INTRODUCTION 2 hours

Introduction to Life Sciences

Introduction

Life Sciences can be defined as the scientific study of living things, from molecular level to their interactions with one another and their interactions with the environment. In other words, living systems show levels of organisation from molecules to biomes. These systems are dynamic, with homeostasis maintaining balance at every level of organisation.

Life Sciences follows on from the Natural Sciences that you studied in the Intermediate grades and allows you to study specific aspects of Natural Sciences, such as zoology and botany, in more detail. You will also learn about the details of life processes and how life originated, evolved and changed on Earth over billions of years.

Life Sciences is important to you, the learner, for the following reasons:

- to provide useful knowledge and skills that are needed in everyday living
- to expose you to the range and scope of biological studies, and to stimulate interest in and create awareness of possible specialisations, e.g. medicine, pharmacy, genetics, research, environmental science occupations, botany, zoology, etc.
- to provide sufficient background/foundation for further studies in one or more of the biological sub-disciplines, e.g. Botany, Zoology, Physiology, Genetics, Biochemistry, Biotechnology, etc.

In **Grade 11**, three of the four Knowledge Strands are addressed and serve to ensure progression. The content described in Life at Molecular, Cellular and Tissue level in Grade 10 is used to understand Life Processes in Plants and Animals in Grade 11 but it is not taught as a separate strand in Grade 11. The recommended **Grade 11** teaching sequence for the three Knowledge Strands is:

1. Diversity, change and continuity (micro-organisms, plants and animals)
2. Life processes in plants and animals (processes that sustain life)
3. Environmental studies (population ecology and human impact)

Table 1 on the following page shows the concept and content progression in the Life Sciences.

Table 1 The concept and content progression in the Life Sciences

Strands/ Grades	Molecules to organs	Life processes in plants and animals	Diversity, change and continuity	Environmental studies
10	1. Chemistry of life – inorganic and organic compounds 2. Cell – unit of life 3. Cell division (mitosis) 4. Plant and animal tissues	1. Support and transport systems in plants 2. Support systems in animals 3. Transport systems in mammals	1. Biodiversity and classification 2. History of Life on Earth	1. Biosphere to ecosystems
11		1. Energy transformations to support life : photosynthesis 2. Animal nutrition 3. Energy transformations: respiration 4. Gas exchange 5. Excretion	1. Biodiversity – classification of micro-organisms 2. Biodiversity – plants 3. Reproduction – plants 4. Biodiversity - animals	1. Population ecology 2. Human impacts on the environment: current crises
12	1. DNA: the code of life 2. RNA and protein synthesis 3. Meiosis 4. Genetics	1. Reproduction in vertebrates 2. Human reproduction 3. Nervous system 4. Senses 5. Endocrine system 6. Homeostasis	1. Darwinism and natural selection 2. Human evolution	

Specific aims of life sciences

There are **three** broad subject-specific aims of Life Sciences which relate to the purposes of learning science. These are:
Specific Aim 1, which relates to knowing the subject content ("theory");
Specific Aim 2, which relates to doing science or practical work and investigations; and
Specific Aim 3, which relates to understanding the applications of Life Sciences in everyday life, as well as understanding the history of scientific discoveries and the relationship between indigenous knowledge and science.

How science works

Scientists answer questions of interest to them using the process of inquiry. This involves a search for information and explanation. They conduct this inquiry by discovering and describing and by explaining things in nature.

Scientists use both inductive and deductive reasoning to investigate or inquire about things in nature.

Inductive reasoning involves scientific inquiry where observations are made and data are collected and recorded and then carefully analysed and evaluated. Based on a large number of observations and analyses of the information collected, scientists come up with generalisations. The process of arriving at a generalisation based on a large number of specific observations is called inductive reasoning. For example, by around the middle of the nineteenth century scientists formulated the cell theory (a generalisation). This states that all living organisms are made up of cells. Many scientists using simple to advanced microscopes based this theory on their observations.

Deductive reasoning involves scientific inquiry where scientists look for reasons for the generalisations and observations on which these generalisations were based. Scientists put forward one or more possible explanations for their observations and design and carry out investigations to test whether their possible explanations are correct or not. Each possible explanation is referred to as a hypothesis. The process of designing an investigation and carrying out the investigation to test whether the explanation is valid is called hypothesis testing. Scientists use deductive reasoning during hypothesis testing. In deductive reasoning the generalisation is used to predict a specific result.

The methods, results and conclusions are evaluated and debated through the publication of findings in journal articles, and at conferences and meetings, before the scientific community accepts the new knowledge as valid.

Knowledge generation in science is an ongoing process that usually occurs gradually. However, sometimes insights into some phenomena take a leap forward as new knowledge, or a new theory, replacing what was previously accepted. Scientific knowledge changes over time as scientists improve their knowledge and understanding. It also changes as technology and techniques improve, and as people change their view of the world around them.

However, the scientific community can accept the new knowledge only if such knowledge is produced through certain accepted methods. These methods must lend themselves to replication and a step-by-step approach to scientific inquiry. This step-by-step approach is sometimes referred to as the "scientific method". The diagram on the next page represents the steps in such an approach.

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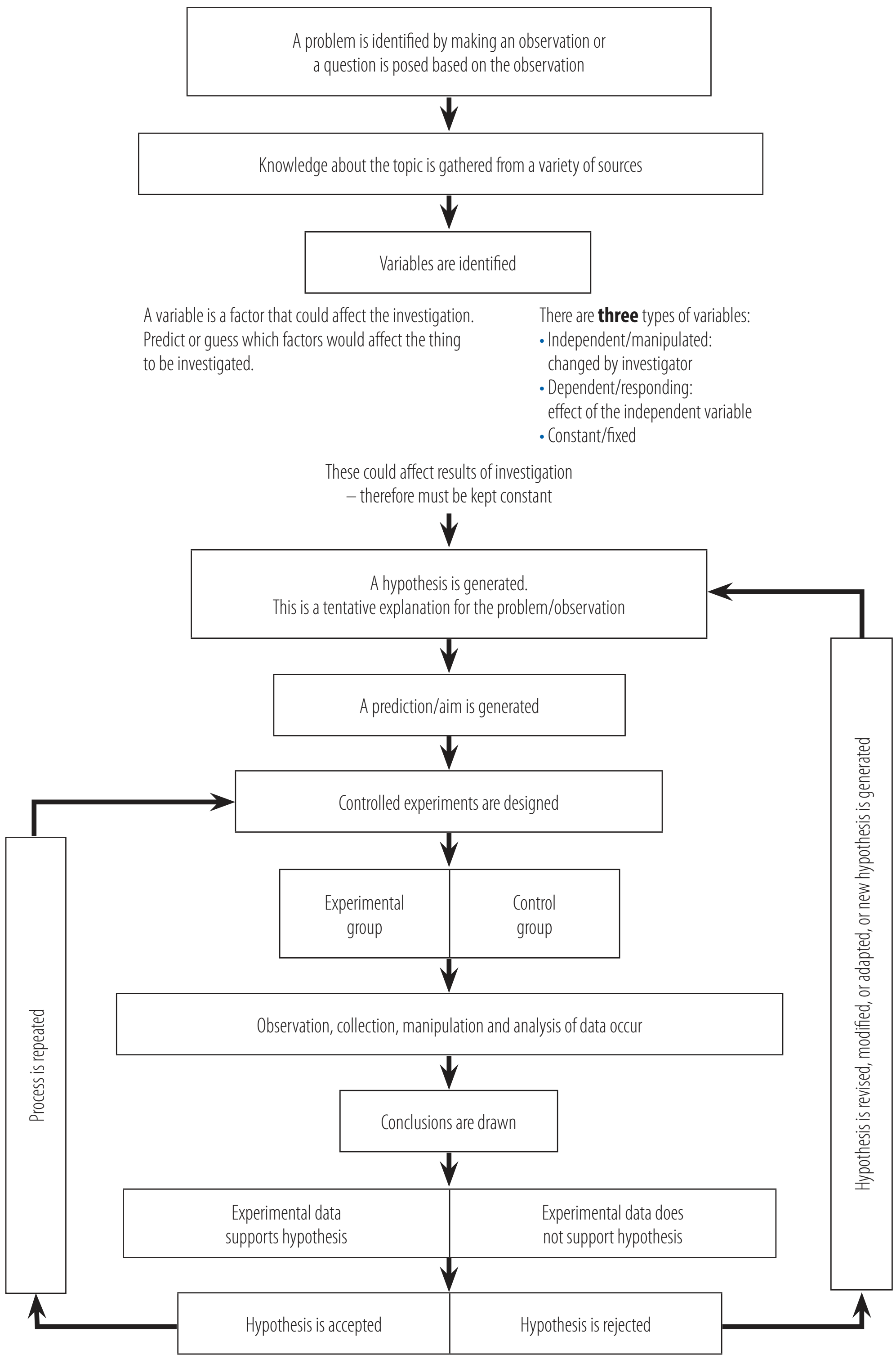

Figure 1 Summary of the scientific method

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The science knowledge that is taught at school is not in doubt as most of it has been tested and is generally accepted for now. However, as a Life Sciences learner you will be provided with opportunities to engage with activities to work and think like a scientist in order to help to develop inquiry and scientific skills.

Scientific skills

The following are some of the scientific skills and principles you will study in Life Sciences.

Surface area to volume ratio

One of the goals in Life Sciences is to understand themes/principles such as the relationship between surface area and volume/size. For example, smaller organisms such as bacteria have a high surface area to volume ratio and can therefore exchange gases by a simple process of diffusion and at a high enough rate for their needs. These organisms therefore do not require specialised organs or structures for gaseous exchange. Larger organisms have a smaller surface area to volume ratio and therefore need to have specialised gaseous exchange organs.

Another theme in the Life Sciences curriculum is understanding the relationship between structure and function – that is, how different parts of an organism are suited for its functions. For example, the inner membrane of the mitochondrion is folded. This increases the surface area available for maximum cellular respiration.

Biological drawings

Drawings and diagrams are essential in any science and are particularly important in Life Sciences because you use them to interpret what you see, for example, when you look at a specimen under the microscope or when you understand how the human body works. But there are rules about scientific drawings and diagrams. Remember that your drawing or diagram is not a sketch. It is an easy-to-understand representation of what you see.

Rules for drawings and diagrams

There are general rules that you need to follow when doing drawings and constructing diagrams.

Drawings and diagrams must:
- be drawn in pencil (using a sharp HB pencil to draw clear smooth lines)
- be labelled in ink

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- be large enough (at least half of an A4 page) to see all the structures that are in the diagram
- be positioned in the centre of the page
- usually be two-dimensional (i.e. show length and width only)
- not be shaded
- have a heading/caption below them.

The following rules apply to the caption/heading:
- Remember that a biological specimen can be sliced in different ways. This is the section of the part, i.e. whether it is the transverse section (TS), cross section (CS), or longitudinal section (LS).
- The caption should show the source of the diagram, i.e. whether it is from a specimen, a micrograph or a slide.
- The magnification/scale of the drawing should be placed either in the caption or in one corner of the drawing itself.

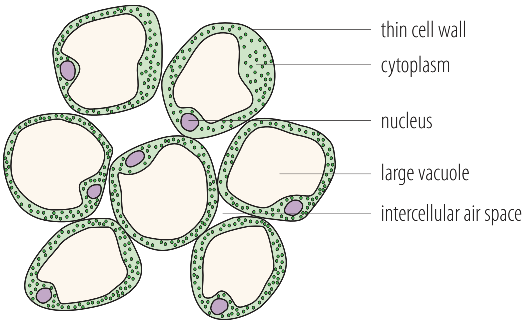

Figure 2 A drawing of a typical parenchyma

Label lines must:
- be drawn in with a ruler (not hand-drawn)
- not cross each other
- not have arrows at the end
- touch the part/structure that is labelled
- be on one side of the diagram if there are few labels, otherwise both sides can be used
- be aligned neatly, preferably one label below the other.

As an example, look at the label lines in the drawing in Figure 1 on the left.

Translating three-dimensional (3D) objects/specimens into two-dimensional (2D) drawings and photographs

Most observations in Life Sciences are made using two-dimensional (2D) microscope sections and photographs. The two common sections taken of biological specimens are longitudinal section (LS) and transverse section (TS)/cross section (CS)

Longitudinal section

Longitudinal section (LS) is taken through the long axis of the specimen.

Transverse section/cross section

Transverse section (TS) is taken through the short axis of the specimen, that is, at right angles to the LS.

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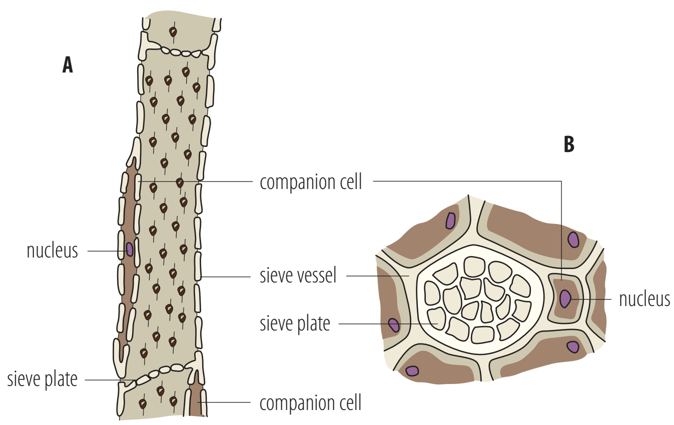

Figure 3 Phloem: sieve tube and companion cell: **A** longitudinal section, **B** cross section

The range of skills associated with the Specific Aims 1, 2 and 3

Table 2 The range of skills associated with the Specific Aims in the Life Sciences

Specific Aim 1: Knowing Life Sciences	Specific Aim 2: Investigating phenomena in Life Sciences	Specific Aim 3: Appreciating and understanding the history, importance and application of Life Sciences in society
Acquire knowledge by: • accessing information • selecting key ideas • recalling information • describing knowledge of Life Sciences Understand, comprehend, make connections between ideas and concepts to make meaning of Life Sciences by: • building a conceptual framework • organising or reorganising knowledge • writing summaries • developing flow charts and mind maps • recognising patterns and trends	• Follow instructions • Handle equipment or apparatus • Make and record observations in different ways such as: - drawings - descriptions - grouping - measurements - comparison - results of an experiment - counting • Record information or data in a variety of ways • Measure • Interpret, do calculations and represent information in different ways	Acquire knowledge by: • accessing information • selecting key ideas • recalling information • describing knowledge of Life Sciences Understand, comprehend, make connections between ideas and concepts to make meaning of Life Sciences by: • building a conceptual framework • organising or reorganising knowledge • writing summaries • developing flow charts and mind maps • recognising patterns and trends

Specific Aim 1: Knowing Life Sciences	Specific Aim 2: Investigating phenomena in Life Sciences	Specific Aim 3: Appreciating and understanding the history, importance and application of Life Sciences in society
Apply knowledge of Life Sciences in new and unfamiliar contexts by: • applying knowledge in new contexts • using knowledge in a new way Analyse, evaluate and synthesise scientific knowledge, concepts and ideas by: • analysing information/data • critically evaluating scientific information • recognising relationships between existing knowledge and new ideas • identifying assumptions • categorising information	• Design/plan investigations or experiments by: - identifying a problem - hypothesising - selecting apparatus/ materials - identifying variables - suggesting ways of controlling variables - planning an experiment - suggesting ways of recording results - understanding the need for replication or verification	Apply knowledge of Life Sciences in new and unfamiliar contexts by: • applying knowledge in new contexts • using knowledge in a new way Analyse, evaluate and synthesise scientific knowledge, concepts and ideas by: • analysing information/data • critically evaluating scientific information • recognising relationships between existing knowledge and new ideas • identifying assumptions • categorising information

Introduction to graphs

Scientists use different types of graphs to represent their findings in a concise way.

Bar graphs

Bar graphs are used to represent data where the independent variables, that is, the variables on the *x*-axis, are each associated with something different. In other words, the bars on the graph compare different facts or information. The example on the next page shows the different types of transport that different learners use to reach school. There is no relationship between the different types of transport, so a bar graph is the best way to represent these data.

The table on the next page and the bar graph drawn from the data in the table shows how a bar graph should be drawn.

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Example

The following table and bar graph represent the type of transport that various learners in a class use to get to school.

Table 3 Methods used by learners to get to school

Type of transport	No. of learners using this method
Walking	26
Bicycle	2
Taxi	1
Bus	3

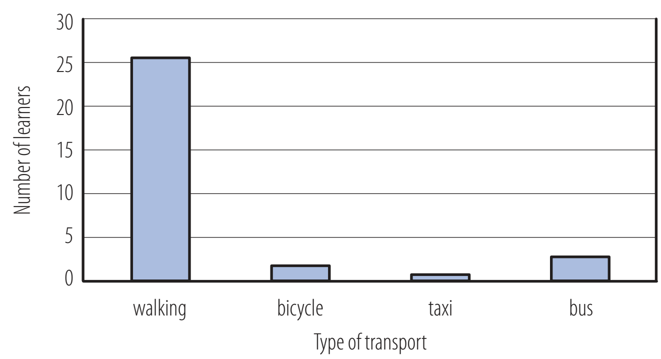

Figure 4 A bar graph showing the methods used by learners to get to school

Histograms

A histogram is a type of bar graph. A histogram is used to represent data when the independent variable (*x*-axis) represents groups of information along a continuous scale. Histograms are similar to bar graphs, except that in histograms, there are no spaces between the bars because each bar is showing data that are related to each other in some way, so the bars are continuous (next to each other).

Example

The following table and histogram show the range of learners' marks in an assignment:

Table 4 Number of learners with a particular %

Range (%)	Number of learners with a particular %
0–9	0
10–19	0
20–29	2
30–39	3
40–49	4
50–59	7
60–69	10
70–79	6
80–89	3
90–100	0

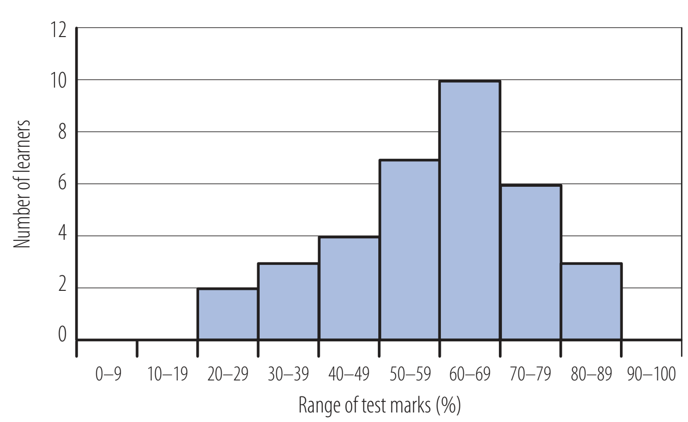

Figure 5 A histogram showing the number of learners with a particular percentage test score

Line graphs

A line graph is used when the relationship between the independent and dependent variables can be represented in a continuous way. The independent variable (on the *x*-axis) is the variable that the scientist controls or alters, for example, time. The dependent variable (on the *y*-axis) is the evidence that scientists collect.

Example

Using the graph below, determine how long it took for the plant to release 30 bubbles.

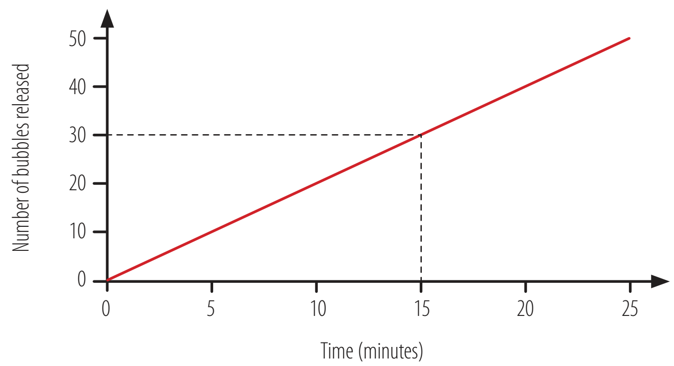

Figure 6 Line graph showing the relationship between number of bubbles released by a plant and time

Your reading shows that it took 15 minutes for the plant to release 30 bubbles of gas.

Pie charts

A pie chart shows data as a percentage or as a relative proportion of a circle. You draw a pie chart by dividing a circle into sectors/slices (think of a pizza) to represent each item as a percentage of the whole. A complete circle represents the whole or 100%, a half circle represents 50%, and so on.

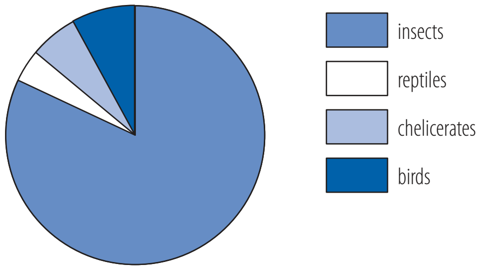

Figure 7 Pie chart showing the percentage of each animal type present in the ecosystem