Science Key Concepts

The '14 Big Ideas' of Science:

Cells are alive:

Cells are alive; all living things are composed of cells, both singly and in multicellular organisms, working together as tissues, organs and organ systems. The exchange of substances between cells and their environment allows the life processes to occur, fuelled by the organelles within performing their function. Differentiated cells allow living things to thrive in a vast variety of habitats.

Bodies are systems:

Cells work together as tissues. Tissues work together as organs. Many organs work together as organ systems. Multicellular organisms (such as humans, animals and plants) can survive because many organ systems work simultaneously to carry out the 7 life processes. When one part of the system doesn't work, this can have a negative impact on the health of the organism.

Organisms are interdependent:

Living organisms may form populations of single species, communities of many species and ecosystems, interacting with each other, with the environment and with humans in many ways. Living organisms are interdependent and rely on other organisms in their community to survive and reproduce.

Ecosystems recycle resources:

All of the resources required for life, and produced by living things, are recycled in nature. The chemicals in ecosystems such as water, minerals and carbon are continually cycling through the natural world. Animals are ultimately dependent on green plants (or other producers) as their source of energy.

Characteristics are inherited:

Genetic information in a cell is held in the chemical DNA. All living things have DNA, which is passed from parent to offspring during reproduction. A section of DNA which is responsible for a particular protein (or part of the body) is called a gene. Genes determine the development and structure of organisms.

Species show Variation:

All life today is directly descended from a universal common ancestor that was a simple one-celled organism. Over countless generations changes resulting from natural variation within a species lead to the selection of those individuals best suited to survive under certain conditions. Species not able to respond sufficiently to changes in their environment become extinct.

Structure determines properties:

Matter is composed of atoms; atoms can link together and arrange in a variety of ways leading to the formation of different structures. This behaviour and arrangement of atoms explain the properties of different materials.

Reactions rearrange matter:

In chemical reactions, atoms are rearranged to form new substances. All chemical reactions involve the rearrangement of atoms. The numbers and types of atoms are the same before and after a chemical reaction. We can represent these reactions using equations.

Earth Systems Interact:

The composition of the Earth and its atmosphere and the processes occurring within them shape the Earth's surface and its climate. Chemicals in the earth have industrial uses and human industry produces chemicals which can affect the earth.

Forces predict motion:

The ways in which objects move depends on the forces acting on them. If the forces acting on an object are unbalanced, the object will change its speed, direction or shape. The behaviour of objects in motion follow mathematical laws that can be used to make predictions about speed, distance travelled, the time taken and acceleration.

Fields produce forces:

Objects can influence other objects without touching them. In some cases, the effect travels out from the source to the receiver in the form of radiation. In other cases, action at a distance is explained in terms of the existence of a field of influence between objects such as a magnetic, electrical or gravitational field.

Energy is conserved:

Energy cannot be created or destroyed, although it can be transferred from one store to another. Different events can be explained in terms of the energy transfers involved. Energy can be transferred in useful ways for example for transportation, heating and to generate electricity. In these processes, some energy becomes less easy to use.

Electricity transfers energy:

An electrical current is the flow of charge and is a way of transferring energy. The electricity that we rely on for everyday use is generated in power stations and transferred to homes and businesses using the National Grid. Electrical devices use circuits with various components to transfer energy in useful ways

Radiation transfers energy:

Waves carry energy from one place to another and can also carry information. Electromagnetic waves have various uses, particularly in communications and medicine. Ionising radiation is released from changes to the nuclei of atoms.

The four key elements of science education underpinning the Science Mastery curriculum, adapted from the National Curriculum, are outlined below:

1: Factual and conceptual understanding

All pupils will:

· Acquire factual knowledge

· Make links between topics of study

· Represent concepts using objects, pictures, models and analogies

· Finish their secondary science education with an appreciation of how scientific understanding evolves over time

2: Mathematics, practical and enquiry skills

All pupils will:

· Understand the nature, processes and methods of science ('working scientifically')

· Develop procedural knowledge in order to show a wide range of practical skills

· Be able to evaluate experimental design such that they are able to recognise good and bad science

· Be able to think numerically

· Embed relevant mathematics skills from the programme of study for mathematics

· Develop their use of scientific vocabulary, including the use of scientific nomenclature and units and mathematical representations.

3: Language and communication

All pupils will:

· Use technical terminology accurately and precisely

· Build up an extended specialist vocabulary

· Be able to present scientific information accurately

· Critique scientific information they are exposed to in their daily lives

· Hear high quality scientific language being used

· Practice articulating scientific concepts clearly and precisely

Our Science Mastery curriculum promotes pupil dialogue using talk tasks that are integrated into every lesson. These talk tasks uncover key misconceptions and provide pupils with the opportunity to discuss scientific ideas. Pupils are supported to develop their scientific vocabulary using Frayer organisers, etymology and exposure to scientific texts. Extended reading opportunities are embedded across the curriculum, with a reading comprehension focus promoted. Science is

communicated using a wide range of forms, with pupils being exposed to information presented using symbols, models, graphs, tables and diagrams.

4: Application of knowledge and skills

All pupils will:

· Be able to use knowledge and skills in new contexts to answer questions, solve problems and explain observations

· Relate scientific explanations to phenomena in the world around them

· Use modelling and abstract ideas to develop and evaluate explanations

Knowledge and skills are introduced and revisited across an interleaved map, so teachers can support pupils to see how concepts link. Each unit includes materials to support pupils appreciate how their learning can be applied to the real world, linking pupils to possible career options and current scientific developments. Pupils will develop an appreciation of the relevance of the science they are learning through Science in the News activities. Every lesson provides pupils with the opportunity to engage in independent work, applying knowledge learnt in the first part of the lesson to a range of scenarios. As the course progresses, pupils will apply skills learnt in the first years of the programme to new scientific enquiry; planning experiments and selecting the most appropriate procedures and techniques.