National Curriculum for science Key Stages 1 and 2 – Draft

National Curriculum review

Contents

Purpose of study

A high-quality science education provides the foundations for understanding the world through the specific disciplines of biology, chemistry and physics. Science has changed our lives and is vital to the world's future prosperity, and all pupils should be taught essential aspects of the knowledge, methods and uses of science. Through building up a body of key foundational knowledge and concepts, they should be encouraged to recognise the power of rational explanation and develop a sense of excitement and curiosity about natural phenomena. They should be encouraged to understand how key foundational knowledge and concepts can be used for explanation of what is occurring, prediction of how things will behave, and analysis of causes. This foundational understanding should be consolidated through appreciation of specific applications in society and the economy.

Aims

The National Curriculum for science aims to ensure all pupils:

- develop **scientific knowledge and conceptual understanding** through the specific disciplines of biology, chemistry and physics
- develop understanding of the **nature, processes and methods of science** through practical activity
- are equipped with the scientific knowledge required to understand its **uses and implications** today and for the future.

The Programmes of Study describe a sequence of knowledge and concepts. While it is important that pupils make adequate progress, it is of vital importance that they develop secure understanding of each key block of knowledge and concepts in order to progress to the next stage of the sequence. Insecure, superficial understanding will not allow genuine progression - pupils can struggle at key points (e.g. from primary to secondary), build up serious misconceptions, and/or experience significant difficulties with higher-order content.

Pupils should develop secure understanding of scientific concepts and be able to describe associated processes and key characteristics in common language, but be familiar with, and use accurately, the technical terminology appropriate to such concepts. They should build an extended specialist vocabulary, and use this with precision, as they progress. They should also apply their mathematical knowledge to their understanding of science. The social and economic implications of science are considered to be important but generally to be most appropriately addressed within the wider school curriculum, as schools will wish to use different contexts to maximise the engagement and motivation of their pupils in science.

Understanding the nature, processes and methods of science is specified under the heading 'Working scientifically' for each year group. This should not be taught as a separate strand. The Notes and Guidance set out examples of how 'Working scientifically' can be embedded into the content of biology, chemistry and physics, focusing on the foundational aspects of the practice of science: observation, recording, measurement, and experimental control. In Upper Key Stage 2, the key elements of scientific enquiry are introduced. These will be developed further, in a more elaborated and critical way, in secondary once pupils have built up sufficient understanding of science to engage meaningfully with more sophisticated discussion of experimental design and control.

Spoken language
The National Curriculum for science reflects the importance of spoken language in pupils' development – linguistically, cognitively and socially – across the whole curriculum. The quality and variety of language that pupils hear and speak are key factors in developing their scientific vocabulary and articulating scientific concepts clearly and precisely. They must be assisted in making their thinking clear to themselves as well as others and teachers should ensure pupils build secure foundations by using discussion to probe and remedy their misconceptions.

School curriculum
Each Programme of Study is set out year-by-year in science. All maintained schools are only required to teach the Programme of Study by the end of each key stage. Within each key stage, maintained schools therefore have the flexibility to introduce content earlier or later than set out in the Programme of Study. In addition, schools can introduce key stage content during an earlier key stage if appropriate. All schools are also required to set out their school curriculum for science on a yearly basis and make this available online.

Inclusion
Teachers should set high expectations for all pupils and should also be aware of the requirements of the equal opportunities legislation that covers gender, race and disability. A minority of pupils will have particular requirements that arise as a consequence of Special Educational Needs, disability or learning English as an additional language. Teachers must take account of these requirements and make provision, where necessary, to support this diverse group of pupils. During end of key stage assessments, teachers should bear in mind that special arrangements are available to support individual pupils.

Attainment targets
By the end of each Key Stage, pupils are expected to have the knowledge, skills and understanding of the matters taught in the relevant Programme of Study.

Digital Technology
Digital technologies have changed the nature of all disciplines. In Science digital technologies enhance the range, scope and opportunities in Biology, Chemistry and Physics. In addition teachers need to consider how digital technologies can best be used to support the teaching of Science. As technology changes, teachers need to assess what the latest innovations offer in teaching science.

Science Programme of Study: Key Stage 1

The teaching of science in **Key Stage 1** should introduce pupils to a variety of plants and animals (including humans), materials and physical phenomena.

Pupils should study (by working scientifically, working practically, and using a variety of research methods including using books and ~~ICT~~ digital technologies):

- Basic structures and simple classification of common plants and animals
- Life processes, including growth, reproduction and feeding, and growing plants
- Habitats, including food chains
- Simple physical properties of everyday materials in relation to their uses
- Sources of light
- Night and day, and the movement of the Sun across the sky
- Forces that make things move, speed up and slow down, and change shape.

Science biographies, for example, Charles Darwin.

'Working scientifically' is to be delivered through the teaching of substantive subject content, and is **not to be taught separately** as content in its own right. In Year 1 and Year 2, 'working scientifically' includes aspects of:

- Observing closely using simple equipment
- Performing simple tests
- Identifying and classifying
- Recording findings in various formats.

Ensure pupils read and write scientific vocabulary, consistent with their phonic knowledge at Key Stage 1.

Year 1 Programme of Study	Notes and guidance
Plants Pupils should be taught to: • identify and name a variety of common plants, including garden plants, wild plants and trees, and those classified as deciduous and evergreen [1] • describe the basic structure of a variety of common plants including roots, stem, leaves and flowers. [2]	**Plants** Ensure pupils use the local environment throughout the year to study plants growing in their habitat. This should include making collections and observing and recording the weather and its effect on plants (plants growing and leaves turning towards the sunlight). [3] Ensure pupils frequently name plants so that they become very familiar with common names (e.g. daffodil, tulip, crocus, daisy, dandelion) and examples of deciduous (e.g. oak, horse chestnut, apple, beech, willow, sycamore) and evergreen (e.g. fir, pine, holly). Ensure pupils become familiar with plant structures (trees: trunk, roots, branches, leaves, fruit; garden and wild plants: flower, petals, stem, leaves, roots, bulb and seed). [4] Pupils can apply their knowledge and skills by: • comparing, describing and recording the structures of known common plants to a range of uncommon plants, including whether they are deciduous or evergreen, through e.g. labelling different parts, drawings, diagrams, displays, photographs, models. • describing and comparing how plants grow in a variety of habitats (e.g. in the desert, in the rainforest, mountain range, pine forests etc). See 'Habitats' section for more detail. [5] **In Year 2**, pupils will be taught more about plants including their requirements for life and life cycles. [6]
Animals including humans Pupils should be taught to: • identify and name a variety of common animals that are birds, fish, amphibians, reptiles, mammals and invertebrates [7] • identify and name a variety of common animals that are carnivores, herbivores and omnivores [8] • describe and compare the structure of a variety of common animals (birds, fish, amphibians, reptiles, mammals and invertebrates, and including pets) and describe how they are suited to their environment [9] • identify, name, draw and label the basic parts of the human body and say which part of the body is associated with each sense. [10]	**Animals including humans** Ensure pupils use the local environment throughout the year to study animals in their habitat. This can include making collections (e.g. insects, snails, worms) for later study. However pupils should understand how to take care of animals taken from their local environment, and the need to return them after study. Pupils should also use the local environment to observe and record the weather and any effects on animals (e.g. earth worms coming to the surface in wet weather). Pupils can establish a 'nature walk' in the school grounds or local environment that can be revisited at different times of year. They can relate this to the biography of Charles Darwin and his 'Sand Walk' at Downe House. [11] Ensure pupils have the opportunity to name animals regularly so that they

Year 1 Programme of Study	Notes and guidance
	become very familiar with common names, types and animal structures. Pupils should be introduced to classification but it is not necessary in Y1 to use the correct classification groupings. Content can include: • birds (e.g. blackbird, robin, blue tit, pigeon), fish (e.g. goldfish), amphibians (e.g. frogs), reptiles (e.g. snakes, tortoises), mammals (e.g. cat, dog, cow, rabbit, horse) and invertebrates (e.g. snails, slugs, worms, centipedes, bees, wasps, beetles, butterflies, flies). • herbivorous animals eat only plants (e.g. horses, rabbits, tortoises, cows, sheep), carnivorous animals eat only meat (e.g. foxes, domestic cats, snakes, birds of prey), and omnivorous animals eat plants and meat (e.g. humans, crabs, pigs). • fish have eyes, scales, fins, gills, tail; birds have eyes, beaks, feathers, wings, tails, legs and feet; cats have eyes, teeth, fur, four legs, tail. [12] Ensure pupils have plenty of opportunity to learn the names of the main body parts (through speech, games, actions, songs and rhymes). The basic parts of the body to be introduced here can include: head, neck, arms, elbows, legs, knees, face, ears, eyes, hair, mouth, teeth, etc. [13] Pupils can apply their knowledge and skills by: • comparing, describing and recording the structures of known common animals through e.g. labelling different parts, drawings, diagrams, displays, photographs and models. • comparing known common animals (carnivores, herbivores and omnivores) to a range of uncommon animals (at the zoo, on a farm, in the ocean and in the rainforest) and describing and recording findings. • describing and comparing how animals are found in, and suited to, a variety of habitats (see 'Habitats' section for more detail). • drawing and labelling the basic parts of the human body. • performing simple comparative tests on the five senses and describing the findings for sight, hearing, taste, touch and smell. [14] **In Year 2**, pupils will be taught more about animals including their requirements for life and life cycles. [15]
Light Pupils should be taught to: • identify and name a variety of sources of light that we can see with our eyes, including electric lights, flames and the Sun [16]	**Light** Ensure pupils practise naming a variety of sources of light regularly so that they become very familiar with the common names. • simple comparisons: e.g. dark, dull, bright, very bright. • comparative vocabulary: e.g. brighter, duller, darker.

Year 1 Programme of Study	Notes and guidance
• explain that darkness is the absence of light [17] • compare the variety of sources of light, using simple comparisons, comparative vocabulary and superlative vocabulary [18] • describe the features of day and night, including changes in light and temperature [19] • describe the movement of the Sun across the sky during the day. [20]	• superlative vocabulary: e.g. brightest, dullest, darkest. [21] Pupils can apply their knowledge and skills by: • observing closely the movement of the Sun during the day, looking to see when it is at its highest point in the sky (noon); at some times of year, observing sunrise and sunset; looking at how high the Sun is in the sky from one month to the next. Pupils can observe closely and record their findings in the form of simple measurements (for example, time of day/year), drawings, diagrams, photographs, filling in tables and charts, and making displays. • measuring the length of a shadow cast by a stick (detailed work on shadows begins in Year 4). Pupils can record their findings in the form of simple measurements (for example, time of day/year), drawings, diagrams, photographs, filling in tables and charts, and making displays. [22] Pupils at this stage should not be expected to learn that day and night are caused by the Earth rotating on its axis. [23] Ensure that pupils are clear about safety at all times and particularly that they take appropriate precautions when observing the Sun (do not look directly at it, even whilst wearing sunglasses). [24] **In Year 4**, pupils will be taught more about light and will study the Sun in our solar system. [25]
Working scientifically During Year 1, through teaching Programme of Study content, pupils should use the following practical scientific processes and methods: • observing closely using simple equipment [26] • performing simple tests [27] • identifying and classifying photography [28] • recording findings using standard units, drawings, diagrams, ~~photographs~~, simple prepared formats such as tables and charts, tally charts, and displays. [29]	**Working scientifically** All the items listed should be covered by pupils during the course of Year 1, but pupils are not expected to cover each item for every area of study. Teachers should refer to the notes and guidance for examples of specific aspects of working scientifically related to subject content. [30]

Year 2 Programme of Study	Notes and Guidance
All living things Pupils should be taught to: • explain the differences between things that are living and things that have never been alive. [31]	**All living things** Ensure pupils are introduced to the concept that all living things have certain characteristics that are essential for keeping them alive and healthy. Pupils should be familiar with the term organism and the life processes common to all living things. [32] Pupils can apply their knowledge by: • discussing the life processes common to plants and animals, including humans, and recording similarities and differences e.g. using scientific labels; and • deciding whether things are living, dead or non-living. [33] Pupils can be introduced to the idea that all living things are made up of cells. However, they would not be expected to understand cell structures and functions at this stage. [34]
Plants Pupils should be taught to: • describe how seeds and bulbs grow into mature plants [35] • describe how plants need water, light and a suitable temperature to grow and stay healthy. [36]	**Plants** Ensure pupils use the local environment throughout the year to identify and study plants growing in their habitat (including seeds, bulbs, fruit and vegetables, deciduous and evergreen bushes and trees). [37] Ensure pupils are introduced to the requirements of plants for growth and survival, as well as the process of reproduction and growth in plants. This will be encountered in more detail in Year 6. The focus at this stage is to help pupils recognise growth; they should not be expected to understand how reproduction occurs. [38] Please note: seeds and bulbs need water to grow but do not need light - seeds and bulbs have a store of food inside them. It is not necessary, in Year 2, to carry out tests on plants or measure their growth. [39] Pupils can apply their knowledge and skills by: • growing and recording with some accuracy the growth of a variety of plants from a seed or bulb, through e.g. drawings, diagrams, bar charts, displays, photographs. • setting up a comparative test to show that plants need light and water to stay healthy e.g. comparing plants growing in the dark and in the light; with and without water; and in warm and cold places. Please note: pupils are not conducting a fair test or predicting what they think will happen; the

Year 2 Programme of Study	Notes and Guidance
	tests are purely for gaining knowledge and evidence about conditions for plant growth. In addition, the effects of temperature on plant growth will be tested in Key Stage 2. • discussing the food we eat from plants: fruits, seeds, cereals, grasses and vegetables. [40] Ensure pupils practise measuring length in millimetres (mm), centimetres (cm) and metres (m) using rulers. [41] **In Key Stage 2**, pupils will be taught more about growing plants and how plants make their own food. [42]
Animals including humans Pupils should be taught to: • explain that animals including humans have offspring which grow into adults [43] • explain the basic needs of animals, including humans, for survival (which are water, food and air) [44] • describe the importance for humans of exercise and eating the right amounts of different types of food. [45]	**Animals including humans** Ensure pupils are introduced to basic needs of animals for survival as well as the importance of exercise and nutrition for humans. Pupils will also be introduced to the process of reproduction and growth in animals. This will be encountered in more detail in Year 5. The focus at this stage is to help pupils recognise growth; they should not be expected to understand how reproduction occurs. The following examples can be used: • egg, chick, chicken; egg, caterpillar, pupa, butterfly; spawn, tadpole, frog; lamb, sheep. • growing into adults can include reference to: baby, toddler, child, teenager, adult. [46] Pupils can apply their knowledge and skills by: • describing, comparing and recording, with some accuracy, information about animals though e.g. drawings, labelling, diagrams, displays, photographs, models and maps. • exploring and describing how animals kept or used by humans need special care to remain healthy: e.g. looking after pets, zoo animals, farm animals and their young. [47]

Year 2 Programme of Study	Notes and Guidance
Habitats Pupils should be taught to: • identify that living things live in habitats to which they are particularly suited and describe how different habitats provide for the basic needs of different kinds of animals and plants, and how they depend on each other [48] • identify and name a variety of plants and animals they study in a variety of habitats, including microhabitats [49] • describe how animals obtain their food from plants and other animals using the idea of a simple food chain, and identify and name different sources of food. [50]	**Habitats** Ensure pupils use the local environment regularly throughout the year to observe and record the weather, using measurements where possible: rain fall (mm), temperature (°C) and wind direction. [51] Ensure pupils also use the local environment to identify and study a variety of plants and animals within their habitat. Pupils can be introduced to the terms 'habitat' (a natural environment or home of a variety of plants and animals) and 'microhabitat' (a very small habitat e.g. for woodlice under stones, logs or leaf litter). An example of how living things can depend on each other can involve: plants serving as a source of food and shelter for animals. [52] This can include the study of: • school grounds or nearby field/park/garden: type of tree (e.g. oak); birds (e.g. sparrow, blackbird); invertebrates (e.g. snail, worm, woodlice) including insects (e.g. ants, butterflies, beetles). This can also provide an example of a simple food chain – e.g. berries, insects, bird and fox. • a wood: type of tree (e.g. oak, beech, horse chestnut, fir); birds (e.g. thrush, blackbird, woodpecker); invertebrates (e.g. snail, worm) including insects (e.g. ants, butterflies, beetles). • the sea/seaside: plants (e.g. grass); animals (e.g. shellfish, fish, starfish); algae (e.g. seaweed). [53] Pupils can apply their knowledge and skills by: • recording findings from a variety of plants and animals, studied in a variety of habitats, including a simple food chain through e.g. drawings, labelled diagrams, plotting maps, matching diagrams, sorting trees; constructing graphs and tables. • comparing animals in known habitats to animals found in other habitats: e.g. at the zoo, on a farm, in the ocean, in the rainforest. • constructing a simple food chain that includes humans (e.g. grass, cow, human; worms or plants, crab, fish, human). [54] **In Key Stage 2**, pupils will be taught more about food chains and food webs within a variety of habitats and microhabitats. [55]

Year 2 Programme of Study	Notes and Guidance
Everyday materials Pupils should be taught to: • distinguish between an object and the material from which it is made [56] • identify and name a variety of everyday materials, including wood, plastic, glass, metal, water, and rock [57] • describe the simple physical properties of a variety of everyday materials [58] • compare and group together a variety of everyday materials on the basis of their simple physical properties [59] • find out how the shapes of solid objects made from some materials can be changed by squashing, bending, twisting and stretching. [60]	**Everyday materials** 'Materials' is used here in the sense adopted by materials scientists i.e. a material used for specific purposes because its intrinsic physical properties make it suitable for that purpose. The intrinsic physical properties are those associated with the material itself. Teachers should be aware that physical attributes may present differently in different forms, shapes and objects. For example, a thin piece of wood may be bendy while a thick piece is rigid. Nylon cloth is 'soft' to feel, but nylon wheels are very hard. [61] Ensure pupils practise exploring, naming and discussing everyday materials regularly so that they become very familiar with the names of materials and properties. [62] Examples of properties include: hard/soft; stretchy/not stretchy; shiny/dull; rough/smooth; bendy/not bendy; transparent/not transparent. [63] Pupils may study materials additional to those listed in the Programme of Study; for example: • in school: brick, sand, paper • in cooking: flour, butter, milk • in school grounds: soil. [64] Pupils can apply their knowledge and skills by: • comparing the everyday materials in and around the school with materials found in other places (e.g. at home, the journey to school, on visits and in stories, rhymes and songs). They can observe closely, identify and classify materials, and record their observations in simple forms; for example, by making drawings, diagrams, photographs, filling in tables and charts, and making displays. • studying the biographies of some people who have developed useful new materials; for example, Dunlop, MacKintosh or MacAdam. [65]
Uses of everyday materials Pupils should be taught to: • identify and compare the uses of a variety of everyday materials, including wood, metal, plastic, glass, brick/rock, and paper/cardboard. [66]	**Uses of everyday materials** Examples of uses of materials listed include: • wood, metal and plastic: tables, chairs, window frames, climbing frames, shelves, boxes, toys. • glass: windows, screens, ornaments. • brick: walls, steps, buildings, houses. • paper/cardboard: books, wallpaper, boxes. [67]

Year 2 Programme of Study	Notes and Guidance
	Ensure pupils practise identifying and discussing the uses of different everyday materials so that they become familiar with how some materials are used for more than one thing or for the same thing (spoons can be plastic, wood, metal, but not glass; tables can be made from plastic, wood, metal but not paper). [68] Pupils can apply their knowledge and skills by: • comparing the uses of everyday materials in and around the school with materials found in other places (at home, the journey to school, on visits and in stories, rhymes and songs). They can observe closely, identify and classify the uses of different materials, and record their observations in simple forms, e.g. by making drawings, diagrams, photographs, filling in tables and charts, and making displays. • participating in a class project to make a doll's house, discussing what the materials represent in a real house, and what properties are important for each part of the house. [69] **In Year 3**, pupils will be taught more about properties of materials, including materials that are attracted to a magnet, materials that sink or float, and how rocks that have different properties have been formed in different ways. [70]
Forces and motion Pupils should be taught to: • describe how things move at different speeds, speed up and slow down, using simple comparisons, comparative vocabulary and superlative vocabulary. [71]	**Forces and motion** Ensure pupils have opportunities to experience phenomena associated with movement, and to observe closely some things moving. Pupils should not be encouraged to talk in terms of 'forces' or 'energy', or be introduced to forces as pushes or pulls affecting motion. Choose instead activities that give experiences of speed (low and high) and speeding up and slowing down. [72] Ensure pupils practise discussing, describing and comparing the movement of a variety of objects and also themselves (through actions, games, songs and rhymes) so that they become familiar with the movement of objects. [73] Ensure that pupils can discuss how when there is no movement, the object is still, including: • simple comparisons: e.g. fast, slow, very fast, very slow • comparative vocabulary: e.g. faster, slower, speeding up, slowing down • superlative vocabulary: e.g. fastest, slowest. [74] Examples of ways in which things can be made to speed up and slow down:

Year 2 Programme of Study	Notes and Guidance
	sliding, rolling, falling, flying, walking, running, braking and dragging. [75] Pupils can apply their knowledge and skills by: • describing the movement of specific objects (paper aeroplanes, parachutes, toy cars, balls) found in everyday life or moving objects found in stories, songs and rhymes. They can perform simple tests to explore how different objects move, observe the results closely, and record their observations in simple forms; for example, by making drawings, diagrams, photographs, filling in tables and charts, and making displays. • discussing what makes things slow down e.g. brakes on a bicycle or speed up e.g. pushing on a scooter. They can perform simple tests to explore how moving objects can be made to slow down, observe the results closely, and record their observations in simple forms; for example, by making drawings, diagrams, photographs, filling in tables and charts, and making displays. • observing animals e.g. cheetah is the fastest, dogs are fast, snails and earthworms are slow. • making 'motors' out of cotton reel, matchstick and elastic band. [76]
Working scientifically During Year 2, through teaching Programme of Study content, pupils should use the following practical scientific processes and methods. • observing closely using simple equipment [77] • performing simple tests [78] • identifying and classifying [79] • recording findings using standard units, drawings, diagrams, photographs, simple prepared formats such as tables and charts, tally charts, and displays. [80]	**Working scientifically** All the items listed should be covered by pupils during the course of Year 2, but pupils are not expected to cover each item for every area of study. Teachers should refer to the notes and guidance for examples of specific aspects of working scientifically related to subject content. [81]

Science Programme of Study: Lower Key Stage 2

The teaching of science in **Lower Key Stage 2** should ensure that pupils know about a variety of plants and animals (including humans), materials and everyday phenomena.

Pupils should study (by working scientifically, working practically, and using a variety of research methods including using books and ~~ICT~~):

- The function of different parts of plants, and what plants need to survive
- What animals need to survive
- Movement in vertebrates, including humans
- Classification of living things: plants and animals
- Human digestion
- Food chains and food webs
- Introduction to evolution and inheritance
- Everyday materials that are attracted to magnets, or that sink/float
- How to make a magnet and the properties of magnets
- Simple physical properties of some kinds of rocks, and how rocks and fossils are formed
- States of matter and changes of state, with particular reference to water
- Sources of sound
- Light and shadows
- Solar systems and galaxies, including the motion of the Earth in relation to the Sun
- The uses of electricity, and how to wire a simple circuit.

digital technologies

Science biographies, for example, Carl Linnaeus, Charles Darwin, Nicholas Copernicus, Galileo Galilei and Neil Armstrong.

'Working scientifically' is to be delivered through the teaching of substantive subject content, and is **not to be taught separately** as content in its own right. In Year 3 and Year 4, 'working scientifically' builds on earlier content and also includes aspects of:

- setting up simple comparative and fair tests
- beginning to make accurate measurements using standard units
- recording findings in various formats
- reporting on findings
- using results to draw conclusions and make predictions for setting up further tests.

Ensure pupils read and spell scientific vocabulary correctly and with confidence, using their growing knowledge of spelling patterns and rules.

Year 3 Programme of Study	Notes and guidance
Plants Pupils should be taught to: • identify and describe the functions of different parts of plants: roots, stem, leaves and flowers [82] • identify the requirements of plants for life and growth (air, light, water, nutrients from soil and space) and how they vary from plant to plant [83] • describe the ways in which nutrients, water and oxygen are transported within plants. [84]	**Plants** Pupils should be introduced to the relationship between structure and function – the idea that every part of the plant has a job to do. At this stage, this should focus on the role of the roots in nutrition, the stem in nutrition and reproduction, leaves for nutrition and growth, and flowers for reproduction. [85] Pupils should apply their knowledge by: • describing and recording with accuracy information about plants e.g. comparing a variety of common plants and identifying that, while each is different, they all have parts in common e.g. through photographs, displays, labelling and drawings. • discussing how each part of the plant is suited to the job it has to do. • discussing and comparing different plants and their different requirements e.g. comparing the flowers of insect- and wind-pollinated plants and discussing why they are different. • setting up and conducting a simple test to explore how water is transported in plants e.g. putting cut white carnations into coloured water and observing how water travels up the stem to the flowers. Record observations. [86] Pupils can be introduced to idea that plants can make their own food, but they do not need to understand how this happens at this stage. [87]
Animals including humans Pupils should be taught to: • explain that animals, including humans, need the right types and amount of nutrition and that they cannot make their own food; they get nutrition from what they eat [88] • describe the ways in which nutrients, water and oxygen are transported within animals, including humans [89] • identify that humans and some animals have skeletons and muscles for support and movement. [90]	**Animals including humans** Pupils will continue to learn about the importance of nutrition (including a balanced diet). Pupils should be introduced to the main body parts associated with the skeletal, muscular system, and how they have special functions. This can include: • skeletal system – skeleton, bones and specific bones: skulls, ribs, legs, arms and spine; • muscular system – muscles: arms, legs, abdomen/stomach muscles; • the skeleton and muscular system work together for movement. [91] Pupils should apply their knowledge and skills by: • describing how the body uses up the food eaten and the oxygen breathed in. • setting up a simple comparative test to show how everyday activities (e.g. exercise, resting, walking) affect the human body (e.g. breathing

Year 3 Programme of Study	Notes and guidance
	increasing and slowing down, tired muscles). • recording information about the skeletal and muscular system though e.g. scientific labels, models, displays etc. [92]
Everyday materials Pupils should be taught to: • based on testing, explore differences between materials, including attraction to a magnet, and floating or sinking [93] • compare and group together a variety of everyday materials on the basis of whether they are attracted to a magnet or will sink/float. [94]	**Everyday materials** Ensure pupils have plenty of opportunity to practise measuring time in seconds (s). [95] Please note: pupils are not conducting a fair test or predicting what they think will happen; the tests are purely for gaining knowledge and evidence about, for example, the effects of exercise on the human body. [96] Examples of simple comparative tests on effects of everyday activities include measuring the effect of exercise, resting, walking or lifting on rate of breathing, and measuring number of heart beats or breaths in relation to time. [97] Ensure pupils understand that it is the material from which an object is made that determines whether it will sink or float and whether it is attracted to a magnet. [98] Pupils can apply their knowledge and skills by: • discussing the differences between materials that sink (metal e.g. coins; ceramic e.g. plates; glass e.g. kitchen utensils; stones and rocks; sand) and those that float (wood e.g. matchsticks, twigs and sticks; air e.g. bubbles in water); identifying objects that need to sink or float in order to be useful. Pupils can set up and perform simple tests on whether materials float or sink, record their findings (using simple scientific language, drawings, labelled diagrams, bar charts or tables), report on their findings including presenting written explanation, and use their results to suggest improvements and predictions for setting up further tests. • investigating whether materials that will float/sink in water will also float/sink in salty water or oil. Pupils can set up and perform fair tests, record their findings (using simple scientific language, drawings, labelled diagrams, bar charts or tables), report on their findings including presenting written explanation, and use their results to suggest improvements and predictions for setting up further tests. • making boats from different materials (e.g. plasticine, wood) to see which will float, and finding out how boats that float can be made out of materials that do not float.

Year 3 Programme of Study	Notes and guidance
	• comparing materials that are attracted to a magnet (iron and steel e.g. some kinds of food and drink cans, fridge doors, paper clips, iron filings) and materials that are not attracted to a magnet (aluminium, copper, lead e.g. some other kinds of food and drink cans, water and gas pipes, coins); plastic (carrier bags, plastic containers, toys), wood (doors, pencils), wax (crayons, candles), and identifying objects that need to be magnetic or non-magnetic to be useful. • setting up and performing simple tests on whether materials are attracted to a magnet, record their findings (using simple scientific language, drawings, labelled diagrams, bar charts or tables), report on their findings including presenting written explanation, and use their results to suggest improvements and predictions for setting up further tests. [99] In selecting exemplars, teachers should ensure that it is the material that determines whether an object will sink or float, and not the form in which the material is presented; for example, some plastic objects will float only because they are hollow and have air trapped inside. Teachers should avoid composite materials. [100] Teachers may find it useful to teach the standard equivalence between mass and volume of water: 1 kg of water = 1 l of water. [101]
Rocks Pupils should be taught to: • compare and group together different kinds of rocks on the basis of their simple physical properties [102] • relate the simple physical properties of some rocks to their formation (igneous or sedimentary) [103] • describe in simple terms how fossils are formed when things that have lived are trapped within sedimentary rock. [104]	**Rocks** Ensure pupils understand that different kinds of rocks are found on and under the Earth's surface, and that the properties of different kinds of rocks relate to the way in which the rocks were formed. [105] Pupils can apply their knowledge and skills by: • discussing different kinds of rocks and how their properties make them useful in different ways e.g. granite is hard and polishes to a smooth surface, so makes good work surfaces and monuments; limestone is soft and crumbly and you can draw with chalk; sandstone is an attractive building material but does not weather well because it erodes relatively quickly; jewellery can be made from crystals in rocks. Pupils can set up and perform simple tests on the properties of a variety of kinds of rock, record their findings (using simple scientific language, drawings, labelled diagrams, bar charts or tables), report on their findings including presenting written explanation, and use their results to suggest improvements and predictions for setting up further tests. • discussing the differences between igneous rocks (hard, have crystals in

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	them, found where volcanoes have erupted e.g. granite, basalt) and sedimentary rocks (found where there has been a seabed, made up of layers of sediment squeezed and squashed together, tend to be softer and a bit crumbly e.g. limestone, sandstone and shale). • looking at rocks with a hand lens to decide if they are made of grains or crystals, and whether they have fossils in them. Pupils can observe closely and report on their findings, including presenting written explanation. • discussing the different kinds of living things whose fossils have been found in sedimentary rock: for example, plants, dinosaurs, sea creatures (e.g. ammonites and trilobites). • making: 'biscuit fossils' using crumbled biscuits, syrup, and raisins; a model of igneous rock formation using molten chocolate; or a model volcano using bicarbonate of soda and vinegar. [106] Teachers should be aware that a third category of rocks, metamorphic, consists of rocks which have been changed through the action of heat or pressure. Pupils are not expected to be taught about this category, but teachers should be prepared to answer questions about the nature of e.g. marble and slate. [107]
Sound Pupils should be taught to: • identify and name a variety of sources of sound that we can hear with our ears, and how the sounds are made [108] • compare the variety of sources of sound, using simple comparisons, comparative vocabulary and superlative vocabulary [109] • explain that sound travels away from sources and get fainter as it does so [110] • develop understanding of patterns of pitch and volume, and explore varying sound systematically [111] • explain how sounds are heard using results of any comparative tests, and the scientific idea that sounds are made by vibrations that travel from a source and through materials (solids, liquids and gases) to the ear. [112]	**Sound** Ensure pupils practise naming a variety of sources of sound regularly so that they become very familiar with where sounds come from and how they are made. [113] Pupils can apply their knowledge and skills by: • experiencing making sounds, for example using musical instruments to explore and discuss the different sounds and how they can be made (drums can be tapped, hit with a stick, tapped on the side; a stick can be used to make a sound on lots of different musical instruments); • discussing louder and softer sounds, and how to make louder sounds; • investigating what happens to the loudness of a sound as you move further away – outdoors, perhaps in the playground, talking more or less quietly while other pupils indicate whether or not they can hear; • filling bottles with water to make different notes, discussing higher and lower pitch, trying to make a tune, and looking for patterns in how low/high the note is; • making simple comparative tests, where appropriate, to explain everyday phenomena related to sound (e.g. using a variety of everyday materials to

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	compare how sound is conducted through them; increasing the length or thickness of a stringed instrument to alter the pitch, using everyday devices such as ear muffs, and information from non-fiction books, to find which materials are the best insulation against sound). [114] In carrying out the above activities, pupils can record their findings (taking accurate measurements and using simple scientific language, drawings, labelled diagrams, bar charts or tables), report on their findings including presenting written explanation, and use their results to suggest improvements and predictions for setting up further tests. [115]
Forces and magnets Pupils should be taught to: • explore and discuss how a push or a pull is exerted by something and acts on something else [116] • describe how some forces are made by contact (pushing, pulling) while others act at a distance (e.g. gravity and magnets) [117] • explain how gravity pulls things down, and that on the Earth's surface, we are supported by a contact force with the ground [118] • describe the use of magnets in familiar objects [119] • explain that magnets attract magnetic materials; that magnets work through, e.g. cardboard [120] • make a magnet. [121]	**Forces and magnets** Ensure pupils experience making things move by pushing them. They should notice that there are always two objects involved in a force – one that exerts the force, which acts on something else. [122] Pupils can apply their knowledge and skills by: • observing what happens when they push e.g. scooters, toy cars. • putting objects in water and seeing what happens when they try to immerse a floating object – noticing that there is a contact force with the water, and carrying out simple tests to see how the strength of the force varies. • trying out ways of slowing things down e.g. braking on a bicycle, the effect of friction between surfaces. • making things that move; for example, windmills. [123] In carrying out the above activities, pupils can set up and perform comparative and fair tests on the actions of the various types of force, record their findings (taking accurate measurements and using simple scientific language, drawings, labelled diagrams, bar charts or tables), report on their findings including presenting written explanation, and use their results to suggest improvements and predictions for setting up further tests. Magnets push and pull on each other. The method used for making the magnet can be that of stroking an existing magnet against metal that is attracted to a magnet; for example, stroking a magnet against a paper clip to demonstrate that the paper clip becomes magnetic and can be used to pick up other paper clips. [124] Pupils can apply their knowledge and skills by: • trying out different strengths of magnet. Pupils can set up and perform

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	comparative tests on magnets of different strengths, record their findings (taking accurate measurements and using simple scientific language, drawings, labelled diagrams, bar charts or tables), report on their findings including presenting written explanation, and use their results to suggest improvements and predictions for setting up further tests. • trying to balance magnets on each other, and using one magnet to push another around a table, noticing that they do not need to be touching to exert a force. • using a magnet to make paper clips move through cardboard, or iron filings in a sealed clear plastic container, observing the effects of different thicknesses of card/container, and looking for patterns in the difference thickness makes. [125] Pupils should not be formally introduced to like and unlike poles at this stage. [126]
Working scientifically During Year 3, through teaching Programme of Study content, pupils should use the practical scientific processes and methods to which they were introduced in Years 1-2. In addition, they should also use the following practical scientific processes and methods, as appropriate: • setting up simple comparative and fair tests, using a range of equipment including dataloggers [127] • beginning to make accurate measurements using standard units [128] • recording findings using simple scientific language, drawings, labelled diagrams, bar charts, and tables [129] • reporting on findings from investigations, including written explanations of results and conclusions, displays or presentations [130] • using results to draw simple conclusions and suggest improvements and predictions for setting up further tests. [131]	**Working scientifically** All the items listed should be covered by pupils during the course of Year 3, but pupils are not expected to cover each item for every area of study. Teachers should refer to the notes and guidance for examples of specific aspects of working scientifically related to subject content. [132]

Year 4 Programme of Study	Notes and guidance
Classification of living things Pupils should be taught to: • identify and name a variety of living things (plants and animals) in the local and wider environment, using classification keys to assign them to groups [133] • give reasons for classifying plants and animals based on specific characteristics and how they are suited to their environment. [134]	**Classification of living things** Ensure pupils regularly discuss and write, with increasing precision, about the various characteristics associated with the classification of plants and animals. Ensure pupils use the local environment throughout the year to identify and study plants and animals in their habitat. [135] In Key Stage 1, pupils were taught about grouping plants and animals through studying common animals within their local environment. In Year 4, pupils will be introduced to more scientific classification. This can include: • plants – flowering (e.g. sunflowers, roses, apple trees, thistles) and non-flowering (e.g. ferns, mosses); • vertebrates (animals with backbones): - fish (cold blooded; live in water; scales; eggs laid outside the female in water) - amphibians (cold-blooded; live partly in water and on land; have gills, then lungs; moist skin; lay eggs in water) - reptiles (cold-blooded; hatch from eggs; dry, thick, scaly skin) - birds (warm-blooded, most can fly; feathers; hatch from eggs) - mammals (warm-blooded; hair, young grow inside the mother and the mothers make milk to feed the new-born baby) • invertebrates (animals without backbones): - snails and slugs; worms; spiders - insects (three parts to the body; six legs; most have wings, distinguish from spiders) [136] Pupils can apply their knowledge and skills by: • recording information about scientific classification of plants and animals through e.g. classification keys, drawings, scientific labels etc. • describing and comparing the classification of common plants and animals to living things found in other places (at the zoo; under the sea; at the farm; prehistoric life; extinct plants and animals). Support this work by using the science biographies of Charles Darwin (explained the diversity of life) and Carl Linnaeus (pioneer in classification). [137]

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Animals including humans Pupils should be taught to: • identify and name the basic parts of the digestive system in humans [138] • identify the simple functions of the teeth and different types of teeth in humans. [139]	**Animals including humans** Ensure pupils are introduced to the main body parts associated with the digestive system and how they have special functions. This can include: • digestive system – mouth, tongue, teeth, oesophagus, stomach and intestine • the digestive system digests the food eaten and (with oxygen) gives the body energy • process of digestion • types of teeth including milk and permanent teeth; incisors, canines and molars. [140] Pupils can apply their knowledge and skills by: • comparing the teeth of carnivores and herbivores, and comparing how they are used. • recording information about organs and systems of the human body through e.g. drawings, labels, diagrams, displays, ~~photographs~~ photography etc. [141]
Habitats Pupils should be taught to: • identify and name a variety of living things that can be grouped as producers, consumers, predator, prey, herbivores, carnivores and omnivores (including examples of plants and animals) [142] • explain, using food chains and simple food webs, how feeding relationships occur in the local environment, including a variety of habitats and micro habitats. [143]	**Habitats** Ensure pupils regularly discuss and write, with increasing precision, about the various characteristics associated with the classification and feeding relationships of plants and animals. [144] Ensure pupils use the local environment throughout the year to identify and study plants and animals in their habitat. In Key Stage 1, pupils were taught about simple food chains within a variety of habitats. In Year 4, habitats extend to studying a variety of food chains and simple food webs; for example: school grounds (berries, insects; birds, fox); garden (fruits, insects, birds, cat); and pond (pond weed, snails, newts). • food chain: a way of showing how food (energy) passes from a producer (a plant makes or produces its own food) to consumers (animal, such as herbivores, carnivores and omnivores). • food web: a way of showing how food (energy) passes through a number of food chains. Many of the food chains in a food web include some of the same organisms, plants, herbivores, carnivores, omnivores, predator and prey. They show the feeding interrelationships between the animals and plants in a habitat. [145] Pupils can apply their knowledge and skills by: • recording, with increasing knowledge, the complexity of information about

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	plants and animals associated with feeding relationships through e.g. drawing labels, keys, food chains and food webs, photographs, models, presentations, tables, graphs, writing explanatory paragraphs and reports. [146] **In Year 6**, pupils will be taught more about the classification and relationships between living things. [147]
Evolution and inheritance Pupils should be taught to: • describe how plants and animals, including humans, resemble their parents in many features [148] • explain how the human skeleton has changed over time, since we separated from other primates, and discuss the advantages and disadvantages of being on two feet rather than four. [149]	**Evolution and inheritance** Ensure pupils are introduced to how characteristics are passed from one generation to another, and the idea of inheritance; they would not be expected to understand how genes and chromosomes work at this stage. [150] Ensure pupils are introduced to the idea of adaptation and how the human skeleton has changed over time. This should be linked to the topic on the skeletal and muscular system in humans. [151] Pupils can apply their knowledge and skills by: • identifying, comparing and recording similarities and differences among themselves such as eye colour, hair colour, hand spans (e.g. through photographs, videos, drawings, and bar charts). • recording the evolutionary progression of the human skeleton e.g. through drawings, charts, displays, and discussing the advantages and disadvantages of being on two feet rather than four. • exploring dog breeding, and how dogs are all the same species but have been bred to have distinctive characteristics associated with different breeds. • finding out about how cross breeding and selective breeding has led to improvements in the usefulness to humans of many plants and domestic animals. [152] At this stage, pupils should be introduced to the ideas of inheritance, adaptation and evolution. These topics will be further explored in Upper Key Stage 2. [153]

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States of matter Pupils should be taught to: • compare and group together materials according to whether they are solids, liquids or gases [154] • explain that some materials change state when they are heated or cooled, and measure the temperature at which this happens in degrees Celsius (°C) [155] • compare and give reasons, based on measurements, for changes to the state of water, using correct scientific vocabulary [156] • identify the part played by evaporation and condensation in the water cycle. [157] Digital technologies might provide safe alternatives, through simulations and professional videos.	**States of matter** Ensure pupils regularly practise measuring temperature in degrees Celsius (°C) with thermometers. Pupils can set up and perform comparative and fair tests on the temperature at which water boils and freezes, record their findings (taking accurate measurements and using simple scientific language, drawings, labelled diagrams, bar charts or tables), report on their findings including presenting written explanation, and use their results to suggest improvements and predictions for setting up further tests. [158] Ensure pupils continually practise using the words associated with change of state. [159] Pupils will be introduced to simple descriptions of the states of matter (solids can be 'handled', made into a heap, held in your hands; liquids are 'runny', form a pool not a pile, and can't be held in your hands; and gases are 'like air', most gases can't be seen, will escape from an unsealed container). Water has been chosen for study in Year 4 because pupils are able to observe water as a solid, liquid and a gas, and observe changes to water when heated or cooled. [160] Selected materials should be ones that are readily classified (i.e. avoid jellies, mousses, suspensions, and other materials that are composites of materials in different states). Examples of materials include: • solids: wood, metal, plastic, glass, sugars, flour, butter, chocolate • liquids: water, cooking oil • gases: air (a mixture of gases), helium. [161] At this stage, students are not required to identify or name different gases, only to be able to classify some substances as gaseous. The mixture of gases of which air is constituted should not be explicitly introduced. [162] Materials should be selected to illustrate change of state. Teachers should avoid using materials where heating and cooling is associated with chemical change; for example, through baking or burning. [163] Examples of materials other than water that change state when heated or cooled: • solids at room temperature that become liquid when heated: chocolate, butter, wax. • liquids at room temperature that become solid when cooled: water, oil.

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	• liquids at room temperature that become gases when heated: water. [164] Correct vocabulary associated with change of state includes: solid, ice, liquid, water, gas, vapour, steam, melting, heating up, evaporation, boiling, cooling down, condensation. [165] Pupils can be introduced in simple form to the idea that matter is conserved when materials change state; for example, when water evaporates, no material is 'lost'; it simply exists in a different state. [166] Pupils can apply their knowledge and skills by: • comparing the changes to water with materials found in other places ~~(at home, in a cafe, in fiction and non-fiction books, such as chocolate factories, steelworks, volcanoes)~~. • discussing changes to foodstuffs through heat during cooking (frozen, melting, heating up). [167]
Light Pupils should be taught to: • explain how shadows are made when a light source is blocked by something that is not transparent [168] • investigate the size of shadows. [169]	**Light** Ensure pupils continue to practise discussing how light travels from a light source into our eyes. In Key Stage 1, pupils were taught about light sources, including the Sun, and that we use our eyes to see objects. [170] Pupils can apply their knowledge and skills by: • exploring and discussing shadows and how they are made (on a wall, the playground, in stories) when the light source (a torch, lamp, the Sun) is blocked by something that is not transparent. • making shadow puppets and projecting them onto a screen, exploring how to make the shadows bigger and smaller, and looking for patterns in shadow size. Pupils can set up and perform comparative tests on shadow formation, record their findings (taking accurate measurements and using simple scientific language, drawings, labelled diagrams, bar charts or tables), report on their findings including presenting written explanation, and use their results to suggest improvements and predictions for setting up further tests. • showing that we see things because light reflected from them enters the eye – pupils can build a 'set' inside a box with a peep hole and a hatch that can be opened to let in light, demonstrating that the set is only visible through the peep hole when the hatch is open. [171] Pupils should not be formally introduced to the idea of rays of light at this

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	stage. Pupils are not required to draw ray diagrams. [172]
Earth and space Pupils should be taught to: • explain that the Sun is at the centre of our solar system and that the Sun, Earth and Moon are approximately spherical [173] • explain that the Sun is one of a great many stars in the galaxy called the Milky Way, and the Milky Way is one of a vast number of galaxies in the universe [174] • explain that there are other planets around distant stars, and name some constellations, as observed by Earth [175] • explain that the Earth moves around the Sun, taking one year to do so; that the Moon moves around the Earth, taking 28 days to do so; and that the Earth revolves, taking one day [176] • identify the four seasons and the regular changes in sunlight and weather associated with them in the UK. [177]	**Earth and space** Ensure pupils practise naming the planets, the Sun and the Earth's moon using information from: non-fiction ~~books~~ texts, posters and ~~ICT~~ digital technology. [178] The Sun is a star and at the centre of our solar system. Biographies of Galileo and Copernicus may be taught with reference to the heliocentric model of the solar system. There are eight planets (starting from nearest the Sun): Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune. [179] For teacher information, Pluto was reclassified as a 'dwarf planet' in 2006 – pupils are not expected to learn this, although teachers may use it as an example of how science changes over time. [180] The star at the centre of our solar system is one of millions of stars in the galaxy called the Milky Way. The position of stars is fixed relative to each other, although they appear to move across the sky (in a similar way to the Sun during the day). Identifiable clusters of stars are called constellations. Constellations that pupils might be expected to recognise and name include: Orion (The Hunter); Ursa Major (Great Bear, whose seven brightest stars form the Plough); and Ursa Minor (Lesser Bear). [181] Conversely, the Moon and the Earth change their position relative to the fixed stars (the position and movement of planets other than Earth will be mentioned, but do not need formal introduction at this stage). [182] Moon - a celestial body that orbits a planet (Earth has one moon, Jupiter has four large moons and numerous smaller ones). [183] Pupils can apply their knowledge and skills by: • collecting data and recording the movement of the Moon, observing its changing shape and taking photographs to show the pattern. • observing the movement of some planets, and taking photographs to show that the planets move against the fixed stars. • making an approximately scale model of the Sun, Moon and Earth in the playground, using a beach ball for the Sun, a football for the Earth and a table tennis ball for the Moon; setting up the distances to demonstrate that the Moon and Sun look the same size from Earth, despite being vastly

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	different in size. • studying the story of Neil Armstrong (the first man on the Moon) and looking at pictures from the Apollo missions. • making a sundial, calibrated to show midday and the start and end of the school day. [184] Pupils can observe closely, regularly measuring length in millimetres (mm), centimetres (cm) and metres (m), as well as saying and recording the time of day, and report on their findings, including presenting written explanation. [185] Ensure that pupils are clear about safety at all times, and particularly that they take appropriate precautions when observing the Sun (do not look directly at it, even whilst wearing sunglasses). [186]
Electricity Pupils should be taught to: • describe the use of electricity to power common appliances [187] • construct a simple electric circuit, demonstrating that the circuit must be correctly constructed and complete in order for components to function [188] • explain that some materials conduct electricity while others do not, using results of any comparative tests [189] • explain about closed and open circuits, and that a switch placed anywhere in a circuit switches everything on/off. [190]	**Electricity** The basic series circuit should include a battery of cells, switch and lamp. Pupils can apply their knowledge and skills by: • constructing simple series circuits and trying different components, such as bulbs, buzzers and motors, and including switches and different combinations of switches. • observing patterns; for example, that bulbs get brighter if more cells are added, that metals tend to be conductors of electricity, and that some materials can and some cannot be used to connect up a gap in a circuit. Pupils can observe closely and report on their findings, including presenting written explanation. [191] produce Pupils should ~~draw~~ the circuit as a pictorial representation, not using conventional circuit symbols at this stage – these will be introduced in Year 6. [192] Pupils should be taught about precautions necessary for working safely with electricity. [193] Pupils might use the words current and voltage, but these terms should not be formally introduced or defined at this stage. [194]

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Working scientifically During Year 4, through teaching Programme of Study content, pupils should use the practical scientific processes and methods to which they were introduced in Years 1-2. In addition, they should also use the following practical scientific processes and methods, as appropriate: • setting up simple comparative and fair tests, using a range of equipment including data-loggers [195] • beginning to make accurate measurements using standard units [196] • recording findings using simple scientific language, drawings, labelled diagrams, bar charts, and tables [197] • reporting on findings from investigations, including written explanations of results and conclusions, displays or presentations [198] • using results to draw simple conclusions, and suggest improvements and predictions for setting up further tests. [199]	**Working scientifically** All the items listed should be covered by pupils during the course of Year 4, but pupils are not expected to cover each item for every area of study. Teachers should refer to the notes and guidance for examples of specific aspects of working scientifically related to subject content. [200]

Science Programme of Study: Upper Key Stage 2

The teaching of science in **Upper Key Stage 2** should ensure that pupils know about a variety of plants and animals (including humans), materials and everyday phenomena.

Pupils should study (by working scientifically, working practically, and using a variety of research methods including using books and ~~ICT~~ digital technology):

- Life cycles, including reproduction and growth
- Human circulatory system and gaseous exchange
- The diversity of organisms, including classification
- Life processes, including reproduction
- Inheritance and evolution happening over long periods of time
- Testing everyday materials for: hardness, solubility, conductivity (heat and electricity), magnetic behaviour
- Properties of everyday materials and reversible change
- Changes that form new materials and are hard to reverse
- Types of force and measurement of forces
- Electrostatics and magnetism
- The basic parts of a simple electric series circuit; short circuits
- The ray model of light.

Science biographies, for example David Attenborough; Gerald Durrell, William Harvey, Galen, Charles Darwin, Sir Isaac Newton, and the Wright Brothers.

'Working scientifically' is to be delivered through the teaching of substantive subject content, and is **not to be taught separately** as content in its own right. In Year 5 and Year 6, 'working scientifically' builds on earlier content and also includes aspects of:

- Planning investigations, including controlling variables
- Taking measurements with increasing accuracy and precision
- Recording data and results of increasing complexity using various formats
- Reporting on findings from investigations, including written explanations, causal explanations and conclusions
- Presenting reports of findings in written form, displays and presentations
- Continuing to develop the ability to use test results to make predictions to set up further comparative and fair tests.

Ensure pupils read and spell all scientific vocabulary correctly.

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All living things Pupils should be taught to: • describe the life cycles common to a variety of animals including humans (birth, growth, development, reproduction, death), and to a variety of plants (growth, reproduction and death) [201] • describe respiration as the activity that releases energy from food as a fuel to maintain the body's activity, and identify that plants also respire. [202]	**All living things** Ensure pupils study their local environment throughout the year so that they recognise the stages of growth and reproduction in a variety of living things. [203] Pupils can apply their knowledge and skills by: • observing, measuring and recording information about plants and animals, including humans, on the life processes involved in growth and development, through e.g. drawings, time lines, life cycles, charts, videos and diagrams. • comparing the life cycles of plants and animals that pupils have studied with other plants and animals around the world (the rainforest, under the oceans, desert areas and prehistoric times). Support this work with a study of the biographies of David Attenborough (naturalist) and Gerald Durrell (behavioural biologist). [204] **In Year 6**, pupils will be taught more about reproduction. [205]
Animals including humans Pupils should be taught to: • Identify and name the basic parts and organs of the human circulatory and gaseous exchange systems, and explain their functions, including: - human circulatory system - the heart, blood vessels, blood, blood pressure and clotting - gaseous exchange system - lungs, nose, throat, bronchi, bronchial tubes, diaphragm, ribs and breathing. [206]	**Animals including humans** Ensure pupils continue to learn about the main body parts and internal organs introduced in Year 4 (skeletal, muscular and digestive system, and how they have special functions). They will be introduced to: • circulatory system – made up of the heart and blood vessels that carry blood to and from the heart; blood; blood pressure. • human gaseous exchange system – made up of the lungs and air vessels that carry air to and from the lungs; nose, throat, trachea, bronchi, bronchial tubes, diaphragm, ribs; breathing as the movements that cause exchange of gases between the body and its surroundings. [207] Pupils can apply their knowledge and skills by: • recording information about organs and systems of the human body through e.g. drawings, labels, diagrams, displays, photographs etc. • comparing the organ systems of the human body with the organ systems of a variety of animals, e.g. the human heart has four chambers; the frog's heart has three chambers. Record findings with accuracy and using scientific techniques. [208] This work can be supported by studying the story of William Harvey (described the circulatory system) and Galen's work on dissection. [209]

Year 5 Programme of Study	Notes and guidance
Properties of everyday materials and reversible change Pupils should be taught to: • compare and group together everyday materials based on evidence from comparative tests and fair tests, including hardness, solubility, conductivity and insulation (electricity and heat), behaviour with magnets [210] • explain that some substances will dissolve in liquid to form a solution, and how to recover a substance from a solution [211] • use knowledge of solids, liquids and gases to decide how mixtures might be separated, including filtering, sieving and evaporating [212] • give reasons, where appropriate, for the uses of everyday materials based on evidence from comparative tests and fair tests, including metals, wood and plastic [213] • demonstrate that dissolving, mixing and change of state are reversible changes. [214]	**Properties of everyday materials and reversible change** Ensure pupils continue to practise the names, properties and uses of everyday materials, begun in Key Stage 1. In Year 4, they were taught to classify materials as solids, liquids and gases. Pupils will also be familiar with the ideas of hardness, electricity and magnetism. [215] Reversible changes: dissolving salt in water – salt can be retrieved by evaporating the water; non-dissolvable solids such as sand - can be retrieved from liquid by filtering; ice – can be returned to liquid state of water by melting; solids – can separate flour and sugar by sieving. [216] Ensure that pupils are clear about safety at all times. [217] Pupils can apply their knowledge and skills by: • describing examples of reversible changes from everyday life (in cooking, in fiction and non-fiction books, and from other pupils' test results); • discussing and recording the uses of a variety of materials found in a variety of places (at home, buildings around a town or city, forms of transport). [218] In Year 6, pupils will be taught about changes that are difficult to reverse, and the formation of new materials. [219] In Year 5, pupils should be planning investigations, including recognising and controlling variables where appropriate; for example, a fair test of factors influencing solubility might involve varying mass of sugar and temperature of water to test how these variables influence time taken for sugar to dissolve. They should be taking measurements using a range of scientific equipment, with accuracy and precision; using stopwatches: seconds (s) and minutes (min); using a thermometer: temperature in degrees Celsius (°C); mass in grams (g); and volume in millilitres (ml). They should record their data using e.g. scientific diagrams and labels, tables, bar and pie charts or models, and report their findings, including written explanation of results, causal explanation and conclusions. They should be presenting their reports in written form or as displays or presentations, and using their results to make predictions for further tests. [220] Pupils are not required to make quantitative measurements of heat and electrical conductivity at this stage. It is sufficient to demonstrate that some materials will conduct electricity better than others (for example, some

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	conductors will produce a brighter bulb in a circuit than others), and that some materials feel hotter than others when a heat source is placed against them. [221]
Forces Pupils should be taught to: • compare and give reasons, based on testing, for how forces, including gravity, friction, air and water resistance, affect the movement of a variety of objects [222] • explain, through observation, that forces push and pull objects, making them change shape, and that there is always something doing the pushing or pulling either by contact or at a distance [223] • explain that drag forces tend to slow things down, including air resistance and, to a greater extent, resistance in liquids [224] • measure the size of a force. [225]	**Forces** Ensure pupils continue to practise the scientific vocabulary of forces (gravity, friction, air resistance). [226] Pupils will be introduced to the idea that one body exerts a force, and this acts on another e.g. the Earth pulls downwards on objects on its surface, and the force between the two objects is gravity. When something begins to move, gets faster or slows down, a force is acting. When something happens that could make something begin to move, get faster or slow down, a force is acting. [227] Teachers should be aware of the relationship between the force of gravity, mass and weight. For the purposes of primary level work, pupils should measure mass in grams and kilograms, and the difference between mass and weight should not be addressed. [228] Pupils can apply their knowledge and skills by: • discussing how other objects move and the effects of forces: gravity, friction, air resistance and water resistance (para-gliding; aeroplanes; parachutes; swimming animals and those found in fiction and non-fiction texts ~~books~~). Support the work by studying the stories of Wright Brothers (built the first aeroplanes), Galileo (movement of objects) and Isaac Newton (recognised gravity as a force). • making their own Newton meter from a spring, and hanging different weights on it (they do not need to know that the extension is proportional to the force). [229] In Year 5, pupils should be planning investigations, including recognising and controlling variables where appropriate. They should be taking measurements using a range of scientific equipment with accuracy and precision, using mass in grams (g) and kilograms (kg); force in Newtons (N); length in millimetres (mm), centimetres (cm) and metres (m) using rulers; and area in cm² using rulers. They should record their data using scientific diagrams and labels, tables, bar and pie charts or models, and report their findings, including written explanation of results, causal explanation and conclusions. They should be presenting their reports in written form or as

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	displays or presentations, and using their results to make predictions for further tests. [230]
Static electricity and magnetism Pupils should be taught to: • explain that magnets have two poles, and that magnets can both attract and repel – unlike poles attract and like poles repel [231] • describe the effects of static electricity and show that they occur when some materials are rubbed together. [232]	**Static electricity and magnetism** Through magnets, ensure pupils are introduced to the idea of a predictive model – that by investigating how magnets behave, we can make a rule for the force between them. The rule predicts the way that any two magnets will behave. Pupils should be guided towards discovering for themselves that like poles repel and opposite poles attract. [233] Pupils can apply their knowledge and skills by: • exploring how magnets hanging from a thread or on a float in water will line up in the same direction, pointing towards the Earth's poles. understanding how the magnet in a compass is used for navigation. • investigating simple electrostatic phenomena caused by insulators rubbing together. [234]
Working scientifically During Year 5, through teaching Programme of Study content, pupils should use the practical scientific processes and methods to which they were introduced in Years 1-4. In addition, they should also use the following practical scientific processes and methods, as appropriate: • planning investigations, including, recognising and controlling variables where appropriate [235] • taking measurements using a range of scientific equipment with increasing accuracy and precision [236] • recording data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, bar and line graphs, and models [237] • reporting findings from investigations, including written explanations of results, explanation involving causal relationships, and conclusions [238] • presenting reports of findings in written form, displays and presentations [239] • continuing to develop the ability to use test results to make predictions to set up further comparative and fair tests. [240]	**Working scientifically** All the items listed should be covered by pupils during the course of Year 5, but pupils are not expected to cover each item for every area of study. Teachers should refer to the notes and guidance for examples of specific aspects of working scientifically related to subject content. [241]

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All living things Pupils should be taught to: • explain the classification of living things into broad groups according to common observable characteristics and based on similarities and differences, including plants, animals and micro-organisms [242] • compare the life process of reproduction amongst plants and animals [243] • describe the changes as humans develop from birth to old age. [244]	**All living things** This should build on the previous content by introducing pupils to the importance of classification, including introduction to the term kingdom, the five kingdoms of all living things (bacteria, protists, animals, plants and fungi); vertebrates (reptiles, fish, amphibians, birds and mammals) and their similarities and differences; invertebrates; and ways of splitting these large groups into smaller groups e.g. mammals can be divided into three groups according to how their young develop: placental (live/ fully formed babies at birth); marsupial (pouched); and monotreme (egg laying) mammals. [245] Ensure pupils study their local environment throughout the year so that they recognise the stages of growth and reproduction in a variety of living things. [246] Examples that can be used include: • some plants reproduce sexually (an offspring has two parents): mosses and ferns reproduce with spores, conifers reproduce with seeds contained in cones, flowering plants reproduce with seeds contained in fruit. • Other plants also reproduce asexually: runners (strawberries), bulbs (daffodils), stems (roses). • animals reproduce sexually: fish: eggs are externally fertilised; birds: eggs are internally fertilised and laid as a shelled egg; mammals, including humans: eggs are internally fertilised and young are born alive. [247] Pupils can apply their knowledge and skills by: • comparing the characteristics of vertebrates and invertebrates including: whether they have a backbone, scales, feathers, hairy skin; body temperature; whether they lay eggs; and whether they feed young on milk etc. • observing and recording, with accuracy, the parts of a flower e.g. by taking apart a flower and identifying its constituent parts. • discussing how fruits and seeds develop from the ovary and ovules in the carpel. [248]
Evolution and inheritance Pupils should be taught to: • give reasons why living things produce offspring of the same kind, but in many cases offspring are not identical with each other or with their parents [249]	**Evolution and inheritance** Building on the topic on Rocks in Year 3, pupils should be introduced to the fossil as evidence for evolution. This can include how they are formed, the types of plants and animals most likely to be preserved as fossils, and how fossils are used to explore the characteristics of prior animals and plants. Pupils can be introduced to the work of palaeontologists. [251]

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• explain that evolution happens over time, fossils provide information about living things that inhabited the Earth many years ago; how animals and plants are suited to and adapt to their environment in different ways; and how this leads to evolution. [250]	Pupils can apply their knowledge by: • discussing and comparing examples of how different species have adapted over time and recording their findings. • discussing how fossils are formed and how they help build a picture of what animals and plants were like, including what we know about dinosaurs. • considering how some plants and animals are adapted to extreme conditions; for example, cacti vs conifers; penguins vs camels. • discussing the work of Charles Darwin on adaptation. [252]
Changes that form new materials Pupils should be taught to: • explain that some changes result in the formation of new materials, and that this kind of change is difficult to reverse. [253]	**Changes that form new materials** In Key Stage 1, pupils were introduced to a variety of everyday materials and their uses. In Year 4, they learned to classify them as solids, liquids and gases. In Year 5, pupils were taught to test a variety of materials and recognise that some changes are easily reversible. [254] Examples of changes that are difficult to reverse: • burning. • oxidisation (rusting). • reaction of limestone with acid (vinegar) to release carbon dioxide. • examples from cooking (raising agents, effect of heat on dough etc). [255] Biographies of Lavoisier and Priestley can be introduced – chemists who furthered understanding of how new materials are produced. [256] In Year 6, ensure pupils are planning investigations, including recognising and controlling variables where appropriate. They should be taking measurements using a range of scientific equipment, with accuracy and precision, using stopwatches, seconds (s) and minutes (min), temperature in degrees Celsius (°C) using a thermometer, mass in grams (g) and volume in millilitres (ml). They should record their data using scientific diagrams and labels, tables, bar and pie charts, line graphs or models, and report their findings, including written explanation of results, causal explanation and conclusions. They should be presenting their reports in written form, or as displays or presentations, and using their results to make predictions for further tests. [257]

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	In Year 7, pupils will be taught more about materials, including the introduction of atoms and how elements are organised on the periodic table. [258]

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Light Pupils should be taught to: • explain that objects are seen because they give out or reflect light into the eye, using results of any comparative tests. Explain the scientific idea that light travels in straight lines from a light source or is reflected from a surface into the eye [259] • explain that light can be broken into colours and that different colours of light can be combined to appear as a new colour [260] • explain how the ray model of light explains the size of shadows [261] • use simple optical instruments. [262]	**Light** Ensure pupils are introduced to the idea of a predictive model through light – that light travels in straight lines, so we can think of it as a ray. Using this model, we can explain and predict the size of shadows and pools of light. [263] Pupils can apply their knowledge and skills by: • being introduced to the idea that we see things because light enters the eye. • studying the story of Isaac Newton (built the first reflecting telescope). • Investigating how to change the size of a pool of light and the size of shadows, using the ray model to explain their findings. • making a periscope and examining how it works by reflecting light between mirrors. • using a ray box or shining a torch through a slit in cardboard to make rays. • demonstrating how light splits into different colours when it passes through a prism, and relating this to how a rainbow is formed. • colouring sections of a card circle in red, blue and green and demonstrating how spinning the disc results in the card appearing white. • using some simple optical instruments, for example a mirror, magnifying glass, binoculars, telescope and microscope. [264] Teachers should be aware that the effects of mixing different colours of light are not similar to the effects of mixing different colours of pigment, but do not need to explain the difference to pupils. [265] In Year 6, ensure pupils are planning investigations, including recognising and controlling variables where appropriate. They should be taking measurements using a range of scientific equipment, with accuracy and precision, using stopwatches, seconds (s) and minutes (min), mass in grams (g) and kilograms (kg); force in Newtons (N); length in millimetres (mm), centimetres (cm) and metres (m) using rulers; and area in cm^2 using rulers. They should record their data using scientific diagrams and labels, tables, bar and pie charts, line graphs or models, and report their findings, including written explanation of results, causal explanation and conclusions. They should be presenting their reports in written form, or as displays or presentations, and using their results to make predictions for further tests. [266]

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Forces Pupils should be taught to: • explain the idea of speed [267] • determine the distance travelled based on the speed and time of travel. [268]	**Forces** Ensure pupils continue to observe phenomena and look for patterns in their observations. They can be introduced to the idea of a mathematical model through speed. [269] Pupils should be encouraged to discuss the distance that is accumulated while something is travelling. The faster it is going, the more distance it accumulates; the longer it travels, the more distance it accumulates. Distance is given by speed x time. [270] Pupils can be introduced to different units of speed. [271]
Electricity Pupils should be taught to: • identify and name the basic parts of a simple electric series circuit, including cells, wires, bulbs, switches, and buzzers, and compare and give reasons for variations in how components function, including brightness of bulbs, loudness of buzzers and on/off position of switches [272] • explain that short circuits may cause wires to heat up and that fuses are electrical safety devices that are triggered by short circuits [273] • explain the effect of changing the voltage of a battery. [274]	**Electricity** In Year 6, pupils are only expected to learn about series circuits, not parallel circuits. [275] Ensure pupils continue to practise the names of the basic parts of a simple series circuit and to discuss simple electrical series circuits using simple comparisons (e.g. bright/dull), comparative vocabulary (e.g. brighter/duller) and superlative vocabulary (e.g. brightest/dullest). [276] Ensure that pupils can represent a simple circuit in a diagram using recognised symbols. [277] Pupils can apply their knowledge and skills by: • using simple electric series circuits (bulbs, buzzers, wires and batteries) to light up and/or make sounds in a variety of objects (e.g. model houses, model burglar alarms, model solar system). • discussing the uses and dangers of electricity found in everyday life. [278] Pupils are not expected to explain how the effects of short circuits occur, only to be able to recognise the phenomenon, and explain that short circuits will cause wires to overheat and a fuse to blow. [279] Pupils can be given a simple explanation that there is a current flowing in the circuit, that the push of the battery is measured in volts, and that the bigger the push, the bigger the current. They can try batteries with different voltages or add additional batteries and look at the effect of this on brightness of a bulb or loudness of a buzzer. These effects should not be explained in terms

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	of energy or electric charge. [280]
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