Entire NZ Sci Draft Curriculum as of Oct 2026:

Just the "knowledge" sections from files found on this site.
A further table can include the “practices” info.

Condensed (summation) version that is printable.

Note:

- MoE consultation survey found here.
- And a copy/pasted google-doc of those sci-curriculum consultation survey Qs found here (to be used to type up your answers before filling in MoE’s survey)
- FYI: here are examples of Sci Year Plans based on draft curriculum for Yr10, 9, 8 and 7 (using AI)

	Phase 1			Phase 2			Phase 3		Phase 4	
	Yr1	Yr2	Yr3	Yr4	Yr5	Yr6	Yr7	Yr8	Yr9	Yr10
materials	Materials and their properties • Objects are made of different materials. • Materials can be combined to make objects. Materials have observable properties (e.g. shape, texture, colour, hardness, flexibility). • Soils and rocks have different properties, including firmness, texture, colour, and heaviness.	Material properties and uses • Materials take up space and have mass. • Mass is the amount of matter present in an object. • Materials can have different mechanical properties (they behave differently when pushed, pulled, or twisted): ○ flexible materials can be bent ○ elastic materials can be stretched or bent and returned to their original shape ○ some elastic materials can return to their original shape faster than others. • Materials can be cut, broken, and worn down into smaller fragments. These smaller parts remain (e.g. sand, breadcrumbs, glass shards). • Materials can be natural or manufactured (made by humans).		Heat and states of matter • Matter is anything that has mass and takes up space. • Matter exists in different states — solid, liquid, and gas: ○ a solid is a state of matter that has a definite shape and volume (e.g. ice) ○ a liquid is a state of matter that has a definite volume but no definite shape (e.g. water, milk) ○ a liquid flows and takes the shape of the container it is in ○ a gas is a state of matter that has neither definite shape nor definite volume ○ a gas flows easily and expands to the size of the container it is in (e.g. air in a balloon) ○ volume is the amount of space a solid, liquid, or gas takes up ○ powders are granular solids and can flow and be poured, like liquids. • Matter can change state if heated or cooled (melting, boiling/evaporation, freezing, condensation). • At sea level, freshwater boils at 100°C and freezes at 0°C. • Robert Boyle (1627–1691) established the relationship between temperature and pressure in gases, known as Boyle’s Law. He is considered one of the founders of modern chemistry.	Mass, volume, and density • Mass is the amount of matter in an object, measured in kilograms (kg) or grams (g). • Volume is measured in cubic metres (m^3) or litres (L). • Objects may have the same volume but different masses and vice versa. • The relationship between mass and volume is known as density. • The density of an object determines whether it will float or sink in another material: ○ less dense materials will float on more dense materials (e.g. foam on water, oil on water, helium balloons in air, air in water) ○ more dense materials will sink in less dense materials (e.g. coins in water, vinegar in oil, dishwashing liquid in water). • The French Academy of Sciences (1790s) developed the metric system for weight, length, and volume, standardising measurements across science, industry, and education. • Note: Floating and sinking only occurs in liquids and gases.		Material properties • Plasticity is a property that leads to permanent changes in an object’s shape (e.g. bending a paper clip). • Elasticity is a property that enables temporary changes in an object’s shape (e.g. stretching a rubber band). • Conduction is the transfer of heat or electricity through a material without the material itself moving. • Thermal conductivity is a property that measures the ability to transfer heat by conduction (see Year 4, Matter Interactions and Energy). • Insulating materials have poor thermal conductivity. States of matter • Most matter exists in one of three states: solids, liquids, and gases. • Changes of state occur when thermal energy is added to or removed from a substance, causing it to change between solid, liquid, and gas forms (during condensation, evaporation, freezing, melting, deposition, and sublimation) (see Year 4, Matter Interactions and Energy). • Mass is conserved when a substance undergoes a change of state. • Antoine Lavoisier (1743–1794) was known for quantitative science based on the law of conservation of mass and for his work with oxygen, among other discoveries. Particle nature of matter • All matter is made of sub-microscopic particles. • The particle model explains the properties of the states of matter and changes of state. • In any state of matter, particles don’t change size, and there is no matter between the particles — only empty space. • Particles are held together by attractive forces. • Particles move faster when heated, overcoming attractive forces (see Year 4, Matter Interactions and Energy). • The particles that make up a substance do not change in size, shape, or type when the substance changes state (e.g. from solid to liquid) or expands/contracts due to heating or cooling. • Reversible physical changes like melting, freezing, or expansion affect how particles are arranged and the distance between each particle but do not alter the particles themselves. • Democritus (c.460–370 BCE) proposed that all matter is composed of indivisible atoms, laying the philosophical foundation for atomic	Mixtures • Mixtures are physical combinations of substances. • Mixtures can be homogeneous (e.g. salt dissolved in water) or heterogeneous (e.g. sand mixed in water). • Homogeneous mixtures have a uniform appearance and properties due to the arrangement of particles. • Heterogeneous mixtures have a non-uniform appearance and properties. • Heterogeneous mixtures can be separated based on their properties (particle size, density) by settling and decanting, sieving, and filtration. • Homogeneous mixtures are harder to separate. • Some homogeneous mixtures can be separated by evaporation or distillation. Solutions and concentration • Solutions are homogeneous mixtures. • Solutions are formed when a substance (solute) is dissolved in another substance (solvent), creating a uniform mixture. • The observable properties of a solution (e.g. boiling point) can change depending on the solvent used and the concentration (amount) of solute. • Suspensions are not solutions, and the components may separate over time depending on particle size. Solubility • Solubility depends on the combination of solute and solvent. • The solubility of most solids and liquids increases with temperature. • The solubility of gases decreases with temperature. Chemical change • Chemical change occurs when particles are rearranged to form new substances. • Signs a chemical reaction has taken place include colour change, temperature change, production of electricity or light, and appearance of new solids or gas bubbles. • Many chemical changes are irreversible (e.g. burning, metal corrosion) and some are reversible (e.g. recharging a battery). • Jabir ibn Hayyan (721–815) established systematic experimentation and classified substances, laying the foundation for modern chemistry.	Elements, molecules, and compounds • All matter is composed of atoms. • The particles that make up substances are composed of atoms. • The different types of atoms are known as elements. • Each element has an atomic symbol (e.g. H, O, Ag). • Compounds are substances made of more than one element (e.g. water, carbon dioxide). • Chemical symbols and formulas represent the types and numbers of atoms in substances. Common substances and their chemical formulas: O2, H2, H2O, CO2, CO, HCl, NaCl, Fe2O3. • Molecules are particles made of two or more atoms bonded together (e.g. water, oxygen, nitrogen, carbon dioxide) and may be compounds. • Substances may be pure or mixtures: ○ a substance is pure if it includes only one type of atom, molecule, or compound ○ a substance is a mixture if it includes more than one type of atom, molecule, or compound. • Jöns Jakob Berzelius (1779–1848) introduced chemical symbols and determined atomic weights, helping standardise chemical notation and atomic theory. Periodic table • Elements are arranged in the periodic table based on their physical and chemical properties. • The periodic table is organised into vertical columns called groups and horizontal rows called periods. • Elements can be classified as either metals or non-metals: ○ metals have the physical properties of higher melting points, lustre, and higher electrical and thermal conductivity ○ non-metals have the physical properties of lower boiling points (most are gases at room temperature) and lower electrical and thermal conductivity. • Elements in the same group have similar chemical properties (reactivity, metallic characteristics). • The periodic table can be used to predict how elements will react (group 1, 2, 17, 18): ○ group 1 and 2 are metals, and groups 17 and 18 are non-metals (group 17 is halogens, group 18 is noble gases) ○ reactivity increases down groups 1 and 2 ○ reactivity decreases down group 17 ○ group 18 is non-reactive. • Dmitri Mendeleev (1834–1907) created the periodic table of elements and predicted properties of undiscovered elements, revolutionising chemistry.	Atomic theory • The Bohr model describes an atom as having a nucleus made of subatomic components (protons and neutrons), surrounded by shells of electrons. • The Bohr model’s development from Rutherford’s discovery of the nucleus demonstrates that improved scientific understanding builds on earlier evidence and ideas. • Protons, neutrons, and electrons have different charges and relative masses: ○ protons and neutrons have approximately the same mass ○ the element number of an element is equal to the number of protons, and elements on the periodic table are sorted by this number ○ the mass number of an element is equal to the sum of neutrons and protons ○ electrons have relatively no mass ○ protons have a single positive charge, and electrons have a single negative charge ○ neutrons do not have a charge. • The number of protons in an atom determines which element it is. • The electronic structure of an atom determines how it bonds and reacts with other atoms: ○ atoms in the first three periods of the periodic table have electron configurations that follow the pattern 2,8,8 ○ the valence shell is the outermost electron shell of an atom; electrons in this shell are called valence electrons and are involved in chemical bonding ○ compounds form when atoms transfer or share electrons to obtain a full valence shell (the octet rule for elements in periods 1–3 means the valence shell is full when it has 8 total valence electrons, except for hydrogen and helium, which can have 2 total valence electrons) ○ ions form when metals transfer electrons to non-metals, resulting in positively charged metal cations and negatively charged non-metal anions ○ oppositely charged ions form ionic bonds through electrostatic attraction and often result in the formation of crystals ○ ionic substances are commonly referred to as salts ○ some ions are polyatomic, including carbonate (CO32−) and nitrate (NO3−) ○ the chemical formula for an ionic substance is balanced to cancel out the total charge ○ molecules form when non-metals share electrons to create bonding electron pairs. • J.J. Thomson (1856–1940) discovered the electron, revealing the existence of subatomic particles. • Ernest Rutherford (1871–1937) proposed the nuclear model of the atom, identifying a dense central nucleus through gold foil experiments.
									Chemical reactions	Reactions with acids and bases

							theory.		• Chemical reactions create new substances by rearranging particles and may be observed as bubbles (gases), precipitates (solids), heat change (hotter or colder), or colour changes. • Reactants are the substances present at the start of a chemical reaction, and products are the new substances formed during the reaction. • Chemical reactions involve energy changes, which can be observed as thermal energy transfers to (exothermic) or from (endothermic) the surroundings. • Chemical reactions, including combustion and acid-base reactions, play key roles in both living systems (e.g. digestion) and non-living systems (e.g. engines). • Chemical reactions can be represented using word equations (e.g. sodium hydroxide + hydrochloric acid → sodium chloride + water). • Jean Beguin (1550–1620) published the first recorded chemical equation, helping formalise chemical reactions.	• The pH scale can be used to measure acidity, and this can be identified by the use of chemical indicators. • Many acids and bases are corrosive materials. • Bases that are soluble in water are known as alkalis. • Acids react with bases to produce water and salts in neutralisation reactions. • Acids react with metals to produce hydrogen gas and salts. • Acids react with metal carbonates to produce carbon dioxide, water, and salts. • There are tests to determine which gases have been produced in a reaction (hydrogen, carbon dioxide). • Common acids and bases: hydrochloric acid (HCl), sulfuric acid (H_2SO_4), nitric acid (HNO_3), sodium hydroxide ($NaOH$), potassium hydroxide (KOH), ammonia (NH_3). • Chemical reactions can be represented using balanced chemical equations. • Søren Peter Lauritz Sørensen (1868–1939) introduced the pH scale, quantifying hydrogen ion concentration in solutions. Combustion • Combustion is a chemical reaction between a fuel and an oxidising agent. • Oxygen is a common oxidising agent on earth. • Combustion is a process in which energy is transferred, primarily as heat and light. • Combustion of hydrocarbons with oxygen produces water and carbon dioxide. • Combustion of hydrogen with oxygen produces water. • Common hydrocarbons: methane (CH_4), octane (C_8H_{10}), ethanol (C_2H_6O). • John Warnatz (1944–2007) studied high-temperature hydrocarbon reaction mechanisms, advancing combustion kinetics. Displacement • A more reactive metal can replace a less reactive metal in a salt solution (e.g. iron placed in a copper sulphate solution will take the place of the copper). This is called single displacement. • When salt solutions are mixed, insoluble combinations of ions may form a precipitate, identified as a solid that may settle to the bottom. This is called a double displacement or precipitation reaction. • The solubility of ion combinations can be determined using a solubility table, and this can be used to predict precipitation reactions. • Common precipitates: silver chloride ($AgCl$), barium sulfate ($BaSO_4$), calcium carbonate ($CaCO_3$). • John Daniell (1790–1845) invented an early battery in 1836 that relied on a single displacement reaction between zinc and copper sulfate, providing a clear and practical example of the principle. Rate of reaction • The rate of a chemical reaction can be increased with temperature, concentration, surface area, and catalysis.
Matter Interactions and Energy			Light and shadow • Light is needed for humans to see objects. • Light travels from a source and can be reflected, scattered, or absorbed. • The Sun is a source of light; the Moon is not (it reflects light from the Sun). • It is dangerous to directly observe the Sun. • Objects appear smaller when they are farther away. This effect is due to visual perspective. • Darkness occurs when there is no light present. • Shadows are formed when light is blocked by an object. • Materials may be opaque, translucent, or transparent to light: ◦ opaque materials block light (they reflect or absorb it) ◦ translucent materials let some light through (reflecting, scattering, or absorbing some light) ◦ transparent materials let all or most light through. Sound • Sound travels as a wave through materials. • Shaking or vibrating materials creates sound. • Sound causes materials to vibrate. • The size of a wave or vibration affects how loud a sound is; larger waves produce louder sounds. • Volume is how loud or quiet a sound is.	Heat • Thermal energy comes from many sources (e.g. the Sun, fire, friction, electricity). • Thermal energy moves from warmer materials to cooler materials, not the other way around. • Thermal energy continues to transfer between materials until they both reach the same temperature. • Light can warm objects when it shines on them because some of the light is absorbed and is transformed into thermal energy. • Temperature is a measure of how hot a substance is. Temperature can be measured using thermometers, usually in degrees Celsius (°C). • Anders Celsius (1701–1744) created the Celsius temperature scale, which is widely used to measure temperature changes in physical and chemical processes. • Note: Students at this level are not expected to know that temperature is a measure of the average kinetic energy of a substance.		Behaviour of Light (See Year 3, Light and Sound) • Everything we see is either a light source or reflected light. For an object to be visible, light must travel from a light source to the object to the eyes. This occurs when light travels from a source directly to the eyes or when it reflects off objects and then reaches the eyes. • When an object appears to be reflected (e.g. in a mirror or water), light has travelled from a light source to the object, then to the reflective surface, then to the eyes. • Refraction of light occurs when light changes direction as it passes from one medium to another (e.g. from air into water). Simple circuits • Simple circuits involve a closed loop connecting a source of electricity, wires, and a load (e.g. lightbulb, buzzer). • Switches can open and close a circuit to control the flow of electricity. • Electricity is conducted in a circuit through metal wires. • Circuit diagrams represent the components of circuits using standard symbols for the battery, wires, switch, and load. • Thomas Edison (1847–1931) developed practical electric circuits for lighting and invented the incandescent light bulb. He held over 1,000 patents and revolutionised modern technology.	Thermal energy • Thermal energy is transferred by conduction, convection, and radiation. • Materials typically expand when thermal energy increases (heated) and contract when it decreases (cooled). • Most materials are denser as a solid than as a liquid (e.g. wax, iron). • Unusually, water expands when it freezes. • Water is less dense as a solid than as a liquid. • Jean-Baptiste Joseph Fourier (1768–1830) developed the theory of heat conduction and introduced Fourier series, which became essential in physics, engineering, and signal processing. • W.J.M. Rankine (1820–1872) investigated the anomalous expansion of water and developed the Rankine cycle, a key thermodynamic model for steam engines.	Electric charge and static electricity • Electric charge is a property of matter that causes electric fields, which can cause attraction or repulsion. Charge can build up on surfaces or flow through conductive materials. • Static electricity happens when electric charge builds up on a surface, often due to friction between materials. • Current is the flow of electric charge through a conductor. It transfers energy to make devices work. • Current is the rate at which electric charge flows. It is measured in amperes (A) and indicated with the symbol I. • Voltage is the difference in electric potential between two points in a circuit. It is measured in volts (V). • Resistance restricts the flow of electric current. It is measured in ohms (Ω). • Ohm's Law: resistance is calculated as the ratio of voltage to current ($\Omega = V / I$). • Conductors allow electric charge to flow easily (e.g. metals), insulators do not (e.g. plastic), and resistors limit the flow. • Resistors can convert electrical energy into other forms, like thermal or light. • Series circuits and parallel circuits are types of electrical circuit: ◦ series circuits are a single continuous path for electric current ◦ parallel circuits are continuous paths for electric current with several branches ◦ in a series circuit, one break stops the flow; in a parallel circuit, if there is a break in one path, other paths can still work ◦ voltage is equal across all branches of a parallel circuit ◦ the current of each branch of a parallel circuit will sum to the total current of the circuit ◦ the resistance in a series circuit is equal to the sum of the resistance of each		Energy • Energy is a quantifiable property of a system that is conserved and can be calculated based on other measurable quantities, but it cannot be directly observed or measured. • Work is done when a force causes an object to move in the direction of the force, resulting in a transfer of energy. • Energy in a system may be associated with different properties, commonly described as kinetic or potential energy: ◦ kinetic energy is associated with motion, including the energy of moving objects and the random motion of particles in thermal energy ◦ potential energy is associated with the position or configuration of a system, including gravitational, elastic, and chemical energy. • The law of conservation of energy states that energy cannot be created nor destroyed, but can be transferred between systems or transformed based on changes in motion, position, or configuration. In a closed system, the total energy remains constant. • Energy is measured in the standard unit Joule (J). • Energy diagrams are used to model the transfer and transformation of energy and to represent energy efficiency in a system: ◦ energy transfers and transformations are not 100% efficient. Some energy is always dispersed to the surroundings in forms that are not useable for the intended purpose. This dispersal can be observed as heat, light, sound, or movement. ◦ energy efficiency is the percentage of input energy that is usefully transferred or transformed for the intended purpose. ◦ the overall energy efficiency of a series of transfers or transformations can be calculated by multiplying the individual efficiencies (expressed as decimals). • Changes in the natural and human world involve the transfer and transformation of energy: ◦ when food is digested, energy stored in chemical bonds is released and used to support the functions of organisms (see Year 8, Body Systems) ◦ photosynthesis involves a transformation of energy from sunlight into chemical energy stored in sugars (see Year 7, Body Systems). • Combustion of fuels involves chemical reactions that release energy stored in molecular bonds. This energy increases the thermal energy of the system and can result in light emission: ◦ in combustion engines (e.g. cars), the increase in thermal energy causes gases to expand rapidly, generating pressure that drives mechanical components (e.g. pistons), resulting in motion. ◦ in rockets, combustion increases the temperature and pressure of gases, which are expelled at high velocity through a nozzle. the resulting thrust is produced by the reaction force, in accordance with Newton's third law. • Julius Robert von Mayer (1814–1878) established the mechanical equivalent of heat, linking energy conservation to thermodynamics.

			• The volume of a sound decreases as the distance from its source increases. • Pitch is how high or low a sound is (e.g. a whistle has a high pitch, a drum has a low pitch). • Sound frequency is a measure of how often a sound happens every second. Higher frequency means a higher pitch, and lower frequency means a lower pitch. • How much a material vibrates affects frequency (how high or low the sound is). • Sound frequency is determined by the source and typically remains constant. • Materials can affect the volume and clarity of sound as it travels. • The way sound travels through a material depends on the material's properties, such as its size (length and thickness), how stretchy or hard it is, and how smooth or rough its surface is. • Note: Concepts related to the scientific definition of frequency are not expected at this level					◦ individual resistor ◦ the resistance in a parallel circuit is less than the resistance of any individual resistor. • Electric fields are regions around charged objects where other charges experience a force, even without contact. • Electricity can be generated by converting other forms of energy (e.g. motion in turbines, light in solar panels) into electrical energy. • Alessandro Volta (1745–1827) invented the electric battery and discovered methane, laying the foundation for electrochemistry and electrical energy storage. • André-Marie Ampère (1775–1836) formulated Ampère's law and pioneered the study of electric currents in circuits, contributing to electromagnetism. • Georg Ohm (1789–1854) established Ohm's law, describing the relationship between voltage, current, and resistance in electrical circuits. • Note: Electromagnetic induction as a concept is introduced at this level; however, in-depth understanding is not expected at this level as it is conceptually advanced.		• James Prescott Joule (1818–1889) quantified the relationship between heat and mechanical work, contributing to the first law of thermodynamics. • William Thomson (Lord Kelvin) (1824–1907) defined absolute temperature and helped formulate thermodynamic laws. • William Pickering (1910–2004) was a New Zealand born rocket scientist who directed NASA's Jet Propulsion Laboratory and contributed to the development of space exploration and satellite technology. Waves • Waves are an oscillating disturbance in matter or a field (region of space) that transfers energy but not matter. • Mechanical waves transfer energy through matter and include sound and water waves. • Electromagnetic waves transfer energy through fields and include visible light; they can travel through a vacuum with a constant speed, the 'speed of light' (c). • Waves can be transverse or longitudinal: ◦ transverse waves oscillate perpendicularly to the direction of travel ◦ longitudinal waves oscillate in the direction of the travel. • Sound travels as a longitudinal mechanical wave: ◦ sound waves transfer kinetic (vibrational) energy ◦ sound is produced by and produces vibrations of matter ◦ sound is sensed when waves of sound cause sensors or ear drums to vibrate ◦ the range of sounds heard by animals varies ◦ sound travels more quickly through denser materials (e.g. faster through water than air) ◦ soundwaves are measured in hertz (Hz, frequency, pitch) and decibels (dB, amplitude, volume). • Light travels as a transverse electromagnetic wave: ◦ when light interacts with matter, energy can be transferred (e.g. absorbed as heat) ◦ when light interacts with a surface it may be absorbed (and thus transferred or transformed), transmitted, or reflected ◦ when light is transmitted through the boundary of two different media (e.g. water, glass, air), it can be refracted, bending the path of light ◦ reflection can be specular, where light rays maintain parallel paths of travel, or diffuse, where light rays travel in different directions, also known as scattering ◦ electromagnetic waves, including light waves, are characterised by their wavelength (λ), which ranges from kilometres (radio) to picometers (gamma), and their frequency (Hz) ◦ there is an inverse relationship between wavelength and frequency ◦ the spectrum of light visible to most humans has wavelengths of approximately 400–700 nanometres (nm) ◦ the frequency of light waves determines their colour as perceived by humans (e.g. red has lower frequency and longer wavelength than violet, which has higher frequency and shorter wavelength) ◦ white light contains all visible wavelengths of light ◦ when white light is refracted through a prism, it disperses (splits) into its constituent wavelengths ◦ black is not a colour of light, but how we perceive an absence of light ◦ objects absorb some wavelengths of light and reflect others — the reflected wavelengths are perceived as the colour of the object ◦ transparent materials let light through. Coloured transparent materials transmit wavelengths that correspond to their perceived colour; other wavelengths are absorbed. • Christiaan Huygens (1629–1695) proposed the wave theory of light, explaining reflection and refraction phenomena. • James Clerk Maxwell (1831–1879) formulated electromagnetic wave theory, unifying electricity, magnetism, and light. • Heinrich Hertz (1857–1894) provided experimental proof of electromagnetic waves, validating electromagnetic theory.
Motion and Forces		Motion and changes • Pushes and pulls are interactions between two or more objects and can act in different directions. • Magnets can cause pushes or pulls with some metals or other magnets. • Pushing or pulling an object can cause the object to change direction, speed, or shape. • Objects can move in different ways (e.g. roll, slide, bounce) depending on their shape. • Materials and objects can be changed physically by pushing, pulling, and twisting. • Pushing or pulling something harder can make it move faster. • Different surfaces and shapes can change how fast an object moves. • Note: Units for speed are not expected at this level.		Contact forces and movement • A force is a push or pull that can cause an object to move, stop, change direction, or change shape. • Forces have direction and size, and this can be represented by simple force-arrow diagrams. • Friction is a force that opposes the relative movement of objects in contact. The type of surface changes how much friction there is between two objects. • Speed is the distance an object travels in a given time and can be measured in kilometres per hour (km/h) or metres per second (m/s). • Speed can be described as fast, slow, changing (increasing or decreasing), or constant. • Leonardo da Vinci (1452–1519) studied the laws of friction and motion through mechanical designs and observations. His notebooks contain early insights into physics and engineering. See Technology Learning Area for further reference. • Note: Students at this level are not expected to calculate speed. Shorthand for units of speed is not required. Focus should be on describing, comparing, and observing movement and forces using everyday language and observable features (e.g. fast,	Non-contact forces (See Year 2, Materials) • Some forces need contact between two objects, but non-contact forces can act at a distance. • Magnetic force is a non-contact force that can pull or push. • Magnets have two poles (north and south). Opposite poles attract (north/south), and like poles repel (north/north or south/south). • Magnets attract some metals (e.g. iron). Not all metals are attracted to magnets. • Gravity is a non-contact force that pulls objects towards the centre of the Earth. • Weight is the force of gravity acting on an object due to its mass. • Note: at this level, units for mass are expected (e.g. kilogram, tonne) but not units for weight (newton, N). • William Gilbert (1544–1603) studied magnetism and non-contact forces. He coined the term 'electricity'. Simple machines • Simple machines (e.g. levers, pulleys, ramps) make it easier to move objects by reducing the amount of force needed or increasing the force		Deformation and friction • Forces may be internal or external to an object. • Internal forces include tension and compression. • External forces include applied force and friction. • Forces can change the shape, size, or position of objects. • Friction opposes the relative motion of objects in contact with each other, and causes heat. • Leonhard Euler (1707–1783) made foundational contributions to mathematics and mechanics, including the analysis of stress and strain in materials. • Charles-Augustin de Coulomb (1736–1806) developed a theory of friction and formulated Coulomb's law, describing the electrostatic force between charged particles. • Note: Mathematical analysis of tension and compression is not appropriate for this level.	Pressure • Pressure is the perpendicular force applied to a surface, divided by the area over which the force is applied. • The amount of pressure depends on both the total applied force and the total area it is applied to. • Pressure is produced when a force pushes on an area of a solid, liquid, or gas (e.g. applied force or gravity): ◦ smaller areas create higher pressure with the same total force (e.g. a pin vs a knife) ◦ larger areas spread the force and reduce pressure (e.g. squashing vs cutting fruit). • The shape and design of a tool determine its effect when pressure is applied. • Note: In Year 8, the focus is on solid pressure. Fluid and gas pressure are introduced later and do not need to be covered here.	The effect of forces • The action of forces on the movement of objects can be described using Newton's Laws of Motion. • Newton's First Law of Motion: ◦ net force is the overall force acting on an object, after all the individual forces (including their directions) are combined ◦ when the net force on an object is zero (forces are balanced), the object stays at rest or continues to move at constant velocity in a straight line ◦ when the net force on an object is non-zero, the object's motion changes. This can be a change in velocity or direction. ◦ objects resist changes in motion. This property is called inertia and depends on the object's mass. • Newton's Second Law of Motion: ◦ more force causes more acceleration on the same mass, but more massive objects accelerate less when the same force is applied ◦ the relationship between force, mass, and acceleration is given by $F = ma$ ◦ force is measured in newtons (N). • Newton's Third Law of Motion: ◦ forces are always paired as action and reaction force pairs ◦ every interaction between objects involves equal and opposite forces acting on each object.	

				slow, constant, changing).	able to be applied. Fluids, resistance, and buoyancy (See Year 5, Materials) • Fluids are either liquids or gases. • Fluids exert a pushing force, called resistance, on objects that move through them. • Drag (air resistance) opposes the movement of objects moving through gases (e.g. parachute). • Drag (water resistance) opposes the movement of objects moving through water (e.g. a hoe (paddle) on a waka). • Buoyancy is an upwards force exerted by a liquid on an object (e.g. a ship). • Buoyant force depends on the density of the fluid and the object. • An object floats when the upward buoyant force from the liquid is equal to or greater than the object's weight. An object will sink if the buoyant force is less than the object's weight. • Denser fluids exert a greater buoyant force. Saltwater is denser than fresh water, which is why objects float higher and more easily in salt water. • Buoyancy does not explain all movement in water (e.g. flowing water can move rock and soil fragments by pushing them, not by buoyancy). • Archimedes (c.287–212 BCE) formulated the principle of buoyancy. • Note: Measurable quantities should be interpreted through relative comparison rather than absolute measurement.				• Friction opposes relative motion across surfaces and through fluids (e.g. air resistance and water resistance are types of friction) (see Year 5 and Year 7, Motion and Forces). • Equal forces acting on the same rigid body (an object whose shape cannot change) in opposite directions will cancel out. • Forces acting on a rigid body can be summarised in a free body diagram to determine net force. • Velocity is the rate at which an object moves. • Acceleration is the rate at which an object's velocity changes. • Motion can be represented using graphs that show changes in velocity or distance over time (see Year 8, Motion and Forces). • Isaac Newton (1643–1727) developed the laws of motion and universal gravitation, forming the foundation of classical mechanics and celestial dynamics. • Note: At this level, it is not necessary to break down a Newton into its base units ($kg \cdot m/s^2$). Fluids and pressure (See Year 5 and Year 8, Motion and Forces) • Atmospheric pressure decreases with altitude because the weight of air above reduces as height increases. • Pressure in liquids increases with depth due to the increasing weight of liquid above. • Upthrust determines whether objects float or sink. • Blaise Pascal (1623–1662) formulated Pascal's principle of pressure and contributed to fluid mechanics and probability theory.	
Earth Systems	Note: See Social Science learning area — Geography strand.	Note: See Social Science learning area — Geography strand.	Note: See Social Science learning area — Geography strand.	States of matter in the atmosphere (See Year 4, Materials, and Matter Interactions and Energy) • The Sun transfers thermal energy to the Earth's surface, warming the air, water, and land during the day. • Thermal energy from the Sun causes water to evaporate from rivers, lakes, oceans, soil, and plants. • Water is present in the air as an invisible gas called water vapour. • When water vapour in the air cools, it condenses into liquid droplets and forms visible clouds. • Changes of state (evaporation, condensation, and freezing) influence the weather (e.g. rain, fog, frost, snow, types of cloud cover). • Rain, snow, and hail occur when water in clouds changes state and falls to Earth. • Rain, snow, and hail are called precipitation. • The movement of water through different states and between the Earth's surface and the atmosphere is called the water cycle. • John Dalton (1766–1844) proposed the hydrological cycle and atomic theory. His work in meteorology and chemistry advanced the understanding of weather and matter. • Note: See Social Science Learning Area — Geography strand.	Rocks and minerals • Soils are composed of decaying organisms, living organisms (including fungi, plants, and animals), rock particles, air, and water. • Rocks are composed of minerals, which can be characterised by the size, shape, and colour of crystals. • Fossils are formed when organisms are buried in sediment and, over time, minerals replace the organic material. • James Hutton (1726–1797) formulated the Theory of the Earth, proposing that geological processes occur over vast timescales.		Rocks and minerals • Minerals are natural materials with repeating patterns that give them unique shapes and properties (e.g. shiny crystals, hard surfaces). • Rocks are made of minerals and crystals and sometimes contain fossils. • Earth deposits (e.g. minerals, coal, petroleum) are natural materials with observable properties. • Different earth deposits are used based on their properties (e.g. iron is strong and dense, aluminium is strong and less dense). • Earth materials have important uses for humans (e.g. salts, mica). • Charles Cotton (1885–1970) advanced the study of New Zealand's landforms and authored key texts in geomorphology that shaped geological education.		Spheres of the Earth • The atmosphere is a layer of gas surrounding the Earth. • The atmosphere is a mixture of gases (e.g. nitrogen, oxygen, argon, carbon dioxide, water vapour). • The lithosphere is the rocky surface and interior of the Earth. • The biosphere is all living organisms and recently living organisms on Earth. • The hydrosphere is all water on the surface of earth. • Tracking the cycling of matter and the transfer of energy shows how Earth's spheres affect each other (e.g. water evaporates from the hydrosphere into the atmosphere and returns as precipitation). • Solar radiation the Earth receives decreases with increasing latitude (e.g. more at the equator — latitude 0°, less at the poles — latitude 90°N and 90°S). • Global ocean convection circulates water and stabilises the global climate. • Matter cycles and energy transfers occur within and between Earth's spheres through global systems, such as the water and carbon cycle. • Eduard Suess (1831–1914) introduced the terms hydrosphere, lithosphere, and biosphere in 1875, helping define Earth's major interacting systems in geology.	Carbon cycle • Carbon cycles throughout the environment. • Carbon in the biosphere is found in all organisms. • Carbon in the hydrosphere is found as dissolved carbon dioxide. • Carbon in the lithosphere is found in carbonate minerals and fossil fuels. • Carbon enters the atmosphere from natural processes including respiration, decomposition, combustion, and volcanism. • Carbon dioxide from the atmosphere becomes part of living organisms (the biosphere) through photosynthesis. • Human activities remove carbon from the lithosphere (e.g. combustion of fossil fuels, cement production) and biosphere (e.g. logging) and release it into the atmosphere. • Carbon, as carbon dioxide or methane, is a greenhouse gas. • Greenhouse gases increase the amount of thermal energy trapped by the atmosphere and include water, carbon dioxide, and methane. • An increase in greenhouse gases causes global heating, leading to climate change. • Joseph Priestly (1733–1804) discovered oxygen and explored its role in plant-based air renewal and the carbon cycle. • Thomas Chamberlin (1843–1928) developed a model of the carbon cycle, linking geological and atmospheric processes. • Note: See Social Science learning area — Geography strand.
Earth and Space			The Earth and Sun • The movement of the Earth in relation to the Sun causes observable patterns, including the rising and setting of the Sun, the length of a day, and the length of a year. • The Earth is roughly spherical. • The Earth rotates on its axis once every 24 hours. • The side of Earth facing the Sun experiences daytime, receiving light, and warming through the day. The side facing away from the Sun experiences night-time, and gradually cools through the night. • Shadows change during the day, along with the Sun's	Matariki • Matariki is a star cluster that becomes visible in the eastern morning sky during mid-winter in New Zealand. • The visibility of Matariki in the morning sky is used as an indicator of seasonal change for many iwi. • Puanga (Rigel) is a star that rises shortly before Matariki and is more visible in some regions. It also serves as a seasonal indicator for many iwi. • The Matariki star cluster is known by many cultures, including as Makali'i in Hawai'i, Matarii in Tahiti, Subaru in Japan, and Pleiades in Greece.	Earth, Moon, and Sun • The Earth, Moon, and Sun are roughly spherical. • Earth is tilted on its axis. As the Earth orbits the Sun, this causes different parts of the Earth to be angled towards or away from the sun, receiving more or less direct sunlight. This causes seasonal change. • Seasons are associated with changing temperatures and length of daylight through the year. • The Moon orbits the Earth and reflects light emitted from the Sun (see Year 3, Matter Interactions and Energy). • The Moon appears to change shape (full, crescent, quarter, gibbous) in a regular waxing and waning pattern called the lunar cycle.	The Solar System • The Earth is one of eight planets orbiting the Sun in the Solar System. • The order of the planets from the Sun is Mercury, Venus, Earth, Mars (the rocky planets) and Jupiter, Saturn, Uranus, Neptune (the gaseous planets). • The Solar System includes the Sun, planets, moons, asteroids, and comets. • The Solar System is located within the Milky Way galaxy. • Celestial bodies are natural objects in space and include planets, moons, stars, comets, asteroids, nebula, and galaxies.		The Universe • The universe contains trillions of galaxies. Most galaxies hold billions of stars, many of which have planetary systems. Galaxies also contain gas, dust, and dark matter. • Stars, including the Sun, are large luminous bodies that emit vast amounts of radiation through a process called nuclear fusion. (Note: Students are not expected to understand the process of nuclear fusion.) • Gravity is a force of attraction between objects that have mass, so the greater the mass of a celestial body, the greater its gravitational pull. • Planets are celestial bodies that orbit stars and are large enough for their own gravity to pull them into roughly spherical shapes. • A planet's orbital path is usually clear of other debris because its gravity pulls in, slings		Expanding Space • Gravity is the fundamental force that governs the behaviour and interactions of all matter in the universe. It influences the motion of objects on Earth, the orbits of celestial bodies within the Solar System, and the structure and dynamics of galaxies such as the Milky Way. • The observable universe is limited by the speed of light and the age of the universe. • A light year is the distance light travels in a vacuum in one Earth year. • An astronomical unit (AU) is the average distance between the Earth and the Sun. • The Big Bang theory describes the origin of the universe, which originated at a single point and is continually expanding. • Evidence for the Big Bang theory includes the observation that galaxies are moving away from each other — showing that the universe is expanding — and the cosmic microwave background, which is faint electromagnetic radiation from the early universe. • Ole Rømer (1644–1710) demonstrated that light travels at a finite speed using astronomical observations of Jupiter's moon Io • Edwin Hubble (1889–1953) discovered the expansion of the universe and established the relationship between galaxy distance and redshift,

			position in the sky. • The Earth orbits (revolves around) the sun and takes one year (365 and a quarter days) to complete one full orbit. • A planet is a large object that orbits a star. Planets do not emit light. • A star is a massive ball of hot gases that emits light and other radiation. • The Sun is a star and the Earth is a planet. • Aristotle (384–322 BCE) proposed the theory of a spherical Earth. His philosophical and scientific ideas influenced scientific thought for centuries. • Note: Patterns related to seasons and lunar phases are addressed in Year 5. • Note: Concepts related to radiation are not expected at this level.	• Dr Pauline Harris (1970–) revitalised Māori astronomical star lore and contributed to Indigenous science education and astrophysics.	• The lunar cycle occurs because the Moon orbits Earth, changing the portion of its sunlit surface that is visible from Earth depending on the relative positions of the Moon, Earth, and Sun. • The Moon rises and sets at slightly different times and places in the sky each day, following a regular 29.5-day cycle. • The Maramataka is the traditional Māori lunar calendar based on cycles of the moon and stars.	• The Sun is a star that appears larger and brighter than others because it is closer to Earth. • The Sun, Moon, and stars follow observable and predictable patterns that vary by location. • Understanding of the Solar System has evolved from a geocentric to a heliocentric model. • Accurate and detailed star charts have been created through direct human observations and instruments such as telescopes. • Many civilisations developed sophisticated astronomical knowledge (e.g. Babylonian, Chinese, Indian, Celtic, Polynesian). • Galileo Galilei (1564–1642) supported the heliocentric model with telescopic observations. He discovered moons of Jupiter and phases of Venus. Also demonstrated that density is a measurable property of matter and conducted experiments on falling bodies and motion.		away, or captures nearby objects. • Dwarf planets are celestial bodies that orbit stars and are large enough for their own gravity to pull them into roughly spherical shapes but are not large enough to clear their orbits. • Planets can be rocky or mostly gaseous. • Moons are rocky or icy natural satellites that orbit planets. • Asteroids are smaller rocky bodies that orbit stars or drift through space, often found in belts or scattered across the Solar System. • Comets are icy bodies that may orbit stars or travel through interstellar space. • Johannes Kepler (1571–1630) formulated the laws of planetary motion, describing elliptical orbits and supporting the heliocentric model.		supporting the Big Bang theory. • Beatrice Tinsley (1941–1981) made pioneering contributions to galaxy evolution and cosmology, influencing models of the expanding universe.
Organism Diversity	Discovering life • All living things are organisms. • There is a wide variety of organisms (this is diversity), including plants, animals, and fungi. • Plants exist in many forms, including grasses, ferns, trees, and seaweeds; they can be flowering or cone-bearing, deciduous or evergreen. Algae such as seaweeds, share some similarities with plants. • Common structures of flowering plants (including trees) include leaves, flowers, fruit, roots, seeds, trunk, branches, and stem. • Ocean plants have different structures to land-based plants. • Animals include diverse groups such as fish, amphibians, reptiles, birds, insects, and mammals (including humans). Each group has distinct features. • Fungi are living organisms that are different from plants and include mushrooms. • Theophrastus (c.371–287 BCE) described plant forms and structures. His botanical texts were used for centuries as primary references.	Life cycles • Animals, including humans, reproduce and grow into adults. • Offspring often resemble their parents but are not exactly the same as them. • Organisms eventually die. • Different organisms have different life cycles (e.g. butterfly, frog, human, broad bean, kōwhai tree). • Plants grow from seeds, mature, and reproduce. • Flowers are primarily for reproduction. • Flowers play an important role in the life cycle of flowering plants: pollination, seed formation, and seed dispersal. • A seed contains stored nutrients and needs water to germinate. • Maria Sibylla Merian (1647–1717) observed and recorded insect metamorphosis using detailed illustrations. Her work bridged art and science and advanced entomology.	How organisms meet their needs • In plants, each structure has a function (e.g. roots and stems help support the plant and transport water and nutrients). • Plants gain nutrition by absorbing sunlight in their leaves to produce sugar (this is photosynthesis); they take up water and nutrients from the soil through their roots. • Animals gain nutrition by digesting other organisms. • Different types of animals have varied diets, with some eating plants (herbivores), some eating other animals (carnivores), and some eating a variety of foods (omnivores). • Animals have body structures adapted for their diets (e.g. teeth, jaw size, snout/beak length, tongue shape). • The teeth of carnivores and herbivores look different, related to their different functions. • Alfred Brehm (1829–1884) recorded observations of animal diets and feeding behaviours. His writings popularised zoology and animal studies in Europe. • Note: Photosynthesis as a process is beyond the conceptual level for this age group. Focus should remain on the connection between sunlight and sugar production and that this is called photosynthesis.	Taxonomy • The scientific classification system (or taxonomy) uses accepted criteria, including observable features, to divide organisms into categories and sub-categories. • Categories of organisms include animals, plants, fungi, and bacteria. • Animals can be vertebrate or invertebrate: ◦ vertebrates include fish, amphibians, reptiles, birds, and mammals ◦ invertebrates include molluscs (snails and slugs), worms, spiders, and insects. • Plants include flowering plants (including grasses) and non-flowering plants (ferns and mosses). • A species is a group of organisms that are the same kind and can have offspring together. These offspring can also grow up and have their own offspring. • Organisms have a scientific name, based on their species (e.g. humans' scientific name is Homo sapiens). • Some organisms can only be observed through a microscope, not with the naked eye. These are called microorganisms. • Fungi are a diverse group of organisms that include mushrooms, moulds, and yeasts, each with unique structures. • Bacteria are microorganisms that are found everywhere on Earth and can be beneficial (e.g. in the human digestive system), neutral, or harmful (e.g. germs) to humans. • There are many plants and animals that are now extinct. • Organisms that have very different observable features (that look different) are less likely to be closely related. • Organisms that have very similar observable features (that look alike) are often closely related. • Carl Linnaeus (1707–1778) developed a system for classifying organisms by type and habitat. His binomial nomenclature system is still used in taxonomy today.	Reproductive strategies • Organisms have different strategies to enable them to successfully reproduce. • Fruits develop from flowers. • Seeds have specialised parts that aid in dispersal (e.g. wings, hooks, fleshy coatings). • Animals, plants, and fungi reproduce in different ways, including laying eggs, giving birth to live young, and producing seeds or spores. • Some types of organisms produce many offspring (e.g. wētāpunga, mice), while others produce few (e.g. humans, kiwi). • Some organisms can reproduce from parts of themselves (e.g. potato offcuts, stem cuttings). • Note: Students at this level are not expected to understand the r/K model.	Evolution and inheritance • Offspring inherit characteristics from their parents, but there is variation among offspring (they are not identical to their parents). • Organisms that are better adapted to their environment are more likely to survive to reproduce. This is called natural selection. • Natural selection means that over generations, certain inherited characteristics become more or less common in a population. • Over a very long period of time, the process of natural selection can lead to the evolution of new species (e.g. kākā, kea, and kākāpō evolved from a shared ancestor into forest, alpine, and nocturnal parrot species). • Fossils provide evidence that organisms have changed over millions of years. • All organisms share common ancestors. Over long periods of time, those ancestors have gradually evolved into different species. • Scientists try to understand what the family tree of all organisms (the 'tree of life') looks like by studying fossils and the physical features of species. • Joan Wiffen (1922–2009) discovered the first dinosaur fossils in New Zealand. Her work changed the understanding of prehistoric life in the region. • Note: At this stage, students are not expected to understand how genes and chromosomes work.	Cells and organisation (See Year 7, Body Systems) • The invention of the microscope allowed scientists to observe cells, leading to major advances in biology. • Cells are the fundamental unit of living organisms and contain parts (structures) called organelles. • Organelles are structures inside cells that have specialised functions: ◦ the cell membrane is a thin layer around the cell that controls what enters and leaves ◦ the cytoplasm is a jelly-like substance inside the cell where most cell activities happen ◦ the nucleus is a structure that contains genetic material (DNA), which provides instructions for how a cell is shaped and how it works ◦ mitochondria break down glucose (sugar) via cellular respiration ◦ the vacuole is a fluid-filled space that stores water and nutrients; it is large in plant cells and smaller in animal cells ◦ the cell wall is a rigid outer layer found in plant cells that gives strength and shape ◦ the chloroplasts are green structures in plant cells that use sunlight to make sugar (glucose) through photosynthesis. • Plant cells have a cell wall, chloroplasts, and a large vacuole. • Animal cells do not have a cell wall or chloroplasts. • Cells can be specialised for different jobs, such as movement, storage, or sending signals. • Organisms can be single-celled (unicellular) or be made of more than one cell (multicellular). • Unicellular organisms have structural adaptations that are unique to their environment and way of life (e.g. euglena has a tail to swim and can make its own sugars for fuel through photosynthesis). • Organisms which are too small to be seen without a microscope are called microorganisms. They are typically unicellular (e.g. bacteria, yeast (fungi), protists). • Multicellular organisms are organised hierarchically: from cells to tissues to organs to systems to organisms. • Robert Hooke (1635–1703) invented the microscope and was the first to describe cell structures, laying the foundation for cell theory.	Genetic material and inheritance • Sexual reproduction involves the fusion of gametes, each carrying half the genetic information from a parent. This process is called fertilisation (see Year 5, Body Systems). • Gametes are reproductive cells (e.g. sperm, egg, pollen) that carry one set of chromosomes. • Chromosomes are structures that carry DNA, the genetic material that contains instructions for how cells function. • Offspring inherit a unique combination of genetic material, resulting in both similarities and differences among individuals. • In humans, biological sex is determined by the combination of sex chromosomes inherited at fertilisation (XX usually results in a female, XY usually results in a male), although variations in chromosomal patterns can result in diverse sex characteristics. • Gregor Mendel (1822–1884) founded the science of genetics through his experiments on inheritance in pea plants, establishing the laws of heredity. Adaptation and evolution • Individuals of the same species have differences in their genetic material. This is due to mutations' changing DNA and sexual reproduction's creating new combinations of DNA. • These differences mean that some orgabnisms within the same species are better adapted to their environment than others. • When there is selection pressure, better-adapted organisms are more likely to survive and reproduce and therefore to pass their genetic material on to offspring. • Selection pressure is a feature of the habitat or environment that means not all individuals will survive or reproduce, such as predation or competition for space. • Evolution is the change in the genetic make-up of a population over many generations. • Adaptation can lead to evolution when inherited variations that improve survival or reproduction become more common over generations (e.g. elaborate peacock tails; insulating fur on Arctic foxes; different juvenile and adult forms in horoeka, pōkākā, and putaputawētā plants, likely an adaptation that reduced grazing by moa). • Charles Darwin (1809–1882) discovered that orchids have highly specialised floral structures that promote cross-pollination by insects. He showed that these adaptations evolved through natural selection, and predicted specific insect pollinators based on flower morphology, among many other discoveries. • Alfred Wallace (1823–1913) co-developed the theory of natural selection and pioneered the field of biogeography through his studies in Southeast Asia.	Determining organism traits • A phenotype is all the observable characteristics or traits of an organism. This is influenced by genes and the environment. • DNA is packaged in chromosomes and stored in the nucleus. • A gene is a section of DNA that contains instructions for making a protein or part of a protein (e.g. insulin). • Proteins are large molecules made by cells. They help build body structures and carry out specific tasks in cells, such as carrying substances, speeding up chemical reactions, and protecting against disease (e.g. hormones, enzymes, antibodies). • Proteins determine an organism's traits (e.g. chlorophyll in leaves, keratin in hair, nails, feathers). • Some traits are influenced by a single gene, but most traits are influenced by many genes. • When a gene is active, its protein is made; when inactive, the protein is not made. • Traits are also influenced by the environment, for example: ◦ in humans, height is influenced by nutrition and genes ◦ in reptiles like tuatara, sex is determined by nest temperature. • Variation refers to differences in traits among individuals in a population: ◦ discontinuous variation shows distinct categories (e.g. blood type, flower colour) ◦ continuous variation shows a range of values (e.g. height). • Maurice Wilkins (1916–2004) was a New Zealand-born British biophysicist best known for his pivotal role in the discovery of the double helix structure of DNA. • Rosalind Franklin (1920–1958) captured key X-ray images that revealed DNA's helical structure. • James Watson and Francis Crick (20th century) used Franklin's discovery to build the double helix model, explaining how genetic information is stored and replicated.	Disease and immunity (See Year 7, Body Systems) • Infectious diseases are caused by pathogens (e.g. bacteria, viruses, protists, fungi) and can spread through body fluids, contaminated food or water, or airborne particles (e.g. influenza spreads via respiratory droplets, myrtle rust spreads by wind and contact). Infectious disease can be managed through hygiene, quarantine, and other preventative measures. • Non-infectious diseases are not caused by pathogens and do not spread between individuals: ◦ some non-infectious diseases are caused by environmental factors, such as exposure to harmful chemicals, radiation, or air pollution. These conditions can damage cells or disrupt normal body functions (e.g. asbestosis, some cancers) ◦ some non-infectious diseases are genetic disorders (e.g. Huntington's disease, haemophilia, cystic fibrosis) ◦ many non-infectious diseases are caused by a combination of genes and environment (e.g. asthma, diabetes, some cancers) • The human body has non-specific defence systems against pathogens, including physical barriers (skin, hair, cilia), chemical defences (tears, saliva, stomach acid), and the microbiome: ◦ the microbiome is a community of microorganisms living inside or on the body, which is shaped by genes and the environment ◦ microorganisms in the microbiome help the immune system, such as by protecting the skin and mouth from other harmful microorganisms. • The immune system protects the body from disease using white blood cells, antibodies, and memory cells that recognise and respond to pathogens. • Vaccines prevent disease by stimulating the immune system to produce a protective response without causing illness. • Louis Pasteur (1822–1895) formulated germ theory and developed vaccines for rabies and other diseases. • Edward Jenner (1749–1823) developed the smallpox vaccine, founding the field of immunology.
Body Systems	Body basics • The human body consists of major parts such as the head, neck, torso, arms (including elbows), legs (including knees), face, ears, eyes, nose, hair,	What organisms need to survive • Animals and fungi depend on other organisms for nutrients, whereas plants can produce their own nutrition. • Plants need water, carbon dioxide (often from the air), light, and space to	Support and movement • Humans and some other animals have internal skeletons (including spine, ribcage, and skull) and muscles for support, protection, and movement. These are called the skeletal and muscular systems. These systems work together.	Digestion • Animals' digestive systems break down food and absorb nutrients for fuel and growth. • The human digestive system has parts, and the structure of each part relates to its function, including: ◦ Mouth	Reproduction (See Year 2, Organism Diversity) • All living organisms reproduce. • Sexual reproduction involves two parents (e.g. humans, birds, flowering plants) and produces offspring that exhibit a mix of both parents' characteristics.	Interconnected systems (digestive, respiratory, circulatory) • The respiratory system allows animals to take in oxygen, which they need to live, and exchange it for carbon dioxide. This is called breathing. • Air is a mixture of gases such as nitrogen, carbon dioxide, oxygen, and water vapour.	Diffusion • Diffusion is when particles spread from where there are more particles to where there are fewer. • Oxygen and carbon dioxide particles move into and out of cells by diffusion. • Adolf Fick (1829–1901) formulated Fick's laws of diffusion,	Reproductive structures and processes • Many plants and animals reproduce sexually using specialised cells and organs that enable fertilisation and development. • Flowers contain reproductive structures such as anthers, stigmas, styles, ovaries, and pollen. • Flowering plants reproduce through pollination (e.g. by wind or insects), fertilisation,	Transport systems in plants and humans • Multicellular organisms require transport systems to move substances efficiently throughout their bodies due to their size and complexity. Human transport system (circulatory system)	Regulation and response in the human body • Homeostasis is the maintenance of a constant internal environment. • Principles of homeostasis: • A stimulus resulting from a change in the internal environment • Detection by a receptor, followed by a corrective mechanism and negative feedback. • Homeostasis maintains a stable body temperature in humans through coordinated responses such as:

	mouth, and teeth. • Different body parts are associated with senses, including sight, hearing, touch, taste, and smell.	survive. • Animals need food (nutrition), water, oxygen (often from the air), and space to survive. • Organisms have structural features and behaviours that help them to survive where they live. These are called adaptations. • Animals have body parts for sensing, movement, protection, and resource gathering (e.g. kiwi have long, sensitive beaks for finding insects and worms in forest leaf litter and soil). • Organisms sense stimuli (e.g. light, heat, contact) in their environment and respond to them.	• Some animals have external skeletons (e.g. exoskeletons in insects like the wētā and in spiders, shells on molluscs). • Some animals have no skeleton (e.g. slugs) and some also have no muscles (e.g. jellyfish). • Animals with an internal skeleton are called vertebrates. Animals without an internal skeleton are called invertebrates. Most animals are invertebrates. • Some plants have a structural support system (e.g. trunk, branch, stem). Woody plants (e.g. trees) can grow taller than non-woody plants (e.g. grass, ponga). • Andreas Vesalius (1514–1564) accurately described and illustrated the muscles and skeletal structure of humans.	○ teeth (incisors, canines, premolars, and molars, which all have different functions) ○ tongue ○ oesophagus ○ stomach ○ liver ○ small intestine ○ large intestine ○ rectum. • Bacteria can aid digestion by breaking down and helping absorb food.	• Asexually produced offspring are copies of their parent (potato tubers, yeast budding, strawberry plants through runners). • Animals reproduce sexually through: ○ sperm and egg formation ○ fertilisation. • Flowering plants reproduce sexually through: ○ Pollination ○ fertilisation (seed formation) ○ seed dispersal ○ germination. • Most fungi reproduce sexually, involving: ○ Fertilisation ○ fruiting bodies (e.g. mushrooms) ○ spore formation ○ dispersal ○ germination.	• The human respiratory system includes the trachea, lungs, diaphragm, ribs, and intercostal muscles. The structure of each part supports its role in breathing (e.g. the ribs form a protective cage, while the diaphragm and intercostal muscles draw air into the chest cavity). • Some animals, like fish, respire using gills, which take oxygen out of water. • The circulatory system transports nutrients and gases throughout the body. • The human circulatory system moves blood around the body and includes the heart, blood, and blood vessels. The structure of these parts relates to their function. • The digestive, respiratory, and circulatory systems work together to supply oxygen, water, and nutrients to the human body. • William Harvey (1578–1657) discovered the modern pulmonary system and circulation of blood. His experiments laid the foundation for cardiovascular physiology. • Note: Detailed anatomical knowledge such as the names of heart chambers, valves, and specific blood vessels (arteries, veins, capillaries) and formal classification of cell types are not required.	describing how substances move through different media and influencing physiology and physics. Cellular respiration • Respiration is a process in cells where sugar (glucose) is broken down using oxygen, to release chemical energy. • Carbon dioxide and water are produced as 'waste' during respiration. • Chemical energy released during respiration is used by cells for movement, growth, and repair. • Joseph Priestley (1733–1804) discovered oxygen and demonstrated that plants renew air quality, contributing to early understanding of photosynthesis and atmospheric chemistry. • Note: Respiration at this level refers to aerobic respiration only. Students do not need to learn about anaerobic respiration at this stage. Photosynthesis • Photosynthesis is a process that plants, algae, and some bacteria use to make their own fuel in the form of sugar (glucose) using light, water, and carbon dioxide. • The sugars made during photosynthesis can be stored as starch (for fuel) or used to build materials like cellulose (which gives plants strength and structure). • Leaves are adapted for photosynthesis by being thin and containing light-capturing organelles called chloroplasts. • Photosynthesis changes the relative abundance of the gases oxygen and carbon dioxide in the atmosphere, creating conditions that support other life on Earth. • Jan Ingenhousz (1730–1799) discovered that green plants produce oxygen during photosynthesis in sunlight, confirming the role of light in plant respiration.	seed and fruit formation, seed dispersal, and germination. • Human reproduction includes fertilisation and development through stages called zygote, embryo, and foetus, leading to birth. • Puberty is a life stage when organisms develop reproductive ability. • The menstrual cycle in females involves ovulation and menstruation and is regulated by hormones. • In some species, reproductive tissue is shed cyclically if fertilisation does not occur (e.g. menstruation in humans). • Sperm production in males is regulated by hormones. • A hormone is a chemical substance (e.g. oestrogen, progesterone, testosterone), carried by the blood, which alters the activity of one or more specific target organs. • Karl Ernst von Baer (1792–1876) discovered the mammalian ovum and laid the foundation for modern embryology. • George Washington Corner (1889–1981) studied hormonal regulation and reproductive anatomy, contributing to the understanding of human development and fertility. Digestive system • The human digestive system includes the mouth, teeth, tongue, salivary glands, oesophagus, stomach, liver, pancreas, small intestine, large intestine, rectum, and anus, which work together to digest food. • Digestion involves mechanical and chemical processes: • mechanical digestion includes chewing and churning • chemical digestion uses chemicals, such as stomach acid, bile from the liver, and enzymes from saliva, the stomach, and the pancreas, to break down food. • Digestive organs and tissues have adaptations for their functions, such as teeth for chewing, villi for absorption, and peristalsis for moving food. • Beneficial bacteria in the gut support digestion and health. • A healthy diet includes carbohydrates, fats, proteins, vitamins, minerals, fibre, and water. • Digested nutrients are used as building blocks for growth and other life processes. • William Beaumont (1785–1853) studied chemical digestion in the stomach through experiments on a patient with a gastric fistula. Gas exchange • Breathing, gas exchange, and cellular respiration are connected processes that involve the movement and use of oxygen and carbon dioxide. • The human respiratory system includes the nose, mouth, trachea, lungs (bronchi, bronchioles, alveoli), diaphragm, and capillaries, each adapted for efficient gas exchange. • Breathing involves changes in air pressure and volume, controlled by the diaphragm, ribs, and intercostal muscles (see Year 6, Motion and Forces). • Plant leaves are adapted for gas exchange through features such as stomata, guard cells, and a thin, flat shape.	• The circulatory system consists of the heart, blood vessels (arteries, veins, capillaries), and blood (plasma, red and white blood cells, platelets). • The circulatory system transports oxygen, nutrients, hormones, and waste products throughout the body. • Substances move in and out of the blood via diffusion, osmosis, and active transport (e.g. oxygen, carbon dioxide, glucose, water, ions). • Diffusion is the passive movement of particles from an area of higher concentration to an area of lower concentration. • Osmosis is the passive movement of water across a semi-permeable membrane from higher water concentration to lower water concentration. • Active transport is the movement of substances from lower to higher concentration, using energy and transport proteins, against the concentration gradient. • A high surface area to volume ratio facilitates efficient exchange of substances in tissues. • The circulatory system works closely with the respiratory and digestive systems to support cellular function. • René-Joachim-Henri Dutrochet (1776–1847) identified osmosis as a key physiological process in cells. Plant transport system • The xylem transports water and mineral salts from the roots to the rest of the plant. • The phloem transports sugars (mostly sucrose) produced in the leaves to other parts of the plant for growth and storage. • Peter Raven, Ray Evert, and Susan Eichhorn (Contemporary) explored the structure and function of xylem and phloem, advancing plant biology education.	• temperature detection by skin receptors and the hypothalamus followed by, • sweating and vasodilation to decrease body temperature, or shivering and vasoconstriction to increase body temperature • These processes are regulated by the central nervous system. • Claude Bernard (1813–1878) explored internal physiological regulation, laying the foundation for homeostasis. • Walter Cannon (1871–1945) coined the term 'homeostasis' and described the fight-or-flight response. Hormonal control • A hormone is a chemical substance, produced by a gland, carried by the blood, which alters the activity of one or more specific target organs. • The endocrine system includes hormones, glands (including islets of Langerhans in the pancreas), and receptors. • Blood glucose concentration is regulated by insulin and glucagon as a homeostatic mechanism. This is an example of hormonal control. • Diabetes is an example of a disease caused by inability to regulate blood glucose concentration. • Ernest Starling (1866–1927) discovered hormonal control mechanisms and introduced the term 'hormone'. Nervous control • The nervous system has distinct structures and functions in humans, including specialised adaptations such as the brain, spinal cord, and neurons (synapses, axons, dendrites) that transmit nerve impulses: ○ the central nervous system includes the brain and spinal cord ○ the peripheral nervous system includes all the nerves outside the brain and spinal cord. • The nervous system produces stimulus-response actions, including both voluntary actions and reflex arcs. • Sensory neurons, receptors, motor neurons, and effectors work together to detect stimuli and produce coordinated responses. • The eye is a sensory organ, and its parts — including the iris, cornea, crystalline lens, and retina — have specific structures and functions. The pupil reflex is an example of an automatic response to light. • Ivan Pavlov (1849–1936) identified conditioned reflexes through experiments with dogs, influencing behavioural psychology.
Ecosystems	Where and how organisms live • Organisms are found in almost every place on Earth. • Some organisms are active during the day, others at night (nocturnal). • Some organisms live alone (e.g. tree), and others live in groups (e.g. hive of bees). • Karl von Frisch (1886–1982) investigated social behaviour in honeybees, including their communication through dance. He was awarded the Nobel Prize in Physiology or Medicine in 1973.	Habitats • Habitats are places where organisms interact with other organisms and can find the resources they need for survival (e.g. Maui dolphins live in coastal waters where they can catch small fish). • Communities are groups of organisms that live and interact in the same place. • Animals and plants vary across habitats (e.g. beach, ocean, rainforest). • A habitat supports a variety of organisms. • A microhabitat is a small habitat (e.g. under stones or leaf litter). • Whakaotirangi (Tainui) (1300s) introduced kumara to New Zealand and contributed to Polynesian	Food chains • Nutrition is transferred from one organism to another when organisms eat other organisms. • Plants produce their own nutrition and form the beginning of a food chain, followed by herbivores, omnivores, and carnivores. • Charles Elton (1900–1991) introduced the concepts of food chains and ecological pyramids. He is considered one of the founders of modern ecology.		Relationships in an ecosystem • An ecosystem is a community of organisms interacting with each other and with their habitat (e.g. water, land, air). • Organisms in an ecosystem are interdependent and have roles that cycle matter through the system, for example: ○ a producer makes sugars through photosynthesis ○ a consumer eats plants or other animals for sugars and other nutrients ○ a decomposer breaks down dead organisms, returning nutrients to the soil. • There is a range of ways to describe relationships between organisms in an ecosystem, for example: ○ a predator is an organism that hunts and eats other organisms ○ prey are organisms that are hunted and eaten by predators ○ in mutualism, two organisms benefit from helping each other (e.g. bees and flowers) ○ in parasitism, one organism benefits while the other is harmed (e.g. fleas on a dog). • Soils are composed of decaying organisms, living organisms (including		Ecosystem interactions • Ecosystems are composed of biotic and abiotic factors, which interact with each other and are important to the survival of organisms. • Abiotic (physical) factors include air, water, temperature, light, and minerals. • Biotic factors include living or once-living organisms in the ecosystem. • Organisms need fuel (sugars) and nutrients to carry out life processes. • The Sun is the primary source of energy on Earth (light and heat). • Energy transfers and nutrients flow through food chains and food webs, through producers, consumers, and decomposers, and including processes such as photosynthesis and respiration. • Human activity and technology impact the environment. • Humans benefit from managing other species to produce material (food, clothing, building materials, medicines, dyes, fuels). • Humans are part of ecosystems and can change them through their		Ecosystems • Ecosystems are organised from individual organisms to whole systems. • Biotic and abiotic factors in ecosystems can affect the distribution and abundance of organisms; changes in one part can affect the balance and wellbeing of the whole system (e.g. new predator or pathogen, amount of rainfall, removal of trees, hunting). • Indigenous knowledge systems, such as mātauranga Māori, are often founded on long-term observations of environmental patterns. For example, ngā tohu o te taiao can be used to monitor seasonal changes and ecosystem health. • Carbon, nitrogen, and water cycle through living and non-living parts of ecosystems (see Year 9, Earth Systems): ○ forests and oceans store carbon and help cycle it ○ the carbon and water cycles are vital for life. • Microorganisms help recycle materials in ecosystems. • G. Evelyn Hutchinson (1903–1991) regarded as the founder of modern ecosystem ecology, he advanced the study of nutrient cycles and ecological niches.	Environmental impacts of human activity • Human activity (e.g. agriculture, urbanisation, resource extraction, industry, recreation) can cause habitat destruction, pollution, and climate change, which threaten ecosystem stability and biodiversity (see Year 9, Earth Systems). • Human activity can alter environments faster than some species can adapt, leading to biodiversity loss. • Human activity influences large-scale Earth systems, leading to changes such as climate change and ocean acidification. • Some human activities, such as agriculture, can reduce or offset environmental impacts through sustainable methods and practices. • Individually, in communities, or as nations, humans can help protect and restore ecosystems through sustainable practices, including conserving resources, supporting regeneration, and developing alternate methods for resource use. • Ecosystems can usually regenerate naturally, and humans can support this through conservation and restoration. • James Hansen (Contemporary) predicted global warming and developed climate models that influenced international climate policy. • Marama Muru-Lanning (Contemporary) explores mātauranga Māori as environmental knowledge, linking Indigenous perspectives to ecological science.

), rock particles, air, and water. 55) introduced the concept of the ecosystem, d their environment into ecological studies.		actions (e.g. clearing land, growing crops, changing waterways, planting trees, restoring habitats). • Humans can support the health of the environment (e.g. composting, reusing, producing less waste, planting native plants). • Ernst Haeckel (1834–1919) defined the term ‘ecology’ and studied the relationships between organisms and their environments, influencing evolutionary biology. • Rachel Carson (1907–1964) pioneered environmental science through her work in marine biology and her book Silent Spring, which raised awareness of ecological harm.	