St. John's
CE Primary School

Science Intent

Science is a discipline dedicated to explaining the natural world. Scientists seek to understand and explain the natural world and phenomena. When investigating, their thinking is developed by a number of **big organising ideas and generalisations known as concepts**. These concepts form a unique framework of enquiry and shape the questions that scientists investigate.

Concepts in Science

Big ideas are statements that attempt to describe some major understanding that students need to develop. These understandings act as metaphorical 'lenses' by which children can make sense of a whole host of problems. In some ways each big idea is analogous to a giant schema – a hypothetical mental framework that experts have where smaller, related ideas are linked together and stored in long term memory. Ten big ideas of science education have been identified and are detailed in the second order concepts.

Substantive Concepts or First Order Concepts

There are three disciplines in Science, Biology, Chemistry and Physics. Substantive or first order concepts identify the content or focus areas of study at different places such as plant, animals, forces, properties of materials or energy sources.

	Biology			**Chemistry**		**Physics**		
	Living things and their habitats	Plants	Animals, including humans	Properties of Materials	Changing Materials	Space	Sources of Energy	Forces
KS1	• Living and non-living • Habitats • Food chains	• Name and describe common plants • Growing plants •	• Name and describe common animals • Label human body • Animal growth • Human health	• Everyday Materials • Suitability of materials for uses • Force to change materials		• Seasonal changes	• Seasonal changes	• Pushes and Pulls
Lower KS2	• Classification Keys Environmental change	• Flowering plants and reproduction	• Animal nutrition • Human movement • Human digestive system • Animal food chains	• States of matter • Rocks	• Heating and cooling		• Light • Electricity • Sound	• Forces and magnets • Friction

Upper KS2	• Life cycles • Classifying plant and animals • Adaptation and evolution	• life process of reproduction in some plants	• life process of reproduction in some animals • Human life cycle • Human circulation system and healthy lifestyle		• Reversible and irreversible changes • Mixing solutions • Separating solutions	• Day and night • Orbit of earth • Orbit of moon	• Light • Electricity	• Gravity • Gearing • Resistance and friction

Second Order Concepts –shape the enquiry

Second order concepts define the questions that drive the investigations Scientists carry out in places. They can all be applied across the entire subject and everyone is interconnected. The second order concepts used to shape our enquiry questions are:

7 Life Processes Organisms are organised on a cellular basis and have a finite life span	Nutrition Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms	Reproduction Genetic information is passed down from one generation of organisms to another	Diversity or classification The diversity of organisms, living and extinct, is the result of evolution	Materials All matter in the Universe is made of very small particles
Earth Science The composition of the Earth and its atmosphere and the processes occurring within them shape the Earth's surface and its climate	Non-Contact Forces Objects can affect other objects at a distance	Contact Forces Changing the movement of an object requires a net force to be acting on it	Energy The total amount of energy in the Universe is always the same but can transferred from one energy store to another during an event	Earth and Space Our solar system is a very small part of one of billions of galaxies in the Universe

Progression in Concepts:

	Biology			
	Organisms are organised on a cellular basis and have a finite life span All organisms are constituted of one or more cells. Multi-cellular organisms have cells that are differentiated according to their function. All the basic functions of life are the result of what happens inside the cells which make up an organism. Growth is the result of multiple cell divisions.	**Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms** Food provides materials and energy for organisms to carry out the basic functions of life and to grow. Green plants and some bacteria are able to use energy from the Sun to generate complex food molecules. Animals obtain energy by breaking down complex food molecules and are ultimately dependent on green plants as their source of energy. In any ecosystem there is competition among species for the energy resources and the materials they need to live and reproduce.	**Genetic information is passed down from one generation of organisms to another** Genetic information in a cell is held in the chemical DNA. Genes determine the development and structure of organisms. In asexual reproduction all the genes in the offspring come from one parent. In sexual reproduction half of the genes come from each parent.	**The diversity of organisms, living and extinct, is the result of evolution** All life today is directly descended from a universal common ancestor that was a simple one-celled organism. Over countless generations changes resulting from natural diversity within a species lead to the selection of those individuals best suited to survive under certain conditions. Species not able to respond sufficiently to changes in their environment become extinct.
KS1	• There is a wide variety of living things (organisms), including plants and animals. • They are distinguished from non-living things by their ability to move, reproduce and react to certain stimuli.	• All living things need food as their source of energy as well as air, water and certain temperature conditions. • Animals need food that they can break down, which comes either directly by eating plants (herbivores) or by eating animals (carnivores) which have eaten plants or other animals. • Some animals are dependent on plants in other ways as well as for food, for example for shelter and, in the case of human beings, for clothing and fuel.	• Living things produce offspring of the same kind, but offspring are not identical with each other or with their parents.	• There are many different kinds of plants and animals in the world today
Lower KS2	• To survive they need water, air, food, a way of getting rid of waste and an environment which stays within a particular range of temperature.	• Animals are ultimately dependent on plants for their survival. • The relationships among organisms can be represented as food chains and food webs. • Plants also depend on animals in various ways. For example, many flowering plants depend on insects for pollination and on other animals for dispersing their seeds.	• Plants and animals, including humans, resemble their parents in many features because information is passed from one generation to the next.	• There are many different kinds of plants and animals in the world today many kinds that once lived but are now extinct. We know about these from fossils. • Animals and plants are classified into groups and subgroups according to their similarities.
Upper KS2	• Although some do not appear to be active, all will at some stage carry out the life processes of respiration, reproduction, feeding, excretion, growth and developments and all will eventually die.	• Plants containing chlorophyll can use sunlight to make the food they need and can store food that they do not immediately use.	• Other features, such as skills and behaviour, are not passed on in the same way and have to be learned.	• Organisms of the same species breed more of the same. • Different species cannot interbreed to produce offspring that can reproduce. • Although organisms of the same species are very similar they vary a little from each other. • One of the results of sexual reproduction is that offspring are never exactly like their parents.

	Chemistry	
	All matter in the Universe is made of very small particles Atoms are the building blocks of all matter, living and non-living. The behaviour and arrangement of the atoms explains the properties of different materials. In chemical reactions, atoms are rearranged to form new substances. Each atom has a nucleus containing neutrons and protons, surrounded by electrons. The opposite electric charges of protons and electrons attract each other, keeping atoms together and accounting for the formation of some compounds.	**The composition of the Earth and its atmosphere and the processes occurring within them shape the Earth's surface and its climate** Radiation from the Sun heats the Earth's surface and causes convection currents in the air and oceans, creating climates. Below the surface heat from the Earth's interior causes movement in the molten rock. This in turn leads to movement in the plates which form the Earth's crust, creating volcanoes and earthquakes. The solid surface is constantly changing through the formation and weathering of rock.
KS1	• All the 'stuff' encountered in everyday life, including air, water and different kinds of solid substances, is called matter because it has mass, and therefore weight on Earth, and takes up space. • Different materials are recognisable by their properties, some of which are used to classify them as being in the solid, liquid or gas state.	• There is air all around the Earth's surface but there is less and less further away from the surface (higher in the sky). Weather is determined by the conditions and movement of the air. • The temperature, pressure, direction, speed of movement and the amount of water vapour in the air combine to create the weather. • Measuring these properties over time enables patterns to be found that can be used to predict the weather a short time ahead. Long-term patterns in the weather are referred to as the climate of different parts of the world.
Lower KS2	• Other substance simply mix without changing permanently and can often be separated again. • At room temperature, some substances are in the solid state, some in the liquid state and some in the gas state. • The state of many substances can be changed by heating or cooling them. The amount of matter does not change when a solid melts or a liquid evaporates.	• Much of the solid surface of the Earth is covered by soil, which is a mixture of pieces of rock of various sizes and the remains of organisms. • Fertile soil also contains air, water, some chemicals from the decay of living things, particularly plants, and various living things such as insects, worms and bacteria. • The solid material beneath the soil is rock. There are many different kinds of rock with different compositions and properties. The action of wind and water wears down rock gradually into smaller pieces – sand is made of small pieces of rock and silt of still smaller pieces. • About two-thirds of the surface of the Earth is covered by liquid water, which is essential to life. • Water is constantly recycled through processes involving evaporation from oceans and other surfaces, such as soil and plants, condensation in clouds and precipitation as rain, snow or hail.
Upper KS2	• When some substances are combined they form a new substance (or substances) with properties that are different from the original ones.	•

	Physics			
	Objects can affect other objects at a distance All objects have an effect on other objects without being in contact with them. In some cases the effect travels out from the source to the receiver in the form of radiation (e.g. visible light). In other cases action at a distance is explained in terms of the existence of a field of influence, such as a magnetic, electric or gravitational field. Gravity is a universal attraction between all objects however large or small, keeping the planets in orbit round the Sun and causing terrestrial objects to fall towards the centre of the Earth.	**Changing the movement of an object requires a net force to be acting on it** A force acting on an object is not perceived directly but is detected by its effect on the object's motion or shape. If an object is not moving the forces acting on it are equal in size and opposite in direction, balancing each other. Since gravity affects all objects on Earth there is always another force opposing gravity when an object is at rest. Unbalanced forces cause change in movement in the direction of the net force. When opposing forces acting on an object are not in the same line they cause the object to turn or twist. This effect is used in some simple machines.	**The total amount of energy in the Universe is always the same but can transferred from one energy store to another during an event** Many processes or events involve changes and require an energy source to make them happen. Energy can be transferred from one body or group of bodies to another in various ways. In these processes some energy becomes less easy to use. Energy cannot be created or destroyed. Once energy has been released by burning a fossil fuel with oxygen, some of it is no longer in a form that is as convenient to use.	**Our solar system is a very small part of one of billions of galaxies in the Universe** Our Sun and eight planets and other smaller objects orbiting it comprise the solar system. Day and night and the seasons are explained by the orientation and rotation of the Earth as it moves round the Sun. The solar system is part of a galaxy of stars, gas and dust, one of many billions in the Universe, enormous distances apart. Many stars appear to have planets.
KS1	•	• Forces can push, pull or twist objects, making them change their motion or shape. •	• There are various ways of causing an event or bringing about change in objects or materials. • Objects can be made to change their movement by pushing or pulling.	• There are patterns in the position of the Sun seen at different times of the day and in the shape of the Moon from one night to another.
Lower KS2	• Objects can have an effect on other objects even when they are not in contact with them. For instance, light, both from close sources such as light bulbs or flames and from the Sun and other stars very long distances away, is seen because it affects the objects it reaches, including our eyes. • 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 enter our ears. • Other examples of objects affecting other objects without touching them are the interactions between magnets or electric charges.	• Forces act in particular directions. • Equal forces acting in opposite directions in the same line cancel each other and are described as being in balance. • The movement of objects is changed if the forces acting on them are not in balance.	• Heating can cause change, as in cooking, melting solids or changing water to vapour. • Electricity can make light bulbs glow. • Wind can rotate the blades of wind turbines.	• The Earth moves round the Sun taking about a year for one orbit. • The Moon orbits the Earth taking about four weeks to complete an orbit.
Upper KS2	• These sources give out light, which travels from them in various directions and is detected when it reaches and enters our eyes. Objects that are seen either give out or reflect light that human eyes can detect. • The effect of gravity that makes things falls to the Earth.	• The speed of a moving object is a measure of how far it would travel in a certain time. • How quickly an object's motion is changed depends on the force acting and the object's mass. • The greater the mass of an object, the longer it takes to speed it up or slow it down, a property of mass described as inertia.	• In all these changes, energy is transferred from one object, which is an energy source or resource, to another. • Fuels such as oil, gas, coal and wood are energy resources. • Some energy resources are renewable, such as those produced by wind, waves, sunlight and tides, others are non-renewable such as from burning fossil fuels with oxygen.	• The Sun, at the centre of the solar system, is the only object in the solar system that is a source of visible light. • The Moon reflects light from the Sun and as it moves round the Earth only those parts illuminated by the Sun are seen. • The Earth rotates about an axis lying north to south and this motion makes it appear that the Sun, Moon and stars are moving round the Earth. This rotation causes day and night as parts of the Earth's surface turn to face towards or away from the Sun. • Earth's axis is tilted relative to the plane of its orbit round the Sun so that the length of day varies with position on the Earth's surface and time of the year, giving rise to the seasons.

Second order concepts: knowing how Scientists establish knowledge through Scientific enquiry

<table>
<tr><td></td><td>Key Concepts</td><td colspan="8">Key Concepts
Substantive or first order concepts identify the content or focus areas of study</td></tr>
<tr><td rowspan="2"></td><td rowspan="2"></td><td colspan="3">Biology</td><td colspan="2">Chemistry</td><td colspan="3">Physics</td></tr>
<tr><td>Living things and their habitats</td><td>Plants</td><td>Animals, including humans</td><td>Properties of Materials</td><td>Changing Materials</td><td>Space</td><td>Sources of Energy</td><td>Forces</td></tr>
<tr><td>Second Order Concepts – shape the enquiry
Second order concepts define the questions that drive the investigations.</td><td>• 7 Life Processes
• Nutrition
• Reproduction
• Diversity or classification
• Materials
• Earth Science
• Non-Contact Forces
• Contact Forces
• Transference of Energy</td><td colspan="8">Disciplinary knowledge:
Establishing knowledge through enquiry / activity
• Recognise
• Identify
• Describe
• Observe
• Select
• Categorise/Classify
• Sequence
• Compare and contrast
• Recall
• Reason/speculate
• Summarise
• Synthesise
• Explain
• Empathise
• Informed conclusion
• Reasoned judgement
• Justify
• Apply
• Evaluate
• Critique
• Hypothesise</td></tr>
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For example:

Describe the reproductive process in amphibians.

Classify materials according to their matter structure

Explain how sound enters our ears.

Progression of Knowledge and Skills

Key Concepts	EYFS	End of KS1	End of Lower KS2	End of KS2
Biology				
Knowledge of the importance of the 7 life processes common to living things: 1. Nutrition 2. Respiration 3. Response 4. Movement 5. Excretion 6. Growth 7. Reproduction Living things on Earth come in a huge variety of different forms that are all related because they all came from the same starting point 4.5 billion years ago. The different kinds of life, animals, plants and microorganisms, have evolved over millions of generations into different forms in order to survive in the environments in which they live.	**Plants**			
	• developing an understanding of growth, decay and changes over time by studying a range of plants within the classroom and their local area. • Children able to name flora in their local environment e.g. flower, tree, leaves, petals, grass	**Year 1** • Identify and name a variety of common wild and garden plants, including deciduous and evergreen trees. • Identify and describe the basic structure of a variety of common flowering plants, including trees **Year 2** • Observe and describe how seeds and bulbs grow into mature plants. • Find out and describe how plants need water, light and a suitable temperature to grow and stay healthy.	**Year 3** • Identify and describe the functions of different parts of flowering plants: roots, stem, leaves and flowers • Explore requirements of plants for life and growth (air, light, water, nutrients from soil and room to grow) and how they vary from plant to plant. • Investigate the way in which water is transported within plants. • Explore the role of flowers in the life cycle of flowering plants, including pollination, seed formation and seed dispersal.	
	Animals including Humans			
	• Explore the natural world around them, making observations and drawing pictures of animals	**<u>Year 1</u>** • Identify and name a variety of common animals including fish, amphibians, reptiles, invertebrates, birds and mammals. • Identify and name a variety of common animals that are carnivores, herbivores and omnivores. • Describe and compare the structure of a variety of common animals (fish, amphibians, reptiles, birds and mammals, including	**<u>Year 3</u>** • Identify 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. • Identify that humans and some animals have skeletons and muscles for support, protection and movement. **<u>Year 4</u>**	**<u>Year 5</u>** • Describe the changes as humans develop from birth to old age **<u>Year 6</u>** • Identify and name the main parts of the human circulatory system, and describe the functions of the heart, blood vessels and blood. • Recognise the impact of diet, exercise, drugs and lifestyle on the way their bodies function. • Describe the ways in which nutrients and water are

Key Concepts	EYFS	End of KS1	End of Lower KS2	End of KS2
		pets). • Identify, name, draw and label the basic parts of the human body and say which part of the body is associated with each sense **<u>Year 2</u>** • Notice that animals, including humans have offspring which grow into adults • Find out and describe the basic needs of humans for survival • Describe the importance for humans of exercise, eating the right amounts of different foods and hygiene.	• Pupils recognise that invertebrates have an external skeleton and vertebrates have skeletons inside them. (check this what year group) • Construct and interpret a variety of food chains, identifying producers, predators and prey • Describe the simple functions of the basic parts of the digestive system in humans • Identify the different types of teeth in humans and their simple functions	transported within animals, including humans
	Living things and their Habitats			
	• Children talk about the features of their own immediate environment and how environments might vary from one another. • Children know that the environment and living things are influenced by human activity. They can describe some actions which people in their own community do that help to maintain the area they live in.	**Year 2** • Explore and compare the differences between things that are living, dead, and things that have never been alive. • Identify that most living things live in habitats to which they are 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 • Identify and name a variety of plants and animals in their habitats, including microhabitats. • Describe how animals obtain their food from plants and other animals, using the idea	**Year 4** • Recognise that living things can be grouped in a variety of ways. • Explore and use classification keys to help group, identify and name a variety of living things in their local and wider environment. • Recognise that environments can change and that this can sometimes pose dangers to living things. • Construct and interpret a variety of food chains, identifying producers, • predators and prey	**Year 6** • Describe how living things are classified into broad groups according to common observable characteristics and based on similarities and differences, including micro-organisms, plants and animals. • Give reasons for classifying plants and animals based on specific characteristics. • I can recognise that living things have changed over time and that fossils provide information about living things that inhabited the Earth millions of years ago • I can recognise that living things produce offspring of the same kind, but normally offspring vary and are not identical to their parents

Key Concepts	EYFS	End of KS1	End of Lower KS2	End of KS2
		of a simple food chain, and identify and name different sources of food.		• I can identify how animals and plants are adapted to suit their environment in different ways and that adaptation may lead to evolution

Key Concepts	EYFS	End of KS1	End of Lower KS2	End of KS2
All matter in the Universe is made of very small particles	**Chemistry**			
	Properties of Materials			
The composition of the Earth and its atmosphere and the processes occurring within them shape the Earth's surface and its climate Objects can affect other objects at a distance Changing the movement of an object requires a net force to be acting on it The total amount of energy in the Universe is always the same but can transferred from one energy store to another during an event	•	**Year 1** • distinguish between an object and the material from which it is made • identify and name a variety of everyday materials, including wood, plastic, glass, metal, water, and rock • describe the simple physical properties of a variety of everyday materials • compare and group together a variety of everyday materials on the basis of their simple physical properties **Year 2** • identify and compare the suitability of a variety of everyday materials, including wood, metal, plastic, glass, brick, rock, paper and cardboard for different uses • find out how the shapes of solid objects made from some materials can be changed by squashing, bending, twisting and stretching	**Year 3** • compare and group together different kinds of rocks on the basis of their appearance and simple physical properties • describe in simple terms how fossils are formed when things that have lived are trapped within rock • recognise that soils are made from rocks and organic matter. **Year 4** • compare and group materials together, according to whether they are solids, liquids or gases • observe that some materials change state when they are heated or cooled, and measure or research the temperature at which this happens in degrees Celsius (°C) • identify the part played by evaporation and condensation in the water cycle and associate the rate of evaporation with temperature.	**Year 5** • compare and group together everyday materials on the basis of their properties, including their hardness, solubility, transparency, conductivity (electrical and thermal), and response to magnets

Key Concepts	EYFS	End of KS1	End of Lower KS2	End of KS2
	Changing materials / States of matter			
				Year 5 • know that some materials will dissolve in liquid to form a solution, and describe how to recover a substance from a solution • use knowledge of solids, liquids and gases to decide how mixtures might be separated, including through filtering, sieving and evaporating • give reasons, based on evidence from comparative and fair tests, for the particular uses of everyday materials, including metals, wood and plastic • demonstrate that dissolving, mixing and changes of state are reversible changes • explain that some changes result in the formation of new materials, and that this kind of change is not usually reversible, including changes associated with burning and the action of acid on bicarbonate of soda.

Key Concepts	EYFS	End of KS1	End of Lower KS2	End of KS2
Knowledge about different sources of energy and how it allows things to happen The universe follows unbreakable rules that are all about forces, matter and energy.	**Physics**			
	Earth and Space			
	• Children talk about the features of their own immediate environment. They understand that the sun gives light	**Year 1** • observe changes across the 4 seasons • observe and describe weather associated with the seasons and how day length varies	•	**Year 5** I can describe the movement of the Earth, and other planets, relative to the Sun in the solar system I can describe the movement of the Moon relative to the Earth

Key Concepts	EYFS	End of KS1	End of Lower KS2	End of KS2
Forces are different kinds of pushes and pulls that act on all the matter that is in the universe. Matter is all the stuff, or mass, in the universe. Energy, which cannot be created or destroyed, comes in many different forms and tends to move away from objects that have lots of it.				I can describe the Sun, Earth and Moon as approximately spherical bodies I can use the idea of the Earth's rotation to explain day and night and the apparent movement of the sun across the sky.
	Light			
	•	•	**<u>Year 3</u>** • recognise that they need light in order to see things and that dark is the absence of light • notice that light is reflected from surfaces • recognise that light from the sun can be dangerous and that there are ways to protect their eyes • recognise that shadows are formed when the light from a light source is blocked by a solid object • find patterns in the way that the size of shadows change.	**<u>Year 6</u>** • Pupils recognise that we see things when light from a source enters our eyes, and without light we are unable to see. • Pupils recognise that even scientists never look directly at the sun and instead use specially adapted telescopes or observe images sent from unmanned space-probes, millions of miles away in space. • Use the idea that light travels in straight lines to explain that objects are seen because they give out or reflect light into the eye Explain that we see things because light travels from light sources to our eyes or from light sources to objects and then to our eyes • Use the idea that light travels in straight lines to explain why shadows have the same shape as the objects that cast them
	Sound			
	•	•	**<u>Year 4</u>** • identify how sounds are made, associating some of them with something vibrating • recognise that vibrations from sounds travel through a medium to the ear	•

Key Concepts	EYFS	End of KS1	End of Lower KS2	End of KS2
			• find patterns between the pitch of a sound and features of the object that produced it • find patterns between the volume of a sound and the strength of the vibrations that produced it. • recognise that sounds get fainter as the distance from the sound source increases	
	Forces and Magnets			
			<u>Year 3</u> • Compare how things move on different surfaces. • Notice that some forces need contact between two objects, but magnetic forces can act at a distance. • observe how magnets attract or repel each other and attract some materials and not others • compare and group together a variety of everyday materials on the basis of whether they are attracted to a magnet, and identify some magnetic materials • describe magnets as having 2 poles • predict whether 2 magnets will attract or repel each other, depending on which poles are facing.	**<u>Year 5</u>** • explain that unsupported objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object • identify the effects of air resistance, water resistance and friction, that act between moving surfaces • recognise that some mechanisms including levers, pulleys and gears allow a smaller force to have a greater effect

Key Concepts	EYFS	End of KS1	End of Lower KS2	End of KS2
	Electricity			
			Year 4 • identify common appliances that run on electricity • construct a simple series electrical circuit, identifying and naming its basic parts, including cells, wires, bulbs, switches and buzzers • identify whether or not a lamp will light in a simple series circuit, based on whether or not the lamp is part of a complete loop with a battery • recognise that a switch opens and closes a circuit and associate this with whether or not a lamp lights in a simple series circuit • recognise some common conductors and insulators, and associate metals with being good conductors.	**Year 6** • associate the brightness of a lamp or the volume of a buzzer with the number and voltage of cells used in the circuit • compare and give reasons for variations in how components function, including the brightness of bulbs, the loudness of buzzers and the on/off position of switches • use recognised symbols when representing a simple circuit in a diagram.

Spine Plans

- Substantive and disciplinary knowledge are brought together in spines which:
    - Identify the conceptual pre requisites, linked knowledge and future knowledge
    - The big question under which the knowledge is organised
    - The ancillary questions and teaching sequence which detail the building of essential knowledge for the spine.
    - Opportunities to teach the school vision and allow for SMSC development
    - Teaching sequence and key vocabulary
    - How to go deeper