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Introduction

Welcome to the Cambridge Lower Secondary Science Curriculum Framework.

This framework provides a comprehensive set of progressive learning objectives for science. The objectives detail what the learner should know or what they should be able to do in science in each year of lower secondary education. They provide a structure for teaching and learning and a reference against which learners' ability and understanding can be checked.

The Cambridge Lower Secondary science curriculum is presented in four content areas: *Scientific enquiry*, *Biology*, *Chemistry* and *Physics*. *Scientific enquiry* is about considering ideas, evaluating evidence, planning investigative work and recording and analysing data. The *Scientific enquiry* objectives underpin *Biology*, *Chemistry* and *Physics*, which are focused on developing confidence and interest in scientific knowledge. Environmental awareness and some history of science are also incorporated. The Cambridge Lower Secondary Science Curriculum Framework continues the journey from the Cambridge Primary science framework and provides a solid foundation upon which the later stages of education can be built.

The Cambridge Curriculum is founded on the values of the University of Cambridge and best practice in schools. The curriculum is dedicated to developing learners who are confident, responsible, innovative and engaged. Each curriculum framework for English, mathematics and science is designed to engage learners in an active and creative learning journey.

Safety issues

An essential part of this programme is that learners develop skills in scientific enquiry. This includes the collection of primary data by experiment. Scientific experiments are engaging and provide opportunities for first hand exploration. However, they must, at all times, be conducted with the utmost respect for safety, specifically:

- It is the responsibility of the teacher in charge to adhere and conform to any national, regional and school regulation in place with respect to safety of scientific experimentation.
- It is the responsibility of the teacher in charge to make a risk assessment of the hazards involved with any particular class or individual when undertaking a scientific experiment that conforms to these regulations.

Cambridge International takes no responsibility for the management of safety for individual published experiments or for the management of safety for the undertaking of practical experiments in any given location. Cambridge International only endorses support material in relation to curriculum content and is not responsible for the safety of activities contained within it. The responsibility for the safety of all activities and experiments remains with the school.

Animal welfare and the use of animals in science

Throughout biology, learners study a variety of living things, including animals. As part of the University of Cambridge, Cambridge International shares the approach that good animal welfare and good science go hand-in-hand.

Learners should have opportunities to observe animals in their natural environment. This should be done responsibly and not in a way that could cause distress or harm to the animals or damage to the environment.

If living animals are brought into schools then the teacher must ensure that any national, regional and school regulations are followed regarding animal welfare. In all circumstances, the teacher responsible must ensure all animals have:

- a suitable environment, including being housed with, or apart from, other animals (as required for the species)
- a suitable diet
- the opportunity to exhibit normal behaviour patterns
- protection from pain, injury, suffering and disease.

There is no requirement for learners to participate in, or observe, animal dissections for Cambridge Lower Secondary Science. Although dissection can provide a valuable learning opportunity, some learners decide not to continue studying biology because they dislike animal dissection. Several alternatives are available to dissection (such as models and diagrams) which teachers should consider during their planning.

If a teacher decides to include animal dissection then animal material should be obtained from premises licensed to sell them for human or pet consumption, or from a reputable biological supplier. This approach helps to ensure animal welfare standards and also decreases the risk from pathogens being present in the material. No teacher or learner should kill animals for dissection.

When used, fresh material should be kept at 5 °C or below until just before use. Frozen material should be defrosted slowly (at 5 °C) without direct heat. All fresh or defrosted material should be used within 2 days. Preserved animal materials should only be handled when wearing gloves and in a well-ventilated room.

The responsibility for ensuring the welfare of all animals studied in science remains with the school.

Policy framework

It is expected that schools will have their own sex education policy set within their national legislative framework and drawn up in consultation with parents. We are aware that these policies will be distinct and varied due to the diversity in tradition and culture enjoyed over our global network of schools. For this reason, the focus of the Lower Secondary curriculum is the factual and preparative aspects of sex education. It does not address attitudes and values or personal and social skills as we expect each school to make a judgement on how these aspects of sex education are addressed within their wider curriculum framework/ obligations.

Note on codes

Each learning objective has a unique curriculum framework code, e.g. **7Ep1**. These codes appear in the Cambridge Teacher Guide, schemes of work and other published resources. Each sub-strand has a green reporting code, e.g. **Ep**. These codes appear in Checkpoint feedback reports. Please note that the **Ep** reporting code covers both the *Ideas and evidence* and the *Plan investigative work* sub-strands. The **Eo** reporting code covers the *Obtain and present evidence* and **Ec** reporting strand covers the *Consider evidence and approach* sub-strands.

Stage 7

E Scientific enquiry

Ep Ideas and evidence

- **7Ep1** Be able to talk about the importance of questions, evidence and explanations
- **7Ep2** Make predictions and review them against evidence

Ep Plan investigative work

- **7Ep3** Suggest ideas that may be tested
- **7Ep4** Outline plans to carry out investigations, considering the variables to control, change or observe
- **7Ep5** Make predictions referring to previous scientific knowledge and understanding
- **7Ep6** Identify appropriate evidence to collect and suitable methods of collection
- **7Ep7** Choose appropriate apparatus and use it correctly

Eo Obtain and present evidence

- **7Eo1** Make careful observations including measurements
- **7Eo2** Present results in the form of tables, bar charts and line graphs
- **7Eo3** Use information from secondary sources

Ec Consider evidence and approach

- **7Ec1** Make conclusions from collected data, including those presented in a graph, chart or spreadsheet
- **7Ec2** Recognise results and observations that do not fit into a pattern, including those presented in a graph, chart or spreadsheet
- **7Ec3** Consider explanations for predictions using scientific knowledge and understanding and communicate these
- **7Ec4** Present conclusions using different methods

B Biology

Bp Plants

- **7Bp1** Recognise the positions, and know the functions of the major organs of flowering plants, e.g. root, stem, leaf

Bh Humans as organisms

- **7Bh1** Explore the role of the skeleton and joints and the principle of antagonistic muscles
- **7Bh2** Recognise the positions and know the functions of the major organ systems of the human body. Secondary sources can be used
- **7Bh3** Research the work of scientists studying the human body

Bc Cells and organisms

- **7Bc1** Identify the seven characteristics of living things and relate these to a wide range of organisms in the local and wider environment
- **7Bc2** Know about the role of micro-organisms in the breakdown of organic matter, food production and disease, including the work of Louis Pasteur
- **7Bc3** Identify the structures present in plant and animal cells as seen with a simple light microscope and/or a computer microscope
- **7Bc4** Compare the structure of plant and animal cells
- **7Bc5** Relate the structure of some common cells to their functions. Secondary sources can be used
- **7Bc6** Understand that cells can be grouped together to form tissues, organs and organisms

Be Living things in their environment

- **7Be1** Describe how organisms are adapted to their habitat, drawing on locally occurring examples. Secondary sources can be used
- **7Be2** Draw and model simple food chains
- **7Be3** Discuss positive and negative influence of humans on the environment, e.g. the effect on food chains, pollution and ozone depletion
- **7Be4** Discuss a range of energy sources and distinguish between renewable and non-renewable resources. Secondary sources can be used

Bv Variation and classification

- **7Bv1** Understand what is meant by a species
- **7Bv2** Investigate variation within a species. Secondary sources can be used
- **7Bv3** Classify animals and plants into major groups, using some locally occurring examples

C Chemistry

Cs States of matter

- **7Cs1** Show in outline how the particle theory of matter can be used to explain the properties of solids, liquids and gases, including changes of state

Cp Material properties

- **7Cp1** Distinguish between metals and non-metals
- **7Cp2** Describe everyday materials and their physical properties

Cc Material changes

- **7Cc1** Use a pH scale.
- **7Cc2** Understand neutralisation and some of its applications
- **7Cc3** Use indicators to distinguish acid and alkaline solutions

Ce The Earth

- **7Ce1** Observe and classify different types of rocks and soils
- **7Ce2** Research simple models of the internal structure of the Earth
- **7Ce3** Examine fossils and research the fossil record
- **7Ce4** Discuss the fossil record as a guide to estimating the age of the Earth
- **7Ce5** Learn about most recent estimates of the age of the Earth

P Physics

Pf Forces and motion

- **7Pf1** Describe the effects of forces on motion, including friction and air resistance
- **7Pf2** Describe the effect of gravity on objects. Secondary sources can be used

Pe Energy

- **7Pe1** Understand that energy cannot be created or destroyed and that energy is always conserved
- **7Pe2** Recognise different energy types and energy transfers

Pb The Earth and beyond

- **7Pb1** Describe how the movement of the Earth causes the *apparent* daily and annual movement of the sun and the stars
- **7Pb2** Describe the relative position and movement of the planets and the sun in the solar system
- **7Pb3** Discuss the impact of the ideas and discoveries of Copernicus, Galileo and more recent scientists
- **7Pb4** Understand that the sun and other stars are sources of light and that planets and other bodies are seen by reflected light

Stage 8

E Scientific enquiry

Ep Ideas and evidence

- **8Ep1** Discuss the importance of developing empirical questions which can be investigated, collecting evidence, developing explanations and using creative thinking
- **8Ep2** Test predictions with reference to evidence gained

Ep Plan investigative work

- **8Ep3** Select ideas and turn them into a form that can be tested
- **8Ep4** Plan investigations to test ideas
- **8Ep5** Identify important variables; choose which variables to change, control and measure
- **8Ep6** Make predictions using scientific knowledge and understanding

Eo Obtain and present evidence

- **8Eo1** Take appropriately accurate measurements
- **8Eo2** Use a range of equipment correctly
- **8Eo3** Discuss and control risks to themselves and others
- **8Eo4** Present results as appropriate in tables and graphs

Ec Consider evidence and approach

- **8Ec1** Make simple calculations
- **8Ec2** Identify trends and patterns in results (correlations)
- **8Ec3** Compare results with predictions
- **8Ec4** Identify anomalous results and suggest improvements to investigations
- **8Ec5** Interpret data from secondary sources
- **8Ec6** Discuss explanations for results using scientific knowledge and understanding. Communicate these clearly to others
- **8Ec7** Present conclusions to others in appropriate ways

B Biology

Bp Plants

- **8Bp1** Explore how plants need carbon dioxide, water and light for photosynthesis in order to make biomass and oxygen
- **8Bp2** Describe the absorption and transport of water and mineral salts in flowering plants

Bh Humans as organisms

- **8Bh1** Identify the constituents of a balanced diet and the functions of various nutrients. Secondary sources can be used
- **8Bh2** Understand the effects of nutritional deficiencies
- **8Bh3** Recognise the organs of the alimentary canal and know their functions. Secondary sources can be used
- **8Bh4** Understand the function of enzymes as biological catalysts in breaking down food to simple chemicals
- **8Bh5** Recognise and model the basic components of the circulatory system and know their functions
- **8Bh6** Understand the relationship between diet and fitness
- **8Bh7** Discuss how conception, growth, development, behaviour and health can be affected by diet, drugs and disease
- **8Bh8** Recognise the basic components of the respiratory system and know their functions
- **8Bh9** Define and describe aerobic respiration, and use the word equation
- **8Bh10** Explain gaseous exchange
- **8Bh11** Describe the effects of smoking. Secondary sources can be used
- **8Bh12** Discuss the physical and emotional changes that take place during adolescence
- **8Bh13** Describe the human reproductive system, including the menstrual cycle, fertilisation and foetal development

C Chemistry**Cs States of matter**

- **8Cs1** Show how the particle theory of matter can be used to explain the properties of solids, liquids and gases, including changes of state, gas pressure and diffusion

Cp Material properties

- **8Cp1** Describe and explain the differences between metals and non-metals
- **8Cp2** Give chemical symbols for the first twenty elements of the Periodic Table
- **8Cp3** Understand that elements are made of atoms
- **8Cp4** Explain the idea of compounds
- **8Cp5** Name some common compounds including oxides, hydroxides, chlorides, sulfates and carbonates
- **8Cp6** Distinguish between elements, compounds and mixtures

Cc Material changes

- **8Cc1** Use a word equation to describe a common reaction. Secondary sources can be used
- **8Cc2** Describe chemical reactions which are not useful, e.g. rusting

P Physics**Pf Forces and motion**

- **8Pf1** Calculate average speeds, including through the use of timing gates
- **8Pf2** Interpret simple distance/time graphs

Ps Sound

- **8Ps1** Explain the properties of sound in terms of movement of air particles
- **8Ps2** Recognise the link between loudness and amplitude, pitch and frequency, using an oscilloscope

Pl Light

- **8Pl1** Use light travelling in a straight line to explain the formation of shadows and other phenomena
- **8Pl2** Describe how non-luminous objects are seen
- **8Pl3** Describe reflection at a plane surface and use the law of reflection
- **8Pl4** Investigate refraction at the boundary between air and glass or air and water
- **8Pl5** Explain the dispersion of white light
- **8Pl6** Explain colour addition and subtraction, and the absorption and reflection of coloured light

Pm Magnetism

- **8Pm1** Describe the properties of magnets
- **8Pm2** Recognise and reproduce the magnetic field pattern of a bar magnet
- **8Pm3** Construct and use an electromagnet

Stage 9

E Scientific enquiry

Ep Ideas and evidence

- **9Ep1** Discuss and explain the importance of questions, evidence and explanations, using historical and contemporary examples
- **9Ep2** Test explanations by using them to make predictions and then evaluate these against evidence
- **9Ep3** Discuss the way that scientists work today and how they worked in the past, including reference to experimentation, evidence and creative thought

Ep Plan investigative work

- **9Ep4** Select ideas and produce plans for testing based on previous knowledge, understanding and research
- **9Ep5** Suggest and use preliminary work to decide how to carry out an investigation
- **9Ep6** Decide whether to use evidence from first hand experience or secondary sources
- **9Ep7** Decide which measurements and observations are necessary and what equipment to use
- **9Ep8** Decide which apparatus to use and assess any hazards in the laboratory, field or workplace
- **9Ep9** Use appropriate sampling techniques where required

Eo Obtain and present evidence

- **9Eo1** Make sufficient observations and measurements to reduce error and make results more reliable
- **9Eo2** Use a range of materials and equipment and control risks
- **9Eo3** Make observations and measurements
- **9Eo4** Choose the best way to present results

Ec Consider evidence and approach

- **9Ec1** Describe patterns (correlations) seen in results
- **9Ec2** Interpret results using scientific knowledge and understanding
- **9Ec3** Look critically at sources of secondary data
- **9Ec4** Draw conclusions
- **9Ec5** Evaluate the methods used and refine for further investigations
- **9Ec6** Compare results and methods used by others
- **9Ec7** Present conclusions and evaluation of working methods in different ways
- **9Ec8** Explain results using scientific knowledge and understanding. Communicate this clearly to others

B Biology

Bp Plants

- **9Bp1** Define and describe photosynthesis, and use the word equation
- **9Bp2** Understand the importance of water and mineral salts to plant growth
- **9Bp3** Understand sexual reproduction in flowering plants, including pollination, fertilisation, seed formation and dispersal

Be Living things in their environment

- **9Be1** Explain the ways in which living things are adapted to their habitats. Secondary sources can be used
- **9Be2** Research the work of scientists studying the natural world. Secondary sources can be used
- **9Be3** Explain and model food chains, food webs and energy flow
- **9Be4** Explain the role of decomposers
- **9Be5** Describe factors affecting the size of populations
- **9Be6** Describe and investigate some effects of human influences on the environment

Bv Variation and classification

- **9Bv1** Use and construct keys to identify plants and animals
- **9Bv2** Understand that organisms inherit characteristics from their parents through genetic material that is carried in cell nuclei
- **9Bv3** Describe how selective breeding can lead to new varieties
- **9Bv4** Discuss the work of Darwin in developing the scientific theory of natural selection

C Chemistry

Cp Material properties

- **9Cp1** Describe the structure of an atom and learn about the methods and discoveries of Rutherford
- **9Cp2** Compare the structures of the first twenty elements of the Periodic Table
- **9Cp3** Describe trends in groups and periods
- **9Cp4** Talk about the contribution of scientists. Secondary sources can be used

Cc Material changes

- **9Cc1** Explore and explain the idea of endothermic processes, e.g. melting of ice, and exothermic reactions, e.g. burning, oxidation
- **9Cc2** Describe the reactivity of metals with oxygen, water and dilute acids
- **9Cc3** Explore and understand the reactivity series
- **9Cc4** Give examples of displacement reactions
- **9Cc5** Explain how to prepare some common salts by the reactions of metals and metal carbonates and be able to write word equations for these reactions
- **9Cc6** Give an explanation of the effects of concentration, particle size, temperature and catalysts on the rate of a reaction

P Physics

Pf Forces and motion

- **9Pf1** Explain that pressure is caused by the action of a force on an area
- **9Pf2** Determine densities of solids, liquids and gases
- **9Pf3** Explain pressures in gases and liquids (qualitative only)
- **9Pf4** Know that forces can cause objects to turn on a pivot and understand the principle of moments

Pm Electricity

- **9Pm1** Describe electrostatics and the concept of charge, including digital sensors
- **9Pm2** Interpret and draw simple parallel circuits
- **9Pm3** Model and explain how common types of components, including cells (batteries), affect current
- **9Pm4** Explain how current divides in parallel circuits
- **9Pm5** Measure current using ammeters and voltage using voltmeters, including digital meters

Pe Energy

- **9Pe1** Use knowledge of energy sources including fossil fuels and renewable energy resources to consider the world's energy needs, including research from secondary sources
- **9Pe2** Identify and explain the thermal (heat) energy transfer processes of conduction, convection and radiation
- **9Pe3** Explain cooling by evaporation