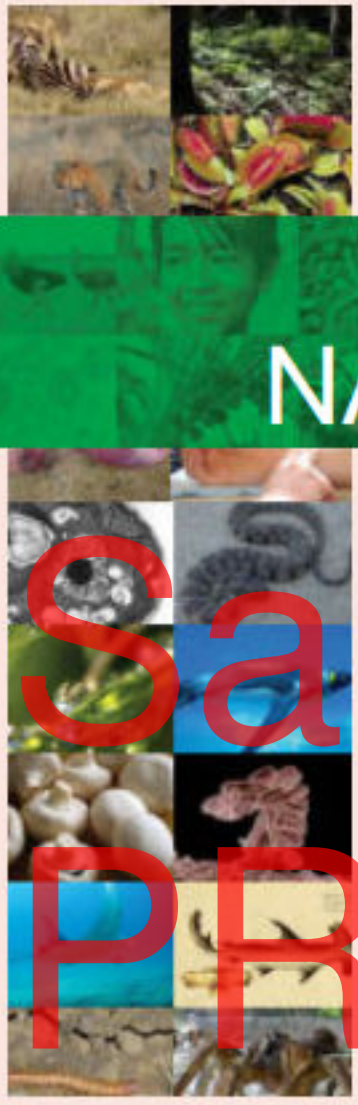


EXPLORE NATURAL SCIENCE

7th Grade
Biology & Chemistry

Periodic Table of the Elements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H																	2 He
3 Li	4 Be						No Element					5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57-71 La-Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89-103 Ac-Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Uuq	115 Uup	116 Uuh	117 Uus	118 Uuo

- Transition Metal
- Metal
- Metalloid
- Non-metal
- Noble Gas
- Lanthanide
- Actinide

57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Table of Contents

Life and living **2**

1 The Biosphere **4**
1.1 What is the biosphere? . . . 4
1.2 Requirements for sustaining life . . . 12

2 Biodiversity **28**
2.1 Classification of living things . . . 28
2.2 Diversity of animals . . . 37
2.3 Diversity of plants . . . 62

3 Sexual reproduction **78**
3.1 Reproduction in angiosperms . . . 79
3.2 Human reproduction . . . 104

4 Variation **124**
4.1 Variation within a species . . . 124
4.2 Inheritance in humans . . . 131

Matter and Materials **146**

1 Properties of materials **148**
1.1 Physical properties of materials . . . 148
1.2 Impact on the environment . . . 168

2 Separating mixtures **176**
2.1 Mixtures . . . 176
2.2 Methods of physical separation . . . 180
2.3 Sorting and recycling materials . . . 197

3 Acids, bases and neutral substances **206**
3.1 Tastes of substances . . . 206
3.2 Properties of acids, bases and neutral substances . . . 209
3.3 Acid-base indicators . . . 216

4 The Periodic Table of Elements **232**
4.1 Arrangement of elements on the Periodic Table . . . 233
4.2 Properties of metals, semi-metals and non-metals . . . 239

Image Attribution **260**

1 The Biosphere

KEY QUESTIONS:

- What is the biosphere?
- What are the coldest or hottest places where life can exist?
- How deep can you go in the sea before you do not find anything living anymore?
- Are there living organisms on top of the world's highest mountains?
- How can you tell if something is alive or if it was never alive?
- What do organisms need to stay alive?
- How come some organisms can live in certain places while others cannot?

NEW WORDS

- atmosphere
- biosphere
- depend
- environment
- habitat
- microorganism
- organism

Let's start exploring the world around us and how it works! Remember that this is your book! You must use it to explore and ask questions about the world around you, and also to learn about yourself and who you are. Do not be afraid to take notes in the margins of this book - make your own scribbles and notes to yourself about points to remember or questions you would like to ask. Be curious! Explore and imagine the possibilities of what you can do with science!

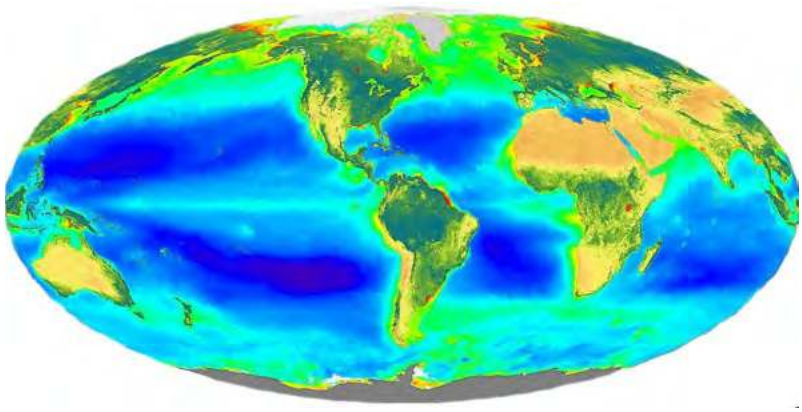
1.1 What is the biosphere?

Have you heard the word 'sphere' before? Do you know what it means? A sphere is normally used when talking about a round shape (like a ball). Now, what do we mean when we talk about the **biosphere**? The prefix 'bio-' indicates something to do with life. For example, 'biology' is the study of living organisms. So, can you put these two meanings together to work out what 'biosphere' means?

The biosphere is the place where life exists on planet Earth. When we talk about the biosphere, we are talking about a huge system (the whole world!) and how all the different parts work together to support life. We will look at these different parts in more detail a bit later.

TAKE NOTE

All the 'New words' listed in the boxes in the margin are defined in the glossary at the end of this section



The biosphere is where life exists on our planet, including the soil and rocks, water and air.

We can also use the term biosphere in different ways. When we speak of all life on Earth as it interacts with the non-living rocks and soil, water and air (**atmosphere**), we call this the biosphere.

Biosphere 2 is a man-made research centre in America, in the Arizona desert, where scientists have built a large enclosed artificial biosphere.

We can also call a specific part or region on Earth that supports life, a biosphere, especially when we refer to the living organisms and the **environments** in which they live.

ACTIVITY: Where do you think life exists on Earth?

INSTRUCTIONS:

1. The following table contains some photos of different places on Earth. Describe what each photo is showing.
2. Then decide if you think life exists there or not. If you do think so, list some of the organisms which you think live in this place.

A place on Earth	What is this image showing?	Do you think there is life there? If so, what?
		

NEW WORDS

- adapt
- aquatic
- component
- hydrosphere
- lithosphere
- marine
- matter
- organic
- photosynthesis
- respire

After doing this activity, did you see that life exists everywhere on Earth? From the highest mountains to the deepest oceans, from the hottest deserts to the thickest jungles, there is life. Did you also notice that when describing the places on Earth where life exists, you used words such as soil, rocks, water, air? These are all part of the biosphere and have special names.

Components of the biosphere

In the previous activity we saw that life can be found in water, soil and rocks or the air around us. These **components** form part of the biosphere and have special names:

- **Lithosphere** which includes the soil and rocks.
- **Hydrosphere** which includes all the water.
- **Atmosphere** which includes all the gases.

The biosphere includes the lithosphere, hydrosphere and atmosphere. The biosphere includes all living organisms, and also dead **organic matter**.

ACTIVITY: Describe the components of the biosphere

INSTRUCTIONS:

1. Study the following photo that shows the components of the biosphere.
2. Identify and describe the elements of the lithosphere, hydrosphere and atmosphere that you can see in the photo.

The lithosphere, hydrosphere and atmosphere on Earth.

1. Lithosphere:

2. Hydrosphere:

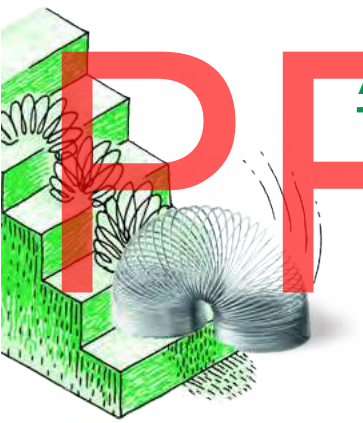
3. Atmosphere:

4. Even though you cannot see living organisms in this photo, there are many living and dead plants and animals that could live on a beach such as this one. Make about 10 plausible (believable) guesses of the types of organisms which would live in this environment. (Hint: think about what might be living in the sea, sand or air.)

Different organisms can exists in different places in the biosphere. Let's have a look at the different components of the biosphere and which types of organisms exist there.

Atmosphere

The atmosphere is the layer of gases that surrounds the Earth. The three most important gases in the atmosphere are nitrogen, oxygen and carbon dioxide. The atmosphere is made up of several layers.



ACTIVITY: The atmosphere

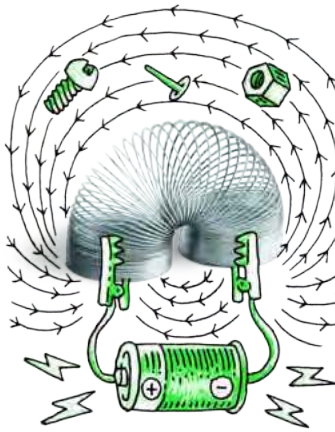
QUESTIONS:

1. Discuss with your partner whether you think organisms could live on Earth without the atmosphere. Explain why you think so.

Hydrosphere

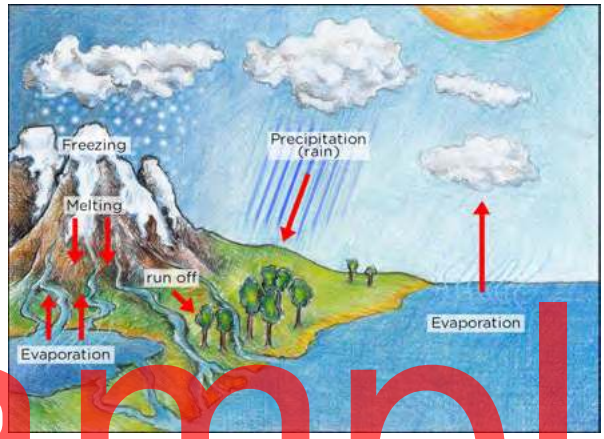
The hydrosphere consists of all water on Earth in all its forms.

ACTIVITY: The water cycle



INSTRUCTIONS:

1. Study the following diagram describing the water cycle on Earth.
2. Answer the questions that follow.



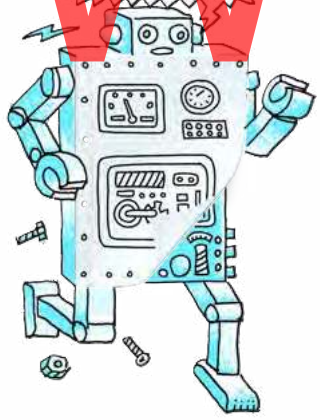
QUESTIONS:

1. Do you remember learning about the different states of matter? The hydrosphere includes all water in all the states of matter. Look at the diagram of the water cycle and identify water in the different states of matter.

2. The water cycle shows different sources of freshwater and saltwater. Many plants, animals and microorganisms have adapted to live in an aquatic habitat. A very small percentage of the world's water sources are freshwater and the rest is saltwater. Write down as many different types of aquatic habitats that you can think of where different organisms exist.

TAKE NOTE

The word 'aquatic' is used to describe something to do with water. Therefore aquatic animals are animals that live in or near water. The word 'marine' describes organisms that live in saltwater or the sea. So someone studying the organisms in the sea is called a marine biologist.



Lithosphere

As we have said, the lithosphere includes the rocks, soil and sand on Earth. Organisms **depend** on the lithosphere in many different ways. We find out how in the next activity.

ACTIVITY: How do organisms depend on the lithosphere?

INSTRUCTIONS:

1. Below are several photos depicting different ways that organisms depend on and interact with the lithosphere.
2. Use these images to write a paragraph about how different organisms depend on the lithosphere in different ways.

Bird nests

A rock pool

A termite mound

A tree growing in the ground

An earthworm in soil

A mud hut

NEW WORDS

- abiotic
- cellular respiration

We have now looked at the different parts of the biosphere and seen that there are many different types of organisms that exist. Each of the organisms that we have seen so far needs to be able to stay alive in those specific conditions. We say they need to **adapt** to live in their particular habitat. What does it mean to stay alive though?

Characteristics of living plants and animals

There are seven processes that all living organisms perform that determine whether they are alive or not. Let's have a look at the seven life processes:

1. All living things need to be able to **move**. Moving does not have to consist of big movements. Even plants move, for example as the flowers and leaves turn to face the sun during the course of the day.
2. All living things need energy to perform the life processes. Organisms release energy from their food by a process called **cellular respiration**.
3. All living things need to be **sensitive** to their environment. Think of an example of why animals need to sense their environment and write it down below.

4. All living things need to be able to **grow.**
5. All living things need to be able to **reproduce** so that they do not die out.

NEW WORDS

- favourable
- requirement
- sustain

6. All living things need to be able to **excrete** waste.
7. All living things need **nutrition,** as they need to break down nutrients during cellular respiration to release energy.

Now that we can determine whether something is living or not, we can take a look at what living things need to survive. In other words, what are the requirements for life?

1.2 Requirements for sustaining life

After studying the seven life processes, we now know what animals, plants and other living organisms need to *do* in order to be classified as living. In order to stay alive these living organisms **require** (need) certain things or specific conditions. In this section we are going to study the requirements necessary to **sustain** life.

ACTIVITY: Identify the requirements for sustaining life

Imagine that you are the design team for the first International Moon Space Station, similar to the International Space Station already orbiting Earth, but situated on the Moon!

The international space station that orbits Earth, seen from above.

INSTRUCTIONS:

1. Work in groups of four.
2. What do you think the astronauts and plants living on the new Moon Station will need in order to live? Discuss the five most important requirements that you need to provide in order for the astronauts and plants to remain alive on your Moon Space Station.
3. Explain why your group chose these five requirements as the most important to sustain life. Write down your notes from your group discussion on the lines provided. Decide which member of your group is going to report back your findings to the rest of the class.
4. Have a class discussion after you have finished discussing this in your group.

Living organisms require certain conditions or things to be able to stay alive. We say that these things or conditions sustain life.

You would have discussed some of these requirements in the last activity. Did you come up with the same or similar requirements? Living organisms require the following to survive:

- energy
- gases
- water
- soil
- favourable temperatures

Next, we look at these in a bit more detail.

Energy: All living organisms need energy to stay alive and perform the life processes. Plants need energy from sunlight in order to photosynthesize. Other organisms get their energy from the food that they eat.

All living things need a source of energy. The grass and trees get their energy from the Sun to photosynthesize. The cow gets its energy by eating the grass.

All living things need oxygen to respire, such as this dog which is breathing air in through its nose.

TAKE NOTE

'Sustain' means to keep things alive or in existence. We also use the word sustainable when we want to say that something can continue or be continued for a long time.

DID YOU KNOW?

When astronomers search for life outside of our solar system, they search for planets that might contain liquid water, believing that where there is water there may be life.

Gases: All living things require oxygen for cellular respiration. Oxygen is used to release energy from nutrients and carbon dioxide and water is produced as a waste product of respiration. Green plants also need carbon dioxide to photosynthesize.

Water is vital to life. Every organism on our planet needs water to live.

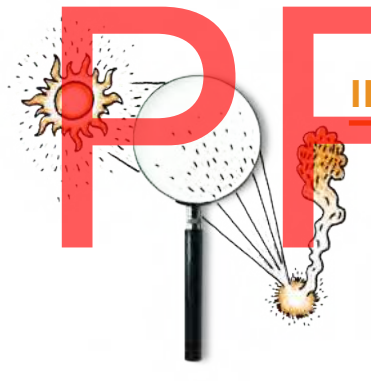
Water is vital for life on Earth.

Most plants need soil to grow in.

Soil sustains life on Earth. Most plants depend on soil for support, minerals and water. Without the soil, plants would not be able to produce the food that animals and other organisms depend on.

Favourable temperatures: All organisms are adapted to live in a particular temperature. In general, our planet has favourable temperatures to support life. Earth is at an optimal distance from the sun so that it is not too hot, like on Mercury, and not too cold, like on Neptune.

Let's find out what the requirements are to grow seedlings. We will learn how to conduct a scientific investigation to do this.



INVESTIGATION: What are the requirements to sustain life in plants?

In this investigation, we are going to germinate bean seeds (or any other seeds that your teacher provides you with). Each group in the class is going to be testing a different requirement for germination and growth of the seedling.

AIM:

A scientific investigation always has an aim or question that needs to be answered. What is the aim of this investigation? Write down what you aim to find out.

HYPOTHESIS:

A hypothesis is where you propose (suggest) what the outcome of the investigation will be. It is a prediction of what the results will be. Write a hypothesis for this investigation.

NEW WORDS

- dependent variable
- hypothesis
- independent variable
- scientific method
- variables

VARIABLES:

Scientists often use investigations to search for cause and effect relationships. This means that they design experiments to investigate how changes to one part will cause an effect on another. These changing quantities are called **variables**. There are usually three kinds of variables:

1. **Independent variables:** This is the thing that you are changing in the investigation. You are in control of the independent variable. For example, if you wanted to investigate if eating a lot of sugar makes you gain weight, then the amount of sugar you eat is the independent variable. You control how much sugar you eat. We want to achieve something called a FAIR TEST which means that only ONE independent variable is changed at one time. Once the independent variable has been changed the scientist then observes what the effect will be. In the example of investigating if sugar makes you gain weight, you cannot at the same time investigate whether exercise makes you lose weight. This would not be a fair test.
2. **Dependent variables:** The dependent variable is the thing that you observe in an investigation. You do not change it. The dependent variable will change depending on the independent variable. For example, in the investigation to see if eating a lot of sugar makes you gain weight, then the dependent variable will be how many kilograms you gain (or lose) as a result of eating sugar. How much weight you gain depends on how much sugar you ate. Dependent variables should be measured in an objective way using numbers as far as possible.
3. **Controlled variables:** These are the quantities that a scientist wants to remain the same or unchanged throughout the experiment. The controlled variable needs to be carefully monitored to make sure that it stays the same. In the example to see if sugar makes you gain weight, you could have one person eat a lot of sugar and the other person eat no sugar and then see the changes in weight. There are some things that need to stay the same for both of these people so that it is a fair test. For example, both people must do the same amount of exercise so that this does not influence their weight. This is a controlled variable.

TAKE NOTE

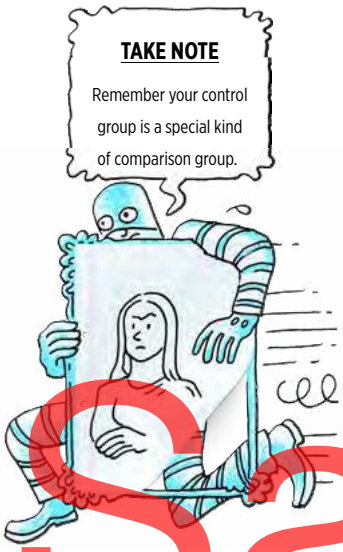
A hypothesis is an educated guess about what the outcome of the investigation will be. The hypothesis is stated before starting the investigation and must be written as a statement and must be in the future tense.

You can also do a control test. For example, in this investigation about the growth of plants, you will be taking away one of the requirements for growth. You need to do a control test where another plant is given all the requirements, including the one you took away in the other plant. You can then compare your plant where you took one requirement away to the control plant which has that requirement to see if there is a difference.

Identify the variables for this investigation.

1. **Independent variable**. What will you change?

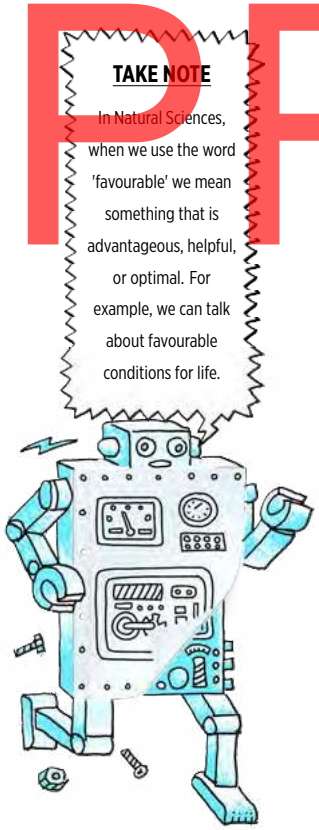
2. **Dependent variable**. What will you measure to see the effect of the independent variable on the germination and growth of the plant?



3. **Controlled variables and control group**. What will your control test be and what will you keep the same between the control plant and the tested plant?

METHOD:

In your group, plan how you are going to do the investigation. Think about which requirement you are testing and how you will take this requirement away. For example, if you are looking at light, where could you place the seeds so that they do not receive light? Remember, if you are looking at light, then you need to make sure the control and test seeds both receive the same amount of water. Once you have planned the investigation on rough paper and discussed it with your teacher, write up the method below (in numbered steps) explaining what you will do.



MATERIALS AND APPARATUS:

Write a list of all the materials and apparatus that you will be using in this investigation.

RESULTS AND OBSERVATIONS:

Use this space to record the results for your investigation. If you are seeing whether plants germinate or not, then you need to draw a table to show this. If you are measuring how much the plants grow, then you will also need a table for this.

DID YOU KNOW?

Every solar system has a 'Goldilocks' zone which is a region that is not too hot (close to the sun), and not too cold (far from the sun) to be able to sustain life. Earth is in the middle of our solar system's Goldilocks zone!

ANALYSIS:

Once we have collected our results in a scientific investigation, we need to analyse them. This often involves drawing a graph. If you measured the growth of the seedlings over time, then you can draw a line graph to show this. If you have counted the number of seeds that germinated you can express this using a bar chart (provided you used the same number of seeds in each group), or you can express the percentage of seeds that germinated as a pie chart. Your teacher will help you do this.

DID YOU KNOW?

Not all plants need to grow in soil. Epiphytes, such as mosses and orchids, are a group of plants which grow on other plants or rocks. They get their moisture and minerals from the air and rain.

CONCLUSION:

After collecting all your results and drawing a graph using these results, you will need to use this to draw a conclusion about the requirements to sustain life in plants. The following questions will guide you in drawing your conclusion.

1. I found out...

2. I know this because...

3. The investigation was fair because...

4. I can trust the results because...

5. While I conducted (did) this investigation I also discovered that...

6. If I did this investigation again I could improve it by...

What did you learn from doing this scientific investigation?

Write 3 to 5 sentences explaining what you learned from doing this scientific investigation following the scientific method.

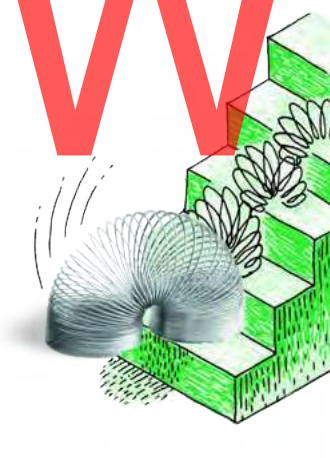
Each organism is able to survive and continue to survive in their environment because they have acquired the characteristics that allow them to do things in a special way in their particular environment. We say they have adapted to life in their particular type of environment.

Adapted for life

Do you think you could put a polar bear in the Kalahari desert or a gemsbok in Antarctica and they would survive? Why, or why not?

These animals are specifically adapted to live in their specific environments. All organisms are adapted to their specific environments. In the next activity we examine some more examples of how organisms are adapted to their environments.

ACTIVITY: Adaptations in organisms



INSTRUCTIONS:

1. Study the photos below showing different organisms in different environments.
2. Answer the questions.
3. You might need to do some extra research in books and on the Internet to complete your answers.

QUESTIONS:

Look at the photos of a penguin in the water and an eagle flying in the air. Both of these are birds, but they live in very different environments that make the penguin adapted for the water and the eagle adapted for flight.

A penguin in the water.

A flying fish eagle about to catch some food.

1. How do you think the penguin is adapted to swim in water? Hint: What are its wings used for? Does it have small or large feathers? How do you think this helps?

2. How do you think the eagle is adapted to fly and catch its prey? Hint: Look at its feathers and wings.

South Africa is home to two very skilled predators, the great white shark and the lion. Both of these animals are very skilled at catching their prey, but in very different environments.

A great white shark in Gansbaai, Western Cape.

A lioness attacking a buffalo in Kruger National Park.

3. What characteristics does the shark have that makes it adapted to living and feeding in the sea? Hint: Look at its streamlined body shape and sharp teeth.

4. What characteristics does a lion have that makes it adapted to living and hunting in the savanna? Hint: Look at the color of its fur and the color of the grass and its strong limbs.

We have now looked at how a few of the animals on Earth are adapted to their environments. There are many, many more organisms with very unique and interesting adaptations. In the next chapter we will learn more about the diversity of plants and animals on Earth.

SUMMARY:

Key Concepts

- Life on planet Earth exists in the biosphere.
- The biosphere consists of the lithosphere, hydrosphere and atmosphere, as well as the many living organisms and dead, organic matter.
- Many different kinds of living organisms exist in the biosphere.
- Things can be classified as living if they perform the seven life processes:
  - Movement
  - Reproduction
  - Sensing the environment
  - Growth
  - Respiration
  - Excretion
  - Nutrition
- Living things need energy, gases, water, soil and a favourable temperature to survive.
- Living things are suited or adapted to the environment in which they live.

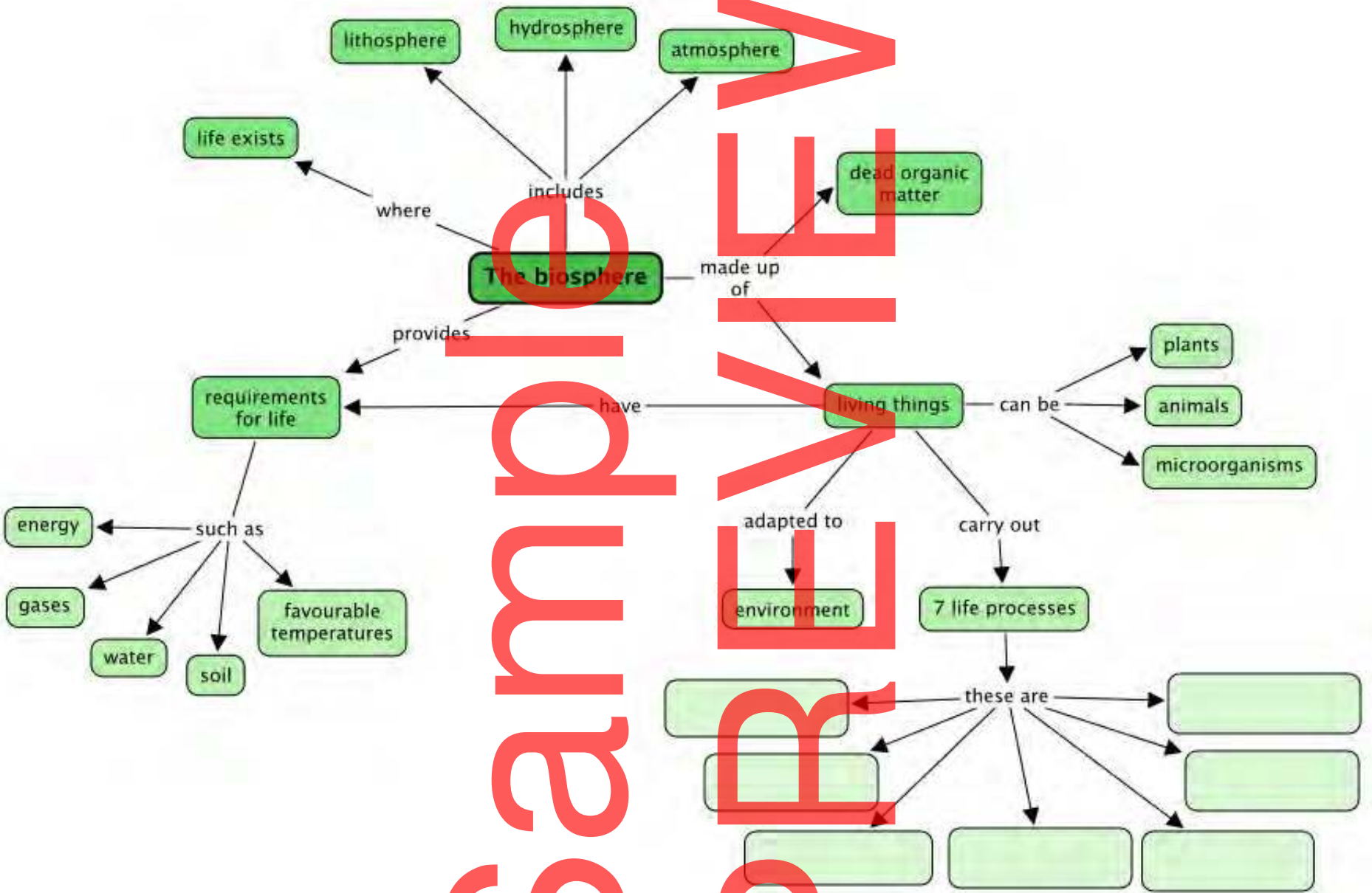
Concept Map

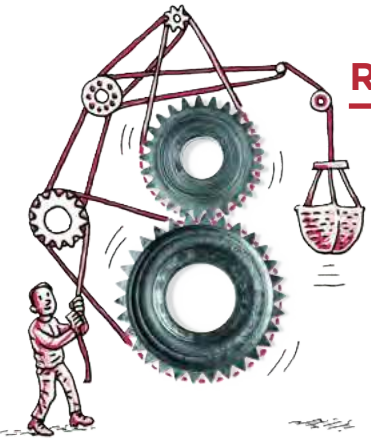
Do you know what a concept map is? This year in Natural Sciences, we are going to learn more about how to make our own concept maps.

Above you have the 'Key concepts' for this chapter. This is a written summary and the information from this chapter is summarized using words. We can also create a concept map of this chapter, which is a map of how all theconcepts (ideas and topics) in this chapter fit together and are linked to each other. A concept map gives us a more visual way of summarizing information.

Different people like to learn and study in different ways: some people like to make written summaries, whilst others like to draw their own concept maps when studying and learning. These are useful skills to have, especially for later in high school and after school!

Have a look at the concept map for 'The Biosphere' on the next page. Complete the concept map by filling in the 7 life processes in the blank spaces.





REVISION:

1. Explain what the biosphere is. [2 points]

2. Give an example of something that is found in each of the following: [3 points]
   a) Lithosphere:

   b) Hydrosphere:

   c) Atmosphere:

3. Discuss why the atmosphere is important for life on Earth. [pointks]

4. Imagine an alien creature arrives on Earth attached to a meteorite (fallen space rock). You were tasked with deciding whether it lives in the conventional way that we understand organisms to live. Draw up seven questions to determine how this organism lives and whether it can be classified as alive. [7 points]

5. What are the requirements for sustaining life on Earth? [5 points]

6. Look at the following photos of different organisms in their environments. Answer the questions about how they are adapted.
   a) Giraffe

How are giraffe adapted to eat their food? Hint: They eat the leaves of trees. [1 point]

   b) A cactus

This cactus is adapted to live in hot environments? How do you think it stores water for long periods? Hint: Look at its leaves. [1 point]

How do you think the cactus has adapted to prevent other animals from eating it? Hint: What is on the leaves? [1 point]

c) A stick insect.

Can you see the stick insect in this photo? How do you think it is adapted, especially to hide away from predators? [1 point]

7. Think back to the scientific investigation you did in this section. Evaluate how well you think you followed the scientific method to make your experiment fair or not fair. [2 points]

Total [25 points]

Here is your chance to discover the possibilities. What can this apple become?

2 Biodiversity

KEY QUESTIONS:

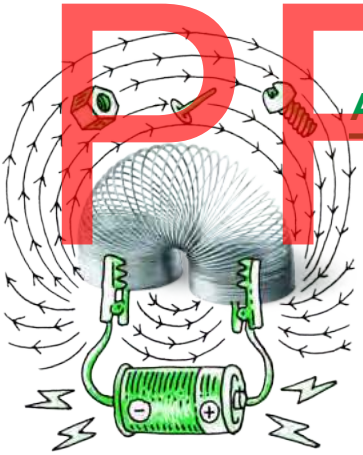
- How do we group or classify all the living organisms in the world?
- Why do we need to group or classify living things?
- How can we classify all the animals on Earth?
- What is the difference between reptiles and amphibians?
- Are insects and arachnids (spiders) different?
- Is there a way to classify plants?
- What is the diversity of plants and animals in South Africa?

Over many years, each species living today has changed and adapted to live in a specific type of environment in order to ensure the survival of that species. Biodiversityis a term used to describe the great variety of living organisms on Earth and their varied habitats.

There are just so many types of organisms. How can we make sense of all the organisms on Earth? We need some way to group them. This is called classifying. Let's find out how we do this!

2.1 Classification of living things

Grouping has been a common activity in humans for thousands of years as we make sense of the world around us.



ACTIVITY: Group some everyday objects

MATERIALS:

- objects from home
- shoe boxes/ ice-cream tubs

INSTRUCTIONS:

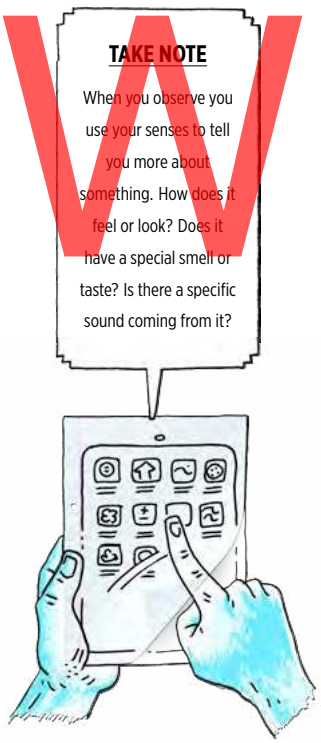
1. Work in groups of four.
2. Each member of the group should bring five items from home. Choose items that are easy to carry around and that will fit into a standard shoe box.
3. Carefully observe each of the items that everyone in your group brought.
4. Use the shoe boxes to group the items according to your observations.
5. Place all objects brought by the whole class on a display table in the front of the class.
6. Discuss the different grouping methods that each group has used as a class. Work towards a standard grouping or classifying method that you could use to **classify** ALL the items that you all brought to school.

QUESTIONS:

1. Draw a table in the space below and record all the items in your class in the groups you assigned them to.

2. How did your small group classify your items to begin with? What features did you use to classify the items?

3. Write three or four sentences about the standard classification method that you decided to use in your class. What **characteristics** of the items did you use to classify and group them? Were these different to what you used in your small group?



NEW WORDS

- characteristic
- class
- classify
- kingdom
- order
- phyla

Aristotle was a Greek philosopher and thinker who lived about 2400 years ago. Aristotle came up with the following grouping system that was used for almost 2000 years after his death!

- He divided all organisms into either animals or plants.
- Then he divided animals into those 'with blood' and those 'without blood'.
- Lastly animals are divided into three groups based on their method of movement: walkers, flyers or swimmers.

Plato and Aristotle in a famous painting by Raphael called "School of Athens".

ACTIVITY: Aristotle's classification system

INSTRUCTIONS:

1. Look at the following photos of different kinds of animals.
2. Use Aristotle's method of classification to group the animals based on the way that they move.
3. Draw a table of your groupings in the space provided after the photos. Give your table a heading.

A penguin

A butterfly

A cat

An elephant

A crocodile

An eagle

A human

Dolphins

Bats

QUESTIONS:

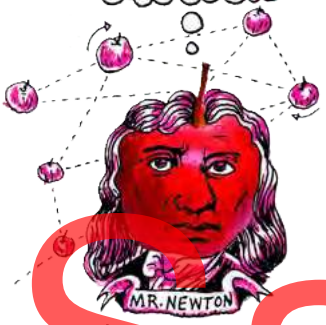
1. Were there any animals which you battled to classify into one group? Which ones were these?

2. Do you think Aristotle's classification system has any problems? Explain any problems that you might find when using it.

As more and more animals, plants and microorganisms were discovered, scientists started questioning Aristotle's classification system. It was not working as well as everyone had believed it would. Why do you think it is important to evaluate *how* we classify things?

DID YOU KNOW?

Scientists estimate that there are up to 30 million species of organisms on Earth! If they use systems to classify these organisms they can see patterns in nature and can see how organisms relate to each other.



In the 1700s Carl Linnaeus developed the classification system that classified organisms according to their similarities, functions and relationships with other organisms.

Today with the use of modern microscopes and genetics we can classify living organisms very accurately. In this way we are able to classify living organisms according to their shared characteristics.

Carl Linnaeus

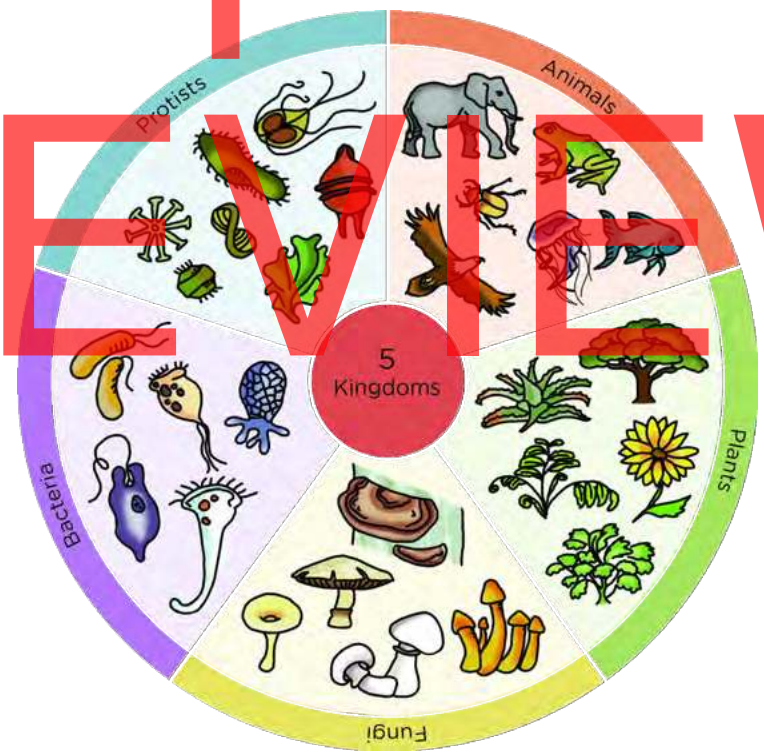
Our classification system

All living organisms can be divided into five **kingdoms**:

1. **Animals**
2. **Plants**
3. **Fungi**
4. **Protists**
5. **Bacteria**

TAKE NOTE

The kingdom Bacteria is often also referred to as **Monera**.



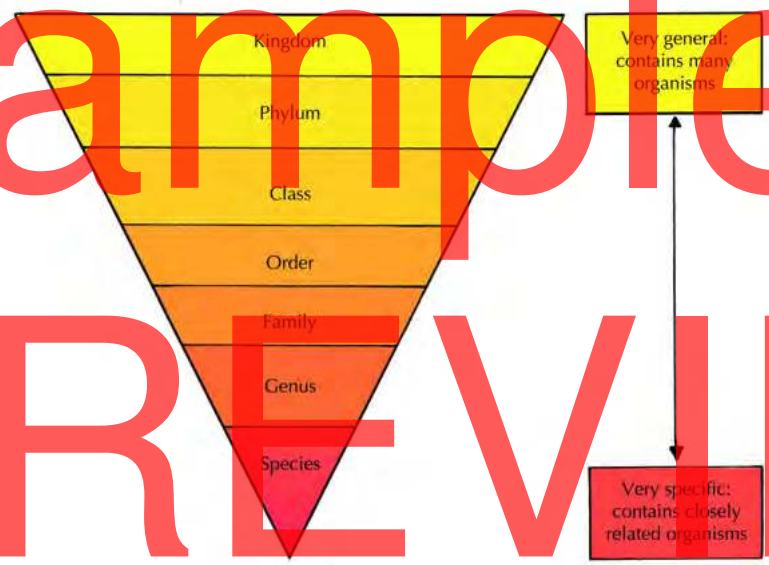
What are humans? Which kingdom do we belong to?

Think back to the example of how we classify learners at school. First, school is divided into pre-primary school, primary school and high school. If we compare school to the way we classify organisms, we can say that the school system has three kingdoms. But, we need to divide learners up further. So primary school is divided into seven grades (Gr. 1-7) and high school is divided into five grades (Gr. 8-12). The classification system for organisms also needs to divide organisms up further as each kingdom contains thousands of different types of organisms.

Each kingdom is divided into smaller groups or divisions called **phyla**. Organisms with similar traits (characteristics) will occupy a similar phylum. In each phylum, smaller divisions called **classes** are found and each class is further divided into **orders**, **families**, **genera** and then **species**.

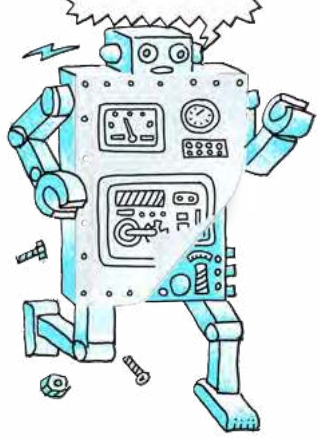
Think of your school again. Your primary school contains many learners. When you divide your entire school into grades, there are fewer learners in each grade. Your grade might be divided into different classes, and each class has fewer learners in it. When we classify organisms, the same thing happens. A kingdom is a very big group, whereas a species is a much smaller group.

Study this diagram to help you remember the order:



TAKE NOTE

Be careful to use these words correctly: one *phylum*, many *phyla*. Similarly, one *genus*, many *genera*.



TAKE NOTE

A mnemonic takes the first letters of a group of terms to make a funny rhyme.

King **P**hil **C**uts **O**pen **F**ive **G**reen **S**nakes

We need to be able to distinguish between organisms too. So how do we name organisms?

Carl Linnaeus designed a special naming system called the **binomial nomenclature** to name all organisms. All organisms are therefore given **two** (bi- means two) words in their name.

- The first part of the name refers to the genus that the organism belongs to. This is always written with a capital letter.
- The second part of the name refers to the species within the genus
- If you are typing you will put both these names in *italics* but if you are doing a handwritten piece you underline it. This shows that you are identifying the organism by its scientific name.

For example, the scientific name for the African elephant is *Loxodonta africana*. Humans belong to the genus *Homo* and to the species *sapiens* so we are *Homo sapiens*.

Now that we have seen how to classify organisms, let's take a closer look at the differences between the kingdoms.

Plants and animals

ACTIVITY: Comparing plants and animals

INSTRUCTIONS:

1. Study the diagram that shows the five kingdoms that we commonly use to classify organisms. Pay close attention to the plants and animals.
2. Answer the following questions.

QUESTIONS:

1. Study the organisms in the animal kingdom. What are some common features that you can see in all the animals?

TAKE NOTE

When we compare plants and animals we can often compare them based on the way that they move, what and how they get food or nourishment, and how they reproduce.

2. Study the organisms in the plant kingdom. What are some features that are common to all plants?

3. Draw a table in the space below and compare the characteristics of plants that make them different to animals. Discuss your plant and animal comparisons with your group and then with the class.

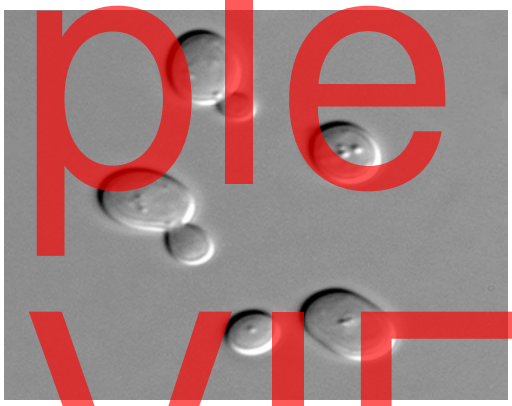
Fungi

Most people will not eat bread covered in bread mould but will eat a plate of fried mushrooms, truffles and morels. These are all examples of fungi, including yeast.

Morel

A truffle

Bread mould



Yeast cells

DID YOU KNOW?

Morels are a type of edible mushroom. They are distinctive for the appearance of their caps, which are have pits and ridges that resemble a honeycomb.

A very poisonous mushroom

Button mushrooms (like we buy in the shops)

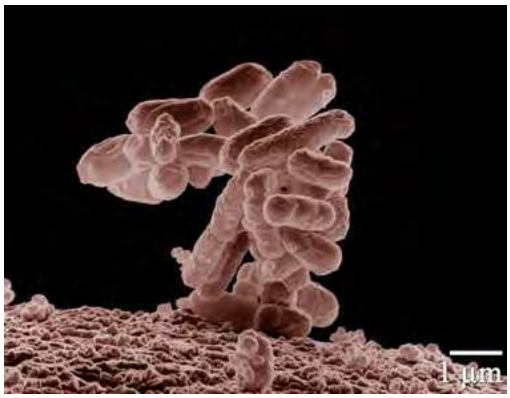
Fungi play a very important role in our biosphere since they break down dead organic material and return nutrients to the soil for plants to use. Some fungi cause diseases while others, such as penicillin (an antibiotic) are very useful to us. Yeast is used in many of our products, such as making bread rise and fermenting wine and beer.

Protists and Bacteria

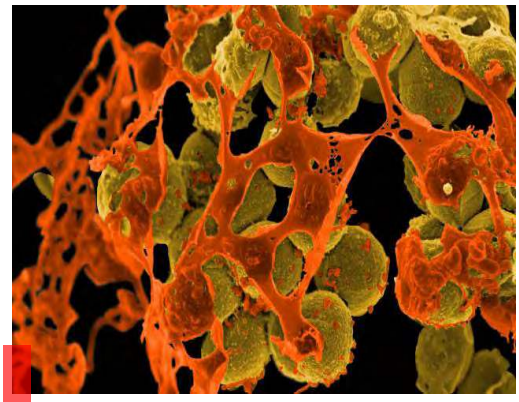
We will look at Protists and Bacteria in more detail later on in Gr. 9. For now, lets look at some of the basic features of these kingdoms.

Organisms in these two kingdoms are microscopic which means you cannot see them with your naked eye. However we can see them if we look at them under a microscope.

Different bacteria:



Escherichia coli bacteria, commonly found in the intestines of animals

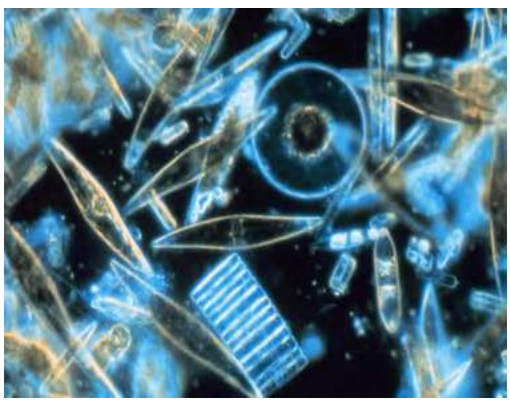


Staphylococcus aureus (yellow cells) often causes skin infections and pneumonia

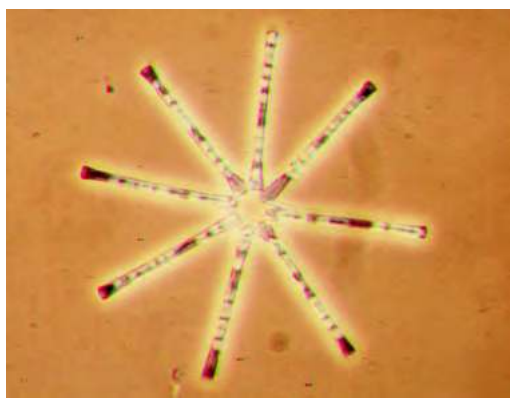
Pseudomonas aeruginosa is found in soil and water and cause infections in animals

Actinomyces bacteria which cause diseases in the mouth

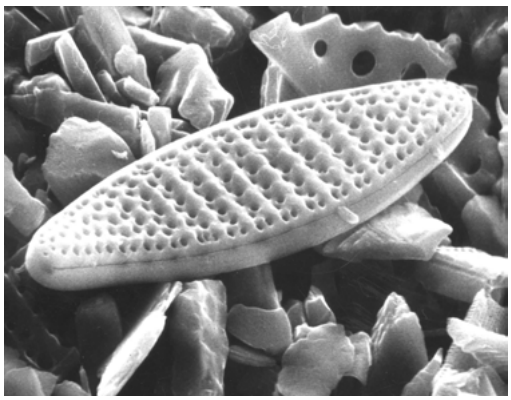
Different Protists:



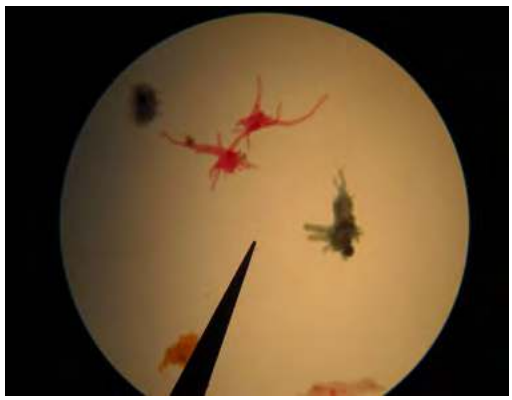
Phytoplankton from the Antarctic sea



Asterionella formosa



Nitzschia kerguelensis



Different colored amoebas

Now we will look at the amazing diversity of animals and plants on Earth, and especially in South Africa.

2.2 Diversity of animals

Classifying animals

All the animals in the world form part of the animal kingdom.There are two distinct divisions or groups of animals within the animal kingdom: the **vertebrates** and the **invertebrates**. Can you remember what is used to classify an animal as a vertebrate or invertebrate? Look at these x-rays of animals for a clue.

NEW WORDS

- diversity
- invertebrate
- vertebrate

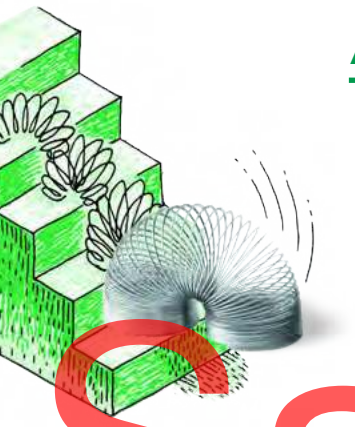
DID YOU KNOW?

Almost 98% of all the animals that have been discovered on Earth are invertebrates!

Animals that have a backbone with a hollow tube inside to hold the nerves are vertebrates. As we can see in the x-ray images of the dolphin, dog and goose, we can see the skeletons of these vertebrates. They are made of bone. We say that vertebrates have an endoskeleton.

What about the grasshopper and the crab? Why can we not see their bones? This is because invertebratesdo not have a skeleton made of bones. The grasshopper and crab have a hard shell covering on the outside of their bodies. This supports their soft bodies inside. We say they have an exoskeleton. But not all invertebrates have an exoskeleton.

What about a jellyfish? It does not have a backbone, so it is not a vertebrate, so it must be an invertebrate. Does it have a hard, outer covering called an exoskeleton? Discuss this with your class. Make sure to take note of the third type of skeleton in your discussion.



ACTIVITY: Classifying vertebrates and invertebrates

INSTRUCTIONS:

1. In the table identify the type of skeleton that each animal has and write it down beneath each picture.
2. Write down whether the animal is an invertebrate or a vertebrate.

Animal	 A grasshopper	 A bluebottle
Type of skeleton		
Vertebrate or invertebrate		
Animal	 Cape sparrow	 Butterfly
Type of skeleton		

Vertebrate or invertebrate		
Animal	 Tortoise	 Frog
Type of skeleton		
Vertebrate or invertebrate		
Animal	 Crab	 Earthworm
Type of skeleton		
Vertebrate or invertebrate		

The invertebrates are divided into five phyla. The invertebrate phyla are:

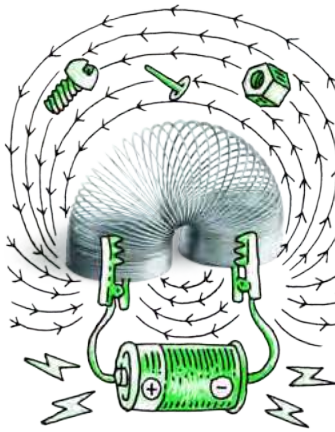
1. Sea sponges
2. Jellyfish
3. Roundworms
4. Molluscs
5. Arthropods

Vertebrates belong to the phylum Chordata. Vertebrates are subdivided into five classes.

Have a look at the following diagram which shows the different classes of vertebrates and phyla of invertebrates. Remember, all vertebrates belong to the phylum Chordata.

TAKE NOTE

'Phylum' is the singular and 'phyla' is the plural use of the word.



ACTIVITY: Identify the five classes of vertebrates

INSTRUCTIONS:

1. Study the previous chart showing vertebrates and invertebrates and identify the names of the five classes of vertebrates. Write these on the lines below.
2. Use the pictures that you previously collected from magazines to find at least 5 examples of each of these classes of animals.

QUESTIONS:

1. Identify at least one distinguishing characteristic that each class shares or has in common (that makes that class different from other classes.) Write this on the line next to the classes that you identified above.

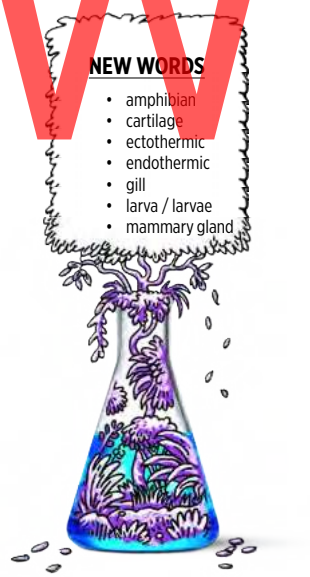
Vertebrates

The five classes of vertebrates are:

1. Fish
2. Amphibians
3. Reptiles
4. Birds
5. Mammals

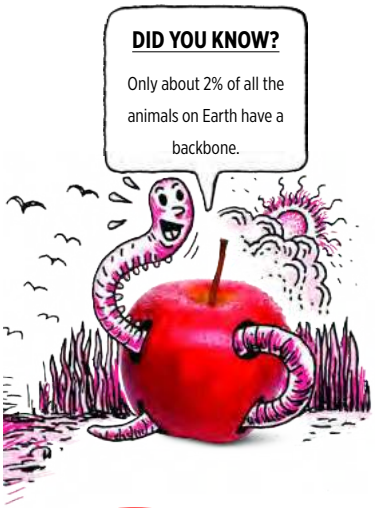
NEW WORDS

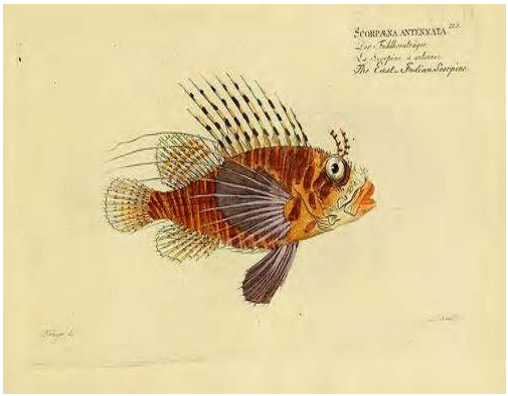
- amphibian
- cartilage
- ectothermic
- endothermic
- gill
- larva / larvae
- mammary gland



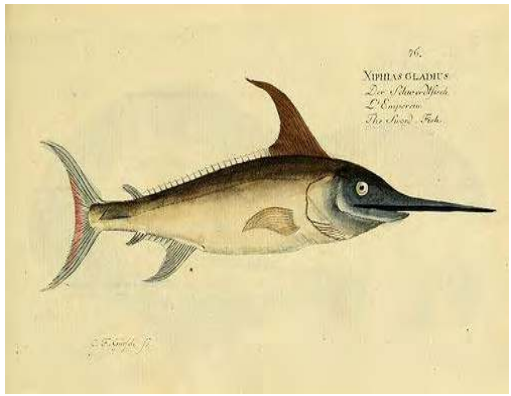
Fish

Fish come in all sorts of shapes, sizes and colors. There is huge diversity amongst fish. Have a look at some of the following drawings of different types of fish.

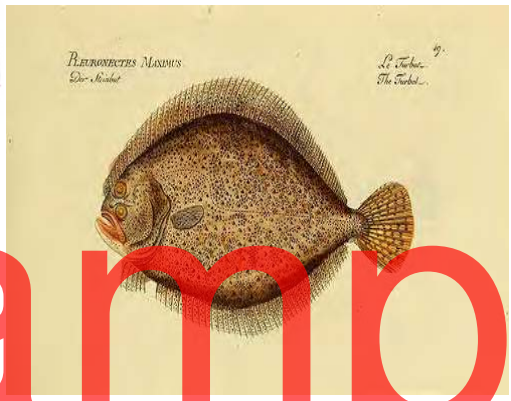




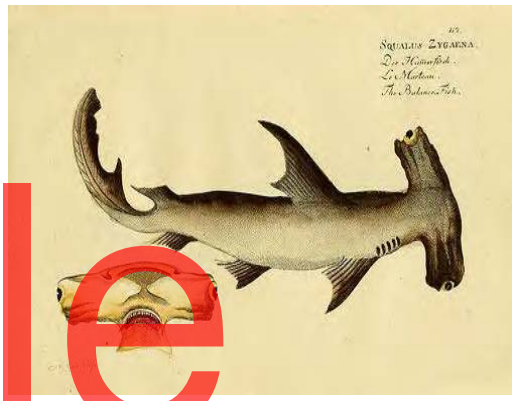
Scorpion fish



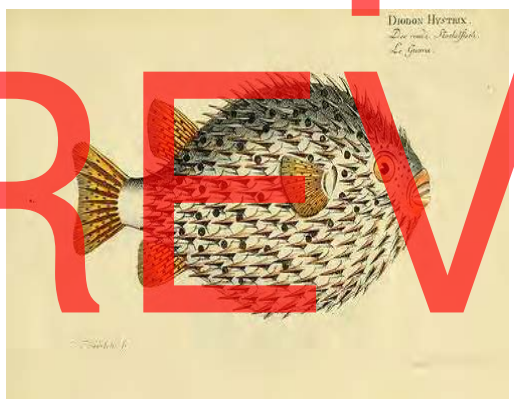
Swordfish



Sole Fish



Hammerhead shark



Puffer fish

Goldfish

ACTIVITY: Identify defining features of fish

QUESTIONS:

1. Carefully study the drawings of the fish shown previously. Although they are different shapes, sizes and colors, you should be able to identify common features to all fish. List as many of the defining features of fish as you can.

2. Some of the features that you listed might apply to other animals that are not fish. Look at your list again. Make a tick next to any of the features you listed that only apply to fish, or perhaps a combination of characteristics that only apply to fish.

When classifying fish we look closely at the material that makes up the skeleton of the fish. This leads us to divide fish into two main groups:

- **Cartilaginous fish** have skeletons made of **cartilage**.
- **Bony fish** that have skeletons made of bone.

Sharks, skates and rays are part of a group of cartilaginous fish because their skeletons are made of cartilage. These fish breathe using five to seven pairs of **gills**.

Manta ray

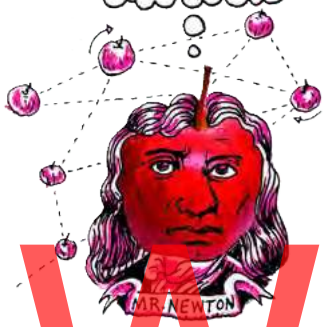
Spotted eagle ray

A whale shark surrounded by other fish

A great white shark

DID YOU KNOW?

The coelacanth was thought to be extinct for 65 million years, but was discovered in a catch of fish in 1938. Since then, more have been found along the coast of Southern Africa.



DID YOU KNOW?

A whale shark is a shark and not a whale. It is the world's largest fish and it eats only plankton.

The largest group of all vertebrates are bony fish. Bony fish have a hard, bony skeleton.

DID YOU KNOW?

The male seahorse actually becomes pregnant! The female squirts her eggs into the male's pouch and he then fertilizes them and incubates them until they are ready to hatch.

Challenge question: Is a seahorse a fish? Search books and the internet to find out and explain why we can or cannot consider it to be a fish.

A sea horse.

Amphibians

Did you know that the word amphibia comes from two Greek words, *amphi* meaning both and *bios* meaning life? So an amphibian is an animal that has 'both lives'. What does this mean?

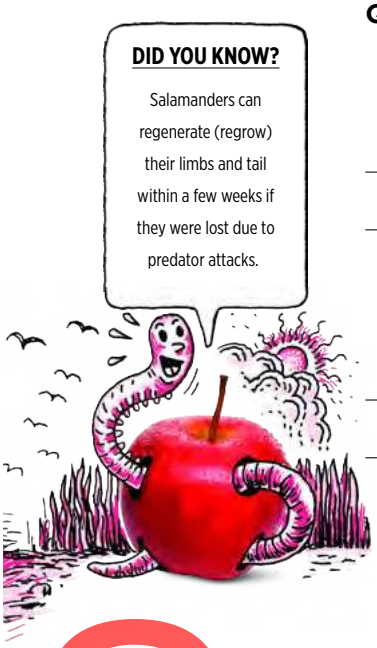
Amphibians are animals that include salamanders, newts, caecilians, frogs and toads. Let's find out what is meant by amphibians having 'both lives'.

ACTIVITY: Describing amphibians

INSTRUCTIONS:

1. Study the photos of different amphibians in the following table.
2. Answer the questions which follow.

Amphibian	Larva (young)	Adult
Frog		
Toad		
Salamander		
Newt		



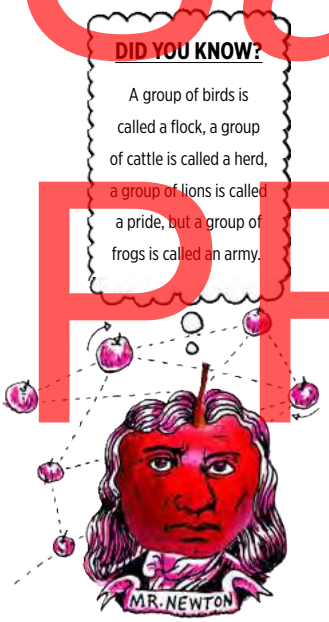
QUESTIONS:

1. What do you notice about the habitat of the young amphibians compared to the adult amphibians?

2. What do you think the larvae need to breathe underwater? What do the adult amphibians need to breathe when they are on land?

3. Can you now explain why amphibians have a name which comes from two Greek words and means 'double life' or 'both life'? Write your explanation below.

4. Amphibians are **ectothermic**. Explain how an amphibian keeps its body warm.



5. Most amphibians have a slimy, moist skin. Discuss possible reasons why they need to have this specific type of skin.

6. Look at the following image of a caecilian. There is a debate going on in a Gr. 6 class. Some learners think this animal is a worm, making it an invertebrate. Others think it is a snake, making it a vertebrate. What do you think?

A caecilian.

The caecilian is actually an amphibian! What characteristics would you test or make sure this animal displayed to explain to the Gr. 6 learners that it is not a worm. Secondly, what would you need to find out and explain to the learners to explain that it is not a reptile (a snake) but an amphibian?

7. Amphibians lay their eggs in water, like this frog. Why do you think they need to do this? Give two reasons.

A frog that has just laid its eggs

Reptiles

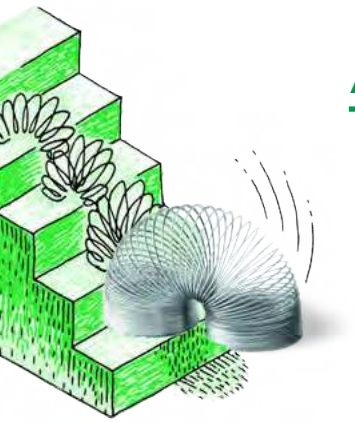
Most reptiles live on land although some, like crocodiles, terrapins and turtles, and some snakes and lizards spend large portions of their lives in water. Reptiles are ectothermic. They cannot regulate their body heat but depend on their environment for heat.

A lizard lying in the sun to warm up

Reptiles are covered in dry scales. Reptiles reproduce by laying their eggs on dry land. The eggs are covered by a leathery or hard shell.

DID YOU KNOW?

You can tell the difference between frog eggs and toad eggs because frogs lay their eggs in clumps and toads lay their eggs in strings. Have you ever seen frog or toad eggs?



ACTIVITY: Reflect on reptiles

QUESTIONS:

1. Complete these sentences.
   a) Since reptiles all have a backbone they are one of the classes of _____.

_____

   b) Reptiles are ectothermic which means that _____.

_____

_____

2. Make a biological drawing with labels and a heading of the lizard lying in the sun in the previous photo.

3. We can divide reptiles into four main groups. Each of the photos in the table below shows an example of a reptile from each of these groups. Try to identify the four groups based on the animal in the photo.

Birds

The blue crane is South Africa's national bird.

DID YOU KNOW?

Turtles are only found in the sea, terrapins are found in freshwater, and tortoises do not swim around, but walk on land.