prey to eat (Y4 Aut) • A food web shows the transfer of energy between different organisms (Y4 Aut) • An ecosystem is made up of all organisms living in an area and the non-living features of the environment (Y4 Aut) • Animals and plants need to digest food to transfer energy from it (Y4 Aut) • **Geography:** Adaptations of plants and animals in different climate zones, including tundra and hot desert (Y5 Sum)
Disciplinary knowledge	• A&P: There are four main stages of enquiry (A&P, M&O, R&P, A&E) (Y2 Spr) • A&P: Scientists look for patterns in the world around them (Y1 Spr) • A&E: Make simple statements about the results of an enquiry (Y1 Spr)	***Examine microhabitats using a magnifying glass and counting the number and type of living organisms found in an area*** • A&P: Scientists conduct investigations to identify whether a pattern they think they've seen is really there • M&O: Observe using a magnifying glass safely	• A&P: Scientists look for patterns in data to try to identify correlations (Y5)
Vertical concepts	• 4: Things around us can be made to change or happen. We can pull objects behind us or push them across the table (Y1)	• 4: All living things need food to give them energy • 4: The arrows in a food chain show where energy is being transferred from and to • 8: Most plants make their own food • 8: Animals need food, which comes by eating plants (herbivores) or by eating animals (carnivores), which have eaten plants or other animals. • 8: Plants and animals are dependent on each other. • 8: Organisms are adapted to their environment. If conditions in a habitat change, organisms may not be able to survive.	• 4: The arrows in a food web show where energy is being transferred from and to (Y4) • 8: Plants make their own food using sunlight, carbon dioxide and water (Y3) • 8: Animals are ultimately dependent on plants for their survival (Y4) • 8: The relationships among organisms can be represented as food chains and food webs. (Y4)

Year 2: Summer

Chemistry: Solids, liquids and gases

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• Understand some important processes and changes in the natural world around them, including the seasons and changing states of matter (EYFS Sum) • An object is a 'thing' that can be seen and touched (Y1 Spr) • Objects have a name and often have a purpose for example a cup is the object and its purpose is for drinking from (Y1 Spr)	• All **materials** are made of a single **substance** or a **mixture** of **substances** • There are three **states of matter**: **solids**, **liquids** and **gases** • Substances can exist as solids, liquids and gases • The three states of matter have different properties • Liquids take the shape of the container they are in, when you move the liquid into a different container the shape will change • Solids keep their shape unless a force is put on it. They will change their shape if you cut them or squash them. • Gases have no fixed shape or volume, they spread out to fill a container. If they are not in a container, they will keep spreading out • We can decide is a substance is a solid, liquid or gas by looking at its properties • One substance can exist in the different states, when the substance is in a different state it is still the same substance • Each substance in its state of matter is made up of parts that are too small to see without **magnification**	• The different substances in their different forms (solids, liquids and gases) are all made of particles (Y4 Spr) • The particles in the different states of matter are arranged differently (Y4 Spr) • Substances can change from one state of matter to another. Solids can change to become a liquid (melting), liquids can change to become a gas (evaporating), gases can change to become liquids (condensing) and liquids can change to become a solid (freezing) (Y4 Spr) • Materials change state at different temperatures, i.e. they have different melting and boiling points (Y4 Spr) • The water cycle relies on evaporation and condensation. Water is collected in the oceans from rivers; it evaporates and then condenses to form clouds; it then precipitates and the cycle begins again (Y4 Spr)
DK	• A&P: Scientists group objects or living things based on their properties (Y1 Spr)	***Classify different substances as solids, liquids or gases***	
Vertical concepts	• 1: All the 'stuff' encountered in everyday life, including air, water and different kinds of solid substances is called matter (Y1)		• 1: If a material could be divided into smaller and smaller pieces it would be found to be made of pieces, particles, smaller than can be seen even with a microscope. These particles are not in a material; they are the material (Y4)

Year 3: Autumn 1

Chemistry: Rocks

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• **Geography**: We live on the Earth (Y1 Aut) • Materials have physical properties that make them better or worse for certain uses, such as waterproof, absorbent, windproof, heatproof, malleable (Y2 Spr) • Materials such as wood, metal, plastic, brick, rock, paper and cardboard have these physical properties to different extents (Y2 Spr) • Living things are called organisms (Y2 Spr) • Everything in the world is either living (or used to be living) or not-living (Y2 Sum)	• A rock is a naturally occurring material which is made up of different minerals. • The Earth's crust is it's the outermost layer of our planet. It is made of rocks and minerals. • Natural rocks are either **igneous**, **sedimentary** or **metamorphic** • Man-made rocks, like concrete, are called **anthropic** rocks • **Igneous** rock is formed when **magma** cools down • **Sedimentary** rock is formed when layers of small **sediments** are **compressed** over a long period of time. Igneous rock can become sedimentary rock if it breaks down into small pieces and forms layers • **Metamorphic** rock is formed when igneous or sedimentary rock is put under lots of **pressure** • Different rocks have different properties, including **permeable/impermeable** • A **fossil** is physical evidence of an ancient plant or animal , this could be their **preserved** remains or other **traces** that they made when they were alive. • **Trace fossils** are not physical remains of living things they are indirect evidence of life, examples include imprints of, or a mark left by an organism such as a footprint, imprint of a feather or poo • Fossils are formed when a living thing or trace is buried under sediment. The remains break down slowly and as layers of sediment build up the layers are squashed, turning them into sedimentary rock • Fossils can form when dead organisms are frozen in ice or preserved in amber • **Soil** is a mixture of tiny pieces of rock, dead plants and animals, air and water. Different soils have different properties	• **History:** Rocks that build historical monuments including Stonehenge and the Great Pyramid in Egypt (Y3) • **History:** Importance of fossils in archaeology (Y6) • **Geography:** Beneath the Earth's solid crust is a hot later called the mantle (Y3) • **Geography:** Volcanic eruptions release magma (Y3 Spr) • Fossils provide evidence for evolution, because they show how organisms have changed over time (Y6 Aut) • The rock cycle and the formation of igneous, sedimentary and metamorphic rocks (KS3) • The composition of the Earth (KS3) • The structure of the Earth (KS3) • Earth as a source of limited resources and the efficacy of recycling (KS3)
Disciplinary Knowledge	• A&P: A&P: Scientists group objects or living things based on their properties (Y1 Spr) • M&O: Observe using a magnifying glass safely (Y2 Spr) • M&O: Make systematic observations of an object (Y2 Aut) • R&P: Use a pair of axes to classify items based on the extent to which it displays two properties (Y2 Spr)	***Make observations about rocks using senses and magnifying glass, and classify them in a Carroll diagram/pair of axes***	
Vertical concepts		• 5: Much of the solid surface of the Earth is covered in soil, which is a mixture of pieces of rock of various sizes and the remains of organisms. Some soil also contains air, water and some nutrients • 5: There are many different kinds of rock with different composition and properties. • 10: Fossils are the preserved remains or traces of living things	• 5: The action of water wears down rock gradually into smaller pieces (see **Geography, Year 5 : Investigating water**) • 5: Beneath the Earth's solid crust is a hot layer called the mantle. The Earth's crust consists of a number of solid plates which move relative to each other, carried along by movements of the mantle. The formation of mountains, earthquakes and volcanic activity are likely to occur at these cracks (see **Geography Year 3 Spring: Mountains and Volcanoes and Year 4 Summer: Earthquakes**)

Year 3: Autumn 2

Physics: Light

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• Daytime happens when we are facing the sun; nighttime happens we are facing away from the sun (Y1 Aut) • The Moon is more visible at night (Y1 Aut)	• **Light** travels in straight lines • We see when light enters our eyes • **Darkness** is the absence of light • **Sources** of light **emit** their own light, and others **reflect** light; both occur in nature as well as man-made objects • Some objects are more **reflective** than others • **Opaque**, **translucent** and **transparent** materials allow no, some or all light to pass through them • **Shadows** form behind an opaque object when light from a source is blocked • The shape of shadows changes with the angle and the distance of the light source • Light from the sun can be dangerous and there are ways to protect our eyes	• In ray diagrams, straight lines with arrows show where the energy is being transferred from and to by light (Y6) • On a flat surface, all light meeting a surface from one direction will be reflected in the same direction. This is known as specular reflection (Y6 Spr) • On a rough surface, light will be reflected in all directions. This is known as diffuse reflection (Y6 Spr) • Specular reflection between mirrors allow us to see the objects that do not directly reflect light into our eyes (e.g. periscope) (Y6 Spr) • When light meets an opaque object, some of the light is reflected and some of it is absorbed (Y6 Spr) • White light, which comes from most light sources we use in the classroom, contains all the colours of the visible spectrum (Y6 Spr) • When a light meets a surface, some colours are absorbed and some are reflected. We see the colour(s) that are reflected (Y6 Spr) • Objects appear black if they absorb all the colours in white light, and reflect none. Objects appear white if they reflect all the colours in white light, and absorb none (Y6)
Disciplinary Knowledge	• **Mathematics**: Measure length and height (cm/m) (Y2) • A&P: There are four main stages of enquiry (A&P, M&O, R&P, A&E) (Y2 Spr) • A&P: Scientists look for patterns in the world around them; they conduct investigations to identify whether a pattern they think they've seen is really there (Y2 Spr) • A&P: It is important that we keep as much as we can the same, apart from the thing we measure and the one thing we change (Y1)	***Investigate how the height of a shadow varies as the distance between light source and object changes*** • A&P: A dependent variable is what you measure; an independent variable is what you change; controlled variables are things that stay the same • A&P: Scientists identify factors in an investigation that should be controlled, and try to find ways to control them • A&P: Recognise risk and build a plan to minimise them • A&P: Select most appropriate equipment to measure (the variables) • A&P: Write an appropriate method	• A&P: Scientists must work out if the factor is the cause of the outcome in a correlation (Y5)
Vertical concepts	• 6: Daytime is when the Earth is facing the Sun; nighttime is when the Earth is facing away from the Sun (Y1)	• 2: Objects can have an affect on other objects even when they are not in contact with them. Light reaches our eyes, even though the light source may be far away • 6: The Moon reflects light from the Sun	• 2: The non-contact force of magnetism mean magnets can attract or repel other magnets (Y3) • 6: Our Sun is one of many stars that make up the Universe (Y5)

Year 3: Spring 1

Biology: Organisms

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• Animals can be placed into groups (carnivores, herbivores and omnivores) based on the foods they eat (Y1 Sum) • Humans are omnivores, but some choose to eat only plants (Y1 Sum) • Humans need to eat a healthy and balanced diet (Y2 Aut) • Humans are made of many different body parts including head, neck, back, ears, eyes, nose, mouth, arms, shoulders, elbows, hands, fingers, legs, knees, feet, toes, ears, eyes, nose, mouth, arms, legs, hands, feet, toes(Y2 Aut) • Living things grow, need air and nutrients, react to their surroundings, move, get rid of their waste, reproduce (Y2 Spr) • Living things are called organisms (Y2 Spr) • Animals get their food from plants and other animals, this food provides the energy animals need (Y2 Spr)	• The main food groups are **carbohydrates** (starch and sugars), **proteins**, **fats**, **dairy**, **fruit** and **vegetables** • Humans need a **balanced diet** which is made of main food groups • **Vitamins**, **minerals** and **fibre** are needed and being deficient in these causes **diseases** • Different animals have different **nutritional** needs • Our **skeleton** is made up of bones that grow as we grow • Humans and some other animals have skeletons • **Organs** are parts of the body that do a particular job, the **heart** pumps blood around the body and the **lungs** are used for breathing which gets air into your body. • The skeleton **protects** organs, e.g. the skull protects the brain; and the ribcage protects the lungs, heart and other important organs • The skeleton **supports** the body, e.g. the spine helps the body stand • The skeleton **helps the body move**, e.g. pelvis and knee joints • The **muscles** and skeleton are required to help the body move. When muscles **contract** they pull the bone • Some organisms have **endoskeletons**, some have **exoskeletons**, and some have neither • Endoskeletons grow with the organisms, exoskeletons do not so need to be shed and replaced	• Invertebrates can be placed into groups based on their skeletons; endoskeletons, exoskeletons, or hydrostatic skeletons (Y4 Aut) • There are four main types of teeth: incisors, canines, pre-molars and molars. They each have a different purpose (Y4 Aut) • Herbivores, carnivores and omnivores have these types of teeth in different proportions (Y4 Aut) • Animals and plants need to digest food to transfer energy from it (Y4 Aut) • The digestive system is the group of organs that help your body digest food (Y4 Aut) • The heart is a muscle that pumps blood around the body through blood vessels (Y6 Sum)
Disciplinary knowledge	• R&P: Draw a diagram, a simple scientific drawing that explains or informs	• Science is studied as three disciplines: biology (study of living organisms), chemistry (study of materials) and physics (study of energy) ***Label the main bones on a diagram of a human skeleton, give the function of each bone.***	• A&P: Science is studied as three disciplines: biology (study of living organisms), chemistry (study of properties of matter and how it interacts with energy) and physics (study of energy) (Y5)
Vertical concepts	• 4: All living things need food to give them energy (Y2)		

Year 3: Spring 2

Biology: Plants

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• Coniferous plants keep their leaves all year round; deciduous plants lose their leaves in winter (e.g. oak, silver birch, horse chestnut, sycamore, ash) (Y1 Aut) • Trees are a type of plant that have a tall stem made of wood (Y1 Aut) • The basic parts of a plant are leaves, flowers, roots, stem/trunk/branch (Y1 Aut) • Germination is the development of a plant from a seed , during germination roots and shoots emerge and grow (Y1 Aut) • Germination is the development of a plant from a seed. During germination roots and shoots emerge and grow • A seed is living. A seed is the embryonic stage of the plant life cycle. A seed consists of three parts: the seed coat, the endosperm and the embryo. To germinate, a seeds needs water and a certain temperature (Y2 Aut) • Many plants make fruits or vegetables; some of these grow below ground (Y2 Aut) • Animals and plants depend on each other in their habitats (Y2 Spr) • Living things have adapted to their environment. This means they may not be able to survive in other habitats (Y2 Spr) • Soil is a mixture of particles of rock, dead plants and animals, air and water (Y2 Aut)	• **Oxygen** and **carbon dioxide** are found in the air • Plants need air (oxygen and carbon dioxide), water, light, nutrients from the soil, space, and a suitable temperature to grow • Requirements for life vary from plant to plant and they adapt to their **environment** • **Roots** absorb **nutrients** from the soil and help anchor the plant • The **stem/trunk** supports the plant and transports water up the plant. The **xylem** transports water and nutrients from the roots, and the **phloem** transports food from the leaves to the all parts of the plant • Leaves use sunlight, carbon dioxide from the air and water to make their own food • The four main stages of the plant's life cycle include **germination**, **pollination**, **fertilisation** and **seed dispersal** • **Coniferous** trees transport their seeds in cones; **deciduous** trees use seeds and flowers/fruit • **Pollination** and **fertilisation** usually takes place in flowers. Dispersal is important to make sure there is enough space for seeds to germinate and plants to grow. • Seeds can be dispersed by wind (e.g. sycamore), by animals in their droppings (e.g. things that are eaten, like a raspberry), attached to animal fur (e.g. goosegrass), or seeds can be **self-propelled** (pea pod)	• The male part of the plant is called the stamen, made up of the anther and filament, and the anther produces pollen grains (Y5 Spr) • The female parts of the plant are the ovary (which produces the female sex cells which are contained in the ovule) and the stigma which collects pollen (Y5 Spr) • Sexual reproduction is two parents - usually male and female - create a new organism by mixing their gene (Y5 Spr). Asexual reproduction does not involve sex cells or fertilisation. Only one parent is needed, and the offspring are (genetically) identical to the parent and each other (Y5 Spr) • Potatoes develop tubers and daffodils have bulbs, which will grow to be identical copies of the plant (Y5 Spr) • **Geography**: Adaptations of some plants in rainforests (e.g. buttress roots) (Y4 Spr) • **Geography**: A symbiotic relationship is a long-term relationship between one or more species, in which both species receive benefits (Y4 Spr)
Disciplinary knowledge	• **Mathematics**: Measure length and height (cm/m) (Y2); Interpret and construct block diagrams (Y2) • A&P: Dependent, independent and control variables (Y3 Aut) • A&P: Make a prediction based on substantive knowledge (Y2 Spr) • A&P: Scientists identify factors in an investigation that should be controlled, and try to find ways to control them	***Investigate the impact of light on the growth of plants, drawing a block diagram to illustrate results*** • R&P: Design a table to collect data with the appropriate number of rows and columns and correct headings ***Research methods of seed dispersal of different plants*** • M&O: Gather information from the internet	
VCs	• 4: All living things need food to give them energy (Y2) • 7: Living things grow, need, water, air and food, react to their surroundings, move, get rid of their waste, reproduce (Y2) • 8: Most plants make their own food (Y2)	• 7: Living things – organisms – need water, air, food, a way of getting rid of water and an environment that stays within a particular temperature range • 8: Plants make their own food using sunlight, carbon dioxide and water	• 7: Micro-organisms are organisms that are so small that we cannot see them with our eyes alone (Y6) • 8: Animals are ultimately dependent on plants for their survival (Y4)

Year 3: Summer 1

Physics: Forces & motion

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• Solids keep their shape unless a force is put on it. They will change their shape if you cut or squash them (Y2 Sum)	• **Forces** are **pushes** or **pulls** or **twists** • Forces can cause a change in speed, direction or shape of an object • Forces act in particular **directions** • Forces that act in opposite directions are called **opposing forces**. • Forces that are equal and act in opposite directions are described as **balanced forces**, they 'cancel each other out' • When forces are balanced, an object will move at a constant speed in the same direction. This includes being stationary! • When the forces acting in the opposite directions are not equal this can cause the object they are acting on to move at a different speed, in a different direction or to change shape. • We can work out the **speed** of an object if we know how far it travelled and how long it took to get there • The greater the **mass** of an object, the longer it will take to speed it up or slow it down.	• Contact forces require contact between two objects (e.g. friction). Non-contact forces can affect an object at a distance (e.g. magnetism) (Y3 Spr) • Friction is a contact force between two surfaces that are sliding or trying to slide over each other (Y3 Spr) • Magnetism is a non-contact force exerted by magnets when they attract or repel each other (Y3 Spr) • Gravity is a non-contact force (Y5 Sum) • Air and water resistance are contact, frictional forces (Y5 Sum)
Disciplinary Knowledge	• **Mathematics**: Measure length and height (cm/m) (Y2) • A&P: Science is studied as three disciplines: biology (study of living organisms), chemistry (study of materials) and physics (study of energy) (Y3 Spr) • A&P: Dependent, independent and control variables (Y3 Aut) • R&P: Design a table to collect data with the appropriate number of rows and columns and correct headings • A&E: Make simple statements about the results of an enquiry	***Investigate the how long it takes cars of different masses to stop after travelling down a ramp*** • M&O: Data is repeatable if the same person repeats the investigation and gets the same results; data is reproducible if the investigation is repeated by a different person and the results are the same • A&E: Suggest ways to improve practical procedures to obtain more accurate measurements • A&E: Draw conclusions (e.g. 'the greater the… , the greater the…')	• The difference between accurate data and precise data (KS3) • Using the mean as a method of analysing a set of data (Y6)
Vertical concepts		• 3: Forces can push, pull or twist objects, making them change shape or motion • 3: Things can only change their motion if there is a net force acting on them • 3: When forces acting on an object are not equal and opposite in direction, they are unbalanced and will change an object's speed, direction or shape	• 3: An object on Earth pulls the Earth as much as the Earth pulls the object, but because the Earth's mass is much bigger, we observe the motion of the object (Y5) • 3: The downward force of gravity on an object on the Moon is less than that on Earth because the Moon has less mass on Earth (Y5)

Year 3: Summer 2

Physics: Friction & magnetism

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• Forces are pushes or pulls or twists (Y3 Sum) • Forces can cause a change in speed, direction or shape of an object (Y3 Sum) • Forces act in particular directions (Y3 Sum) • Forces that act in opposite directions are called opposing forces (Y3 Sum) • Forces that are equal and act in opposite directions are described as balanced forces, they cancel each other out (Y3 Sum) • **Geography:** The North Pole and the South Pole are at the top and bottom of the Earth (Y1 Spr)	• **Contact** forces require contact between two objects (e.g. friction). **Non-contact** forces can affect an object at a distance (e.g. magnetism) • **Friction** is a force between two surfaces that are sliding or trying to slide over each other • Friction is a contact force because it requires the two objects to be touching • The bumpier or rougher the surfaces, the more friction there will be • **Magnetism** is the force exerted by magnets when they attract or repel each other • Magnets can exert a force at a distance, which is called a non-contact force • Magnets have a **north** and a **south** pole. • If opposite poles are facing the magnets will be **attracted** to one another (the magnets pull towards each other). If the same poles are facing the magnets will **repel** (the magnets will push away from each other). • Magnets attract **magnetic** objects • Some metals are magnetic but not all are. Plastics, wood, fabric, glass are all non-magnetic • The stronger the magnet, the heavier the object it can attract or the further away it can attract the object from	• Force is measured in newtons (Y5 Sum) • Gravity is a non-contact force that pulls all objects towards each other (Y5 Sum) • The greater the mass of an object, the greater the gravitational pull around it (Y5 Sum) • Gravity is most commonly experienced as the pull of the Earth (and all objects on it) towards each other (Y5 Sum) • The Earth's gravitational pull is so large that all objects - regardless of how heavy they are - are pulled towards Earth at the same rate (Y5 Sum) • Air resistance is a frictional force that acts between air and a moving object to slow it down (Y5 Sum) • Water resistance is a frictional force that acts between water and a moving object to slow it down (Y5 Sum)
Disciplinary Knowledge	• Mathematics: Measure length and height (cm/m) (Y2) • A&P: Dependent, independent and control variables (Y3 Aut) • A&E: Draw conclusions (e.g. 'the greater the… , the greater the…')	***Investigating how the surface of a ramp affects the distance a car will roll*** • M&O: Anomalous results should be discarded and re recorded • M&O: Taking multiple readings allows you to see if your data is repeatable, helps identify outliers and allows a mean to be calculated • A&E: Use scientific understanding to explain their findings • A&E: Use findings of an investigation to make further predictions ***Test which materials are magnetic, and use this knowledge to make predictions about which objects will be magnetic***	
Vertical concepts	• 2: Objects can have an affect on other objects even when they are not in contact with them. Light reaches our eyes, even though the light source may be far away (Y3)	• 2: The non-contact force of magnetism mean magnets can attract or repel other magnets	• 2: Sound comes from things that vibrate and can be detected at a distance from the source because the air or other material around is made to vibrate. Sounds are heard when the vibrations in the air reach our ears (Y4)

Year 4: Autumn 1

Biology: Classifying organisms

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• Plants are classed as living things because they grow, move, reproduce, and need nutrition (Y1 Aut) • Animals can be grouped into fish, amphibians, reptiles, birds and mammals (name common examples) (Y1 Sum) • Animals can be placed into groups (carnivores, herbivores, omnivores) based on what they eat (Y1 Sum) • Animals, including humans, reproduce. This means they have offspring that grow into adults (Y2 Aut) • Living things are called organisms (Y2 Spr) • Animals move from place to place, while plants move on the spot (Y2 Spr) • Habitats are the places that living things live. A very small habitat is called a micro-habitat (Y2 Spr) • Living things are adapted to their environment. This means they may not be able to survive in other habitats (Y2 Spr) • **Geography**: Land use is how land is used by humans, and could include housing, farm land, office or shop (Y2 Sum) • Some organisms have endoskeletons, some have exoskeletons, and some have neither (Y3 Aut) • **History**: The Ancient Greeks contributed knowledge that is relevant today, including medicine, science, mathematics and astronomy (Y3 Sum)	• **Classification** refers to a method used to place all living things into groups. • **Organisms** can be classified in a number of ways • A **species** is a group of one type of organism, individuals in this group can breed with each other to produce **offspring** that can go on to **reproduce** • Fish, amphibians, reptiles, birds and mammals are all vertebrates • **Vertebrates** have **endoskeletons** • Vertebrates can be grouped in a number of ways based on their characteristics, e.g. **warm/cold blooded**; or physical features like fur, beak, wings etc. • **Invertebrates** can be grouped based on their characteristics as **snails** and **slugs**; **worms**; **spiders** and **insects** • **Invertebrates** can be placed into groups based on their skeletons; **endoskeletons**, **exoskeletons**, or **hydrostatic skeletons** • Plants can be grouped into **flowering** and **non-flowering** plants • Buildings and new developments have destroyed many **habitats**. This means number and types of organisms in these areas has gone down • Creating **nature reserves** is one way to prevent the loss of habitat. Setting aside land that cannot be used for building (**greenbelt**) helps keep habitats intact	• Invertebrates can be grouped based on their characteristics as poriferans (sponges) cnidarians, echinoderms, molluscs, annelids, platyhelminths and arthropods (spiders, insects, crustaceans and myriapods). Plants can be grouped into moss, ferns, conifers and flowering plants. (Y6 Spr) • Fungi are different to plants and animals. They cannot make their own food (like animals) but do not move (like plants) (Y6 Spr) • Micro-organisms are organisms that are so small that we cannot see them with our eyes alone. (Y6 Spr) • Some fungi are microorganisms (e.g. yeast), but not all are (e.g. mushrooms). (Y6 Spr) • Bacteria are microorganisms, some bacteria can cause disease in other organisms (Y6 Spr) • Variation occurs within and between species (Y6 Aut)
DK	• M&O: Observe using a magnifying glass safely	***Identifying animals and plants that do not support Aristotle's approach to classifying living things; exploring history of other debates (e.g. duck-billed platypus)*** • A&P: Identify scientific evidence that has been used to support or refute ideas ***Use a classification key to sort organisms*** • R&P: Use a classification key to identify an object ***Draw a classification key to identify four animals, and then several leaves (using a magnifying glass)*** • R&P: Draw a dichotomous classification key to help others identify an object	• A&E: Science is never 'complete' and scientists are always working to make models more accurate or to discover new explanations (Y5)
VCs	• 8: There is a wide variety of living things, including plants and animals (Y1)		

Year 4: Autumn 2

Biology: Food & digestion

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• Animals can be placed into groups (carnivores, herbivores and omnivores) based on the food they eat (Y1 Sum) • Humans are omnivores, but some choose to eat only plants (Y1 Sum) • Animals get their food from plants and other animals; this food provides the energy animals need • Most plants produce their own food and are called producers (Y2 Spr) • In a food chain, the arrows show where the energy is being transferred from and to (Y2 Spr) • Different animals have different nutritional needs (Y3 Spr) • Organs are parts of the body that do a particular job, like the heart pumps blood around the body and the lungs are used for breathing, which gets air into the body (Y3 Spr)	• A food chain starts with a **producer** (usually a plant) who can produce its own food. Organisms that eat producers are called **consumers** (primary and secondary) • A **predator** hunts **prey** to eat • A **food web** shows the transfer of energy between different organisms (include water as well as land organisms) • An **ecosystem** is made up of all organisms living in an area and the non-living features of the environment • There are four main types of teeth: **incisors**, **canines**, **pre-molars** and **molars**. They each have a different purpose. • **Herbivores**, **carnivores** and **omnivores** have these types of teeth in different proportions • Animals and plants need to **digest** food to transfer energy from it • The **digestive** system is the group of organs that help your body digest food. Digestion in humans is **chemical** and **mechanical** • Chemical and mechanical digestion takes place in the mouth (saliva and chewing) • Food travels down the **oesophagus** from the mouth into the **stomach** • In the **stomach**, mechanical (churning) and chemical digestion takes place to break down food further • Food is further broken down (chemical digestion) in the **small intestines** where most of the nutrients are absorbed • Water is absorbed in the **large intestine**, leaving behind the **faeces**. • **Faeces** are mainly made of food we could not digest; faeces are stored in the **rectum** and pass out of the human body via the **anus**.	• Each organ and muscle in the human body needs oxygen and nutrients (from breathing in and eating/digesting) (Y6 Sum) • Blood carries oxygen, nutrients and carbon dioxide around the body (Y6 Sum) • Nutrients are absorbed by the blood along the small intestine, and transported to other organs in the body (Y6 Sum) • Some bacteria are helpful for other organisms (e.g. those that help break down food in our digestive system) and those that form part of a symbiotic relationship (Y6 Spr) • The role of enzymes in chemical digestion (KS3) • The interdependence of organisms in an ecosystem and how organisms affect and are affected by their environment to include the accumulation of toxic materials (KS3)
DK	• R&P: Draw a diagram, a simple scientific drawing that explains or informs (Y1 Spr)	***Explain the digestion process using a prop to others in school or at home*** • R&P: Present information orally using a prop or demonstration	
Vertical concepts	• 4: All living things need food to give them energy (Y2) • 4: The arrows in a food chain show where energy is being transferred from and to (Y2) • 8: Plants make their own food using sunlight, carbon dioxide and water (Y3)	• 4: The arrows in a food web show where energy is being transferred from and to • 8: Animals are ultimately dependent on plants for their survival • 8: The relationships among organisms can be represented as food chains and food webs	• 4: Energy cannot be created or destroyed. When energy is transferred from one object to others, the total amount of energy in the universe remains the same; the amount that one object loses is the same as the other objects gain (Y5) • 8: In any given ecosystem there is competition among species for the energy and materials they need to live (Y6)

Year 4: Spring 1

Chemistry: Particle model

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• Materials melt when it is hot and freeze when it is cold (EYFS) • **Geography**: Precipitation is the fall of water as rain, sleet, snow or hail (Y2 Spr) • All materials of made of a single substance or a mixture of substances (Y2 Sum) • There are three states of matter: solids, liquids and gases (Y2 Sum) • Liquids take the shape of the container they are in, when you move the liquid into a different container the shape will change (Y2 Sum) • Solids keep their shape unless a force is put on it. They will change their shape if you cut them or squash them (Y2 Sum) • Gases have no fixed shape or volume, they spread out to fill a container. If they are not in a container, they will keep spreading out (Y2 Sum) • We can decide if a substance is a solid, liquid or gas by looking at its properties (Yr Sum) • One substance can exist in the different states, when the substance is in a different state it is still the same substance (Y2 Sum) • Each substance in its state of matter is made up of parts that are too small to see without magnification (Y2 Sum)	• The different **substances** in their different forms (solids, liquids and gases) are all made of **particles** • The **particles** in the different states of matter are arranged differently • In a solid the particles are packed tightly together, they vibrate slowly and are unable to move away from their neighbours • In a liquid the particles are close together but they can slide past each other • In a gas the particles are spread out and can move freely • Substances can change from one state of matter to another. Solids can change to become a liquid, liquids can change to become a gas, gases can change to become liquids and liquids can change to become a solid • The process that changes a solid to a liquid is called **melting** • When you heat a solid it becomes a liquid. Different substances melt at different temperatures, this is called the **melting point** • The process that changes a liquid to a gas is called **evaporating** • Evaporation happens when a liquid is heated. This is called the **boiling point** • The process that changes a gas to a liquid is called **condensing** • The process that changes a liquid to a solid is called **freezing** • Substances change state at different temperatures, i.e. they have different melting and boiling points • Different substances are different states at **room temperature** • The **water cycle** relies on **evaporation** and **condensation**. Water is collected in the oceans from rivers; it evaporates and then condenses to form clouds; it then **precipitates** and the cycle begins again	• When a solid is heated the solid becomes a liquid. Energy from a chemical store is transferred to the solid, and as the solid becomes hotter its thermal store of energy goes up. The particles in the solid therefore move more (Y5 Aut) • Conservation of material and of mass, and reversibility, in melting, freezing, evaporation, sublimation, condensation, dissolving (KS3) • Similarities and differences, including density differences between solids, liquids and gases (KS3) • Brownian motion of gases (KS3) • Diffusion in terms of the particle model (KS3) • Energy changes on changes of state (KS3)
DK	• **Mathematics**: Measure temperature (°C) and volume (ml/litres) (Y3) • A&P: dependent, independent and control variables (Y3 Aut) • A&P: Scientists identify factors in an investigation that should be controlled, and try to find ways to control them (Y3 Aut) • A&P: Science is studied as three disciplines: biology (study of living organisms), chemistry (study of materials) and physics (study of energy) (Y3 Spr) • A&P: Scientists identify potential hazards in their experiments and plan ways to reduce them (Y2 Aut) • R&P: Draw a diagram, a simple scientific drawing that explains or informs	***Investigate the effect of temperature on the rate of evaporation*** • A&P: Set a hypothesis to test • A&P: Science is studied as three disciplines: biology (study of living organisms), chemistry (study of properties of matter and how it interacts with energy) and physics (study of energy) • A&E: Scientists use models to help explain their ideas	• A&P: Scientists must work out if the factor is the cause of the outcome in a correlation (Y5)
VCs	• 1: All the 'stuff' encountered in everyday life, including air, water and different kinds of solid substances is called matter (Y2) • 1: Different materials are recognisable by their properties (Y2)	• 1: The amount of material does not change when a solid melts or a liquid evaporates • 1: If a material could be divided into smaller and smaller pieces it would be found to be made of pieces, particles, smaller than can be seen even with a microscope. These particles are not in a material; they are the material	• 1: When some materials combine, they do not change permanently and can be separated again (Y5) • 1: Materials can be changed by heating and cooling (Y5)

Year 4: Spring 2

Physics: Sounds

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• Humans have features that are associated with each sense (eyes, ears, nose, mouth and tongue) (Y1 Sum) • In a solid the particles are packed tightly together, they vibrate slowly and are unable to move away from their neighbours (Y4 Spr) • In a liquid the particles are close together, but they can slide past each other (Y4 Spr) • In a gas the particles are spread out and can move freely (Y4 Spr)	• **Sounds** are made when objects **vibrate**. These vibrations cause the air **particles** surrounding them to vibrate and **collide**, causing the vibrations to pass between particles • Vibrations travel through a **medium** (e.g. air, water) to the ear • Vibrations enter the ear, our **inner ear** vibrates and we hear them as sound. • Vibrations are passed on from one particle to the next, and so it travels more easily when particles are closer together (solids and liquids) • Sound cannot travel in a **vacuum** • The **volume** and **pitch** of sound can change	• Sound cannot travel in a vacuum, in space (Y5 Sum) • Frequencies of sound waves, measured in hertz (Hz) (KS3) • Echoes, reflection and absorption of sound (KS3) • Sound needs a medium to travel in (KS3) • The speed of sound in air, water and solids (KS3) • Sound produced by vibrations of objects, in loudspeakers, detected by their effects on microphone diaphragm and the ear drum (KS3) • Sound waves are longitudinal waves (KS3) • The auditory range of humans and animals (KS3)
Disciplinary knowledge	• A&P: Set a hypothesis to test (Y4 Spr) • A&E: Suggest ways to improve practical procedures to obtain more accurate measurements (Y3 Sum)	***Investigate the tautness on pitch using an app*** • M&O: Gather information using a data logger (e.g. sound meter app; heart rate app)	• M&O: Gather information using other data loggers (Y6)
Vertical concepts	• 2: Objects can have an affect on other objects even when they are not in contact with them. Light reaches our eyes, even though the light source may be far away (Y3) • 2: The non-contact force of magnetism mean magnets can attract or repel other magnets (Y3)	• 2: Sound comes from things that vibrate and can be detected at a distance from the source because the air or other material around is made to vibrate. Sounds are heard when the vibrations in the air reach our ears	• 2: The non-contact force of gravity makes things fall to Earth (Y5) • 2: There is gravitational force between all objects, but it is only felt when one or more of the objects has a very large mass (Y5)

Year 4: Summer 1

Physics: Electricity

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• Common materials include wood, paper, metal, glass, water, rock (Yr1 Spr) • Materials have different physical properties, some materials are hard whilst others are soft, some can be described as rough whilst others are smooth, some are dull whereas others are shiny(Yr1 Spr) • Materials can be grouped in a number of ways based on their physical properties(Yr1 Spr) • The material that we choose to make an object from depends on its purpose (e.g. no chocolate kettle) (Yr1 Spr)	• A **lamp** in a **circuit** will only light if there is a **complete circuit**. • A complete circuit must have a **power** source (**cell**/**batteries**) and have all the **components** connected in a loop. If it is missing any of these things it is an **incomplete circuit** • A **short circuit** is the easiest route for electricity to travel and can be created by accident by connecting just the wire to the cell in a circuit. They can be dangerous • Components include **wire**, **lamp**, **buzzer**, **motor** or **switch** • Materials that allow electricity to pass through them easily are called **electrical conductors** • Metals and water are good conductors of electricity • Materials that do not allow electricity to pass through them easily are called **electrical insulators** • Plastic, rubber, wood, glass, paper and fabric are electrical insulators • **Appliances** use electricity to serve a purpose (e.g. toaster, kettle, fan, phone, game)	• In a circuit that has a battery, the battery is the chemical store of energy. Energy is transferred electrically to the device in the circuit but the device does not store the energy, the device changes the way the energy is transferred (Y5 Aut) • There are recognised symbols for cell, lamp, buzzer, motor, and switch. Wires are represented with straight lines (Y6 Aut) • Increasing the voltage in a circuit will increase the brightness of a lamp and increase the volume of a buzzer (Y6 Aut) • The more components in the circuit, the dimmer the lamps in the circuit (Y6 Aut) • As long as batteries have the same voltage, the size of the battery does not affect the brightness of the lamp/loudness of the buzzer (though the smaller batteries will not last as long as the larger ones) (Y6 Aut)
Disciplinary Knowledge	• A&P: Dependent, independent and control variables (Y3 Aut) • A&P: Scientists identify factors in an investigation that should be controlled, and try to find ways to control them (Y3 Aut) • A&P: Scientists identify potential hazards in their experiments and plan ways to reduce them (Y2 Aut) • A&E: Use findings of investigation to make further predictions (Y3 Sum) • R&P: Design a table to collect data with the appropriate number of rows and columns and correct headings (Y3 Spr)	***Investigate which materials are electrical conductors and which are electrical insulators*** • A&P: Draw diagram of the investigation • R&P: Present information in a written format	
Vertical concepts	• 4: Things around us can be made to change or happen. We can pull objects behind us or push them across the table (Y1)	• 4: Things around us can be made to change or happen. We can turn on a light bulb and make it brighter or dimmer.	• 4: Many processes and phenomena are explained in terms of energy exchanges (Y5) • 4: Energy cannot be created or destroyed. When energy is transferred from one object to others, the total amount of energy in the universe remains the same; the amount that one object loses is the same as the other objects gain (Y5)

Year 4: Summer 2 — Chemistry: Properties of materials

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• Materials have different physical properties, some materials are hard whilst others are soft, some can be described as rough whilst others are smooth, some are dull whereas others are shiny (Y1 Spr) • Materials have different physical properties such as malleable, waterproof, heatproof, windproof and absorbent. (Y2 Spr) • The shape of some solid objects made from some materials can be changed by squashing, bending, twisting, or stretching the material (Y2 Spr) • Opaque, translucent and transparent materials allow no, some or all light to pass through them (Y3 Aut) • Magnets attract magnetic objects (Y3 Sum) • Materials that allow electricity to pass through them easily are called electrical conductors (Y4 Sum) • Materials that do not allow electricity to pass through them easily are called electrical insulators (Y4 Sum)	• **Thermal conductors** allow energy to be transferred through it easily when it is **heated** • Metals are good thermal conductors • **Thermal insulators** do not allow heat to be transferred (conducted) through it easily. Thermal insulators include air, plastic and wood • **Physical properties** are properties that we can measure or observe in the classroom • Physical properties include electrical conductivity; melting and boiling points; thermal conductivity; being malleable; windproof; hard/soft; and magnetic • **Chemical properties** are properties that scientists need specialist equipment to measure • Chemical properties include how easy a substance is to set on fire (**flammability**) or how poisonous something is (**toxicity**) • As we learn more about a substance's properties, we may decide to stop using it to make certain objects (e.g. lead in pencils is toxic; asbestos is a good insulator but is toxic	• Differences between physical and chemical changes (Y6 Sum) • The varying physical and chemical properties of different elements (KS3) • The properties of metals and non-metals (KS3) • The chemical properties of metal and non-metal oxides with respect to acidity (KS3) • Properties of ceramics, polymers and composites (KS3)
Disciplinary Knowledge	• A&P: Scientists conduct secondary research to learn from what other scientists have already learned (Y1 Sum) • A&P: Scientists identify factors in an investigation that should be controlled, and try to find ways to control them (Y3 Aut) • M&O: Gather information from text/books/images (Y1 Aut) and the internet (Y3 Spr) • A&E: Ask further questions that could be explored to extend findings (Y2 Spr) • A&E: Identify scientific evidence that has been used to support or refute ideas (Y4 Aut)	***Investigating the physical properties (thermal conductivity; malleability; transparency; magnetism; electrical conductivity etc.) of materials, using own knowledge or setting up comparative tests*** ***Conduct secondary research to identify an object that was once made of one material but, when new evidence showed other chemical or physical properties, are now made of new materials (e.g. asbestos insulation; lead pencils; plastic bottles)***	
Vertical concepts	• 1: All the 'stuff' encountered in everyday life, including air, water and different kinds of solid substances is called matter (Y2) • 1: Different materials are recognisable by their properties (Y2)		• 1: Materials can be changed by heating and cooling (Y5)

Year 5: Autumn 1 — Chemistry: Separating mixtures

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• All materials are made of a single substance or a mixture of substances (Y2 Sum) • Each substance in its state of matter is made up of parts that are too small to see without magnification (Y2 Sum) • Magnets attract magnetic objects (Y3 Sum) • Some metals are magnetic but not all are. Plastics, wood, fabric, glass are all non-magnetic materials (Y3 Sum) • Materials are different states at room temperature (Y4 Spr) • Physical properties include electrical conductivity; melting and boiling points; thermal conductivity; being malleable; windproof; hard/soft; and magnetic (Y4 Sum)	• A **pure substance** is one that contains only one substance and only type of particle, e.g. oxygen, iron, pure water • A **mixture** is two or more different substances, e.g. air, steel • **Mixtures** can be made of two gases (e.g. air), two solids (e.g. steel), two liquids (e.g. squash and water), or a liquid and a solid (e.g. salt water) • A **solvent** is a liquid that is used to **dissolve** other substances. • A **soluble** substance that **dissolves** in a **solvent** is a called a **solute** • An **insoluble** substance is one that will not dissolve in a solvent • When a solute dissolves in a solvent, a **solution** is formed. A solution is a mixture • When no more solute can dissolve in the solvent, the solution is **saturated** • Solutes dissolve more quickly when the particles have more energy (i.e. when heated or stirred) • Two solids can be separated by using **magnets** or **filters** (e.g. sieve) • A solid and a liquid can be separated by using **filtration** (if the solid is insoluble) or **evaporation** (if the solid is soluble) • A **reversible** change is a change that can be undone, where the original substances can be recovered. An **irreversible** change is a change that cannot be undone, where the original substances cannot be recovered	• Physical and chemical changes (Y6 Sum) • The concept of a pure substance (KS3) • Diffusion in terms of the particle model (KS3) • Simple techniques for separating mixtures: distillation and chromatography (KS3) • The identification of pure substances (KS3)
Disciplinary Knowledge	• A&P: Write an appropriate method (Y2 Aut) • A&P: Scientists identify potential hazards in their experiments and plan ways to reduce them (Y2 Aut) • A&E: Make a prediction based on substantive knowledge (Y2 Aut) • A&E: Use findings of investigation to make further predictions (Y3 Sum)	***Separate a mixture including coarse sand, water, salt and lumps of a magnetic material.***	
Vertical concepts	• 1: The amount of material does not change when a solid melts or a liquid evaporates (Y4) • 1: If a material could be divided into smaller and smaller pieces it would be found to be made of pieces, particles, smaller than can be seen even with a microscope. These particles are not in a material; they are the material (Y4)	• 1: When some materials combine, they do not change permanently and can be separated again • 1: Materials can be changed by heating and cooling	• 1: When some materials are combined, they form a new material with different properties to the original materials (Y6)

Year 5: Autumn 2 — Physics, chemistry & biology: Energy

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	**Biology**: • In a food chain, the arrows show where the energy is being transferred from and to (Y2 Spr) • Leaves use sunlight, carbon dioxide from the air, and water to make their own food (Y3 Spr). They are called producers (Y2 Spr) • A food web shows the transfer of energy between different organisms (Y4 Aut) • Animals and plants need to digest food to transfer energy from it (Y4 Aut) **Physics**: • A complete circuit must have a power source (cell/batteries) and have all the components connected in a loop. If it is missing any of these things it is an incomplete circuit (Y4 Sum) • Appliances use electricity to serve a purpose (e.g. toaster, kettle etc.) (Y4 Sum) • Sounds are made when objects vibrate. These vibrations cause the air particles surrounding them to vibrate and collide, causing the vibrations to pass between particles (Y4 Spr) **Chemistry**: • All substances in their different forms (solids, liquids and gases) are made of particles (Y4 Spr) • Melting happens when a solid is heated. Different substances melt at different temperatures. This is called the melting point (Y4 Spr)	• **Energy** can be **transferred** from one **store** to another store • **Fossil fuels**, **batteries** and the **Sun** are all examples of chemical energy stores • **Energy stores** are needed for something to happen • When energy is transferred from one store to another it can be transferred by **light**, or **electrically**. • When energy is removed from one store and is transferred to another store, the amount of energy in the first store goes down and the amount of energy in the second store goes up • Energy is not used up it is just moved around from store to store • In a **food chain** an amount of energy from the Sun (a **chemical store**) is transferred to the plant by light. The energy is then transferred along the food chain as the different organisms are eaten. • In a circuit that has a battery, the battery is the chemical store of energy. Energy is transferred electrically to the device in the circuit, but the device does not store the energy; the device changes the way the energy is **transferred**. • When a solid is heated the solid becomes a liquid. Energy from a **chemical store** is **transferred** to the solid, and as the solid becomes hotter its **thermal store** of energy goes up. The particles in the solid therefore move more • When a person **pushes** or **pulls** an object their chemical energy store decreases a little. • When a person hits a drum to make a **sound**, their chemical energy store decreases a little.	• Thermal conductors allow energy to be transferred through it easily when it is heated (Y4 Sum) • Coal, oil and gas are all used to generate electricity. The store of chemical energy in the fuel is transferred electrically to the appliances that we use in the home (Y6 Aut) • Energy can be stored and transferred; it cannot be created or destroyed (KS3) • A battery is a store of chemical energy (KS3) • Energy can be transferred electrically using an electric current (KS3) • Energy can be transferred electrically from the battery using an electric current to a device like a lamp or a buzzer.(KS3) • Devices such as bulbs do not store the energy. During this process the energy is transferred to a different store.(KS3) • Appliances are items that transfer electrical energy to a different store, e.g. light to the surroundings.(KS3)
DK	• A&P: Science is studied as three disciplines: biology (study of living organisms), chemistry (study of materials) and physics (study of energy) (Y3 Spr) • A&E: Scientists use models to help explain their ideas (Y4 Spr)	• A&P: Science is studied as three disciplines: biology (study of living organisms), chemistry (study of properties of matter and how it interacts with energy) and physics (study of energy)	
VCs	• 4: Things around us can be made to change or happen. We can pull objects behind us or push them across the table (Y1) • 4: All living things need food to give them energy (Y2) • 4: The arrows in food chains (Y2) and food webs (Y4) show where the energy is being transferred from/to.	• 4: Many processes and phenomena are explained in terms of energy exchanges • 4: Energy cannot be created or destroyed. When energy is transferred from one object to others, the total amount of energy in the universe remains the same; the amount that one object loses is the same as the other objects gain	• 4: Across the world, the demand for energy increases as human populations grow and modern lifestyles require more energy, particularly electrical energy (Y6)

Year 5: Spring 1

Biology: Life cycles

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon

Substantive knowledge	• **Germination** is the development of a plant from a seed. During germination roots and shoots emerge and grow (Y2 Aut)
	• Some plants grow from bulbs (Y2 Aut)
	• A seed is the embryonic stage of the plant life cycle (Y2 Aut)
	• Animals, including humans, reproduce. This means they have offspring that grow into adults (Y2 Aut)
	• As animals grow they get bigger, some animals change during their life cycle as the mature (e.g. tadpole to frog) (Y2 Aut)
	
	• The four main stages of the plant's life cycle include germination, pollination, fertilisation and seed dispersal (Y3 Spr)
	• Pollination and fertilisation usually takes place in flowers. Dispersal is important to make sure there is enough space for seeds to germinate and plants to grow (Y3 Spr)
	• A species is a group of one type of organism, individuals in this group can breed with each other to produce offspring that can go on to breed (Y4 Aut)
	• Fish, amphibians, reptiles, birds and mammals are all vertebrates (Y4 Aut)
	• Invertebrates can be grouped based on their characteristics as snails and slugs; worms; spiders and insects (Y4 Aut)
		• Plants and animals look similar to their parents in many features because information is passed from one **generation** to the next. This information comes from the parents' **genome**.
		• **Sexual reproduction** involves two parents - usually male and female - create a new **organism** by mixing their **genomes**
		• Sexual reproduction begins with **fertilisation** of an egg, which mixes the genes from two parents. Fertilisation can be internal or external
		• After an egg is fertilised, an embryo will develop. Embryos develop inside the body in the **gestation** period for **viviparous** animals. Embryos develop outside the body in eggs for **oviparous** animals
		• Viviparous animals are **born**, oviparous animals **hatch** from eggs, plant seeds **germinate**
		• Almost all mammals are viviparous; all birds and most amphibians are oviparous
		• Amphibians and most insects undergo **metamorphosis**
		• Life cycle of:
		  • hedgehog: internal fertilisation, gestation, hoglet, adult, senior
		  • peregrine falcon: internal fertilisation, embryo is incubated in eggs, hatchling, nestling, fledgling, adult, senior
		  • frog: external fertilisation, frogspawn, tadpole, tadpole with legs, adult frog (metamorphosis)
		  • ladybird: internal fertilisation, eggs hatch, larva, pupa, adult
		• Most plants have both male and female parts
		• The male part of the plant is called the **stamen**, made up of the **anther** and **filament**, and the anther produces **pollen grains**.
		• The female parts of the plant are the **ovary** (which produces the female sex cells which are contained in the **ovule**) and the **stigma** which collects pollen
		• **Asexual reproduction** does not involve sex cells or fertilisation. Only one parent is needed and offspring are (**genetically**) identical to the parent and each other.
		• Potatoes develop **tubers** and daffodils have **bulbs**, which will grow to be identical copies of the plant
			• The human life cycle goes through the same stages as those for other animals: fertilisation, gestation, growth (Y5 Spr)
			• Humans are viviparous and a foetus develops inside the mother (or surrogate mother). A human embryo is considered a foetus at the end of the 10th week of pregnancy (Y5 Spr)
			• The gestation period for humans is 40 weeks
			• The bigger the animal, the longer the gestation period (Y5 S2)
			• A foetus is considered a baby when it is born (Y5 Spr)
			• Fertilisation in most humans is internal, but it can happen externally (in vitro fertilisation - IVF - which means 'in glass' fertilisation) (Y5 Spr)

DK	• A&P: Scientists conduct secondary research to learn from what other scientists have already learned (Y1 Spr) • A&P: Science is studied as three disciplines: biology (study of living organisms), chemistry (study of properties of matter and how it interacts with energy) and physics (study of energy) (Y5 Aut) • M&O: Gather information from text/books/images (Y1 Aut) and the internet (Y3)	***Using images, text and the internet to research internal and external fertilisation, and viviparous and oviparous organisms***	
VCs	• 9: Plants and animals reproduce (have offspring) (Y1)	• 9: Organisms produce offspring of the same kind, but in many cases offspring are not identical with each other or with their parents. • 9: Plants and animals, including humans, resemble their parents in many features because information is passed from one generation to the next. • 9: Not all information is passed on from one generation to the other in the same way; some skills and behaviour have to be learned • 10: Although organisms of the same species are very similar, they vary a little	• 9: In a human body, most cells contain 23 pairs of chromosomes. These provide information that is needed to make more cells in growth and reproduction (KS3)

Year 5: Spring 2

Biology: Human development

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• Humans are made of many different body parts including head, neck, back, ears, eyes, nose, mouth, arms, shoulders, elbows, hands, fingers, legs, knees, feet, toes, ears, eyes, nose, mouth, arms, legs, hands, feet, toes (Y1 Sum) • Plants and animals look similar to their parents in many features because information is passed from one generation to the next. This information comes from the parents genome (Y5 Spr) • Sexual reproduction is two parents - usually male and female - create a new organism by mixing their genomes (Y5 Spr) • Sexual reproduction begins with fertilisation of an egg, which mixes the genomes from two parents (Y5 Spr) • Fertilisation can be internal or external (Y5 Spr) • After an egg is fertilised, an embryo will develop (Y5 Spr) • Almost all mammals are viviparous (Y5 Spr) • Embryos develop inside the body in the gestation period for viviparous animals. (Y5 Spr) • Viviparous animals are born, oviparous animals hatch from eggs, plant seeds germinate (Y5 Spr)	• The human life cycle goes through the same stages as those for other animals: **fertilisation**, **gestation**, **growth** • Fertilisation in most humans is internal, but it can happen externally (**in vitro fertilisation** - IVF - which means 'in glass' fertilisation) • The human life cycle: **embryo**, **foetus**, **infant**, **child**, **adolescent**, **adult**, **senior** • Human are **viviparous** and a **foetus** develops inside the mother (or **surrogate** mother) • A human embryo is considered a foetus at the end of the 10th week of pregnancy • The **gestation** period for humans is 40 weeks • The bigger the animal, the longer the gestation period • A foetus is considered a baby when it is born • **Cognitive**, **physical** and **social** and **emotional** development takes place at the greatest rate during infancy • During **puberty**, adolescents' bodies change, e.g. pubic hair, voice deepen, hips widen • **Primary aging** of adults occurs naturally as our bodies get older (e.g. slower reaction time, reduced hearing) • **Secondary ageing** relates to environmental factors, like poor diet, not enough exercise, smoking etc. • There are ages where humans at their peak for different things (e.g. reproduction, running etc.) • Different cultures around the world have different perceptions around the life cycle and ageing	• The structure and function of the male and female reproductive systems (KS3) • The female menstrual cycle (KS3) • The male and female gametes, as specialised cells (KS3) • Fertilisation, gestation and birth (KS3) • The effect of maternal lifestyle on the foetus (through the placenta) (KS3)
DK	• **Mathematics**: Use coordinates in the first quadrant (Y4); Interpret and construct line graphs (Y4) • A&P: Scientists look for patterns in the world around them (Y1 Aut) • A&P: Set a hypothesis to test (Y4 Spr) • A&E: Draw conclusions (e.g. 'the greater the..., the greater the...') (Y4 Spr) • **Geography:** Recognise that people have differing opinions about environmental issues (Y4 Spr)	***Draw a scatter graph to suggest whether there is a relationship between animal size and length of gestation period*** • A&P: Scientists look for patterns in data to try to identify correlations • R&P: Scatter graphs can help you decide if there is a relationship between two variables ***Discuss one aspect of IVF that is appropriate to your class (e.g. who in the world has access; post code lottery within the UK)*** • A&E: Some people may agree or disagree with the use of some scientific discoveries	
Vertical concepts	• 9: Plants and animals reproduce (have offspring) (Y1) • 9: Organisms produce offspring of the same kind, but in many cases offspring are not identical with each other or with their parents (Y5) • 9: Plants and animals, including humans, resemble their parents in many features because information is passed from one generation to the next (Y5) • 9: Not all information is passed on from one generation to the other in the same way; some skills and behaviour have to be learned (Y5)		• 9: In a human body, most cells contain 23 pairs of chromosomes. These provide information that is needed to make more cells in growth and reproduction (KS3)

Year 5: Summer 1

Physics: Forces

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	•Forces are pushes or pulls that act in particular directions. They can cause a change in speed, direction or shape of an object (Y3 Sum) •Forces that act in opposite directions are called opposing forces (Y3 Sum) •Forces that are equal and act in opposite directions are described as balanced forces. They 'cancel each other out' (Y3 Sum) •When forces are balanced, an object will move at a constant speed in the same direction. This includes being stationary (Y3 Sum) •Contact forces require contact between two objects (e.g. friction). Non-contact forces can affect an object at a distance (e.g. magnetism) (Y3 Sum) •Friction is a force between two surfaces that are sliding or trying to slide over each other (Y3 Sum) •Friction is a contact force because it requires the two objects to be touching (Y3 Sum) •The bumpier or rougher the surfaces, the more friction there will be (Y3 Sum)	• **Force** is measured in **newtons** (N) • **Gravity** is a **non-contact force** that pulls all objects towards each other. The greater the **mass** of the object, the greater the **gravitational pull** around it. Gravity is most commonly experienced as the pull of the Earth (and all objects on it) towards each other • The Earth's **gravitational pull** is so large that all objects - regardless of how heavy they are - are pulled towards Earth at the same rate • **Air resistance** is a **frictional force** that acts between air and a moving object to slow it down • **Cross-sectional area** is the area that is facing the direction the object is travelling in. The larger the cross-sectional area of an object, the greater the air resistance • **Water resistance** is a frictional force that acts between water and a moving object to slow it down • **Levers**, **pulleys** and **gears** allow a smaller force to have a greater effect. Examples of levers, pulleys and gears include wheelbarrows, lifts, bicycle gears, in construction • Levers consist of a **beam** and a **fulcrum** (**pivot**). **Effort** lifts a **load** • The components of levers can be arranged in different orders: effort-fulcrum-load (e.g. see saw, neck joint); effort-load-fulcrum (e.g. wheelbarrow, calf muscle); load-effort-fulcrum (e.g. tweezers, bicep) • The greater the distance from the effort to the fulcrum, the less effort is required to move the load	• The Earth's Moon is smaller than the Earth and has less mass, so its gravitational force is less (Y5 Sum) • Using force arrows in diagrams, adding forces in one dimension, balanced and unbalanced forces (KS3) • Moment as the turning effect of a force (KS3) • Forces associated with deforming object; stretching and squashing- springs (KS3) • Measurement of stretch or compression as force is changed (KS3) • Work done and energy changes in deformation (KS3) • Non-contact forces: gravity forces acting at a distance on earth and in space, forces between magnets and forces due to static electricity (KS3) • Opposing forces and equilibrium; weight held by stretched spring or supported on a compressed surface (KS3) • Forces being needed to cause objects to stop or start moving, or to change their speed or direction of motion (KS3) • Change depending on direction of force and its size (KS3)
Disciplinary Knowledge	•**Mathematics**: Round numbers with 1 decimal place to the nearest whole number (Y4); Understand difference between discrete and continuous data (Y4); Interpret and construct bar and line graphs (Y4); Area is the space inside a shape and can be measured by counting squares (Y4) •A&P: Dependent, independent and control variables (Y3 Aut) •A&P: Scientists identify factors in an investigation that should be controlled, and try to find ways to control them (Y3 Aut) •M&O: Anomalous results should be discarded and rerecorded (Y3) •M&O: Data is repeatable if the same person repeats the investigation and gets the same results; data is reproducible if the investigation is repeated by a different person and the results are the same (Y3 Sum) •M&O: Taking multiple readings allows you to see if your data is repeatable, and helps identify outliers (Y3 Sum)	***Fair test to investigate how the distance between the load and the fulcrum affects the force required to lift it*** • A&P: Scientists must work out if the factor is the cause of the outcome in a correlation • M&O: Measure force using a Newtonmeter • R&P: Line graphs can be used when data is continuous; bar charts can be used when data is discrete • A&E: Make judgements on the reliability of the data	
Vertical concepts	•2: Objects can have an affect on other objects even when they are not in contact with them: light (Y3), magnetism (Y3), sound (Y4) •3: Forces can push, pull or twist objects, making them change shape or motion (Y3); Things can only change their motion if there is a net force acting on them (Y3); When forces acting on an object are not equal and opposite in direction, they are unbalanced and will change an object's speed, direction or shape (Y3)	• 2: The non-contact force of gravity makes things fall to Earth • 2: There is gravitational force between all objects, but it is only felt when one or more of the objects has a very large mass • 3: An object on Earth pulls the Earth as much as the Earth pulls the object, but because the Earth's mass is much bigger, we observe the motion of the object	• There is attraction and repulsion between objects that are electrically charged (KS3); Visible light and other forms of radiation can travel through any empty space (KS3); How quickly an object's motion is changed depends on the force acting and the object's mass. The greater the mass of the object, the longer it takes to speed it up or slow it down (inertia) (KS3)

Year 5: Summer 2

Physics: Earth & space

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• **Geography**: We live on the Earth (Y1 Aut) • Daytime is when the Earth is facing the sun; nighttime is when the Earth is facing away from the sun (Y1 Aut) • The Moon is more visible at night (Y1 Aut) • Animals, including humans, need water, food, air, and the right temperature to survive (Y2 Aut) • Light travels in a straight line (Y3 Aut) • Sources of light emit their own light, and others reflect light; both occur in nature as well as man-made objects (Y3 Aut) • Shadows form behind an opaque object when light from a source is blocked • (Y3 Aut) • Sound travels through a medium; it cannot travel in a vacuum (Y4 Spr) • Gravity is a non-contact force that pulls all objects towards each other (Y5 Sum) • The greater the mass of the object, the greater the gravitational pull around it (Y5 Sum) • Air resistance is a frictional force that acts between air and a moving object to slow it down (Y5 Sum)	• The **universe** is made up of many **galaxies**. Our galaxy is called the **Milky Way** • The **Milky Way** is made up of lots of **solar systems** • Our solar system consists of a **star** (**Sun**), **planets** (which **orbit** a star), **satellites** (which orbit **planets**), and other bodies including **asteroids**, **meteoroids**, **meteors** and **meteorites** • The sun, planets and **moons** are approximately **spherical** bodies • The Sun is at the centre of the solar system - the **heliocentric model** • Planets orbit the Sun in the same **plane**; moons orbit planets • The Earth takes 365.25 days to orbit the sun (one year). Every four years our Earth year is one day longer, this is called a **leap year**, this year accounts for the four 0.25 days • Bodies are held in their orbit by **gravity** • There are eight planets (M, V, E, M, J, S, U and N). Each planet has different characteristics, e.g. temperature; time taken to orbit the sun; number of moons; size. • The Earth **rotates** on its **axis** once every 24 hours, so only half of the Earth is facing the Sun at any one time; this creates night and day • The Earth's rotation means that the sun 'rises' in the east and 'sets' in the west, and that the Sun is highest in the sky at midday, this explains why the sun appears to move across the sky. • The time taken for the Moon to **orbit** the Earth is 28 days and, during this time, the sun shines on different parts of the Moon • The phases of the Moon include **new moon**, **crescent**, **quarter moon**, **gibbous moon** and **full moon** • Space is a **vacuum**, which means there are no air particles • The Earth's Moon is smaller than the Earth and has less **mass** so its **gravitational** force is less	• The Earth's tilt creates seasons, and different day lengths at different times of the year (KS3) • Calculating gravity force on different planets and stars (KS3) • The light year as a unit of astronomical distance (KS3) • Movement of stars and constellations (KS3)
DK	• **Mathematics**: Number of minutes in an hour; hours in a day (Y3); Number of days in a month, year and leap year (Y3) • A&P: Scientists must work out if the factor is the cause of the outcome in a correlation (Y5) • A&E: Draw conclusions (e.g. 'the greater the… , the greater the…') (Y3 Sum) • A&E: Identify scientific evidence that has been used to support or refute ideas (Y4 Aut)	***Look for patterns between a planet's distance from the Sun and it's temperature and size*** ***Consider how the number of planets that humans consider to be planets has changed over time*** • A&E: Science is never 'complete' and scientists are always working to make models more accurate or to discover new explanations	• Scientists seek to understand how accurate their results are, and how confident they can be in their findings (KS3)
Vertical concepts	• 6: Daytime is when the Earth is facing the Sun; nighttime is when the Earth is facing away from the Sun (Y1) • 6: The Moon reflects light from the Sun (Y3)	• 3: The downward force of gravity on an object on the Moon is less than that on Earth because the Moon has less mass on Earth • 6: Our Sun is one of many stars that make up the Universe. • 6: The distances between us and the bodies in solar system is huge, and even bigger in the Universe	• 6: The tilt of the Earth's axis gives rise to seasons (KS3) • 6: The movements of galaxies suggest that the Universe is expanding from a past state called the 'big bang', towards a future that is still unclear (KS3)

Year 6: Autumn 1

Physics: Electricity

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• A complete circuit must have a power source (cell/batteries) and have all the components connected in a loop. If it is missing any of these things it is an incomplete circuit (Y4 Sum) • A short circuit is the easiest route for electricity to travel and can be created by accident by connecting just the wire to the cell in a circuit. They can be dangerous (Y4 Sum) • Components include wire, lamp, buzzer, motor or switch Materials that allow electricity to flow through them easily are called electrical conductors; materials that do not are called electrical insulators (Yr4 Sum) • Appliances use electricity to serve a purpose (e.g. toaster, kettle etc.) (Y4 Sum) • Energy can be transferred from one store to another store (Y5 Aut) • Fossil fuels, batteries and the Sun are all examples of chemical energy stores (Y5 Aut) • In a circuit that has a battery, the battery is a chemical store of energy. Energy is transferred electrically to the device in the circuit, but the device does not store energy. Instead, it changes the way that it is transferred (Y5 Aut) • **Geography**: Fossil fuels are materials made from fossils of organisms over millions of years, like coal and oil. Humans use these to run cars/electrical items (Y5 Aut)	• There are recognised **symbols** for cell, lamp, buzzer, motor, and switch. Wires are represented with straight lines • As long as batteries have the same **voltage**, the size of the battery does not affect the brightness of the lamp/loudness of the buzzer (though the smaller batteries will not last as long as the larger ones) • Adding more cells in the circuit increases the voltage. Increasing the voltage in a circuit makes the lamp in the circuit get brighter or the buzzer get louder. • More than one lamp can be put into one circuit. They can be placed in **series** or in **parallel**. • In a **series** circuit, the lamps are placed in a **continuous** loop. In **parallel**, the lamps are placed in separate loops that both connect to the cell • Connecting lamps in parallel means that if one lamp burns out the other will stay on and switches can be used to turn each lamp off independently. • Many of the **appliances** used in the home do not use batteries they use **mains electricity**. • Mains electricity is **generated** in a **power station** and transferred to our homes by overhead cables. Power stations can use both **renewable** and **non-renewable** sources of energy to generate electricity. • A **non-renewable energy source** is one where we have a fixed amount of the source, and where it would take too long for more to be formed. Burning fossil fuels to transfer electrical energy is a non-renewable energy source • **Renewable energy** sources quickly replenish themselves, meaning that we can use them again and again. **Wind**, **solar**, **geothermal** and **hydrological** power are all examples of renewable energy sources • Coal, oil and gas are all used to generate electricity. The store of chemical energy in the fuel is transferred electrically to the appliances that we use in the home.	• **Geography:** Improving the environment, and places in the world that have climates or physical features that lend themselves to using renewable sources to generate electricity (Y6 Aut2) • Electric current is measured in amperes using an ammeter. Current is a flow of charge (KS3) • Current can be measured in parallel and series circuits. The current will be the same at all points in a series circuit (KS3) • Current splits where the circuit branches in a parallel circuit, currents add where branches meet (KS3) • Potential difference is measured in volts (V) using a voltmeter. It is measured across a component (KS3) • In a series circuit the sum of the potential difference across all components will equal the battery voltage. In a parallel circuit the potential difference across each of the components will be the same as that of the battery (KS3) • Resistance is measured in ohms and is the ratio of potential difference to current (KS3) Conducting and insulating components will differ in resistance (KS3)
Disciplinary Knowledge	• **Mathematics**: Interpret and construct bar charts (Y3);: Discrete data is data you count; continuous data is data you can measure (Y4); Interpret and construct bar, line graphs (Y4) • A&P: dependent, independent and control variables (Y3) • A&P: Scientists identify factors in an investigation that should be controlled, and find ways to control them • M&O: Gather information using a data logger (e.g. sound meter app; heart rate app) (Y4 Spr) • R&P: Line graphs can be used when data is continuous; bar charts can be used when data is discrete (Y5 Sum) • A&E: Draw conclusions (e.g. 'the greater the… , the greater the…') (Y4 Spr)	**Three different enquiries, where pupils will plan the most appropriate type of investigation and how they should present their results:** 1. **Investigating the effect of increasing voltage on the volume of a buzzer or the brightness of a lamp** 2. **Investigating the effect of changing the number of components in a circuit on the volume of a buzzer** • R&P: Decide which graph is most appropriate for the enquiry	• Planning more complex investigations to answer more challenging questions (KS3)
VCs	• 4: Many processes and phenomena are explained in terms of energy exchanges (Y5) • 4: Energy cannot be created or destroyed. When energy is transferred from one object to others, the total amount of energy in the universe remains the same; the amount that one object loses is the same as the other objects gain (Y5)	• 4: Across the world, the demand for energy increases as human populations grow and modern lifestyles require more energy, particularly electrical energy	• 4: Objects have energy because of their chemical composition, their movement, their temperature, their position in a gravitational or other field, or because of compression or distortion of an elastic material (KS3)

Year 6: Autumn 2

Biology: Evolution

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• Living things have adapted to their environment. This means they may not be able to survive in other habitats (Y2 Spr) • A fossil is physical evidence of an ancient plant or animal , this could be their preserved remains or other traces that they made when they were alive. Trace fossils are not physical remains of living things they are indirect evidence of life (Y3 Aut) • A species is a group of one type of organism, individuals in this group can breed with each other to produce offspring that can go on to breed. (Y4 Aut) • **Geography**: Animals and plants have adapted to life in the rainforest (buttress roots, lianas, spider monkey, toucan, fig wasp and fire ants) (Y4 Spr) • Sexual reproduction is two parents - usually male and female - create a new organism by mixing their genomes (Y5 Spr) • **History**: Homo sapiens first lived in East Africa ~200,000 BC and migrated across the world over 1000s of years (Y5 Sum) • **Geography**: Flora and fauna that have adapted to life in the tundra (Arctic hare, polar bear) hot desert (cactus, camel, Saharan silver ant, cape ground squirrel) temperate forest (deciduous and coniferous trees, red squirrels, hedgehogs, brown long-eared bats southern wood ants) coral reefs (soft coral, pistol shrimp & goby fish, reef sharks) (Y5 Sum)	• **Variation** occurs within and between **species** • Variation can be **environmental** or **genetic**, or a mixture of both • **Genetic** variation happens randomly through the mixing of **genomes** in **sexual reproduction**. • Some variation is **advantageous** to the organism in their environment; sometimes it is **disadvantageous**; and sometimes it gives no advantage/disadvantage • An **organism** with **advantageous traits** are more likely to survive and reproduce, passing those traits to the next generation. This is called **natural selection** • These advantageous traits - **adaptations** - can be **physiological**, **structural** and **behavioural** • Over many generations, the species will **evolve** so that all organisms have this adaptation/advantageous trait • **Homo sapiens evolved** in East Africa • **Fossils** provide evidence for evolution, because they show how organisms have changed over time • Scientists involved in the development of evolutionary biology include Al-Jahiz, Charles Darwin, Alfred Wallace, Mary Anning and Dr Danielle Lee	• Hereditary is the process by which genetic variation is transmitted from one generation to the next (KS3) • Chromosomes are made of DNA. Small sections of DNA are called genes. We inherit genes from our parents and this is how genetic variation is transmitted from one generation to the next.(KS3) • Variation between individuals of the same species is either continuous or discontinuous, this variation means that some individuals will compete more successfully and are more likely to survive, this drives a process known as natural selection. In this process advantageous versions of genes are passed onto offspring (KS3) • Changes to the environment can lead to individuals of some species or even entire species less well adapted to their environment. This can lead to extinction. Biodiversity is important and we need to maintain it (KS3)
DK	• A&E: Identify scientific evidence that has been used to support or refute ideas (Y4 Aut) • R&P: Use a Venn diagram to classify items into two or three sets based on properties (Y1 Sum) • A&P: Science is never 'complete' and scientists are always working to make models more accurate or to discover new explanations (Y5 Sum)	***Sort variations within species in a Venn diagram, based on whether they are genetic, environmental or a mixture of both*** ***Identify how evidence of fossils has been used to support the theory of evolution. (Horse fossil record as evidence of the horse developing from a small animal with four toes to a large animal with a hoof).*** • A&P: Science is never 'complete' and scientists are always working to make models more accurate or to discover new explanations	
Vertical concepts	• 8: Animals are ultimately dependent on plants for their survival (Y4) • 10: Although organisms of the same species are very similar, they vary a little from each other (Y5)	• 8: In any given ecosystem there is competition among species for the energy and materials they need to live. • 10: There are many kinds of organisms that were once alive but are now extinct. We know about extinct animals from fossils. • 10: Living things are found in certain environments because they have the features that enable them to survive there. This adaptation to their environment has come about because of the small differences that occur during reproduction, resulting in some individuals being better suited to the environment than others. In the competition for materials and energy, those that are better adapted will survive and are more likely to pass on their adapted feature to their offspring.	• 8: Decomposers are essential (alongside producers and consumers) for a stable ecosystem (KS3) • 10: The natural selection of organisms has been going since the first form of life appeared on Earth 3.5 billion years ago (KS3) • 10. Multi-cellular organisms evolved around 2 billion years ago (KS3)

Year 6: Spring 1

Physics: Light

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• Light travels in straight lines (Y3 Aut) • We see when light enters our eyes (Y3 Aut) • Darkness is the absence of light (Y3 Aut) • Sources of light emit their own light, and others reflect light; both occur in nature as well as man-made objects (Y3 Aut) • Opaque, translucent and transparent materials allow no, some or all light to pass through them (Y3 Aut) • Shadows form behind an opaque object when light from a source is blocked (Y3 Aut) • The shape of shadows changes with the angle and the distance of the light source (Y3 Aut) • Light from the sun can be dangerous and there are ways to protect our eyes (Y3 Aut) • Energy can be transferred from one store to another store (Y5 Aut) • Fossil fuels, batteries and the Sun are all examples of chemical energy stores (Y5 Aut) • When energy is transferred from one store to another, it can be transferred by light or electrically (Y5 Aut) • When energy is removed from one store and is transferred to another store, the amount of energy in the first store goes down and the amount of energy in the second store goes up (Y5 Aut) • Energy is not used up; it is just moved around from store to store (Y5 Aut) • Light travels from the Sun to the Earth (Y5 Sum)	• In **ray diagrams**, straight lines with arrows show where the **energy** is being transferred from and to by light • Objects **emit** (give out) or **reflect** light into the eye. We see things because light travels from **light sources** to our eyes, or from light sources to objects and then to our eyes • Objects would be invisible if they did not reflect light. • Many problems with our vision are caused by parts of the eye that are the not the right shape or size, or that have become cloudy. Many of these problems can be corrected through surgery or **prescription** glasses • People living with sight loss or blindness may use long canes or guide dogs when outside, talking books or **Braille**, and different devices in the home • The size and shape of shadows behind an **opaque** object can be explained using ray diagrams • Shadows have the same shape as the objects that cast them because light travels in straight lines. • On a flat surface, all light meeting a surface from one direction will be reflected in the same direction. This is known as **specular reflection** • On a rough surface, light will be reflected in all directions. This is known as **diffuse reflection** • Specular reflection between mirrors allow us to see the objects that do not directly reflect light into our eyes (e.g. periscope) • When light meets an opaque object, some of the light is reflected and some of it is absorbed • **White light**, which comes from most light sources we use in the classroom, contains all the colours of the **visible spectrum** (red, orange, yellow, green, blue, indigo, violet) • When a light meets a surface, some colours are **absorbed** and some are **reflected**. We see the colour(s) that are reflected • Objects appear black if they absorb all the colours in white light, and reflect none. Objects appear white if they reflect all the colours in white light, and absorb none	• The transmission of light through materials, to include absorption, diffuse scattering and specular reflection at a surface (KS3) • Light waves can travel through a vacuum they do not require a medium (KS3) • Light waves travel at the speed of light (KS3) • The similarities and differences between light waves and waves in matter (KS3) • Use of ray model to explain imaging in mirrors, the pinhole camera, the refraction of light and the action of a convex lens in focusing (KS3) • The human eye (KS3) • Light transferring energy from a source to an absorber leading to chemical and electrical effects; photosensitive material in the retina and in cameras (KS3) • Colours and the different frequencies of light, white light and prisms; differential colour effects in absorption and diffuse reflection (KS3)
DK	• R&P: Draw a diagram, a simple scientific drawing that explains or informs	***Draw ray diagrams to show how light travels and how shadows are formed***	
VCs	• 2: Objects can have an affect on other objects even when they are not in contact with them. Light reaches our eyes, even though the light source may be far away (Y2)		• 2: Visible light and other forms of radiation can travel through any empty space (KS3)

Year 6: Spring 2

Biology: Further classification

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• Coniferous plants keep their leaves all year round; deciduous plants lose their leaves in winter (Y1 Aut) • Animals can be grouped into carnivores, herbivores and omnivores (Y1 Sum) • Animals move from place to place, while plants move on the spot (Y2 Spr) • Classification refers to a method used to place all living things into groups. Organisms can be classified in a number of ways (Y4 Aut) • A species is a group of one type of organism, individuals in this group can breed with each other to produce offspring that can go on to breed (Y4 Aut) • Fish, amphibians, reptiles, birds and mammals are all vertebrates. Vertebrates have endoskeletons (Y4 Aut) • Vertebrates can be grouped in a number of ways based on their characteristics, e.g. warm/cold blooded; or physical features like fur, beak, wings etc. (Y4 Aut) • Invertebrates can be grouped based on their characteristics as snails and slugs; worms; spiders and insects (Y4 Aut) • Invertebrates can be grouped based on their skeletons; endoskeletons, exoskeletons, or hydrostatic skeletons (Y4) • Plants can be grouped into flowering and non-flowering plants (Y4 Aut) • **Geography**: A symbiotic relationship is where plants and animals live along and rely on one another (Y4 Spr)	• **Invertebrates** can be grouped based on their characteristics as poriferans (sponges) cnidarians, echinoderms, molluscs, annelids, platyhelminths and arthropods (spiders, insects, crustaceans and myriapods). • Plants can be grouped into moss, ferns, conifers and flowering plants • **Fungi** are different to plants and animals. They cannot make their own food (like animals) but do not move (like plants) • **Micro-organisms** are organisms that are so small that we cannot see them with our eyes alone. • Some **fungi** are microorganisms (e.g. yeast), but not all are (e.g. mushrooms) • **Bacteria** are microorganisms. Some bacteria can cause disease in other organisms • Some bacteria are helpful for other organisms (e.g. those that help break down food in our digestive system) and those that form part of a **symbiotic relationship**	• Plants and animals are made of cells. There are similarities and differences between the cells of animals and plants. (KS3) • Many plant cells have chloroplasts, and this enable plants to photosynthesise. The reactants of this process are carbon dioxide and water, and the products are sugar (glucose) and oxygen. (KS3) • The differences between species and how this difference can drive natural selection. (KS3)
Disciplinary knowledge	• Gather information from text/books/images (Y2 Spr) and the internet (Y3 Spr) • R&P: Use a classification key to identify an object (Y4 Aut) • R&P: Draw a dichotomous classification key to help others identify an object (Y4 Aut) • R&P: Present information in a written format (Y4 Sum)	***Use and draw classification keys to help classify invertebrates and plants*** ***Research the harmful and helpful effects that bacteria can have on humans and other organisms, and present this information in a written format***	
Vertical concepts	• 7: Living things – organisms – need water, air, food, a way of getting rid of water and an environment that stays within a particular temperature range (Y3)	• 7: Micro-organisms are organisms that are so small that we cannot see them with our eyes alone	• 7: All living organisms are made of one or more cells, which can only be seen through a microscope (KS3); All the basic functions of life – growth, reproduction, extracting energy from food – are the results of what happens inside cells (KS3)

Year 6: Summer 1 Biology: Functions of the human body

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• Humans are made of many different body parts (Y1 Sum) • Humans need exercise to stay healthy (Y2 Aut) • Humans need a balanced diet of these food groups (Y3 Spr) • Organs are parts of the body that do a particular job, the heart pumps blood around the body and the lungs are used for breathing which gets air into your body. (Y3 Spr) • The skeleton protects organs, e.g. the skull protects the brain; and the ribcage protects the lungs, heart and other important organs (Y3 Spr) • The muscles and skeleton are required to help the body move. When muscles contract they pull the bone (Y3 Spr) • Oxygen and carbon dioxide are found in the air (Y3 Spr) • The digestive system is the group of organs that help your body digest food (Y4 Aut) • Food is further broken down (chemical digestion) in the small intestines where most of the nutrients are absorbed (Y4 Aut) • Water is absorbed in the large intestine, leaving behind the waste products (Y4 Aut)	• Each **organ** and **muscle** in the human body needs **oxygen** and **nutrients** (from breathing in and eating/digesting). Each organ and muscle releases **carbon dioxide**, which needs to be removed (and breathed out) • **Blood** carries **oxygen**, **nutrients** and **carbon dioxide** around the body • The **heart** is a muscle that pumps the blood through the **blood vessels**. Blood is pumped at a high **pressure**. • The heart pumps **deoxygenated** blood to the lungs, where oxygen is transferred to it and it flows back to the heart. The heart pumps **oxygenated** blood to the rest of the body, where the oxygen is transferred to the organs/muscles and carbon dioxide is transferred to the blood • **Deoxygenated** blood then travels back to the heart to begin the process again • **Nutrients** are absorbed by the blood along the **small intestine**, and transported to other organs in the body. **Water** is absorbed by the blood along the small and large intestines, and transported to other organs in the body • **Arteries** carry blood away from the heart. Arteries have thick walls because they carry blood from the heart which is at a high pressure. blood is being pumped through very quickly. They mostly carry oxygenated blood • **Veins** carry blood back to the heart. They mostly carry deoxygenated blood • Arteries branch into smaller blood vessels called **capillaries**, capillaries are very small and supply our organs (and tissues) with oxygen and nutrients. The capillaries also remove carbon dioxide. • The **heart rate** is how quickly the heart pumps. It is usually measured in beats/min • Muscles need more oxygen when they are being used in exercise, so the heart rate increases • Smoking can damage the lungs, reducing the amount of oxygen that can enter the capillaries; this makes exercise harder. Smoke contains many chemicals, some of which are also absorbed by the blood and transported around the body. These can causes diseases	• The hierarchical organisation of multicellular organisms. Organisms consist of organ systems which are made of organs. Organs are a collection of different tissues and tissues are made of cells. An example being the circulatory system (KS3) • Aerobic respiration occurs in the cells of living organisms, it involves the breakdown of organic molecules (sugar) and using oxygen (KS3) • The blood is oxygenated in the lungs and this is transported to the organs (and cells) that require it for aerobic respiration, along with sugar, by the blood vessels in the circulatory system (KS3) • Gas exchange systems in humans are adapted to their function as they have many alveoli which provides a large surface area for diffusion (KS3) • The mechanism of breathing moves air in and out of the lungs (KS3) • The role of diffusion in the movement of materials in and between cells (KS3) • The impact of smoking on the human gas exchange surface. (KS3)
Disciplinary Knowledge	• **Mathematics**: Calculate and interpret the mean (Y6) • A&P: Set a hypothesis to test (Y4 Spr) • A&P: Make a prediction based on substantive knowledge (Y2 Aut); A&E: Use scientific understanding to explain their findings (Y3 Sum) • A&P: Scientists must work out if the factor is the cause of the outcome in a correlation (Y5 Sum) • A&E: Science is never 'complete' and scientists are always working to make models more accurate or to discover new explanations (Y6 Aut) • M&O: Repeatable and reproducible data (Y3 Sum) • M&O: Taking multiple readings allows you to see if your data is repeatable and helps identify outliers (Y3 Sum)	***Investigate the effect of exercise on heart rate*** • M&O: Planning to take multiple readings allows anomalous data to be identified and enables a mean to be calculated. Repeats show if our data is repeatable. • A&E: Calculating the mean can be used as a method of analysing data ***Research effects of smoking on the human body, and how our scientific understanding has changed over time, including in the current day. The difference between correlation and cause can be discussed in relation to the move from saying smoking is bad for your health to the idea of the many disease smoking cause.***	
VCs			• 7: All living organisms are made of one or more cells, which can only be seen through a microscope (KS3); Cells are often aggregated into tissues, tissues into organs, and organs into organ systems (KS3)

Year 6: Summer 2 Chemistry: Physical & chemical changes

	Required prior knowledge	Knowledge to be explicitly taught	How knowledge will be built upon
Substantive knowledge	• Digestion in the human body can be chemical and mechanical (Y4 Aut) • Physical properties are properties that we can measure or observe in the classroom. They include electrical conductivity; melting and boiling points; thermal conductivity; being malleable; windproof; hard/soft; and magnetic (Y4 Sum) • Chemical properties are properties that scientists need specialist equipment to measure. They include flammability and toxicity (Y4 Sum) • A mixture is two or more substances, e.g. air, steel (Y5 Aut) • Mixtures can be made of two gases (e.g. air), two solids (e.g. steel), two liquids (e.g. squash and water), or a liquid and a solid (e.g. salt water) (Y5 Aut) • A solvent is a liquid that is used to dissolve other substances (Y5 Aut) • A reversible change is a change that can be undone, where the original substances can be recovered (Y5 Aut) • An irreversible change is a change that cannot be undone, where the original substances cannot be recovered (Y5 Aut) • When a solid is heated the solid becomes a liquid. Energy from a chemical store is transferred to the solid, the solid becomes hotter and its thermal store of energy goes up. The particles in a solid therefore move more, and arrange to form a liquid (Y5 Aut)	• A mixture is two or more substances that are mixed but not chemically joined together • A chemical change is a change where a new substance is formed. • A chemical change has usually taken place if: gas bubbles appear; a new solid appears; it changes colour; or smells different • A physical change is where the substance changes its properties, but it does not become a different substance • Some chemical changes are irreversible, (e.g. cook an egg, rusting iron), but some can be reversed • Most physical changes are reversible (e.g. water to ice), but some are not (e.g. crack an egg, turn wood into sawdust) • Reversible and irreversible chemical changes can be written as word equations	• In an chemical reaction mass is conserved (KS3) • In a chemical reaction there is a rearrangement of atoms. (KS3) • Chemical reactions can be represented using formulae and equations (KS3) • Examples of types of chemical reactions include combustion, thermal decomposition, oxidation neutralisation and displacement (KS3) • Reactions of acids with metals produces a salt and hydrogen (KS3) • Reactions of acids with alkalis produces a salt and water (KS3) • Reactions can be endothermic or exothermic (KS3)
Disciplinary Knowledge	• A&P: Scientists group objects or living things based on their properties (Y1 Spr) • A&P: Make a prediction based on substantive knowledge (Y2 Spr) • A&P: Scientists identify potential hazards in their experiments and plan ways to reduce them (Y2 Spr) • R&P: Use a Carroll diagram to classify items based on properties (Y1 Spr) • R&P: Use a classification key to identify an object. Draw a dichotomous classification key to help others identify an object (Y4 Aut) • R&P: Present information in a written format	***Use a Carroll diagram to classify changes as physical/chemical and reversible/irreversible*** ***Create and use a classification key to help identify whether a change is chemical/physical and reversible/irreversible*** ***Carry out changes and identify whether the change created is physical/chemical and reversible/irreversible***	
VCs	• 1: All the 'stuff' encountered in everyday life, including air, water and different kinds of solid substances is called matter (Y2) • 1: Different materials are recognisable by their properties (Y2)		

Vertical concepts

Big ideas of science

	1. All material in the universe is made of very small particles	2. Objects can affect each other at a distance	3. Changing the movement of an object requires a net force to be acting on it
Y1			
Y2	• All the 'stuff' encountered in everyday life, including air, water and different kinds of solid substances is called matter • Different materials are recognisable by their properties		
Y3		• Objects can have an affect on other objects even when they are not in contact with them. Light reaches our eyes, even though the light source may be far away • The non-contact force of magnetism mean magnets can attract or repel other magnets	• Forces can push, pull or twist objects, making them change shape or motion • Things can only change their motion if there is a net force acting on them • When forces acting on an object are not equal and opposite in direction, they are unbalanced and will change an object's speed, direction or shape
Y4	• The amount of material does not change when a solid melts or a liquid evaporates • If a material could be divided into smaller and smaller pieces it would be found to be made of pieces, particles, smaller than can be seen even with a microscope. These particles are not in a material; they are the material.	• Sound comes from things that vibrate and can be detected at a distance from the source because the air or other material around is made to vibrate. Sounds are heard when the vibrations in the air reach our ears	
Y5	• When some materials combine, they do not change permanently and can be separated again • Materials can be changed by heating and cooling	• The non-contact force of gravity makes things fall to Earth • There is gravitational force between all objects, but it is only felt when one or more of the objects has a very large mass	• An object on Earth pulls the Earth as much as the Earth pulls the object, but because the Earth's mass is much bigger, we observe the motion of the object • The downward force of gravity on an object on the Moon is less than that on Earth because the Moon has less mass on Earth
Y6	• When some materials are combined, they form a new material with different properties to the original materials		
KS3	• The smallest piece of a material is called an atom. All materials, anywhere in the universe, living and non--living, are made of a very large numbers of these basic 'building blocks' of which there are about 100 different kind	• There is attraction and repulsion between objects that are electrically charged • Visible light and other forms of radiation can travel through any empty space	• How quickly an object's motion is changed depends on the force acting and the object's mass. The greater the mass of the object, the longer it takes to speed it up or slow it down (inertia)

Vertical concepts

Big ideas of science

	4. The total amount of energy in the Universe is always the same, but energy can be transformed when things change or are made to happen	5. The composition of the Earth and its atmosphere and the processes occurring within them shape the Earth's surface and its climate
Y1	• Things around us can be made to change or happen. We can pull objects behind us or push them across the table	• Plants grow in soil • The weather can change rapidly. Different seasons have different weather patterns
Y2	• All living things need food to give them energy • The arrows in a food chain show where energy is being transferred from and to	• There is air all around us on Earth
Y3		• Much of the solid surface of the Earth is covered in soil, which is a mixture of pieces of rock of various sizes and the remains of organisms. Some soil also contains air, water and some nutrients. • There are many different kinds of rock with different composition and properties. • Beneath the Earth's solid crust is a hot layer called the mantle. The Earth's crust consists of a number of solid plates which move relative to each other, carried along by movements of the mantle. The formation of mountains, earthquakes and volcanic activity are likely to occur at these cracks (see **Geography Year 3 Spring: Mountains and Volcanoes and Year 4 Summer: Earthquakes**)
Y4	• The arrows in a food web show where energy is being transferred from and to • Things around us can be made to change or happen. We can turn on a light bulb and make it brighter or dimmer.	
Y5	• Many processes and phenomena are explained in terms of energy exchanges • Energy cannot be created or destroyed. When energy is transferred from one object to others, the total amount of energy in the universe remains the same; the amount that one object loses is the same as the other objects gain	• There is less and less air further away from the Earth's surface; space is a vacuum • The action of water wears down rock gradually into smaller pieces (see **Geography, Year 5 Spring: Investigating water**) • Light from the Sun warms the Earth's surface and the heat is trapped by the Earth's air. This is known as the greenhouse effect (see **Geography, Year 5 Summer: Climate across the world**)
Y6	• Across the world, the demand for energy increases as human populations grow and modern lifestyles require more energy, particularly electrical energy.	
KS3	• Objects have energy because of their chemical composition, their movement, their temperature, their position in a gravitational or other field, or because of compression or distortion of an elastic material.	• Weather is determined by conditions of the air. The temperature, pressure, direction and speed of the movement and the amount of water vapour in the air combine to create the weather. • Radioactive decay of material inside the Earth since it was formed is its internal source of energy.

Vertical concepts

Big ideas of science

	6. Our solar system is a very small part of one of millions of galaxies in our universe	7. Organisms are organised on a cellular basis	8. Organisms require a supply of energy and materials for which they are often dependent on or in competition with other organisms
Y1	• Daytime is when the Earth is facing the Sun; nighttime is when the Earth is facing away from the Sun.	• Living things, including humans, react to their surroundings with their senses	• There is a wide variety of living things, including plants and animals
Y2		• Living things grow, need, water, air and food, react to their surroundings, move, get rid of their waste, reproduce	• All living things need energy for food, as well as air, water and certain temperature conditions. • Most plants make their own food • Animals need food, which comes by eating plants (herbivores) or by eating animals (carnivores), which have eaten plants or other animals. • Plants and animals are dependent on each other. • Organisms are adapted to their environment. If conditions in a habitat change, organisms may not be able to survive.
Y3	• The Moon reflects light from the Sun.	• Living things need water, air, food, a way of getting rid of water and an environment that stays within a particular temperature range.	• Plants make their own food using sunlight, carbon dioxide and water
Y4			• Animals are ultimately dependent on plants for their survival. • The relationships among organisms can be represented as food chains and food webs.
Y5	• Our Sun is one of many stars that make up the Universe. • The distances between us and the bodies in solar system is huge, and even bigger in the Universe		
Y6		• Micro-organisms are organisms that are so small that we cannot see them with our eyes alone	• In any given ecosystem there is competition among species for the energy and materials they need to live.
KS3	• The tilt of the Earth's axis gives rise to seasons. • The movements of galaxies suggest that the Universe is expanding from a past state called the 'big bang', towards a future that is still unclear	• All living organisms are made of one or more cells, which can only be seen through a microscope • All the basic functions of life – growth, reproduction, extracting energy from food – are the results of what happens inside cells • Cells are often aggregated into tissues, tissues into organs, and organs into organ systems	• Decomposers are essential (alongside producers and consumers) for a stable ecosystem.

Vertical concepts

Big ideas of science

	9. Genetic information is passed down from one generation of organisms to another	10. Diversity of organisms, living and extinct, is the result of evolution
Y1		• There are many different kinds of plants and animals in the world today.
Y2	• Plants and animals reproduce (have offspring)	
Y3		• Fossils are the preserved remains or traces of living things.
Y4		
Y5	• Organisms produce offspring of the same kind, but in many cases offspring are not identical with each other or with their parents. • Plants and animals, including humans, resemble their parents in many features because information is passed from one generation to the next. • Not all information is passed on from one generation to the other in the same way; some skills and behaviour have to be learned	• Although organisms of the same species are very similar, they vary a little from each other.
Y6		• There are many kinds of organisms that were once alive but are now extinct. • We know about extinct animals from fossils. • Living things are found in certain environments because they have the features that enable them to survive there. This adaptation to their environment has come about because of the small differences that occur during reproduction, resulting in some individuals being better suited to the environment than others. In the competition for materials and energy, those that are better adapted will survive and are more likely to pass on their adapted feature to their offspring.
KS3	• In a human body, most cells contain 23 pairs of chromosomes. These provide information that is needed to make more cells in growth and reproduction.	• The natural selection of organisms has been going since the first form of life appeared on Earth 3.5 billion years ago. • Multi-cellular organisms evolved around 2 billion years ago

Vertical concepts

Ideas about science

Ideas about science relate to disciplinary knowledge and working scientifically. They are best taught with explicit reference in appropriate units. Not all the ideas are relevant to every unit (for example, the idea that 'theories and models fit the facts of the time' is better considered through the topics of classification or the solar system than, for example, magnetism). The most relevant ideas are therefore explicitly referenced at an appropriate level in the unit overviews and lesson slides:

Science assumes that for every effect there is one or more causes

Scientific explanations, theories, and models are those that best fit the facts known at a particular time

The knowledge produced by science is used in some technologies to create products to serve human ends

Applications of science often have ethical, social and economic consequences

Disciplinary knowledge (KS1)

The below tables outlines where disciplinary knowledge – the working scientifically elements – is **first taught** and deliberately practised in KS1 or KS2. The curriculum has been sequenced so that the content is also reviewed in subsequent units (and may also be reviewed in other subject areas like geography and history), but to keep the table readable, we have only set out where it is first taught. The Mathematics Programmes of Study have been considered so that pupils never need to apply mathematical skills (e.g. calculating mean, rounding to an appropriate degree, constructing graphs) until they have first been taught in mathematics lessons.

	Scientific Attitudes & Planning (A&P)	Measuring & Observing (M&O)	Recording & Presenting (R&P)	Analysing & Evaluating (A&E)
R		• Measure/observe using senses		• Notice patterns in the world me
Y1	• Scientists look for patterns in the world around them • Scientists group objects or living things based on their properties • It is important that we keep as much as we can the same, apart from the one thing we measure and the one thing we change • Scientists conduct secondary research to learn from what other scientists have already learned	• Gather information from text/ books/ images	• Record numerical or descriptive observations in a table • Draw a diagram, a simple scientific drawing that explains or informs • Use a table to classify items based on properties • Use a Carroll diagram to classify items based on properties • Use a Venn diagram to classify items into two or three sets based on properties	• Make simple statements about the results of an enquiry
Y2	• Make a prediction based on substantive knowledge • There are four main stages of enquiry (A&P, M&O, R&P, A&E) • Scientists identify potential hazards in their experiments and plan ways to reduce them • Scientists conduct investigations to identify whether a pattern they think they've seen is really there	• Make systematic observations of an object • Observe using a magnifying glass safely	• Use a pair of axes to classify items based on the extent it displays two properties	• Ask further questions that could be explored to extend findings

Disciplinary knowledge (KS2)

	Scientific Attitudes & Planning (A&P)	Measuring & Observing (M&O)	Recording & Presenting (R&P)	Analysing & Evaluating (A&E)
Y3	• Select most appropriate equipment to measure (the variables) that will give you the best chance of an accurate result • A dependent variable is what you measure; an independent variable is what you change; controlled variables are things that stay the same • Scientists identify factors in an investigation that should be controlled, and try to find ways to control them • Write an appropriate method • Science is studied as three disciplines: biology (study of living organisms), chemistry (study of materials) and physics (study of energy)	• Gather information from the internet • Anomalous results should be discarded and rerecorded • Data is repeatable if the same person repeats the investigation and gets the same results; data is reproducible if the investigation is repeated by a different person and the results are the same • Taking multiple readings allows you to see if your data is repeatable, and helps identify outliers	• Design a table to collect data with the appropriate number of rows and columns and correct headings	• Draw conclusions (e.g. 'the greater the… , the greater the…') • Use scientific understanding to explain their findings • Suggest ways to improve practical procedures to obtain more accurate measurements • Use findings of investigation to make further predictions
Y4	• Set a hypothesis to test • Draw diagram of the investigation • Scientists use models to help explain their ideas	• Gather information using a data logger (e.g. sound meter app; heart rate app)	• Use a classification key to identify an object • Draw a dichotomous classification key to help others identify an object • Present information orally using a prop or demonstration • Present information in a written format	• Identify scientific evidence that has been used to support or refute ideas
Y5	• Science is studied as three disciplines: biology (study of living organisms), chemistry (study of properties of matter and how it interacts with energy) and physics (study of energy) • Scientists look for patterns in data to try to identify correlations • Scientists must work out if the factor is the cause of the outcome in a correlation	• Measure force using a Newtonmeter	• Scatter graphs can help you decide if there is a relationship between two variables • Interpret and construct climate graph • Line graphs can be used when data is continuous; bar charts can be used when data is discrete	• Make judgements on the reliability of the data • Some people may agree or disagree with the use of some scientific discoveries • Science is never 'complete' and scientists are always working to make models more accurate or to discover new explanations
Y6		• Taking multiple readings allows you to see if your data is repeatable, helps identify outliers and allows a mean to be calculated	• Decide which graph is most appropriate for the enquiry	• Calculating the mean can be used as a method of analysing data
KS3	• Evaluate risks	• Pay attention to objectivity and concern for accuracy, precision, repeatability and reproducibility • Use a wider range of apparatus and techniques • Apply sampling techniques • Evaluate data, showing awareness of potential sources of random and systematic error	• Use a range of graph types to display data, including pie charts, scatter graphs and line graphs	• The difference between correlation and causation, and suggesting ways to test for both • Understand that scientific methods and theories develop as earlier explanations are modified to take account of new evidence and ideas, together with the importance of publishing results and peer review

Books to read if you are interested in Science...

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Autumn 1	**Biology** Plants	**Biology** Plants	**Chemistry** Rocks	**Biology** Classifying organisms	**Chemistry** Separating mixtures	**Biology** Evolution
Autumn 2	**Biology / Physics** Seasonal changes	**Biology** Needs of animals	**Physics** Light	**Biology** Food & digestion	**Biology/Chemistry/Physics**	**Physics** Electricity
Spring 1	**Chemistry** Everyday materials	**Chemistry** Uses of everyday materials	**Biology** Living organisms	**Chemistry** States of matter	**Biology** Life cycle	**Physics** Light
Spring 2	**Consolidation and review**	**Biology** Living things & their habitats	**Biology** Plants	**Physics** Sounds	**Biology** Human development	**Biology** Further classification
Summer 1	**Biology** Animals	**Chemistry** Introducing particles	**Physics** Forces & magnets	**Physics** Electricity	**Physics** Forces	**Biology** Functions of the human body
Summer 2	**Biology** Humans	**Consolidation and review**	**Physics** Forces & magnets	**Chemistry** Properties of materials	**Physics** Earth and space	**Chemistry** Physical and chemical changes

Alignment to the National Curriculum

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Autumn 1	**Biology** Plants *Identifying and naming common plants and describing basic structures*	**Biology** Plant growth *Plants grow from seeds, and require water, light and a suitable temperature*	**Chemistry** Rocks *Comparisons of types of rocks and how fossils are formed*	**Biology** Classifying organisms *Introduction to classifying animals and their environment*	**Chemistry** Separating mixtures *Identifying and separating mixtures; difference between reversible and non-reversible changes*	**Physics** Electricity *Investigating variations in series and parallel circuits, and how electricity is generated*
Autumn 2	**Biology / Physics** Seasonal changes *Observing changes across four seasons and describing associated weather*	**Biology** Needs of animals *Animals need water, food and air to survive and to have offspring*	**Physics** Light *Relationship between light and how we see; the formation of shadows*	**Biology** Food & digestion *The human digestive system and simple food chains*	**Biology, Chemistry, Physics** Energy *Introducing the concept of energy stores and energy transfers, and relating this to prior knowledge*	**Biology** Evolution *Fossils; introduction to the idea that adaptation may lead to evolution*
Spring 1	**Chemistry** Everyday materials *Distinguishing objects from the material it's made from, and describing simple properties*	**Chemistry** Uses of everyday materials *Comparisons of an object's material with its use; impact of bending, twisting on solid objects*	**Biology** Living organisms *The role of muscles and skeletons; the importance of nutrients*	**Chemistry** Particle model and states of matter *States of matter in relation to particle arrangement*	**Biology** Life cycles *Life cycles of a mammal, amphibian, insect and bird, and some reproduction processes*	**Physics** Light *How light travels and is reflected, and how this allows us to see*
Spring 2	**Consolidation and review**	**Biology** Living things & their habitats *Basic introduction to habitats and micro-habitats, and simple food chains*	**Biology** Plants *The key features of flowering plants and what they need to survive*	**Physics** Sounds *Relationship between strength of vibrations and volume of sound*	**Biology** Human development *Human development to old age*	**Biology** Further classification *Further classification of living organisms based on characteristics*
Summer 1	**Biology** Animals *Identifying and naming fish, amphibians, reptiles, birds and mammals; carnivores, herbivores and omnivores*	**Chemistry** Solids, liquids and gases *Understanding how the same substances can exist as solids, liquids and gases*	**Physics** Forces & motion *Introducing pushes and pulls; opposing forces, and balanced forces*	**Physics** Electricity *Simple series circuits*	**Physics** Forces *Gravity, air and water resistance and friction; introduction to pulleys*	**Biology** Functions of the human body *Human circulatory system; transport of nutrients within the body*
Summer 2	**Biology** Humans *Human body parts and senses*	**Consolidation and review**	**Physics** Friction & magnetism *Contact and non-contact forces, including friction and magnetism*	**Chemistry** Properties of materials *Considering physical and chemical properties*	**Physics** Earth and space *Movements of planets and the Moon, and relationship to day and night*	**Chemistry** Physical and chemical changes *Identifying physical and chemical changes*

There are opportunities for pupils to consolidate or review knowledge in KS1, to ensure that these early concepts are fully mastered before KS2. They also allow time for pupils to revisit ideas in different seasons (e.g. observing changes in spring from autumn).

Disciplinary knowledge (working scientifically)

As specified in the National Curriculum, disciplinary knowledge is not taught as a separate strand. Instead, very specific aspects of disciplinary knowledge (for example, recognising and managing risk; or measuring using a Newtonmeter) are explicitly taught as part of the units set out here. They are deliberately practiced in the context of relevant and appropriate experiments, and then reviewed at regularly intervals across the key stages.

Substantive knowledge

The units that are not highlighted in colour align directly to the topics in the Programmes of Study and cover – at a minimum – the statutory content set out.

The statutory content in some topics in the Programmes of Study is substantial. Where this is the case, more time has been dedicated to it and the content is split into two complementary units. This allows sufficient time for mastery.

Three additional units purposefully take pupils beyond the Programmes of Study:

- **Year 2: Solids, liquids and gases**. This introduces pupils to the idea that familiar substances (like water or chocolate) can exist as solids, liquids or gases. It will support understanding of states of matter and the particle model in Year 4, and preempts the misconception that substances only ever exist in one state.
- **Year 5: Energy**. This introduces pupils to energy stores and transfers at a very basic level, and has been designed to preempt misconceptions that need to be unpicked at secondary. It also allows pupils to review content from previous topics across biology, chemistry and physics (like food webs, electricity, and states of matter), and consider them through the lens of energy.
- **Year 6: Physical & chemical changes**. This unit gives pupils the opportunity to run more sophisticated practical investigations. It provides a good transition to Year 7.

Impact

Assessing impact is assessing how well pupils have learned the required knowledge from the implemented curriculum. It is not about lots of tests, or meticulously comparing pupils' outcomes at the start and end of each unit.

If pupils can keep up with a well-sequenced curriculum that has progression built in, they are making progress!

The United Curriculum has this progression built in, and so teachers and subject leads just need to be confident that pupils are keeping up with it.

This can be done through:

- **Formative assessment in lessons**

  There are opportunities for formative assessment in the lesson slides provided, and teachers should continually adapt their lesson delivery to address misconceptions and ensure that pupils are keeping up with the content.

- **Low-stakes summative assessment**

  A post-learning quiz is provided for every unit. These questions usually take the form of multiple-choice questions, and aim to assess whether pupils have learned the core knowledge for that unit. These should also be used formatively, and teachers should plan to fill gaps and address misconceptions before moving on.

- **Books and pupil-conferencing**

  Talking to pupils about their books allows you to assess how much of the curriculum content is secure. These conversations are used most effectively to determine whether pupils have a good understanding of the vertical concepts, and if they can link recently taught content to learning from previous units. (They should not be used to assess whether pupils can recall information, as low-stakes quizzes can gather this information more efficiently).