



Science: Year 1

Teachers: Effective instruction in science requires hands-on experience and observation. In the words of the Association for Science Education: 'A good primary science education:

- Acknowledges that children come to science education with ideas, observations and questions about the world around them and use these as the foundations for their learning.
- Nurtures children's curiosity and inspires them, in a rich learning environment, to discover more and to develop positive attitudes and an appreciation of the nature of science.
- Challenges children to develop and use scientific skills; acquire and apply scientific knowledge, understanding and language; investigate through playing, exploring and experimenting; communicate and collaborate effectively with others; challenge scientific evidence.
- Enables children to make connections between scientific ideas and to see how they are developed and applied in other disciplines and beyond the classroom.'

While experience counts for much, learning from books is also important, for it helps bring coherence and order to a child's scientific knowledge. Only when topics are presented systematically and clearly can children make steady and secure progress in their scientific learning. The child's development of scientific knowledge and understanding is in some ways a very disorderly and complex process, different for each child. However, a systematic approach to the exploration of science, one that combines experience with book learning, can help provide essential building blocks for deeper understanding at a later time.

I. PLANTS AND PLANT GROWTH

Teachers: Reading aloud, observation and activities such as growing plants from seed in varying conditions are useful ways to explore the following topics with children.

- Understand what plants need to grow: sufficient warmth, light and water.
- Recognise basic parts of plants: seeds, roots, stems, branches and leaves.
- Understand that plants make their own food.
- Recognise the importance of flowers and seeds. For example, seeds such as rice, nuts, wheat and corn are food for plants and animals.
- Know that there are two kinds of plants: deciduous and evergreen.
- Become aware of key aspects of farming.
 - How some food comes from farms as crops
 - How farmers must take special care to protect their crops from weeds and pests
 - How crops are harvested, kept fresh, packaged and transported for people to buy and consume

II. ANIMALS AND THEIR NEEDS

Teachers: Through reading aloud, observation and activities, explore with children the common characteristics and needs of animals.

- Make the connection that animals, like plants, need food, water and space to live and grow.
- Recognise that plants make their own food, but animals obtain food from eating plants or other living things.
- Understand that offspring are very much (but not exactly) like their parents.
- Understand that most animal babies need to be fed and cared for by their parents; human babies are especially in need of care when young.
- Recognise that pets have special needs and must be cared for by their owners.

III. THE HUMAN BODY: THE FIVE SENSES

- Identify the five senses and associated body parts:
 - Sight: eyes
 - Hearing: ears
 - Smell: nose
 - Taste: tongue
 - Touch: skin
- Review the importance of taking care of your body: exercise, cleanliness, healthy foods and rest.

IV. INTRODUCTION TO MAGNETISM

Teachers: Through reading aloud, observation and experiments with magnets, introduce children to the idea that there are forces we cannot see that act upon objects. [Cross-curricular connections with Year 3 Science]

- Identify familiar, everyday uses of magnets. For example: in toys, in cabinet locks, in refrigerator magnets, etc.
- Classify materials according to whether they are or are not attracted by a magnet.

V. SEASONS AND WEATHER

Teachers: The emphasis in Year 1 should be on observation and description; technical explanations of meteorological phenomena should be taken up in later years.

- Identify the four seasons.
- Be able to describe characteristic local weather patterns during the different seasons.
- Recognise the importance of the sun as a source of light and warmth.
- Understand daily weather changes.
 - Temperature: thermometers are used to measure temperature
 - Clouds: rainfall comes from clouds
 - Rainfall: how the condition of the ground varies with rainfall; rainbows
 - Thunderstorms: lightning, thunder, hail, safety during thunderstorms
 - Snow: snowflakes, blizzards

VI. TAKING CARE OF THE EARTH

- Identify the importance of conservation: some natural resources are limited, so people must be careful not to use too much of them. For example: logging and subsequent reforestation.
- Recognise practical measures for conserving energy and resources. For example: turn off unnecessary lights, tightly turn off taps, etc.
- Understand that some materials can be recycled. For example: aluminium, glass and paper.
- Become aware that pollution be harmful but, if people are careful, they can help reduce pollution. For example, littering, smog, water pollution.

VII. MATERIALS

Teachers: Children should use correct vocabulary to describe different materials and their properties. Sort materials into groups based on their properties. For example: soft, hard, bendy, ability to float, magnetic or non-magnetic.

- Recognise and name a variety of widely used materials. For example: wood, plastic, rock, paper, metal.
- Explain why materials are chosen for specific tasks based on their properties. For example wool for clothing, glass for windows, wood for tables, metal for bridges.
- Become aware that some materials are natural and some are man-made.

VIII. SCIENCE BIOGRAPHIES

- Joseph Banks (botanist)
- Jane Goodall (studied chimpanzees)
- Wilburn and Orville Wright (made first aeroplane)



Science: Year 2

I. LIVING THINGS AND THEIR ENVIRONMENTS

Teachers: Introduce the idea of interdependence between living things and their environment.

A. HABITATS

- Living things live in environments to which they are particularly suited.
- Specific habitats and what lives there, for example:
 - Forest (for example: oak trees, squirrels, foxes, badgers, snails, mice)
 - Meadow and plains (for example: wildflowers, grasses, prairie dogs)
 - Underground (for example: fungi, moles, worms)
 - Desert (for example: cacti, lizards, scorpions)
 - Water (for example: fish, oysters, starfish)
- The food chain: a way of picturing the relationships between living things
 - Animals: big animals eat little ones, big animals die and are eaten by little ones.
 - Plants: nutrients, water, soil, air, sunlight

B. OCEANS AND UNDERSEA LIFE

- Most of the Earth is covered with water.
- Locate oceans: Pacific, Atlantic, Indian, Arctic
- Oceans are salt water (unlike fresh water rivers and lakes)
- Coast, shore, waves, tides (high and low)
- Currents, the Gulf Stream
- Landscape of the ocean floor: mountain peaks and deep valleys (trenches)
- Diversity of ocean life: from organisms too small for the eye to see (plankton), to giant whales
- Dangers to ocean life (for example, overfishing, pollution, oil spills)

C. ENVIRONMENTAL CHANGE AND HABITAT DESTRUCTION

- Environments are constantly changing, and this can sometimes pose dangers to specific habitats, for example:
 - Effects of population and development
 - Rainforest clearing, pollution, litter

D. SPECIAL CLASSIFICATIONS OF ANIMALS

- Herbivores: plant-eaters (for example, elephants, cows, deer)
- Carnivores: flesh-eaters (for example, lions, tigers)
- Omnivores: plant and animal eaters (for example, bears)
- Extinct animals (for example: dinosaurs)

II. THE HUMAN BODY: SYSTEMS AND PREVENTING ILLNESS

A. BODY SYSTEMS

Teachers: Introduce the idea of body systems, and have children identify basic parts of the following body systems:

- Skeletal system: skeleton, bones, skull
- Muscular system: muscles

- Digestive system: mouth, stomach
- Circulatory system: heart and blood
- Nervous system: brain and nerves

B. GERMS, DISEASES, AND PREVENTING ILLNESS

- Taking care of your body: exercise, cleanliness, healthy foods, rest
- Vaccinations

III. MATTER

Teachers: Introduce children to the idea that everything is made of matter, and that all matter is made up of parts too small to see.

- Basic concept of atoms
- Names and common examples of three states of matter:
 - Solid (for example, wood, rocks)
 - Liquid (for example, water)
 - Gas (for example, steam)
- Water as an example of changing states of matter of a single substance

IV. PROPERTIES OF MATTER: MEASUREMENT

Teachers: Have children describe and classify objects according to what they are made of, and according to their physical properties (colour, shape, size, weight, texture, etc.)

- Units of measurement:
 - Length: centimetre, metre
 - Volume: millilitre, litre
- Temperature: degrees Celsius

V. INTRODUCTION TO ELECTRICITY

Teachers: Through reading aloud, observation and experiment, explore with children the basic principles of electricity and safety rules.

- Static electricity
- Basic parts of simple electric circuits (for example, batteries, wire, bulb or buzzer, switch)
- Conductive and nonconductive materials
- Safety rules for electricity (for example, never put your finger or anything metallic in an electrical outlet, never touch a switch or electrical appliance when your hands are wet or when you're in the bathtub, never put your finger in a lamp socket, etc.)

VI. INTRODUCTION TO ASTRONOMY

- Sun: source of energy, light, heat
- Moon: phases of the moon (full, half, crescent, new)
- The eight planets (Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune)
 - Note that, in 2006, Pluto was classified as a dwarf planet.
- Stars
 - Constellations: the Plough
 - The sun is a star.
- Earth and its place in the solar system
 - The Earth moves around the Sun; the sun does not move
 - The Earth revolves (spins); one revolution takes one day (24 hours)
 - Sunrise and sunset
 - When it is day where you are, it is night for people on the opposite side of the Earth

VII. THE EARTH

A. GEOGRAPHICAL FEATURES OF THE EARTH'S SURFACE

- The shape of the Earth, the horizon
- Oceans and continents
- North Pole and South Pole, Equator

B. WHAT'S INSIDE THE EARTH

- Inside the Earth
 - Layers: crust, mantle, core
 - High temperatures
- Volcanoes and geysers
- Rocks and minerals
 - Formation and characteristics of different kinds of rocks: metamorphic, igneous, sedimentary
 - Important minerals in the Earth (such as quartz, gold, sulphur, coal, diamond, iron ore)

VIII. SCIENCE BIOGRAPHIES

- Rosalind Franklin (often-overlooked woman scientist, discovered double-helix structure of DNA)
- Thomas Edison (invented an electric light bulb)
- Edward Jenner (found a way to stop smallpox)
- Louis Pasteur (made milk safe to drink)

Science: Year 3

I. CYCLES IN NATURE

A. SEASONAL CYCLES

- The four seasons and Earth's orbit around the Sun [Review from Year 1]
- Seasons and life processes
 - Spring: sprouting, sap flow in plants, mating and hatching
 - Summer: growth
 - Fall: ripening, migration
 - Winter: plant dormancy, animal hibernation

B. LIFE CYCLES

- The life cycle: birth, growth, reproduction, death
- Reproduction in plants and animals
 - From seed to seed with a plant
 - From egg to egg with a chicken
 - From frog to frog
 - From butterfly to butterfly: metamorphosis (see below: insects)

C. THE WATER CYCLE

- Most of the Earth's surface is covered by water
- The water cycle
 - Evaporation and condensation
 - Water vapour in the air, humidity
 - Clouds: cirrus, cumulus, stratus
 - Precipitation, groundwater

II. INSECTS

[Cross-curricular links with Year 3 Language and Literature: Poetry]

- Insects can be helpful and harmful to people.
 - Helpful: pollination; products like honey, beeswax, and silk; eat harmful insects
 - Harmful: destroy crops, trees, wooden buildings, clothes; carry disease; bite or sting
- Distinguishing characteristics
 - Exoskeleton, chitin
 - Six legs and three body parts: head, thorax and abdomen
 - Most but not all insects have wings
- Life cycles: metamorphosis
 - Some insects look like miniature adults when born from eggs, and they moult to grow (for example: grasshopper, cricket)
 - Some insects go through distinct stages of egg, larva, pupa, adult (for example: butterflies, ants)
- Social Insects
 - Most insects live solitary lives, but some are social (for example: ants, honeybees, termites, wasps)
 - Ants: colonies
 - Honeybees: workers, drones, queen

III. THE HUMAN BODY: CELLS, SYSTEMS AND HEALTH

A. CELLS

- All living things are made up of cells, too small to be seen without a microscope.
 - Cells make up tissues.
 - Tissues make up organs.
 - Organs work in systems.

B. THE DIGESTIVE SYSTEM

Teachers: **Explore with children what happens to the food we eat by studying body parts and functions involved in taking in food and getting rid of waste. Children should become familiar with the following:**

- Salivary glands, taste buds
- Teeth: incisors, canines, premolars and molars
- Oesophagus, stomach, liver, small intestine, large intestine

C. TAKING CARE OF YOUR BODY: A HEALTHY DIET

- The 'food pyramid'
- Vitamins and minerals

IV. MAGNETISM

Teachers: Magnetism was introduced in Year 1. Review and introduce new topics in Year 3, with greater emphasis on experimentation.

- Magnetism demonstrates that there are forces we cannot see that act upon objects.
- Most magnets contain iron
- Lodestones: naturally occurring magnets
- Magnetic poles: north-seeking and south-seeking poles
- Magnetic field (strongest at the poles)
- Law of magnetic attraction: unlike poles attract, like poles repel.
- The Earth behaves as if it were a huge magnet: north and south magnetic poles (near, but not the same as, geographic North Pole and South Pole).
- Orienteering: use of a magnetised needle in a compass, which will always point to the north

V. SIMPLE MACHINES

Teachers: Examine with children how specific tools are made to perform specific jobs- for example, hammers, screwdrivers, pliers, etc. Through observation and experimentation, examine with children how simple machines help make work easier, and how they are applied and combined in familiar tools and machines.

A. SIMPLE MACHINES

- Lever
- Pulley
- Wheel and axle
 - Gears: wheels with teeth and notches
 - How gears work and familiar uses (for example, in bicycles)
- Inclined plane
- Wedge
- Screw

B. FRICTION, AND WAYS TO REDUCE FRICTION (LUBRICANTS, ROLLERS, ETC.)

VI. SCIENCE BIOGRAPHIES

- Archimedes (ancient Greek mathematician, physicist, engineer, inventor, and astronomer) [Cross-curricular link with History and Geography]
- Aristotle (Greek philosopher: wrote on physics, biology, logic, poetry, theatre, rhetoric, politics and ethics)
- Anton van Leeuwenhoek (invented the microscope)
- The Curie Family including Marie Curie (discovered radiation and two new elements)



Science: Year 4

I. INTRODUCTION TO CLASSIFICATION OF ANIMALS

- Scientists classify animals according to the characteristics they share, for example:
 - Cold-blooded or warm-blooded
 - Vertebrates (have backbones and internal skeletons) or invertebrates (do not have backbone or internal skeletons)
- Different classes of vertebrates

Teachers: Children should become familiar with examples of animals in each class and some basic characteristics of each class, such as:

- Fish: aquatic animals, breath through gills, cold-blooded, most have scales, most develop from eggs that the female lays outside her body
- Amphibians: live part of their life cycle in water and part on land, have gills when young, later develop lungs, cold-blooded, usually have moist skin
- Reptiles: hatch from eggs, cold-blooded, have dry, thick, scaly skin
- Birds: warm-blooded, most can fly, have feathers and wings, most build nests, hatch from eggs, most baby birds must be fed by parents and cared for until they can survive on their own (though some, like baby chickens and quail, can search for food a few hours after hatching)
- Mammals: warm-blooded, have hair on their bodies, parents care for the young, females produce milk for their babies, breathe through lungs, most are terrestrial (live on land) though some are aquatic

II. ECOLOGY

Teachers: Some topics here, such as habitats, were introduced in Year One. In this year, these topics will be covered in more detail and new areas will be studied.

- Habitats, interdependence of organisms and their environment
- The concept of a 'balance of nature' (constantly changing, not a static condition)
- The food chain: producers, consumers, decomposers
- Ecosystems: how they can be affected by changes in environment (for example, rainfall, food supply, etc.) and by man-made changes
- Fossils and how they can tell us about the environment long ago
- Man-made threats to the environment
 - Air pollution: emissions, smog
 - Water pollution: industrial waste, run-off from farming
- Measures we can take to protect the environment (for example, conservation, recycling)

III. THE HUMAN BODY: SYSTEMS, VISION AND HEARING

A. THE MUSCULAR SYSTEM

- Muscles
 - Involuntary and voluntary muscles

B. THE SKELETAL SYSTEM

- Skeleton, bones, marrow
- Musculo-skeletal connection

- Ligaments
- Tendons, Achilles tendon
- Cartilage
- Skull, cranium
- Spinal column, vertebrae
- Joints
- Ribs, rib cage, sternum
- Scapula (shoulder blades), pelvis, tibia, fibula
- Broken bones, X-rays

C. THE NERVOUS SYSTEM

- Brain: medulla, cerebellum, cerebrum, cerebral cortex
- Spinal cord
- Nerves
- Reflexes

D. VISION: HOW THE EYE WORKS

- Parts of the eye: cornea, iris and pupil, lens, retina
- Optic nerve
- Farsighted and nearsighted

E. HEARING: HOW THE EAR WORKS

- Sound as vibration
- Outer ear, ear canal
- Eardrum
- Three tiny bones (hammer, anvil and stirrup) pass vibrations to the cochlea
- Auditory nerve

IV. LIGHT AND OPTICS

Teachers: Through experimentation and observation, introduce children to some of the basic physical phenomena of light, with associated vocabulary.

- The speed of light: light travels at an amazingly high speed.
- Light travels in straight lines (as can be demonstrated by forming shadows).
- Transparent and opaque objects
- Reflection
 - Mirrors: plane, concave, convex
 - Use of mirrors in telescopes and some microscopes
- The spectrum: use a prism to demonstrate that white light is made up of a spectrum of colours.
- Lenses can be used for magnifying and bending light (as in magnifying glass, microscope, camera, telescope, binoculars).

V. SOUND

Teachers: Through experimentation and observation, introduce children to some of the basic physical phenomena of sound, with associated vocabulary.

- Sound is caused by an object vibrating rapidly.
- Sounds travel through solids, liquids and gases.
- Sound waves are much slower than light waves.
- Speed of sound: Concorde
- Qualities of sound
 - Pitch: high or low, faster vibrations = higher pitch, slower vibrations = lower pitch

- Intensity: loudness and quietness
- Human voice
 - Larynx (voice box)
 - Vibrating vocal chords: longer, thicker vocal chords create lower, deeper voices
- Sound and how the human ear works
- Protecting your hearing

VI. ASTRONOMY

- The 'Big Bang' as one theory
- The universe: an extent almost beyond imagining
- Galaxies: Milky Way and Andromeda
- Our solar system
 - Sun: source of energy (heat and light)
 - The nine planets: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto [Note that, in 2006, Pluto was classified as a dwarf planet]
- Planetary motion: orbit and rotation
 - How day and night on Earth are caused by the Earth's rotation
 - Sunrise in the east and sunset in the west
 - How the seasons are caused by the Earth's orbit around the sun, tilt of the Earth's axis
- Gravity, gravitational pull
 - Gravitational pull of the moon (and to a lesser degree, the sun) causes ocean tides on Earth
 - Gravitational pull of 'black holes' prevents light from escaping
- Asteroids, meteors ('shooting stars'), comets, Halley's Comet
- How an eclipse happens
- Stars and constellations
- Orienteering (finding your way) by using North Star, Big Dipper
- Exploration of space
 - Observation through telescopes
 - Rockets and satellites: from unmanned flights
 - Apollo 11, first landing on the moon: 'One small step for a man, one giant leap for mankind'
 - Space shuttle

VII. SCIENCE BIOGRAPHIES

- Alexander Graham Bell (invented the telephone)
- Copernicus (had new sun-centred idea about the solar system)
- Galileo Galilei ('Father of modern science', provided scientific support for Copernicus's theory)
- Caroline Herschel (German-British astronomer, discovered several comets, worked with brother William)
- Isaac Newton (English physicist, mathematician, astronomer, natural philosopher and alchemist)



Science: Year 5

Teachers: Effective instruction in science requires hands-on experience and observation. While experience counts for much, book learning is also important, for it helps bring coherence and order to a child's scientific knowledge. Only when topics are presented systematically and clearly can children make steady and secure progress in their scientific learning. The child's development of scientific knowledge and understanding is in some ways a very disorderly and complex process, different for each child. But a systematic approach to the exploration of science, one that combines experience with book learning, can help provide essential building blocks for deeper understanding at a later time.

I. THE HUMAN BODY: CIRCULATORY AND RESPIRATORY SYSTEMS

A. THE CIRCULATORY SYSTEM

- Pioneering work of William Harvey
- Heart: four chambers (atrium/atria or atriums [plural] and ventricle/ventricles), aorta
- Blood
 - Red blood cells, white blood cells, platelets, haemoglobin, plasma, antibodies
 - Blood vessels: arteries, veins, capillaries
 - Blood pressure, pulse
- Filtering function of liver and spleen
- Fatty deposits can clog blood vessels and cause a heart attack.
- Blood types (four basic types: A, B, AB, O) and transfusions

B. THE RESPIRATORY SYSTEM

- Process of taking in oxygen and getting rid of carbon dioxide
- Nose, throat, voice box, trachea (windpipe)
- Lungs, bronchi, bronchial tubes, diaphragm, ribs, alveoli (air sacs)
- Smoking: damage to lung tissue, lung cancer

II. CHEMISTRY: BASIC TERMS AND CONCEPTS

A. ATOMS

- All matter is made up of particles too small for the eye to see, called atoms
- Scientists have developed models of atoms; while these models have changed over time as scientists make new discoveries, the models help us imagine what we cannot see.
- Atoms are made up of even tinier particles: protons, neutrons, electrons.
- The concept of electrical charge
 - Positive charge (+): proton
 - Negative charge (-): electron
 - Neutral (neither positive or negative): neutron
 - 'Unlike charges attract, like charges repel' (relate to magnetic attraction and repulsion).

B. PROPERTIES OF MATTER

- Mass: the amount of matter in an object, similar to weight
- Volume: the amount of space a thing fills
- Density: how much matter is packed into the space an object fills
- Vacuum: the absence of matter

C. ELEMENTS

- Elements are the basic kinds of matter, of which there are a little more than one hundred.
 - There are many different kinds of atoms, but an element has only one kind of atom.
 - Familiar elements, such as gold, copper, aluminium, oxygen, iron
 - Most things are made up of a combination of elements.

D. SOLUTIONS

- A solution is formed when a substance (the solute) is dissolved in another substance (the solvent), such as when sugar or salt is dissolved in water; the dissolved substance is present in the solution even though you cannot see it.
- Concentration and saturation (as demonstrated through simple experiments with crystallisation)

III. ELECTRICITY

Teachers: Through reading and observation, and experiment, examine the following:

- Electricity as the charge of electrons
- Static electricity
- Electric current
- Electric circuits, and experiments with simple circuits (battery, wire, light bulb, filament, switch, fuse)
 - Closed circuit, open circuit, short circuit
- Conductors and insulators
- Electromagnets: how they work and common uses
- Using electricity safely

IV. GEOLOGY

A. THE EARTH'S LAYERS

- Crust, mantle, core (outer core and inner core)
- Movement of tectonic plates
- Earthquakes
 - Faults, San Andreas fault
 - Measuring intensity: seismograph and Richter scale
 - Tsunamis
- Volcanoes
 - Magma
 - Lava and lava flow
 - Active, dormant and extinct
 - Famous volcanoes: Vesuvius, Krakatoa, Mount St. Helens
- Hot springs and geysers: Old Faithful (in Yellowstone National Park, US)
- Theories of how the continents and oceans were formed: Pangaea and continental drift

B. HOW MOUNTAINS ARE FORMED

- Folded mountains, fault-block mountains, dome-shaped mountains

C. ROCKS

- Formation and characteristics of metamorphic, igneous, and sedimentary rock

D. WEATHERING AND EROSION

- Physical and chemical weathering
- Weathering and erosion by water, wind and glaciers

- The formation of soil: topsoil, subsoil, bedrock

V. METEOROLOGY

- The water cycle (review from Year 3): evaporation, condensation, precipitation
- Clouds: cirrus, stratus, cumulus (review from Year 3)
- The atmosphere
 - Troposphere, stratosphere, mesosphere, thermosphere, exosphere
 - How the Sun and the Earth heat the atmosphere
- Air movement: wind direction and speed, prevailing winds, air pressure, low and high pressure, air masses
- Cold and warm fronts: thunderheads, lightning and electric charge, thunder, tornadoes, hurricanes
- Forecasting the weather: barometers (relation between changes in atmospheric pressure and weather), weather maps, weather satellites
- Weather and climate: 'weather' refers to daily changes in temperature, rainfall, sunshine, etc., while 'climate' refers to weather trends that are longer than the cycle of the seasons

VI. EVOLUTION

- Animals have offspring that are of the same kind but often offspring have different appearances
- Animals and plants have adapted to suit the environment within which they live
- Adaptation may lead to evolution: Darwin's finches

VI. SCIENCE BIOGRAPHIES

- Michael Faraday (chemist and physicist, developed the electric motor and electric generator)
- Elizabeth Garrett Anderson (English physician and feminist, first Englishwoman physician and surgeon)
- Florence Nightingale (pioneering woman nurse during the Crimean War who later established the Nightingale Training School for nurses at St Thomas' Hospital in London)
- Charles Drew (American doctor and medical researcher)
- Charles Darwin (English naturalist known for his theory of evolution called *Natural Selection*)



Science: Year 6

I. CHEMISTRY: MATTER AND CHANGE

A. ATOMS, MOLECULES, AND COMPOUNDS

- Basics of atomic structure: nucleus, protons (positive charge), neutrons (neutral), electrons (negative charge)
- Atoms are constantly in motion, electrons move around the nucleus in paths called shells (or energy levels).
- Atoms may join together to form molecules or compounds.
- Common compounds and their formulas:
 - Water H₂O
 - Salt NaCl
 - Carbon Dioxide CO₂

B. ELEMENTS

- Elements have atoms of only one kind, having the same number of protons. There are a little more than 100 different elements.
- The periodic table: organises elements with common properties
 - Atomic symbol and atomic number
- Some well-known elements and their symbols
 - Hydrogen H
 - Helium He
 - Carbon C
 - Nitrogen N
 - Oxygen O
 - Sodium Na
 - Aluminium Al
 - Silicon Si
 - Chlorine Cl
 - Iron Fe
 - Copper Cu
 - Silver Ag
 - Gold Au
- Two important categories of elements: metals and non-metals
 - Metals comprise about 2/3 of the known elements
 - Properties of metals: most are shiny, ductile, malleable, conductive

C. CHEMICAL AND PHYSICAL CHANGE

- Chemical change changes what a molecule is made up of and results in a new substance with a new molecular structure. Examples of chemical change: rusting of iron, burning of wood, milk turning sour
- Physical change changes only the properties or appearance of the substance, but does not change what the substance is made up of. Examples of physical change: cutting wood or paper, breaking glass, freezing water

II. CLASSIFYING LIVING THINGS

Teachers: As the children study animal classifications, discuss: why do we classify? How does classification help us understand the natural world?

- Scientists have divided living things into five large groups called kingdoms, as follows:
 - Plant
 - Animal
 - Fungus (Mushrooms, yeast, mould, mildew)
 - Protist (algae, protozoans, amoeba, euglena)
 - Prokaryote (blue-green algae, bacteria)
- Each Kingdom is divided into smaller groupings as follows:
 - Kingdom
 - Phylum
 - Class
 - Order
 - Family
 - Genus
 - Species
 - Variety
- When classifying living things, scientists use special names made up of Latin words (or words made to sound like Latin words), which help scientists around the world understand each other and ensure that they are using the same names for the same living things
 - *Homo Sapiens*: the scientific name for the species to which human beings belong to (genus: *Homo*, species: *Sapiens*)
 - Taxonomists: biologists who specialise in classification
- Different classes of vertebrates and major characteristics: fish, amphibians, reptiles, birds, mammals (review from Year 4)

CELLS: STRUCTURES AND PROCESSES

- All living things are made up of cells
- Structure of cells (both plant and animal)
 - Cell membrane: selectively allows substances in and out
 - Nucleus: surrounded by nuclear membrane, contains genetic material, divides for reproduction
 - Cytoplasm contains organelles, small structure that carry out the chemical activities of the cell, including mitochondria (which produce the cell's energy) and vacuoles (which store food, water, or wastes)
- Plant cells, unlike animal cells, have cell walls and chloroplasts.
- Cells without nuclei: monerans (bacteria)
- Some organisms consist of only a single cell: for example, amoeba, protozoans, some algae.
- Cells are shaped differently in order to perform different functions.
- Organisation of cells into tissues, organs, and systems:
 - In complex organisms, groups of cells form tissues (for example: in animals, skin tissue or muscle tissue; in plants, the skin of an onion or the bark of a tree).
 - Tissues with similar functions form organs (for example: in some animals, the heart, stomach, or brain; in some plants, the root or flower).
 - In complex organisms, organs work together in a system (recall, for example, from earlier studies of the human body, the digestive, circulatory, and respiratory systems).

TAXONOMIES

Teachers: Introduce an example of how an animal is classified, in order for students to become familiar with the system of classification, not to memorise specific names. For example, a collie dog is classified as follows:

- Kingdom: Animalia
- Phylum: Chordata (Subphylum: Vertebrata)
- Class: Mammalia (mammal)
- Order: Carnivora (eats meat)
- Family: Canidae (a group with doglike characteristics)
- Genus: *Canis* (a coyote, wolf, or dog)
- Species: *Familiaris* (a domestic dog)
- Variety: Collie (a breed of dog)

IV. PLANT STRUCTURES AND PROCESSES

A. STRUCTURE: NON-VASCULAR AND VASCULAR PLANTS

- Non-vascular plants (for example: algae)
- Vascular plants
 - Vascular plants have tube-like structures that allow water and dissolved nutrients to move through the plant
 - Parts and functions of vascular plants: roots, stems and buds, leaves

B. PHOTOSYNTHESIS

- Photosynthesis is an important life process that occurs in plant cells, but not animal cells (photo = light; synthesis = putting together). Unlike animals, plants make their own food, through the process of photosynthesis.
- Role in photosynthesis of: energy from sunlight, chlorophyll, carbon dioxide and water, xylem and phloem, stomata, oxygen, sugar (glucose)

V. LIFE CYCLES AND REPRODUCTION

A. THE LIFE CYCLE AND REPRODUCTION

- Life cycle: development of an organism from birth to growth, reproduction, death
 - Example: Growth stages of a human: embryo, foetus, newborn, infancy, childhood, adolescence, adulthood, old age
- All living things reproduce themselves. Reproduction may be asexual or sexual.
 - Examples of asexual reproduction: fission (splitting) of bacteria, spores from mildews, moulds, and mushrooms, budding of yeast cells, regeneration and cloning
 - Sexual reproduction requires the joining of special male and female cells, called gametes, to form a fertilised egg.

B. SEXUAL REPRODUCTION IN ANIMALS

- Reproductive organs: testes (sperm) and ovaries (eggs)
- External fertilisation: spawning
- Internal fertilisation: birds, mammals
- Development of the embryo: egg, zygote, embryo, growth in uterus, foetus, newborn

C. REPRODUCTION IN PLANTS

- Asexual reproduction
 - Example of algae

- Vegetative reproduction: runners (for example: strawberries) and bulbs (for example: onions), growing plants from eyes, buds, leaves, roots, and stems
- Sexual reproduction by spore bearing plants (for example: mosses and ferns)
- Sexual reproduction of non-flowering seed plants: conifers (for example: pines), male and female cones, wind pollination
- Sexual reproduction of flowering plants (for example: peas)
 - Functions of sepals and petals, stamen (male), anther, pistil (female), ovary (or ovule)
 - Process of seed and fruit production: pollen, wind, insect and bird pollination, fertilisation, growth of ovary, mature fruit
 - Seed germination and plant growth: seed coat, embryo and endosperm, germination (sprouting of new plant), monocots (for example: corn) and dicots (for example: beans)

VI. THE HUMAN BODY: HORMONES AND REPRODUCTION

A. HUMAN GROWTH STAGES

- Puberty
 - Glands and hormones (see below, Endocrine System), growth spurt, hair growth, breasts, voice change

B. THE REPRODUCTIVE SYSTEM

- Females: ovaries, fallopian tubes, uterus, vagina, menstruation
- Males: testes, scrotum, penis, urethra, semen
- Sexual reproduction: intercourse, fertilisation, zygote, implantation of zygote in the uterus, pregnancy, embryo, foetus, newborn

C THE ENDOCRINE SYSTEM

- The human body has two types of glands: duct glands (such as the salivary glands), and ductless glands, also known as the endocrine glands.
- Endocrine glands secrete (give off) chemicals called hormones. Different hormones control different body processes.
- Pituitary gland: located at the bottom of the brain; secretes hormones that control other glands, and hormones that regulate growth
- Thyroid gland: located below the voice box; secretes a hormone that controls the rate at which the body burns and uses food
- Pancreas: both a duct and a ductless gland; secretes a hormone called insulin that regulates how the body uses and stores sugar; when the pancreas does not produce enough insulin, a person has a sickness called diabetes (which can be controlled).
- Adrenal glands: secrete a hormone called adrenaline, especially when a person is frightened or angry, causing rapid heartbeat and breathing.

VII. SCIENCE BIOGRAPHIES

- Tim Burners-Lee (inventor of the World Wide Web)
- Humphry Davy (chemist and inventor; discovered alkaline earth metals, chlorine and iodine)
- Dorothy Hodgkin (British chemist, confirmed the structures of penicillin and vitamin B₁₂)
- Carl Linnaeus (botanist and 'Father of taxonomy' who standardised the classification system)