Natural Sciences and Technology

Grade 6-A

(CAPS)

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basic education
Department: Basic Education
REPUBLIC OF SOUTH AFRICA

SIYAVULA
TECHNOLOGY-POWERED LEARNING

sasol inzalo foundation

Natural Sciences and Technology

Grade 6-A
Teacher's Guide

CAPS

Revised for 2014

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AUTHORS LIST

This book was written by Siyavula and volunteer educators, academics and students. Siyavula believes in the power of community and collaboration. By training volunteers, helping them network across the country, encouraging them to work together and using the technology available, the vision is to create and use open educational resources to transform the way we teach and learn, especially in South Africa. For more information on how to get involved in the community and volunteer, visit *www.siyavula.com*

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A special thank you goes to St John's College in Johannesburg for hosting the authoring events which led to the first version of these workbooks.

THIS IS MORE THAN JUST A WORKBOOK!

In many places you will see there are "Visit" boxes in the margins. These boxes contain links to videos online, interesting websites which pertain to the content, or else games or activities for learners to complete.

To access these websites or videos, simply type the link provided into your address bar in your internet browser. The links look like this for example, *goo.gl/vWKnF*

You can use these links in your lessons or else explain to your learners that they can watch them at home on a PC, laptop or on their mobile phones.

To download these workbooks or learn more about the project, visit the Sasol Inzalo Foundation website at *http://sasolinzalofoundation.org.za*

THE NATURAL SCIENCES AND TECHNOLOGY CURRICULUM

Science as we know it today has roots in African, Arabic, Asian, European and American cultures. It has been shaped by the search to understand the natural world through observation, testing and proving of ideas, and has evolved to become part of the cultural heritage of all nations. In all cultures and in all times people have wanted to understand how the physical world works and have needed explanations that satisfy them.

Natural Sciences and Technology complement each other

This is the first year that Natural Sciences and Technology have been combined into one subject, which is compulsory for all learners in Grades 4 to 6. Natural Sciences and Technology are also both compulsory subjects for all learners in Grades 7 to 9. These two subjects have been integrated into one subject as they complement each other.

	Natural Sciences	Technology
Goal	Pursuit of new knowledge and understanding of the world around us and of natural phenomena.	The creation of structures, systems and processes to meet peoples' needs and improving the quality of life.
Focus	Focus is on understanding the natural world.	Focus is on understanding the need for human-made objects and environments to solve problems.
Developmental methods	Discovery through carrying out investigations.	Making products through design, invention and production.
Major processes	Investigative and logical processes • planning investigations • conducting investigations and collecting data • evaluating data and communicating findings	Practical solution-orientated processes • identifying a need • planning and designing • making (constructing) • evaluating and improving products • communicating
Evaluation methods	Analysis , generalisation and creation of theories.	Analysis and application of design ideas.

ORGANISATION OF THE CURRICULUM

In this curriculum, the knowledge strands below are used as a tool for organising the content of the subject Natural Sciences and Technology.

Natural Sciences Strands	Technology Strands
Life and Living Matter and Materials Energy and Change Earth and Beyond	Structures Processing Systems and Control

Allocation of teaching time

Time for Natural Sciences and Technology has been allocated in the following way:

- 10 weeks per term, with 3.5 hours per week
- Grades 4, 5 and 6 have been designed to be completed within 38 weeks
- 7 hours have been included for assessment in terms 1, 2 & 3
- Term 4 work will cover 8 weeks plus 2 weeks for revision and examinations

Below is a summary of the time allocations per topic. The time allocations provide an indication of the weighting of each topic. However, this is a guideline and should be applied flexibly according to circumstances in the classroom and to accommodate the interests of the learners.

Life and Living and Structures

Chapter	Time Allocation
1. Photosynthesis	2.5 weeks (8.75 hours)
2. Nutrients in food	1.5 weeks (5.25 hours)
3. Nutrition	1.5 weeks (5.25 hours)
4. Food processing	2.5 weeks (8.75 hours)
5. Ecosystems and food webs	2 weeks (7 hours)

Matter and Materials and Structures

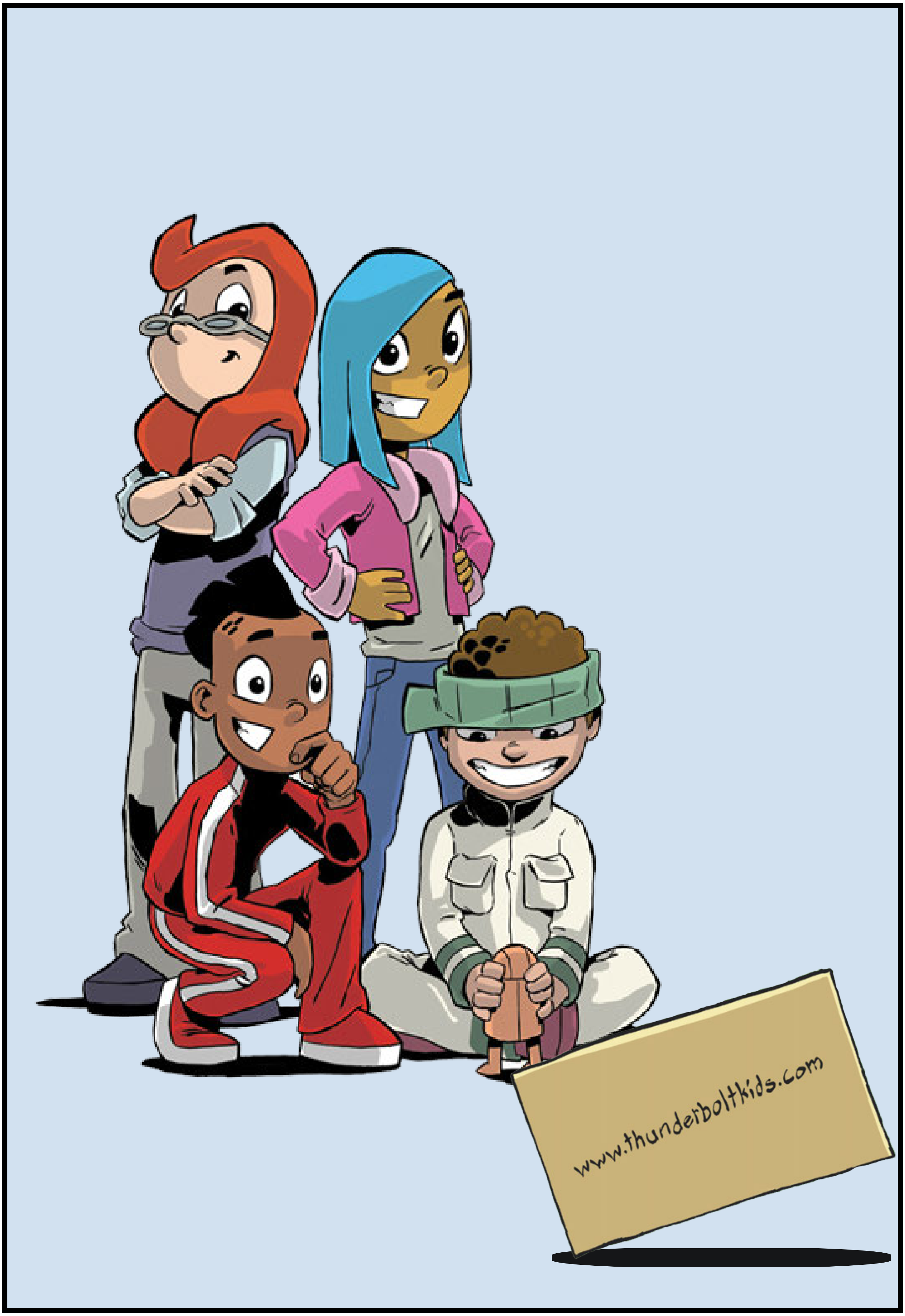
Chapter	Time Allocation
1. Solids, liquids and gases	0.5 weeks (1.75 hours)
2. Mixtures	1 week (3.5 hours)
3. Solutions as special mixtures	2.5 weeks (8.75 hours)
4. Dissolving	1 week (3.5 hours)
5. Mixtures and water resources	2.5 weeks (8.75 hours)
6. Processes to purify water	2.5 weeks (8.75 hours)

Energy and Change and Systems and Control

Chapter	Time Allocation
1. Electric circuits	2.5 weeks (8.75 hours)
2. Electrical conductors and insulators	2 weeks (7 hours)
3. Systems to solve problems	2.5 weeks (8.75 hours)
4. Mains electricity	3 weeks (10.5 hours)

Earth and Beyond and Systems and Control

Chapter	Time Allocation
1. The solar system	2.5 weeks (8.75 hours)
2. Movements of the Earth and planets	1 week (3.5 hours)
3. The movement of the Moon	1 week (3.5 hours)
4. Systems for looking into space	1 week (3.5 hours)
5. Systems to explore the Moon and Mars	2.5 weeks (8.75 hours)


www.thunderboltkids.com

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Life and Living
and Structures

1 Photosynthesis

KEY QUESTIONS

- Why can a plant make its own food but an animal cannot?
- What is needed for photosynthesis to happen?
- How do plants make food and store food?
- Why do plants need so much water?
- Can plants live in the dark?
- Why are plants mostly green?

Teachers are encouraged to make a large circle on the wall using large arrows that can be cut from blue or even black plastic bags. Then cut out white letters to say "Photosynthesis" in the centre of the circle and stick large posters on the arrows to say:

- Plants absorb carbon dioxide
- Plants release oxygen
- Animals breathe in oxygen
- Animals breathe out carbon dioxide

Perhaps cut out pictures of plants or get learners to make plants and animals in Art and stick them next to the specific labels they illustrate. Create a glossary by placing words relating to the topic around the classroom. Tell the learners that they are going to be plant investigators, and that their job is to find out what the words mean, and how they relate to plants and photosynthesis.

When introducing this topic remind them of the work on interdependence they covered in Gr. 5. Discuss how animals and plants are interdependent upon each other - plants produce food and oxygen for animals, while animals - when they die - decay, replacing nutrients in the soil for plants, and releasing carbon into the air to continue the carbon cycle.

1.1 Plants and food

Green plants are just like factories! They make food for themselves and every animal on earth using sunlight energy, water and the gas carbon dioxide. They also recycle the air and make oxygen for us to breathe.

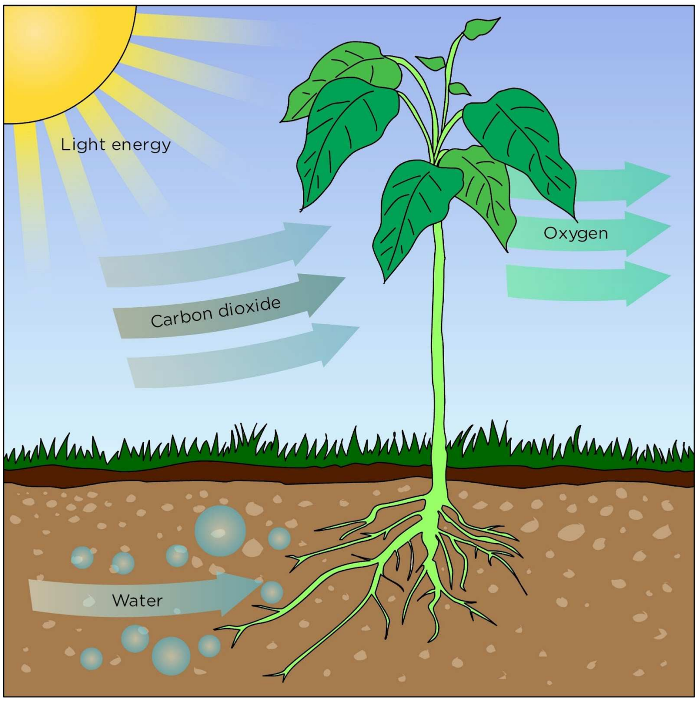
Scientists have found out exactly how plants are able to do all all these things. Let's take a closer look at how scientists did this and see how plants make food for themselves and us.

QUESTIONS

1. What happens in a factory? Why do you think we can say plants are like factories?
   A factory is a place where goods or products are made/assembled/manufactured and then delivered to other places to be used. Plants are therefore like factories as they use raw products to make new products (food).
2. Why can we say that plants make food for themselves and every animal on earth?
   Plants make food for themselves and plants are the beginning of the food chain, therefore all other animals, whether herbivores which eat plants directly, or carnivores which eat the herbivores, depend on plants for food.

The process of photosynthesis

Photosynthesis is the process that plants use to change the energy from sunlight into energy for food. Plants change light energy from the sun into food energy. Photosynthesis happens in all green parts of a plant. Leaves are usually the greenest parts. So plants do this mostly in their leaves.



Do you remember learning about photosynthesis in Gr. 5? Plants need certain things to photosynthesise.

- oxygen
- glucose
- molecule
- conditions
- anchorage
- microbes
- fertile

There are some important requirements for photosynthesis to happen:

DID YOU KNOW?

Scientists have a term for substances like chlorophyll that have a colour. They call them pigments. There are other pigments in plants. Can you think of their colours? There are pigments in your body too! Where do you find them? What do they do?

1. Chlorophyll: Chlorophyll is a green substance that plants use to capture light energy from the sun. Chlorophyll is very important. Without chlorophyll plants cannot use the sunlight energy to make food. Also, oxygen levels in the air will go down. If that happens plants and animals will suffocate.

As a fun activity, take learners outside to see if there are other colours found in leaves, and not just the green pigment chlorophyll. Although green chlorophyll is predominant, there are also yellow, orange and purple pigments found in leaves, especially in autumn when the leaves change colour. In the body, the pigment melanin, is the main determinant of skin colour and it is also found in hair and the iris in the eye.

2. Sunlight: Sunlight has energy. Plants use this energy to make sugars from water and carbon dioxide.

DID YOU KNOW?

The word **photosynthesis** is actually has two parts: **photo**= light and **synthesis** = to make or put together. So it means to use light to make something (in this case, food).

3. Water: The roots of a plant absorb water and nutrients from the soil. Water is a solvent in all living things. Dissolved substances are moved around the body to where they are needed. Just like you, plants have veins for this movement. They move minerals from the roots upwards. They move sugars from the leaves downwards. Photosynthesis can only happen in a water solution. Water is also important because it provides support to the plant to keep it upright. Like you, plants have skeletons. But unlike you many plants have water skeletons!

In the second term in Matter and Materials, learners will do more on mixtures, solutions and dissolving, and this will therefore make sense. Refer back to this section when you are doing solutions and discussing water as a solvent.

4. Carbon dioxide: The plant absorbs or takes in carbon dioxide from the air through little holes. These holes are found all over the plant, mostly under the leaves.

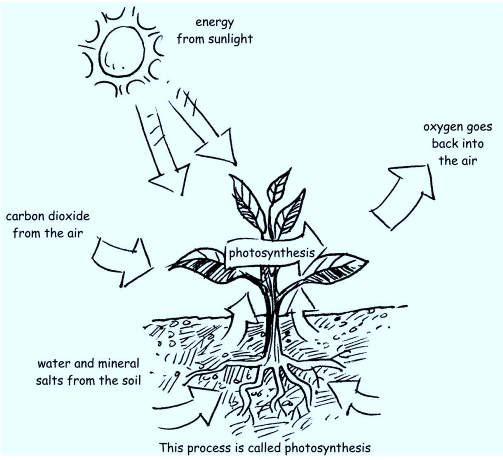
5. Soil: The soil provides mineral nutrients and water for the plant that are necessary during photosynthesis. Soil also provides anchorage to the plant, otherwise the plant cannot stand up straight.

A really good website on photosynthesis [1]

How does photosynthesis occur?

Plants use chlorophyll, sunlight, water and carbon dioxide to make food. Here is a simple illustration to show how this process occurs:

- Chlorophyll captures the sunlight energy.
- This energy splits the water into hydrogen and oxygen.
- The oxygen is released into the air.
- The hydrogen is used with the carbon dioxide to make glucose (sugars).
- The sugars are moved from the leaves to other parts of the plants where they are stored.
- The water in the plant veins carries the sugars. When the sugars reach the storage parts they are changed into starch.
- Plants can store the starch in these places:
  - leaves (cabbage, spinach, lettuce)
  - fruit (apples, banana, peaches)
  - stem (sugar cane)
  - seeds (wheat or mealies)
  - flowers (nasturtiums, broccoli and cauliflower)
  - roots (carrots or beetroot)



A diagram illustrating the process of photosynthesis

Starch is insoluble in water which is why plants store starch and not glucose, which is soluble in water. Refer back to this section when doing soluble and insoluble substances in the second term.

VISIT

Photosynthesis video
goo.gl/oFp5v

DID YOU KNOW?

These holes also allow other gasses and water to enter or leave the plant. They do the same job as your mouth and nose when you breath! The same job as the pores in your skin when you sweat!

VISIT

A game on growing plants [2]

ACTIVITY: Dramatise the process of photosynthesis

Prepare beforehand by collecting the different materials needed. The characters need different colours to identify themselves as what they are, possibly some t-shirts that they can pull over their clothes, or else a scarf or ribbon or coloured piece of paper to pin onto their front. You will also need tin foil, glitter and string for the roots. For the animals, you can make masks out of paper plates with the eyes cut out, and tied around the head with a piece of string. Learners can draw animal faces on the front.

INSTRUCTIONS:

1. Your teacher will explain to you how to act out the process of photosynthesis.
2. Characters needed for this dramatisation:

- **Narrator** to describe the process. This can be a teacher or a learner. It might be a good idea to make short notes from the information above to remember in what order everything is happening.
- **Sun** - this learner can dress in yellow and perhaps get some old tin foil or shiny paper to decorate their head or body to show the light and heat energy that the sun produces.
- **Plants** - a few learners can dress in green and perhaps tie a few strings to their feet to represent roots. They need to hold some rice or shiny glitter in their hands or their pockets to show that the water evaporates after photosynthesis.
- **Rain / water** - a few learners can dress in blue and perhaps have some rice, shiny glitter, small pieces of tin foil or something similar to represent the rain falling.
- **Carbon dioxide** - attach signs to the learner's chests that say 'Carbon dioxide' and dress in purple.
- **Oxygen** - attach signs to the learner's chests that say ' Oxygen' and dress in orange.
- **Glucose energy** as fruit and vegetables - dress up or make posters from scrap cardboard to show large carrots, apples, potatoes, or something similar.
- Some learners need to be **animals** who breathe out carbon dioxide and eat the plants. You can make masks out of paper plates with eyes cut out.

The dramatisation: When the dramatisation starts, the glucose and oxygen actors sit quietly in small groups around the plants with their heads down, not looking at the audience.

The narrator introduces the play and explains the different processes as these occur.

The sun shines in the centre of the stage and can turn and/or raise their arms to show the sunlight radiating from it.

The plants stand away from the sun and the rainwater actors can 'water' them by gently throwing the rice or similar little objects over their heads. Then sit down around the plants.

The carbon dioxide actors run from the animals and circle the plants, and then sit down around the plants.

Now the oxygen and glucose actors rise and run around the plants, and then run to the animals to show they are receiving oxygen and food.

You might want to repeat this a few times to show that this cycle continues.

QUESTIONS:

1. Why do plants die when there is a drought?
   There are many processes which shut down without water, photosynthesis being one of them. Plants cannot photosynthesise sunlight without water. If they cannot photosynthesise they cannot create glucose to support life processes within the plant. If the plant cannot support its own life processes it dies. The plant also loses its support from the water in the veins acting as a 'skeleton'.
2. Design a poster for your Gr. 4 friends to explain the process of photosynthesis to them. You can use sentences and short paragraphs but make sure you use many illustrations.

Soil was looked at in Gr. 5 Earth and Beyond, especially the particles of soil and which types of soil plants grow best in. However, it would be useful to also emphasise soil in this section and have a discussion on what makes up soil, namely organic and inorganic material, water, air, rocks and sand. Where possible, bring examples of different soil types to class (such as loam soil, clay, beach sand) and get the learners to touch and feel the soil and explore what makes up soil.

1.2 Food from photosynthesis

Photosynthesis is the process inside plants that changes the energy from the sun's light into a form of energy that animals can eat and use to carry out their life processes.

New Words

- iodine
- solution
- indicator
- starch
- test

Plants changes the glucose into starch, for example mealies (mealies and maize flour), rice (rice flour and rice) and wheat (flour).

Plants then store this food in different parts of the plant that an animal will eat. They can store it in their leaves, stems or roots, flowers, fruits or seeds.

QUESTIONS

Look at the images below of different plant products. For each image, identify which part of that plant we eat (for example: When we eat an apple, are we eating the leaf, the stem, the root, the fruit or the seed of the plant?) Use the space below to draw a table for your answers.

Plant	Part that we eat
cabbage	flower
tomatoes	fruit
potatoes	root
broccoli	flower
celery	stem
carrots	root
sunflower seeds	seed
lettuce	leaf
sugar cane	stem
hazelnuts	seed
mealies	seed
bananas	fruit

Cabbage [3]

Tomatoes

Potatoes

Broccoli [4]

Celery

Carrots

Sunflower seeds

Lettuce

Sugar cane

Hazelnuts

Mealies

Bananas

We know that plants make glucose (a sugar) but they store starch. Let's now find out what the difference is.

ACTIVITY: Difference between a starch and a sugar

Prepare beforehand: Prepare at least 10 different plant products in advance of this lesson and mark each item from 1 - 10. Cut up fruit/potato/sweets into bite-sized cubes. Place flour/cooked rice/etc. into bowls. Use teaspoons to taste the flour/cooked rice/etc.

IMPORTANT: Before doing this activity find out if any of the learners have any allergies to these foods and if learners with diabetes are allowed to eat/taste the fruit/sweets.

MATERIALS:

- mealie flour
- flour
- cooked rice, potato, bread
- glucose sweets
- sugar
- sugar cane, if possible
- fresh fruit
- blindfold
- clipboard

INSTRUCTIONS:

1. Work in pairs.
2. One partner must be blindfolded.
3. On a piece of paper list the numbers 1 - 10.
4. The other partner must let the blindfolded partner taste each of the foods marked 1 - 10. If it is a flour, use a teaspoon to spoon the flour into your partner's mouth. If it is a kernel like a rice or mealie kernel, or a cube of fruit, put it in the palm of their hand and let them eat it themselves.
5. After each taste your blindfolded partner must guess if it is a sugar or a starch based on the taste.
6. Record your partners answers on the piece of paper containing the numbers 1 - 10.
7. Swap with your partner and repeat the test.

While learners are swapping with their blindfolded partners, rearrange the foods with the numbers to ensure fairness. The aim of the test is not to establish the exact name of the fruits and foods but to establish that taste is not a suitable method to test for sugar or starch. Generally sugars are sweet and starches are not, but not always.

QUESTIONS:

1. Was it easy to distinguish between the sugar and the starch each time? Which foods did you find difficult to classify?
2. What can you say about the difference between a starch and a sugar based on taste?
   Sugars are sweet, starches are not.

Using TASTE to check if a food is a sugar or a starch is not very reliable.

There is a special test that scientists use to see if a food product is a starch or not. It is called the **iodine starch test**.

Iodine solution is a special solution that is normally a **brown liquid**.

Iodine is what we call an **indicator**.

When iodine solution is dropped on starch, the iodine and starch combine and produce a blue colour. We use this to test whether there is starch in a food product.

Let's see how this works!

ACTIVITY: The iodine starch test

Note: There will be NO tasting in this activity.

MATERIALS:

- iodine
- the same foods used in the taste test (they should be marked 1 - 10)
- include some other foods such as cheese and a boiled egg

INSTRUCTIONS:

1. Write the food or plant product that you chose in the first column below.

2. You are going to test whether this food product is a starch or not. When the iodine solution turns blue-black you will know it is a starch.

Explanation for starch turning blue-black when iodine is placed on it: Starch is composed of polymers of glucose. Long linear chains are amylose. Amylose coils into a structure resembling a tube with a hollow core. Certain molecules, including iodine, can lodge inside the core. The complex of iodine stuck inside the amylose coil produces a characteristic blue-black colour. The starch itself is not altered. **NB:** This explanation is not necessary for learners, but do say that the iodine reacts with the starch to form a blue-black colour.

3. Use a dropper and drop iodine solution onto each food group.

4. Put a tick next to the food product that turns blue-black - this is a starch. Put a cross next to the food product that stays brown - this is not a starch.

	Name of Food Product	**Starch or not?**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

QUESTIONS:

1. Which test do you think is more accurate to test for starch - the taste test or the iodine starch test?
2. Did the animal products, such as cheese and boiled egg, contain starch? Why do you think so?
   Animals do not produce or store starch. Starch is only stored in plant products.

Animals do store carbohydrates, but not in the form of starch. Only plants produce and store starch. Animals store glucose in the form of glycogen.

1.3 Plants and air

New Words

- cell
- waste product
- cycle

All animals and plants need oxygen to live and carry out their life processes.

Animals breathe in oxygen and breathe out carbon dioxide, all through the day and the night. Oxygen is used to release energy from food inside the body, which is used for the life processes.

QUESTIONS

1. Do you remember what the seven life processes of living things are? Write them down below.
   Movement, reproducing, sensing, feeding, excreting, breathing, growing.

Just like animals, plants also use oxygen throughout the day and the night. Oxygen is necessary for plant growth and the development of new plants, seeds, leaves and shoots for example. Plants, therefore, also produce carbon dioxide as a 'waste product' once the oxygen has been used.

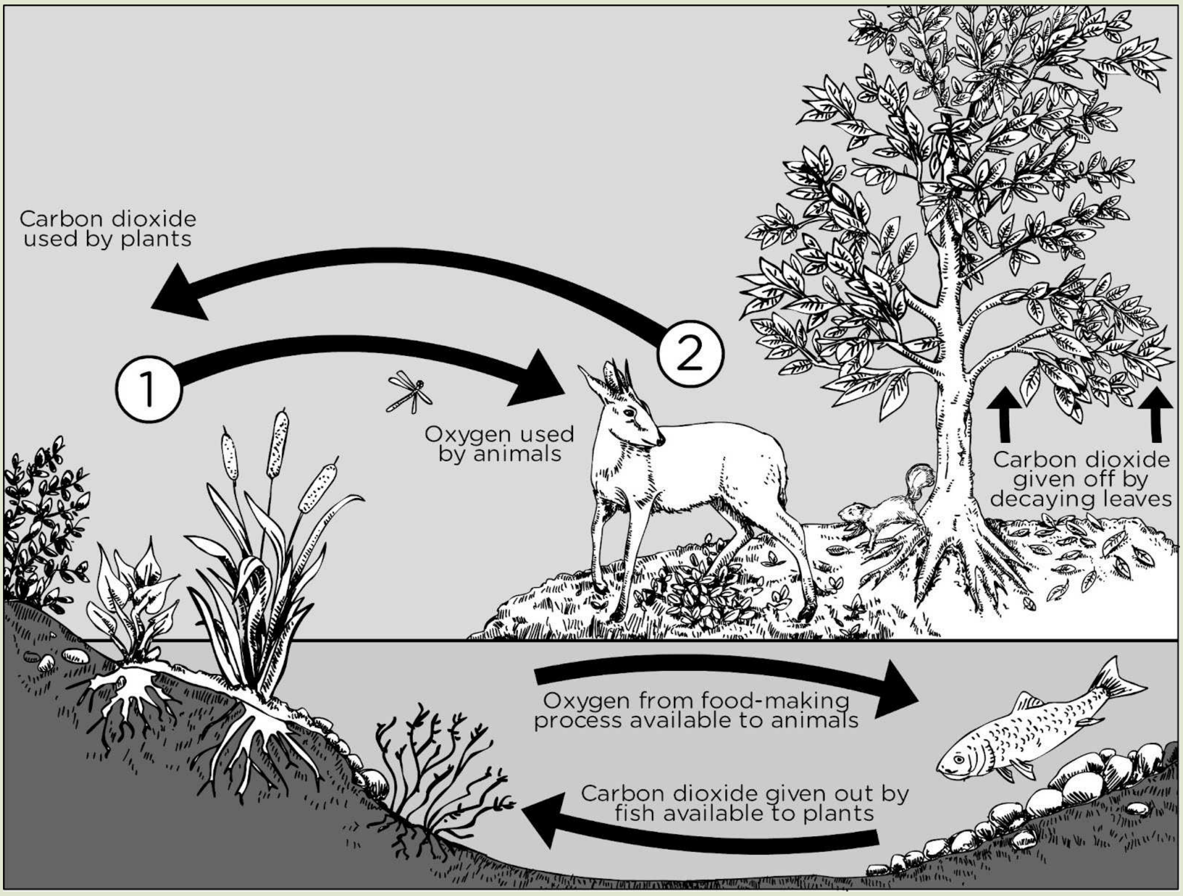
Plants do not photosynthesise through the night because there is no sunlight energy available to do that. This means that plants only need carbon dioxide during the day, for photosynthesis.

This cycle of using and producing both oxygen and carbon dioxide is very important to life on Earth.

ACTIVITY: The oxygen and carbon dioxide cycle

INSTRUCTIONS:

1. Carefully study the following illustration.
2. Answer the questions that follow.



The oxygen and carbon cycle

QUESTIONS:

1. Make a list of living organisms that produce both oxygen and carbon dioxide in this picture.
   Tree, reeds, water plants, and shrubs on the bank

2. Identify three living organisms that cannot produce oxygen in this picture.
   Fish, duiker (buck), squirrel, dragonfly
3. Predict what you think would happen if all the animals were removed from this habitat.
   Probably not much would change as the leaves that decay would still give off carbon dioxide for the plants to use, as well as the carbon dioxide that the plants produce themselves.
4. What two life processes are involved in the carbon dioxide/oxygen cycle?
   breathing in oxygen and giving off carbon dioxide
5. Complete this cycle by filling in the missing information for the two arrows on the left hand side of the illustration. Supply the labels for arrows 1 and 2.
   - *Arrow 1: Plants produce oxygen*
   - *Arrow 2: Animals breathe out carbon dioxide*
6. Explain why animals would not survive if all the plants on earth were to suddenly die.
   - *Animals need oxygen for their cells to work and to carry out life processes.*
   - *If animals do not have oxygen they cannot carry out the life processes and will die.*
   - *Plants also produce food from the sun that animals need to eat for energy to carry out the life processes.*
7. Why do we say the oxygen and carbon dioxide are in a cycle?

   For life on Earth to continue, there needs to be an unlimited supply of carbon dioxide and oxygen. It is in a cycle to ensure that similar amounts of both are produced.

KEY CONCEPTS

- Plants produce their own food (glucose) by a process called photosynthesis.
- Photosynthesis takes place mainly in the leaves.
- During photosynthesis the plant uses chlorophyll, sunlight energy, carbon dioxide (from the atmosphere) and water to make glucose.
- Plants change some of the glucose (sugar) into starch which they store in their leaves, stems and roots, flowers, fruits and seeds.
- Animals take in oxygen from the air and produce carbon dioxide when they breathe.
- Plants recycle carbon dioxide and make oxygen during the process of photosynthesis.

REVISION:

1. List the four things that are vitally important for plants and photosynthesis.
   Sunlight energy, water, carbon dioxide, chlorophyll
2. Choose words from the word box to complete the following sentences. Write the sentences out in full.

Word box:
• organic and inorganic material • photosynthesis • water • air • roots • sand and rocks

   a) The process when the green parts of plants make food is named __________.
   a) Water and minerals are absorbed by the __________ of plants.
   a) Soil is made up of __________, __________, __________, __________.

   a) The process when the green parts of plants make food is named photosynthesis.
   b) Water and minerals are absorbed by the roots of plants.
   c) Soil is made up of organic and inorganic material, water, air,sand and rocks.
3. The seedlings that were planted in the newspaper cuttings or cotton wool did not grow very well at all, even though they had sunlight and water. What could they not get from the newspaper or cotton wool that plants normally get from soil?

   Nutrients and minerals
4. Where does photosynthesis usually take place? Explain your answer.
   Photosynthesis usually takes place in the leaves. The leaves are green as they contain chlorophyll. Leaves also face the sunlight and are exposed to the most sun to drive the process of photosynthesis.
5. Do you think photosynthesis takes place at night? Explain your answer.
   No, it will not take place. At night there is no sunlight energy

to drive the process of photosynthesis.

6. What is the name given to the sugar that plants produce during photosynthesis?
   Glucose
7. What do plants store glucose as? List some places where it is stored.
   Starch. Stored in leaves, stems, roots, flowers, seeds, fruits.

KEY QUESTIONS

- Why do I have to eat so many different things - why can't I just eat what I like?
- I have heard that people say: 'You are what you eat...' - what does that mean?
- What is so bad about sugary sweets - why shouldn't I eat lots of them?
- What is the difference between a fat and an oil?

2.1 Food groups

Learners must collect the wrappers and packaging material of the food they eat for the activity that follows. Advise them to wash all tins or plastic that still contains food particles to avoid nasty odours and insect infestations in your class!

All living plants and animals need to feed or eat to give them energy to carry out the life processes. Plants make their own food from sunlight, water and carbon dioxide through the process of photosynthesis. Animals cannot make their own food and need to eat plants or other animals to get energy. People also have to eat plant or animal products to get energy to grow and develop.

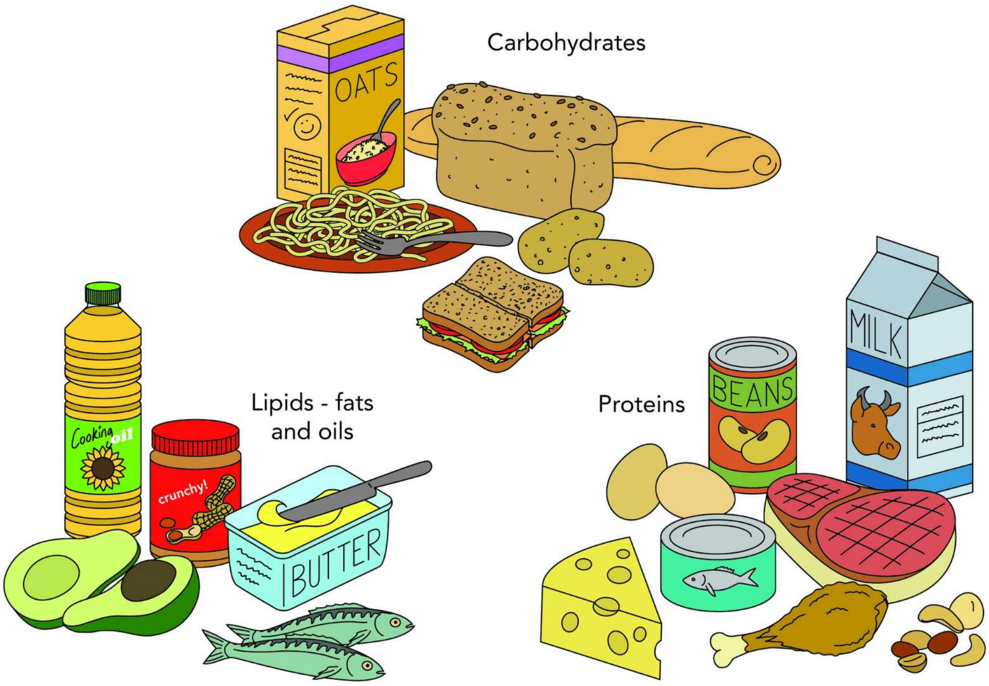
New Words

- classification
- carbohydrates
- proteins
- vitamins
- nutrition
- pyramid
- immune system
- insulate

Classification of food groups

The food we eat can be grouped or classified into different types or groups. We call these *food groups*. There are a four main food groups and each food group does a different job in the body:

- carbohydrates
- proteins
- fats and oils
- vitamins and minerals



Examples of the foods in the food groups; carbohydrates, proteins and fats and oils.

We classify food according to these food groups, although most foods contain a mixture of more than one nutrient group.

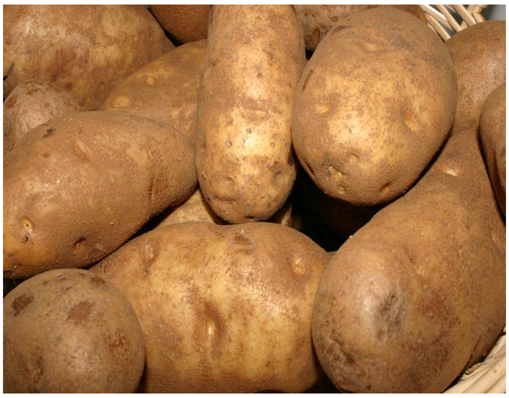
Let's look at each food group separately and see why each one is important:

1. **Carbohydrates:**
   - They are the most important source of energy for the body.
   - They store energy for the body.
   - Carbohydrates are an important part of the body structure.
   - Foods that contain carbohydrates are: pasta, samp, potatoes, cereal, mealie meal, porridge and bread.

Bread

Rice

Pasta



Potatoes

2. **Proteins:**

- Proteins are the building blocks for our body - they build the body's muscles.
- They also help to repair hurt or broken tissue.
- Proteins can be used as reserve energy if there is a shortage of carbohydrates.
- Some foods that contain proteins are: meat, fish, chicken, eggs, beans, milk and cheese.
- Protein is also found in many plant products: chickpeas, beans, lentils, nuts and soya.

Meat

Lentils

Almond nuts

Cheese

3. **Lipids - fats and oils:**

   - Fat is stored around organs like the kidneys to protect them from injury.
   - Fat is also stored under the skin to insulate us (keep us warm).
   - Fat can be used as reserve energy if there is a shortage of carbohydrates.
   - Foods that contain fats include: butter, margarine, sardines, cooking oils, nuts, peanut butter and avocado pears.

Mixed nuts

Cooking oil

Peanut butter

Margarine

4. **Vitamins and minerals:**
   - Vitamins and minerals are essential to the human body and yet we produce very few of them ourselves.
   - Many important minerals are contained in the food we eat. Two of the most important are:
     - **Sodium** that helps to keep the correct balance of water in the body and is found in most food.
     - **Calcium** that is important for strengthening of bones and teeth. Calcium can be found in fish, green vegetables, milk and cheese.
   - Most vitamins are manufactured by plants, so we get vitamins from the food we eat or from vitamin supplements.
   - There are specific foods that contain specific vitamins. The table below shows some important vitamins, their natural sources and/or the food that contains them and some of their functions in the human body.

Name of vitamin	Sources	Function
Vitamin A	Egg yolk, liver, deep-yellow and deep-green fruits and vegetables, fish liver oils	Enables the eye to produce a pigment that helps us to see in dim light.
Vitamin B	Brown rice, whole-wheat bread	There are several types of vitamin B and they have many functions, e.g. they are important in the chemical reactions of breathing.
Vitamin C	Citrus fruit, strawberries, tomatoes, peppers	Strengthens the body's immune system by increasing its ability to fight infections.
Vitamin D	Egg yolk, fish liver oils, can be made in the skin when the ultra-violet rays from the sun convert cholesterol in the skin to vitamin D	Helps the absorption of calcium and phosphate. These nutrients are used for the making of strong bones and teeth.

Milk is a source of calcium.

Fruit and vegetables are sources of vitamins.

VISIT

A simulation about eating and exercise
goo.gl/7APcr

ACTIVITY: Classifying food into the different food groups

MATERIALS:

- Collect wrappers and packaging material, like boxes and tins, of the foods you eat and bring these to school.

INSTRUCTIONS:

1. Work in groups of 2 or 3.
2. Choose the 3 foods that you think are the most healthy to eat from the different wrappers and boxes that you have in your group. Write a reason next to each of these 3 choices why you think they are really healthy.
3. Locate the LIST OF INGREDIENTS on each food container. You should have at least 10 different containers. (If you have too few, swap with another group when they are finished with theirs.)
4. Sort the different foods into the major food groups.
5. Record your work in the table below.

Carbohydrates	Proteins	Lipids	Vitamins and Minerals

Very often food manufacturers add different preservatives, flavourings and colourings, as well as salt and sugar, to make the food look or taste more attractive to their customers. These are called **additives**.

6. Read the ingredients on your 10 packaging labels again.
7. In the first column, write the name of your product.
8. Tick (✓) under each column if your product has any of these items added to it.
9. The first one is done as an example.

	Food	**Additives**		
		Salt	Sugar	Others
EXAMPLE	Bread	✓	✓	✓
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

10. Make a list of the main flavourings that were used in your products.
11. What preservatives are used most often by the food manufacturers?
12. Look at the 3 foods you said were the most healthy at the beginning of this activity and why you said they were healthy options.
    a) Read their packaging details - which additives do they contain?
    b) Do you think these additives make these products healthier or less healthy to eat?
    c) After reading the labels do you still think these are the 3 most healthy foods? Explain your answer.

d) Compare the other labels and decide if there are perhaps other healthier foods on your list.

After doing this activity, did you notice a difference between foods which are naturally occurring (such as meat and vegetables) and foods which have been processed?

The natural foods contained a mixture of more than one nutrient group. For example, nuts are a source of protein and fat. Milk is a source of calcium and protein. Vegetables contain many nutrient groups.

The foods which have been processed, or manufactured, often contained additives, such as salt, sugar, preservatives and flavourings.

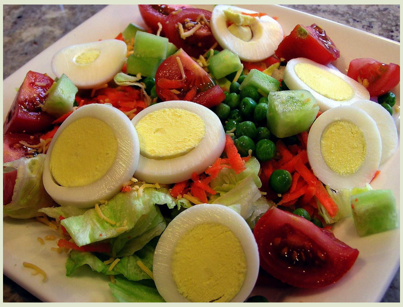
SUGGESTED PROJECT - If required, teachers can use this opportunity for a small research project on additives and the pros and cons of eating foods with additives.

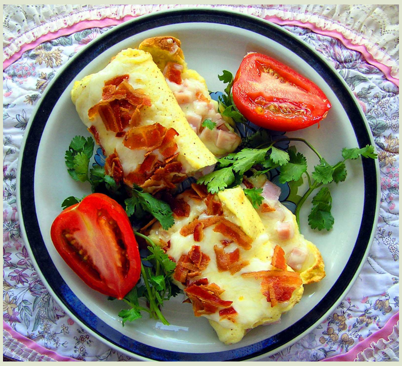
Let's have a look at some different meals to see if we have all the food groups.

ACTIVITY: Sorting foods in a meal into the food groups

INSTRUCTIONS:

1. Below are pictures of five different meals.
2. Study each meal and classify each food on the plate into one of the food groups (protein, carbohydrates, fats and oils, vitamins and minerals).
3. Remember, some foods may contain more than one food group.
4. In the table, write out each food in the meal, and next to it, write the food group it belongs to.

Meal	Food groups
	
	
	

QUESTION:

1. Which meal do you think is the healthiest? Explain your answer.

KEY CONCEPTS

- Food groups:
  - foods for energy - **carbohydrates**
  - foods for growth and repair - **proteins**
  - foods for storing energy (in the form of body fats) and providing insulation and protection for nerves and organs - **fats and oils**
  - foods for maintaining a healthy body and immune system - **vitamins and minerals**
- Most natural foods contain a mixture of more than one foor group.
- Most processed (manufactured) foods have added salt, sugar, preservatives, flavourings and colourings.

REVISION:

1. Write the sentence out in full below and fill in the missing words.
   Foods are classified into the following food types, ***carbohydrates***, __________, ***proteins*** and __________.
2. Name 3 reasons why lipids are important in our diet.
   Fat is stored around organs for protection. Fat is stored under the skin to insulate us. Fat can be used as reserve energy if there is a shortage of carbohydrates.
3. List 3 sources of proteins.
   Meat, fish, chicken, eggs, beans, milk, cheese (accept any 3 sources of protein).
4. Why is it necessary to supplement our diets with vitamins?
   Allow learners to give their own reasons.
5. Complete the table below which shows some important vitamins, their natural sources and functions.

Name of vitamin	Sources	Function
Vitamin A		Enables the eye to produce a pigment that helps us to see in dim light
	Brown Rice, whole-wheat bread	There are several types of this vitamin and they have many functions in the chemical reactions of cellular respiration
Vitamin C		Strengthens the body's immune system by increasing its ability to fight infections
Vitamin D	Egg yolks, fish liver oils, can be made in the skin when the ultra-violet rays from the sun convert cholesterol in the skin to vitamin D	

Name of vitamin	Sources	Function
Vitamin A	*Egg yolk, liver, deep-yellow and deep-green fruits and vegetables, fish liver oils*	*Enables the eye to produce a pigment that helps us to see in dim light*
Vitamin B	*Brown Rice, whole-wheat bread*	*There are several types of this vitamin and they have many functions in the chemical reactions of cellular respiration*
Vitamin C	*Citrus fruit, strawberries, tomatoes, peppers*	*Strengthens the body's immune system by increasing its ability to fight infections*
Vitamin D	*Egg yolks, fish liver oils, can be made in the skin when the ultra-violet rays from the sun convert cholesterol in the skin to vitamin D*	*Used for the making of strong bones and teeth*

6. What are some of the additives that processed foods contain?

   Salt, sugar, preservatives, flavourings, colourings
7. A vegetarian is someone who does not eat meat. What other foods, besides meat, should they be eating and why?
   A vegetarian might not get enough protein. They should eat other sources of proteins such as eggs, beans, cheese and other dairy products and nuts.

KEY QUESTIONS

- I love eating fast foods but why does my mom say it is not good for me?
- Why must I eat my vegetables if I just want to eat protein, bread and pasta?
- Can I get sick if I do not eat the right foods or not enough of a certain type of food?

3.1 A balanced diet

Now we know that there are different foods that are classified into the four food groups. The next step is to see what amounts of each food group we need to eat regularly to stay healthy. This is called a balanced diet. What is a diet?

New Words

- diet
- balanced

QUESTIONS

Discuss the word **'diet'** with your class and come up with a definition for this word. Write it below.

For nutritional scientists (people who study the effects of diet on health and well-being), the word **'diet'** means the sort of food that people regularly eat. When we say we eat a healthy balanced diet we mean that we eat food that contains adequate or the right amounts of all the nutrients our body needs to function.

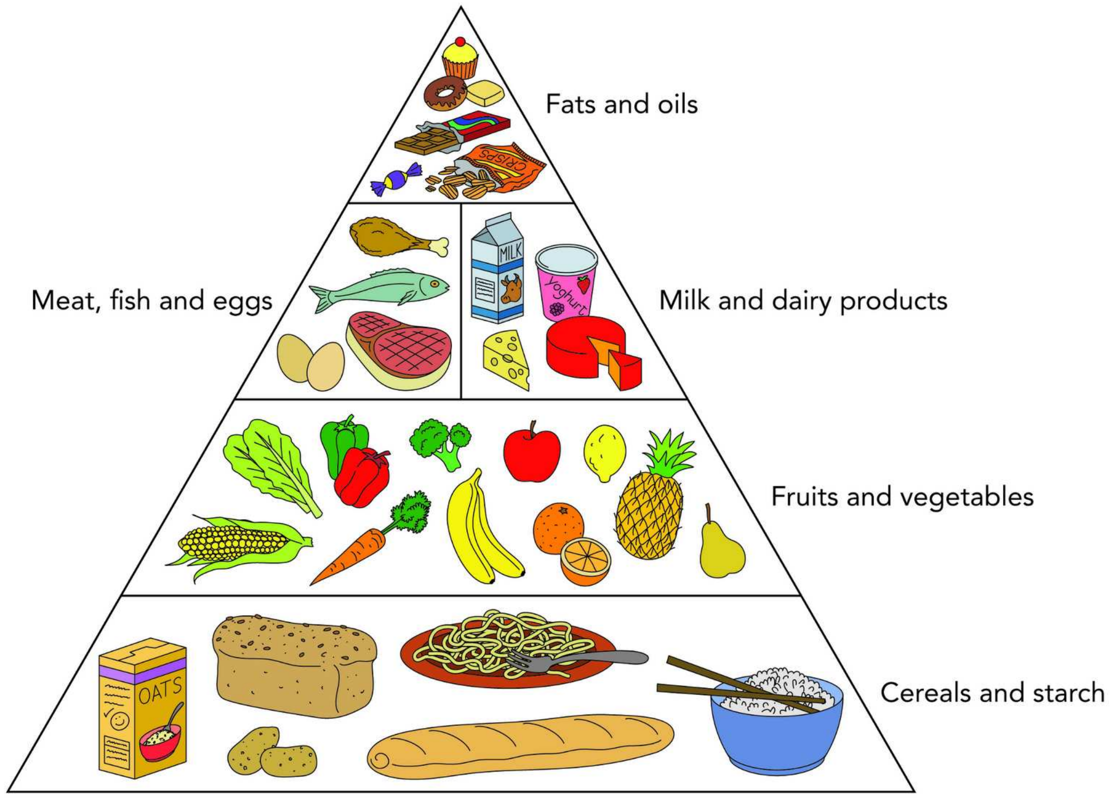
Food pyramids

A food pyramid provides a guide to a healthy balanced diet. It shows how to classify food types into different levels. A balanced healthy diet will include servings from each level of the food pyramid and will show the correct quantities you need to eat:

- You need to eat a little of the food at the top (oils, sweets,

etc.)
- The food in the middle of the pyramid, fruit and vegetables, must also be eaten in fair amounts.
- You should eat less meat, chicken, fish and other proteins than vegetables and fruit.
- You need to eat more of the food at the bottom of the pyramid (breads, pastas, rices, etc.).

Here is an example of a food pyramid:



A food pyramid

Some people eat a very unhealthy diet and turn the food pyramid upside down! They eat far more sweets, cakes, fatty rich food and far less vegetables and starches!

ACTIVITY: Evaluating a diet to see if it contains all the food groups.

MATERIALS:

- a record of the weekly diet of Farrah's brother, Rajesh

INSTRUCTIONS:

1. Carefully study Rajesh's weekly diet.
2. Answer the questions that follow.

	Breakfast	**Lunch**	**Supper**
Monday	toast with peanut butter, coffee with milk and 3 teaspoons of sugar	two-minute noodles, cream soda, jelly (while watching TV)	spaghetti bolognese (with chopped carrots in the mince) with cheese sprinkled on top, fruit juice, tea with milk and 2 teaspoons of sugar
Tuesday	toast with peanut butter, coffee with milk and 3 teaspoons of sugar	two-minute noodles, Coke, toast with peanut butter, popcorn (while watching TV)	Mom and Dad worked late - scrambled egg on toast with baked beans; coffee with milk and 3 teaspoons of sugar

Wednesday	late for school - didn't eat.	2 eggs and toast with cheese, tea with milk and 3 sugars, more toast with jam and peanut butter later (while watching TV)	Hawaiian pizza, coke, cream soda, chocolate milkshake
Thursday	toast with peanut butter, coffee with milk and 3 teaspoons of sugars	indoor hockey practice after school - pie from tuckshop and Coke, chocolate and packet of hot chips	roast chicken, butternut, baked potatoes, salad, fruit juice, coffee with milk and 1 teaspoon of sugar
Friday	toast with butter (peanut butter is finished), coffee with milk and 3 teaspoons of sugar	band practice after school - pie and coke from tuckshop, sweets	takeaway chicken in a bucket, hot chips, Coke, tea with milk and 3 teaspoons of sugar, popcorn

QUESTIONS:

1. Reading only this table showing Rajesh's weekly diet, do you think he has a balanced diet? Why do you think so?
   Assess the learner's capability to make conclusions from the data presented. Rajesh does not have a balanced diet for a few reasons. He consumes a lot of sugar, oil and fat in the sweets, Coke, takeaways and sugar in his drinks. He also has a lot of starch, but not much fresh fruit and vegetables.
2. Now let's use our knowledge of a food pyramid to see how healthy Rajesh's diet for the week was. Use the tallying method to keep score of everything he ate: to tally up results you make one line down for every item you count and when you get to the fifth item you draw a diagonal line through the other four. That makes it easy to count in fives and count the few left over at the end.

Total Fats and Oils	Total Proteins	Total Vitamins and Minerals	Total Carbohydrates

3. List the times and days when Rajesh ate fruit or vegetables.
   On Monday, Rajesh had carrots in the spaghetti bolognaise and on Thursday he had salad and butternut with his meal.
4. What important food group is Rajesh missing from his diet if he does not eat enough fruit and vegetables?
   He will not be getting enough vitamins and minerals.
5. Can you predict what will happen if Rajesh continues with this diet?
   If he is not already very overweight he soon will be overweight and may develop problems that accompany this - diabetes, bad skin, aching joints, greater risk of heart disease etc.
6. Now that you have tallied up the different food groups that Rajesh ate in a week, do you think he ate a balanced diet? Why do you say so?
   Rajesh's diet was not balanced because Rajesh did not eat the correct quantities of food from the different food groups and therefore I don't think their diet is very balanced.
7. Do you think Rajesh is a very active person? Why do you say so?
   He lies in front of the TV most afternoons, and his only extramural activity is band practice, which is not very energetic. Indoor hockey once a week is probably not enough exercise.
8. Takeaways are known for being fatty and oily because restaurants often prepare the food in deep oil. Rajesh and Farrah's family ate takeaways twice in the week and the mom cooked twice. Compare the cooked meals with the takeaways specifically focusing on the amount of oil used to prepare the meals.
   The bolognese and the roast chicken were probably prepared at home and the pizza and 'bucket' chicken were probably

takeaways. The roast chicken meal included a lot of vegetables and the bolognese included carrots in the mince as is the tradition in many homes. These meals are far healthier than the oily chicken or pizza that they had because they contain fewer oils and more vegetables.

9. What advice would you tell Farrah to give to her brother?
Learners should include something about eating a more balanced diet, which would include eating more fresh fruit and vegetables and less fats, sugars and oils. Rajesh should cut down on the amount of sugar he puts in his hot drinks, he should always eat breakfast in the morning, he should not rush when he eats his meals and just buy food from a tuck shop. Rajesh should also become more active and not just lie in front of the TV for the afternoon. Farrah and her brother Rajesh should also consider talking to their parents about the meals they are given in the evening. They should not have takeaways so often and the parents should also take responsibility for what their children eat.
10. Now that you have completed this activity, explain why different portions of the different food groups are necessary for a balanced diet?

ACTIVITY: Comparing meals

INSTRUCTIONS:

1. Below are photographs of different meals for breakfast, lunch and dinner.
2. One of the meals is unhealthy and the other meal is healthy.
3. Choose which is the healthier option and write a paragraph explaining why. List the food groups that are missing from the unhealthy option compared to the food groups that are present in the healthy option.

Breakfast:

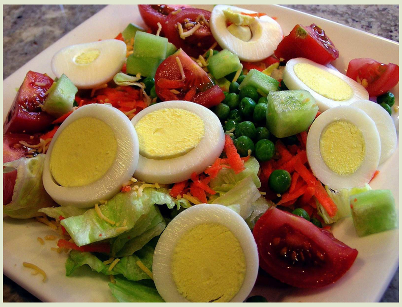
Option 1: Fruit loops	Option 2: Fruit salad
	

The fruit salad is healthier as it contains a variety of fresh fruit which will satisfy some of your daily requirement of fruit and vegetables. The fruit loops are unhealthy as they contain a lot of sugars, colourants and flavourants. They do not have any nutritional value.

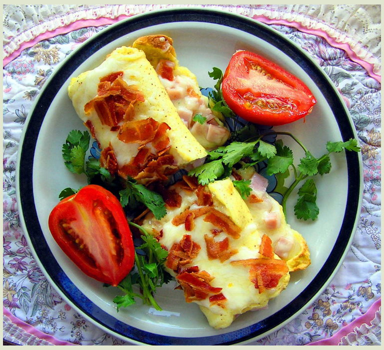
Option 1: Oats with raspberries	Option 2: Flapjacks with syrup
	

The oats with raspberries is more healthy compared to the flapjacks with syrup. Oats is a good source of nutrition and the raspberries are very high in vitamins. The flapjacks are unhealthy for breakfast as they contain a lot of fats and sugar.

Lunch:

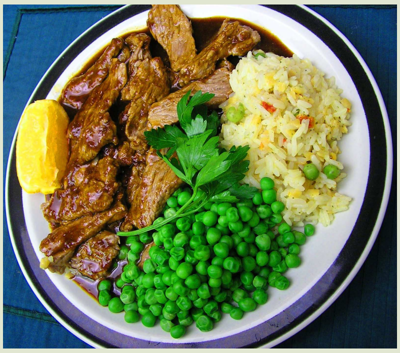
Option 1: Egg salad	**Option 2: Fried chips**
	

The egg salad is the healthy option. This meal contains a variety of food groups as there are fruits and vegetables containing vitamins and minerals and the eggs are a good source of protein. The fried chips are very unhealthy as a meal as this only consists of one food group (starch) and there is added oil from the frying.

Option 1: Hamburger	**Option 2: Omelette with salad**
	

The omelette is the healthy option. As with the egg salad, this meal contains fresh salad and the eggs are a source of protein. the omelette possibly has meat or mushrooms and cheese which also adds to the nutritional content. Although the hamburger contains meat, starch and cheese, it was probably prepared in an unhealthy way. Consider that the meat was fried in oil and that the bread has less nutritional value than vegetable starches. This meal also lacks fresh fruit or vegetables.

Supper:

Option 1: Chicken pieces	Option 2: Beef, peas and rice
	

The beef, peas and rice is the healthy option for supper as the meal contains starch (rice), meat for protein (beef) as well as vegetables (peas). The other meal is unhealthy as it only contains one food group, namely protein from the chicken pieces.

3.2 Diseases caused by an unhealthy diet

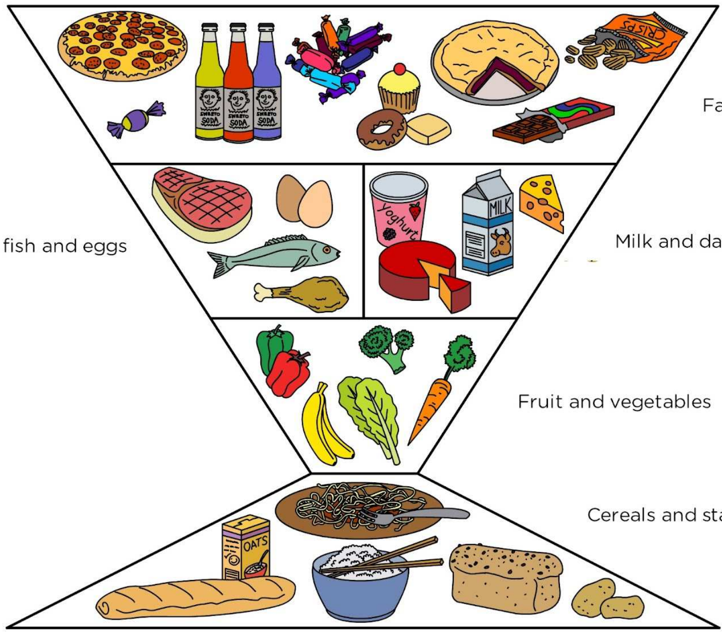
There are many people in the world that do not or are not able to eat a healthy, balanced diet. Many choose to eat an unhealthy diet while others do not have a choice.

New Words

- nourishment
- overeat
- obesity
- diabetes

Many people live in cities and can afford to buy takeaways often, or to eat hastily prepared meals that do not always include foods from the 4 food groups.

Remember the food pyramid we saw before? Below is a picture of the food pyramid of someone with an unhealthy diet.



The food pyramid of an unhealthy person's diet.

QUESTIONS

Discuss in your class why you think this kind of food pyramid is unhealthy. Compare it to the healthy food pyramid and write down some of the differences below.

This food pyramid is out of proportion compared to the previous one and does not form the shape of a pyramid anymore. This is because the person eats a lot more fats and oils compared to how much they should eat in a healthy diet. The amounts of meat and dairy products are about the same. But, there is a lack of fruit and vegetables in the diet. This is very unhealthy as the person will not be getting enough vitamins and minerals in their diet.

Some families have to eat what they can afford. They do not have the privilege of choosing what their food pyramid looks like but eat what they can buy with their small incomes. This would mostly consist of carbohydrates and some vegetables, and rarely includes meat and enough proteins and other vitamins.

Let's look at the causes of a poor, unhealthy diet and then at possible diseases that may arise from this.

Causes of a poor diet

There are many causes of a poor diet.

1. **Diseases and infections**: When someone has a chronic illness, such as HIV/AIDS, they are sick for a very long time. Their bodies become weak and they cannot take in nourishment from the food they manage to eat, resulting in a poor diet.
2. **Dietary practices**: In many countries, people have a preference for certain foods, for example rice, samp or mealie meal. People eat a lot of this particular food type and do not get enough protein or fats and oils in their diet. They also often cannot afford other food types, especially in developing countries. However, some families in developed countries do not eat enough fruit and vegetables out of choice and eat a lot of refined carbohydrates which also leads to disease and illness.
3. **Poverty and high food prices**: Poverty and high food prices stop many people from enjoying foods such as milk, meat, poultry (like chicken) and fruits. This has made it almost impossible for poor families to afford certain food groups. Some families can only afford one type of food group.
4. **Food shortage:** Sometimes famine occurs in a country where drought, poor farming knowledge and skill, and a lack of technology limits the yield of crops and herds of animals. This results in a food shortage in that country.

DID YOU KNOW?

A balanced diet also means drinking water throughout the day!

In these situations, people will eat whatever food is available to them, often leading to an unhealthy diet.

An unhealthy diet can lead to many health problems because the body does not get the right amount of the different food groups and therefore cannot function properly.

Some diseases and conditions

It is not necessary for learners to know the difference between a disease and a condition, but generally a "disease" refers to an illness or some deviation from the normal functioning of the body or organ. A "condition", however, is a more broader term and often refers to the state of something.

Often we get diseases and conditions because our bodies do not get the necessary nourishment. Some of these diseases are:

- **Tooth decay**: When you eat or drink too much sugar, the bacteria in your mouth makes acids that eat away at the tooth surface (called enamel), and causes cavities to form.

Too many sweets can cause cavities to form in your teeth.[1]

Remember to brush your teeth to help prevent tooth decay! [2]

- **Rickets**: This is a condition mostly seen in babies and children. When children do not get enough fruit and vegetables and do not get enough Vitamin D, their bodies cannot absorb calcium and they cannot grow strong bones.
- **Constipation**: This is a painful condition (not a disease) that occurs when bowel movements become difficult and take place days or even weeks apart. An unhealthy diet is often to blame, but there are other causes too. The best way to treat constipation is to eat a healthy diet with lots of fibre in the carbohydrates, to exercise regularly and to drink plenty of water.
- **Obesity**: This is a condition (not a disease) where a person's body weight is more than 20% that of the average weight for other people the same age and height as that person. The best prevention for obesity is to follow a healthy, balanced diet.

VISIT

e.tv news story on obesity in South Africa
goo.gl/h6MgU

Obesity is a condition which is becoming more common all around the world. [3]

VISIT

What is diabetes? (video)

goo.gl/FxJOU

- **Diabetes**: This is a disease that affects the body's ability to use blood sugar for energy. Diabetes symptoms may include an increased thirst and urination, blurred vision and excessive tiredness.

- **Anorexia nervosa**: This is life-threatening eating disorder where the patient starves themselves and deprives their bodies of nourishment to cause themselves to lose tremendous amounts of weight.
- **Kwashiorkor**: This is a disease that affects many children. It is a lack of protein and iodine in their diet. Children suffering from this may have swollen hands and feet, and especially a very large tummy, many ulcers on the skin and their hair might discolour.

ACTIVITY: What diseases or symptoms could Farrah's brother, Rajesh, develop from his diet?

INSTRUCTIONS:

1. Carefully read through Rajesh's diet again.
2. Evaluate his activities in the afternoon as well.
3. Use the information about these diseases and disorders and suggest possible diseases or conditions that Rajesh might develop if he does not change his diet drastically.

Disease	What in Rajesh 's diet could cause this disease?

Disease	What in Rajesh's diet could cause this disease?
Obesity	Overeating and inactivity
Rickets	Possibly because of the small amount of fruit and vegetables eaten
Diabetes	Eating far too much sugar and starches, inactivity
Constipation	Rajesh is very inactive and almost never drinks any water!

ACTIVITY: Research one of the diseases

This can be used as a possible project, where learners can also present their posters to the class and practise their oral skills. Be sensitive to the fact that some children in your class may suffer from some of these diet-related diseases.

MATERIALS:

- books from the library, information from the internet
- sheets of paper
- coloured pens and pencils

INSTRUCTIONS:

1. Choose one of the diseases that is related to an unhealthy diet and do some extra reading and research around the topic.
2. You must prepare a poster about this disease or condition.
3. On your poster, you must include information about the causes of the disease, which people are most likely to suffer from it and why, the symptoms, the health risks, and any possible treatments.
4. You might have to present your poster to the class, depending on your teacher.

KEY CONCEPTS

- A diet refers to the selection of food we eat every day.
- A balanced diet contains sufficient quantities of food from all 4 food groups, as well as water and fibre.
- Some diseases can be related to diet.

REVISION:

1. What do you understand by the term "balanced diet"? Write a description below.
2. Draw a food pyramid of the food that you eat and assess whether it has the correct shape of a balanced diet.

   (Mark individual learner's food pyramids based on the one used earlier in the book.)
3. Rajesh thinks that he can get enough water in his diet by drinking Coke and coffee with sugar in it. Explain to him if this is true or not and why.
4. Write a paragraph where you explain some of the possible causes of a poor diet.

Now it's time to learn about how food is processed!

4 Food processing

KEY QUESTIONS

- How do we make food last longer?
- Is it possible to stop food from going off?
- What can you do to prevent bacteria and germs getting into food?

Introducing this topic

This topic forms part of Food Science which is an exciting branch of Science that incorporates Chemistry, Biology and Physics with real-world applications.

Remind students that this term's work has focused on how food is made through photosynthesis and the important role that plants play in this process. We then moved on to investigate nutrition and the importance of a balanced diet before looking at the diseases and health problems associated with a poor diet. In this chapter we'll look at food processing and how humans have devised ways to keep food healthier for longer.

This is an excellent website for lesson plans and support materials: [1]

4.1 Why do we need food processing?

New Words

- processing
- preserve
- cure/curing
- artificial sweeteners
- preservatives

People have been processing food for thousands of years. Before the invention of fridges and freezers, people had to collect food in summer and store it because in winter food is often scarce. They found out that they could preserve food like meat and fish by salting and spicing, and then drying it - this is called **curing** the meat. In South Africa **biltong** and **bokkoms** are examples of cured meat and fish.

Bokkoms (cured fish) [2]

Pieces of meat are hung up to dry and turn into biltong. [3]

VISIT

Drying foods (video).

goo.gl/3LTE2

ACTIVITY: A time-travelling role play

This is a chance for learners to be creative and use their imaginations. Encourage them to do so. If time does not permit, the learners do not have to actually make the objects to take with them. But allow them time to discuss the possible objects they could make in their groups. They can then draw some designs and report back to the class as a group.

Work in groups of 4 - 5

You are time-travellers and you are joining the Thunderbolt Kids for your first jump through the wormhole! You may not take anything non-organic with you so no metal tins or plastic containers, and certainly no computers, cell phones or laptops!

DID YOU KNOW?

Biltong was invented by the Voortrekkers who travelled by ox-wagon during the Great Trek. They needed to preserve meat for the long journey. The raw meat was preserved using salt, vinegar and spices.

Come on! Follow the Thunderbolt Kids and jump through the wormhole to go back in time!

Imagine being transported 250 years back into history and arriving with only the clothes you are wearing and whatever you have learnt in your head in EXACTLY the same place you are right now. It is late summer and you need to spend a year wherever you are and survive until the wormhole opens again at that exact spot and allows you to return to 'the future'.

Your mission: gather as much information on the local inhabitants and the food they eat, their ways of living and how they survive the elements and natural dangers in their environment. When you return you will need to explain how they preserved and processed different foods to last them through winter and how they packaged and protected this food from scavenging animals and pesky insects.

Brainstorm this problem with your group. List as many different questions or problems that you can think of that will affect you:

- immediately,
- in about a month's time,
- in 6 month's time, and
- right at the end of your stay - a week or so before you return to the present time.

Think especially of food and shelter, and specifically how you will collect, preserve and process any food that you collect. Remember you are not allowed to take anything that is not organic so no pocket knives, nylon rope or even lighters can go with you!

Design the following items that you can make and use when you land.

1. Something that you can collect and carry water in, and store it for 'the future'.

2. Something that you can collect and carry food in, and specifically something that you need to store it in to keep it away from scavenging animals and insects.
3. Something that you can use to cut with - you will need to make a shelter to sleep in and keep safe from wild animals; and also cut material for your food and water containers.
4. Something that you can use to hunt animals or catch fish if you are going to eat meat while you are there.
5. A device that you can use to preserve meat or fish, or perhaps fruit and vegetables for the winter months.

Give each person in your group one of these items to make and bring to class. Make sure you do not use any modern tools or any metal, glass or plastic as it is highly unlikely that you would have any such items to use 250 years ago.

QUESTIONS:

1. List the possible dangers that you will face in your new 'home'.
2. Can you predict how the locals might look and how they might treat you?
3. Describe your first night there.
4. Explain how you will decide what you can and cannot eat on your first day.
5. Complete this sentence: If I want to preserve some of the fish I catch, I will...
6. The local indigenous people use different methods to preserve their fresh fruit and vegetables. Find out about these methods and use one method to preserve some fruit of your own. At the end of this chapter, bring your preserved fruit to show the class. You have two weeks.

Introducing this lesson:

Start this lesson by brainstorming different types of processed foods and facilitating discussion to try and agree on a class definition for 'processed food'. It should be clear after this discussion that:

- Almost all the food we eat is processed in one way or another.
- Food and beverage companies change raw animal and plant products into food that we can eat or drink through various processes. This is called food processing.
- Food processing can include: cooking, baking, roasting, grilling, smoking, drying, spray drying, juice concentrating, freezing, milling (wheat), and sometimes slaughtering animals for their meat is also considered a form of food processing.

- We process food to make it more edible (preparing / cooking), last longer (preserving) and to increase the nutritional value (fermenting).

Make a class list of possible reasons WHY food is processed and possible examples of people who would benefit from this processing - write this on newsprint or poster paper to refer and add to as you go.

Food Processing - Then and Now

Hundreds of years ago explorers like Columbus, Da Gama and Diaz, had to pack supplies for their crews to last a very long time should they not find food and water on their expeditions. They too had to take as much preserved food and drink as they could.

Many of the foods we eat today cannot be eaten in their raw form - we need to process the food to make it edible.

Sometimes food is also processed to add to its nutritional value, for example when we ferment dairy products to make yogurt, cheese and buttermilk.

QUESTIONS

1. There are many reasons to process food. Can you think of any? Write them down below.
2. When you get home today ask your parents, family members and maybe your friends' parents if they think processed food is good or bad and why they say so. Write the results of what you learnt from this quick survey below.

DID YOU KNOW?

The Emperor of France, Napoleon Bonaparte, launched a competition in France in 1975 to develop ways to preserve foods for France's armies! This led to the discovery of canning.

Benefits of food processing

Food processing adds many benefits to our modern lives:

- Transportation of fresh food is quite difficult. If producers can process the fresh fruit and vegetables in some way, the food is easier to transport. Delicate products like grapes, strawberries and peaches can be transported much more easily when they are preserved than if they were fresh. The processing also helps the fruit and vegetables to last longer.

This truck collects the pear and apple boxes and transports them.

Today people can eat fresh fruit and vegetables all year round and do not depend on seasonal availability because of modern methods to process and transport these products. Therefore, food processing and transportation makes the modern 'balanced' and varied diet possible.

- Many times food and beverage producers add extra vitamins and nutrients to their food to make it healthier for their clients.
- Buying and preparing processed food is also more convenient and less time-consuming.
- Foods are processed to preserve them, for example when fruits are preserved to make jam, or pickled (eg. pickled onions).

VISIT

Making cheese at home (video)

goo.gl/EVLhG

This ginger has been preserved so that it lasts longer.

VISIT

Pickling vegetables (video)

goo.gl/6rLA9

- Food processing is lastly very important to people with allergies and diabetes because they are able to eat a greater variety of healthy food. An allergy for cow or goat milk is a very common allergy among small children. They are able to drink 'milk' only because modern food processing has found a way to make milk from rice, oats or soya.

Rice or soya milk are processed foods and an alternative to cow's milk for people with allergies.

VISIT

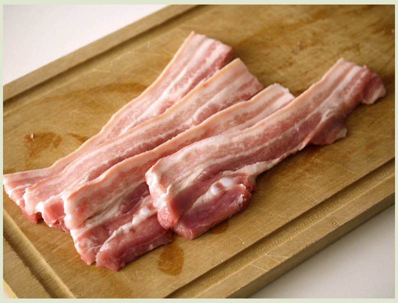
Making plum jam (video)

goo.gl/6vNyq

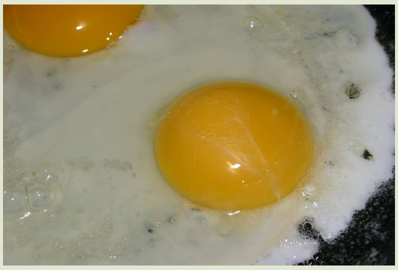
ACTIVITY: Describing processed foods

INSTRUCTIONS:

1. Look at the following photographs of various foods.
2. Each one has either been processed in some way, or needs to be processed before we can eat it.
3. Briefly describe why and how each food has or will be processed.

Food	Reason for being processed
 Raw meat	
 Yoghurt	
 Pickled gherkins	
 Glacé cherries	

S

 Fried eggs	
 Cheese	
 Butternut	
 Frozen meals	

Possible drawbacks of processed food

We have seen that processed foods have many advantages in our modern lives, but processed foods also have drawbacks (disadvantages), especially if they have been over-processed.

QUESTIONS

Write down some possible reasons why people think processed food is not good for you.

ACTIVITY: Class discussion

INSTRUCTIONS:

1. We are going to have a class discussion about some of the possible drawbacks of processed foods and why some people do not like the idea.
2. This is an opportunity for you to practise taking down notes from what was said in class.
3. Your teacher will lead the discussion and also write some things on the board.
4. You must take notes in the space below.

Class discussion: Discuss the results of their homework surveys with the class and make a mindmap on the board showing the possible reasons why people do or don't think processed food is good for you.

The following information must be used to facilitate the class discussion. Make sure to write the main points on the board so that learners can copy the main headings down. Also encourage learners to take down some additional notes. This is an important skill for their school career.

There are different ways to process food, but in almost all of these ways some of the nutrients, vitamins and minerals are destroyed. Any process that uses heat generally also destroys Vitamin C, for example. However, people tend to think that here is very little nutrients left in processed food when this is actually not the case.

Research has shown that only between 5% - 20% of nutrients are lost when food is processed - in a factory or a home. The amount of nutrient loss depends on the method used to process the food.

You might have heard that there are dangerous additives in processed food that make it very bad for you. In the past many food manufacturers have in fact added many extra products to food:

- **Preservatives**: preservatives, such as sulfur dioxide, are added to food to make it last longer. These are not always very healthy.
- **Colourings**: Many food and beverage manufacturers used to add all sorts of artificial colourings to food to make it look more attractive to their consumers - a bit like adding paint to your food! Nowadays, with many consumers complaining, they no longer do this but only add natural colourants that can be made from berries or plants for example.
- **Artificial sweeteners, salt and flavourings:** Manufacturers also used to add artificial sweeteners and flavourings, such as MSG (monosodium glutamate), that are cheaper and allow them to make a larger profit. Artificial flavourings are not very healthy and can cause organ and brain damage. Many people are also allergic to these products. Therefore, many companies have stopped adding artificial sweeteners, salt and flavourings and have instead chosen to add natural products instead.
- Governments around the world have drawn up very strict laws that control the additives that get added to food and beverages, and food manufacturers have to be incredibly careful what they add nowadays. Only additives that have been proven to be safe for humans to eat or drink may be added to food.

4.2 How are foods processed?

Introducing this topic:

The CAPS require that learners research different ways of processing food (raw material) and then choose one way and process food (raw material) using this method. We have set this out as a project that teachers can use to assess. The unit briefly introduces some of the ways of processing food and very briefly touches on each of these. Learners are then required to research their preferred method and present their research using various methods, like posters / slideshows in PowerPoint / etc - about this method of food processing. They also need to process food (raw material) using this method and demonstrate the steps they followed to their class.

There are different levels of food processing. The key question is to ask: has any process occurred from when this plant or animal was in its natural habitat to where it is now? If you can say yes then you know that it has been processed in some way or another.

New Words

- shelf-life

Levels of food processing

Minimally processed foods:

- Fruit and vegetables, nuts, meat and milk undergo very little processing from when the plant or animal product was in its natural habitat to the point where it lands on your table.
- They need to be harvested, washed and sometimes peeled, chopped, juiced or cut to remove inedible parts, before they are sold. These have a very short shelf-life.

DID YOU KNOW?

Many indigenous South African cultures leave milk to curdle in a hide sack or calabash to form a favourite semi-solid, sour yoghurt drink. This drink is called amasi.

Milk and juice are minimally processed.

Vegetables are washed, cut and cooked. This is minimal processing.

Processed food ingredients:

- Products with a longer shelf-life, like flours, oils, fats, sugars, syrups margarine, sweeteners and starches, fall into this category.
- The original product has been changed and the ingredient does not look like the original kernel or grain, or oil seed or beans.
- These processing techniques often break down any nutrient values and the manufacturers often add in extra nutrients, vitamins and minerals to their foods.

Highly processed foods:

- Highly processed foods include snack foods and desserts,

DID YOU KNOW?

Mealie meal made by grinding maize forms a huge part of the diet in many indigenous cultures in southern Africa, such as the Ndebele, Zulu and Swazi.

biscuits, cereal bars, chips, cakes and pastries as well as soft drinks and breads, pastas, breakfast cereals and infant formula.

- Animal products that are highly processed include processed meats (smoked, canned, salted or cured, nuggets, fish fingers, viennas, many sausages and boerewors, and burgers).

Polony is a highly processed food.

The table below shows how a raw product is processed to make a raw ingredient which looks very different to the original raw product. Then the processed raw ingredients are used to make highly processed foods, such as bread.

The raw product: Wheat	The processed ingredient: Flour	The highly processed food: Bread
		

DID YOU KNOW?

The Swazi people make Marula beer by placing the ripe fruit in large traditional pots and letting them ferment.

ACTIVITY: Learning how to summarise

Sometimes we are presented with a lot of information and we need to condense it to make it easier to remember. This is called summarising and it is a very useful skill.

INSTRUCTIONS:

1. Use the space below to draw a table to summarise the information above about the levels of food processing.
2. Include a short description of the level of food processing and examples.
3. Think about how many columns and rows you will need.
4. Give your table a heading.

This question is aimed to help learners to summarise information into a table format. If they are finding this difficult, start them off with drawing the outline of the table on the board and filling in some of the information. One possible solution for a table is given below.

Level	**Minimally processed foods**	**Processed food ingredients**	**Highly processed foods**
Description	Products that undergo very little processing	Products that have been drastically changed and the ingredient does not look like the original	Products consisting of a combination of processed ingredients.
Examples	Fruit and vegetables, milk, nuts, meat	Flour, sugar, oil, syrup.	Snacks, biscuits, desserts, meat products such as fish fingers, boerewors, etc.

DID YOU KNOW?

Dr J. H. Kellogg invented a type of granola cereal in 1860 - it was meant for Seventh Day Adventists who were following a very strict diet. Later his brother joined him and they started their company Kelloggs! Do you think they were successful?!

Food processing methods

As you could see in the above breakdown, the degree in which food is processed determines many of the food preserving processes involved.

Food processing methods have changed in many ways, but the basic principles are still applied. Food is still dried or heated to preserve it, just like people did 300 years ago, but there are many modern methods that are also used today.

- sun drying
- fermenting dairy into cheese, buttermilk (Amasi) or yogurt, or barley or grapes
- pickling vegetables (onions or gherkins, for example)
- salting and spicing meat to preserve it (then drying it)
- adding sugar to berries and/or fruit to make preserves
- pasteurisation: using just the right amount of heat to warm up milk or juice for example, to extend the shelf life
- cooking: roasting, smoking, baking, frying
- toasting
- freezing or refrigerating
- freeze drying
- spray drying
- making juice concentrates

QUESTIONS

When you go home from school today, make a list of the food products that you have at your house (whether they are in the cupboard, the fridge or the freezer). Next to each item, write down the type of processing it might have gone through, using the list above as a guideline.

QUESTIONS

Discuss why you think each of these 5 points are important in food processing. You might need to do some extra reading and have a class discussion.

No matter what food processing method is used, there are 5 extremely important performance parameters that all food processing must adhere to:

1. hygiene
2. energy efficient
3. minimal wastage

4. labour efficient
5. minimal factory shutdowns

Below are guidelines to facilitate the discussion and answers.

1. Hygiene - it is very easy for germs and bacteria to start growing in food. Therefore, manufacturers have to take every possible precaution to ensure that every utensil, mixer, piece of equipment and specifically the workers' hands and clothing is sterile and remains that way.
2. Energy efficient - the extremely high cost of energy sources such as electricity, oil or diesel, makes it vital that food production uses the smallest amount of energy to 'get the job done safely'. The more money that needs to be spent on energy the smaller the profit for the company will be.
3. minimal wastage - manufacturers make every effort to cut down as much as possible on any and all waste. The more waste there is the less profit they make and the more they have to spend on removing and 'getting rid' of the waste.
4. Labour (measured as the number of working hours per ton of finished product) - manufacturers try to cut down on the amount of people that handle any given food product because that increases the cost to the company. Labour in certain countries costs more than in others which also pushes up the price of the goods.
5. Minimal factory shutdowns - each time the factory or operation gets shut down to clean it the factory is not making money. Manufacturers therefore try to keep every small part of their production line as clean and 'maintenance' free as possible. They even try to invent machines that are self-cleaning!

DID YOU KNOW?

The Ndebele people of southern Africa eat a plant called Umrorho. It is cooked or dried by spreading it out in the sun so that it can be stored for the cold winter months.

ACTIVITY: Comparing traditional and commercial food processing methods

We have learnt a lot about food processing methods in our modern lives. However, the indigenous people of southern Africa have been preserving and processing food for many generations, and still use some of their traditional methods today.

INSTRUCTIONS:

1. Read the following description of how beer is made in the Zulu culture.
2. Then answer the questions that follow.

Zulu beer making

Beer (*utshwala*) forms an integral part in the Zulu culture, especially at social gatherings and traditional ceremonies. Zulu beer is traditionally made by the women. To brew the beer, the women soak coarse sorghum and maize in water for one day, typically in a big drum-like *imbiza* pot. The following day, the broth is boiled over a fire and more dry sorghum is added to the mixture. After this, the mixture is mashed together and then allowed to cool for the rest of the day. The next day (day 3 of the brewing process), the mixture is filtered through a sieve to remove the big fibres. The sieve is made from palm fronds and the brew is poured from the big *imbiza* vessel into the serving vessel, *iphangela*, made from clay. The beer is now ready to be served. The *iphangela* is carried from brewery in the kraal (a semi-thatched hut which allows the smoke from the fire to escape and ensures a good supply of oxygen to ferment the mixture) to the drinking assembly. A woman scoops the beer into a drinking vessel, *ukhamba* (a small, round clay pot decorated with traditional patterns) using a dried gourd and presents it on her knees to the men. She will first taste the beer to show the head of the household that she has brewed the beer properly, and then hand him the *ukhamba*, before passing it around to the rest. The beer contains 3% alcohol and it is nutritious as it is made from plant products without modern additives or colourants.

This watertight, hand woven basket, called Ukhamba, is used to store any leftover beer. [4]

QUESTIONS:

1. What are the ingredients used to make utshwala?
   Sorghum, dried sorghum, maize and water
2. What are the Zulu names for the three different clay pots (vessels) used in the beer making process?
   Imbiza (brewing vessel), iphangela (serving vessel), ukhamba (drinking vessel)
3. What are these vessels made from?
   Clay
4. Why does the brewery hut only have a semi-thatched roof and not a fully, enclosed roof?
   This is because the women have to make a fire inside to boil the mixture. So they need an opening to allow the smoke to escape, and they need a supply of oxygen for the fire to burn and the fermentation process.

5. Use the space below to draw a flow diagram to illustrate the Zulu beer-making process. Remember to include arrows to show the direction.

6. For the following task, you need to do some research outside of class, using books and the internet. Find out how beer is made in a modern brewery, such as the South African Brewery in Newlands, Cape Town. In the space below, write a paragraph where you compare this modern beer-making process to the indigenous method of the Zulu people.

ACTIVITY: Food Processing Project

Now that you have a better idea of the different ways that raw food can be processed, choose one particular method that you found really interesting to further research and then process the food at the end.

After researching the method, learners are encouraged to actually carry out the food processing, either at home or in class. On a specified day when learners present their projects, they can bring the actual food product to class for others to taste.

INSTRUCTIONS:

1. You need to read as much as possible about your chosen method of food processing.
2. You will need to interview at least one person who uses this method of food processing. Before your interview you will need write down at least 10 different questions to ask this person during the interview. You need to include these questions and the person's answers in your project's presentation.
3. After your research and interview you need to include a few paragraphs headed: "**What I learnt about food processing ...** " This must be a summary of the information you learnt.
4. Present your findings in a visible form that you like - perhaps a poster, PowerPoint slide show or in a flip-file as a brochure. Be creative and present your information in a lively and interesting way!
5. Use the knowledge and understanding that you gained and process the food using this method.
6. You will need to make your presentation to the class. You must include all the steps you followed to process your chosen food. Bring some of your processed food to class so that you can all enjoy what everyone has made.
7. When you choose a processing method make sure you have food that you will be able to process using this method! If you cannot find fresh (raw) peaches to poach because it is winter then consider choosing another processing method!

Teacher note: Below is a guideline rubric to assess each learner's project.

	5	4	3	2	1
Research skills	Rigorous pursuit of knowledge & understanding; information paraphrased very clearly.	Good coverage of information and new knowledge / understanding; some evidence of paraphrasing	Adequate and fairly precise knowledge gathered. Mostly copied information.	Information gathered by copying and pasting information in random without much planning.	Not much information gathered. Some information is space-filling and serves little purpose.
Interview skills	Questions and answers displays very clear understanding of processes involved and information needed.	Questions are clear and to the point though not always focused. Some answers are well structured.	At least 1/2 of questions are well structured / formulated but not always relevant and focused.	Some questions were formulated well but these are not in any particular order and do not flow one from the other.	Questions don't always pertain to the topic. Some questions are difficult to understand. Did not formulate 10 questions.
Ability to synthesise information in a summary	Summary creates a very good overview of main ideas. Clear and precise synthesis of information from research and interview.	Summary is fairly concise and contains many main ideas but often supporting ideas have been included as well making it too long.	Summary is in places a copy of the previous texts. Some main & many supportive ideas included. Incomplete.	Summary is very short & contains only a few strands of information. Imprecise and lacking.	If summary is included it is no more than one or at the most two short sentences. Incomplete & containing many misunder-standings
Referencing and bibliography	All references are noted and bibliography is complete and well presented.	Some sources acknowledged and referenced. Fairly good bibliography.	One or two sources acknowledged. Bibliography contains titles yet incomplete.	No sources references in text but one or two sources were included in bibliography.	No bibliography or referencing of sources.
General impression of presentation	Well presented, neat and creative presentation. Good use of language and resources. Interactive and lively.	Fairly well presented but could be neater. Presentation was good. Fair amount of effort applied.	Some effort applied but presentation could be far more creative and interesting. Could have used resources more effectively	Presentation was generally simplistic with little use of colour, layout or creativity. At times the reader feels confused & cannot follow	Presentation was untidy and sloppy. Information was inaccurate. Poor use of language. Very little evidence of effort applied

Effective use of information to process food	Used knowledge & understanding gained in research & interview very effectively to plan food processing.	Fairly good understanding of food processing procedure & application in own process.	Good correlation between some aspects learnt and practical application, though not all.	Applied at least 3 theoretical concepts learnt but could not sustain this without support.	Could not correlate knowledge from research with practical application.
Appropriate choice of food to process	Excellent choice guided by research, interview and food availability.	Considered majority of constraints & made a good choice.	Choice was made difficult as did not consider all constraints.	Chose a random food that posed tremendous problems as did not consider all constraints.	Did not prepare beforehand. Chose inappropriate food.
Outcome of the food processing	Food was very well processed and looked and tasted delicious.	Some items were processed correctly and looked and tasted fine.	One or two items were successfully processed. Others 'didn't work'	Although the idea was correct the result did not work and tasted / looked unappetizing.	Lack of preparation thus food processing was unsuccessful.
Demon-stration of food processing	Demonstration was lively and entertaining. Audience enjoyed it very much!	Demonstration was fairly well presented yet with a few hiccups.	Very nervous presenting yet tried hard. Audience was lost in places.	Demonstration was short / incomplete. Battled to explain the process.	Tried to present / demonstrate but lacked confidence or understandin of process.
Breakdown of steps to process food	Very precise and clear breakdown of steps.	Fairly precise yet not always clearly communicated breakdown of steps.	Steps were not well ordered but could break down process in main phases.	Could only identify some of the main phases but not in logical order.	Needed much prompting to identify one or two of the main phases in the process..
			TOTAL:		**/50**

KEY CONCEPTS

- Food is processed to make it edible, by cooking or preparing it for example.
- Food is processed to make it last longer - we say to preserve it.
- Food is processed to improve its nutritional value by fermenting it for example.
- During processing many foods may lose some of their nutrients.
- Various methods are used to process food.

REVISION:

1. Write a definition for 'food processing' that will explain what it means.
   Changing raw animal or plant material into products and food that we can eat and use.
2. There are three main reasons why we process food. Explain what is meant by the following words in relation to food processing.
   a) preserving
   b) cooking / frying
   c) fermenting
   a) making food last longer
   b) making food edible
   c) increasing the nutritional value of food
2. Many people believe that processing food is not good for their health. List three possible drawbacks of food processing.
   a) There are many additives added to food - preservatives, colourings, artificial sweeteners and salt, etc.
   b) Nutrients may be lost in the process.
   c) There is a risk of contamination from various sources.
3. Describe how you would preserve extra fish that you had caught while on an overnight camping trip.
   clean and gut the fish; wash it in salt water and fillet the fish; sprinkle course salt and spices over it; hang it to air-dry in a well-ventilated space, away from scavengers and pesky insects.
4. A farmer wants to export table grapes to Australia from his farm near Worcester in the Western Cape. Suggest the best form of transport that you know of that he should use and explain why you gave him this advice.
   He should pack these grapes in special boxes that will protect them and place these directly into cold rooms. A special cooling truck should fetch these boxes and take them to the airport from where they can fly to Australia in the freight planes.
5. Below is a table. Next to each item in column A write the degree to which the raw materials were processed.

Food	Degree of processing
mealie bread	
fresh mealie washed and packaged	
sunflower oil	

6. Explain why many people believe that highly processed food is bad for your health.
The food processes involved in making highly processed foods destroy many nutrients. Some methods of processing add a lot of extra sugar, fats or oils.
7. Compare the methods of any two food processing techniques.
Here the idea is that learners use their project's information to support their explanation of the food processing methods.
8. Write a short paragraph summarising what you have learnt about food processing and why you think it is important in your daily life.
Learner directed answer.

5 Ecosystems and food webs

KEY QUESTIONS

- What is an ecosystem?
- How often does it rain in a rainforest or in a desert?
- Now that I know how people eat, how do animals get their food?
- Why can animals only eat one type of thing - for example why won't a great white start eating kelp or why won't a tortoise hunt a dolphin?

Introducing this topic

Many of the concepts in this unit revise work done in Gr. 5 with the consequence that this unit has taken a different approach: these topics were not dealt with in depth but given a good, clear introduction to revisit and acknowledge existing knowledge and then we move to a stronger focus on environmental problems and permaculture as one of many positive solutions. If at all possible, watch the video clip on permaculture - it is fantastic and inspirational, and makes for far more positive reading than the doom-and-gloom that tends to dominate the media today.

Nothing in the world can live truly on its own. No plant or animal, and certainly no human. Living things are connected to each other, they depend on each other and on the non-living things in their environments.

In this chapter we will take a closer look at ecosystems and examine the different kinds of ecosystems that we get around the world, see how animals, plants and microorganisms depend on each other and learn about food webs and feeding relationships in an ecosystem.

New Words

- ecosystem
- dependent
- interdependent
- permafrost

5.1 Different ecosystems

An ecosystem is an area where living and nonliving things depend on each other in many different ways. An ecosystem can survive on its own without any help or products from any other sources because the living and nonliving things in the ecosystem depend on each other for their survival.

There are many different types of ecosystems on our planet:

- rivers
- mountains
- sea and the rocky shores
- ponds and wetlands
- arctic and alpine tundra are in extremely cold regions close to the North and South poles. There are no trees but some shrubs and dwarf plants grow in wet, spongy soil if it is not permanently frozen (they call this permafrost).
- grasslands: tropical savannas and temperate grasslands.
- forests, including tropical rain forests, and forests of coniferous and/or deciduous trees in moderate climates support many kinds of herbivores and carnivores.
- deserts and semi-deserts

ACTIVITY: Describing different ecosystems

INSTRUCTIONS:

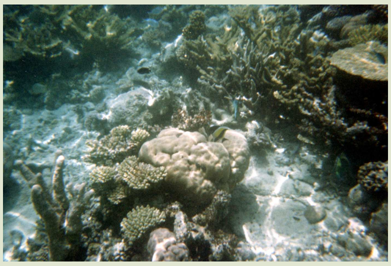
1. Below is a table with photographs of different ecosystems. Study each photograph.
2. In the column next to the photo, identify the type of ecosystem.
3. Then write a description of the ecosystem where you identify:
   a) some important physical features and structures, such as rivers, mountains, rocks, etc.,
   b) the type of climate you expect where this ecosystem is found, and
   c) the types of plants and animals you would expect to find in the ecosystem and why they might benefit from living in these conditions.

Ecosystem	Type and description of ecosystem
	

DID YOU KNOW?

In America, grasslands are prairies and in Asia they are called steppes; in South America they call it the Pampas and in South Africa we often call it bushveld or savanna.]

Answers: Also assess learner's descriptions in terms of the physical features of the ecosystem and how the plants and animals might benefit from these conditions.

- wetland/pond: reeds, water lilies, birds, fish in the water, terrapins, etc
- rocky shore: crabs, mussels, small fish, limpets, sea gulls, penguins, seaweed, etc
- forest: birds, small buck (red duiker), small mammals (mice), big trees, creepers
- desert: cacti, grass, other succulents, snakes, small mice, birds
- river: reeds, trees, fish, birds, otters
- snow-capped mountains: minimal life - sparse vegetation, mountain goats, snow leopards, rabbits, etc
- savanna/grassland: grasses, a few trees, birds, small rodents, game (ie. buck, leopards, zebra, etc)
- coral reef: coral, seaweed, tropical fish, turtles, dolphins, crustaceans, anemones, etc

A unique South African ecosystem

South Africa's fynbos region is unique - it produces an incredible array of plants and specifically flowers. Our national symbol, the Protea, grows wild here - and NOWHERE else in the entire world!

The King Protea, our national flower [1]

Typical fynbos at Cape Point Nature Reserve [2]

A fire passed through this fynbos area near Kleinmond, Western Cape. A year later the indigenous fynbos had regrown but the pine trees that are not indigenous were all dead.

South Africa is famous for its fynbos - it does not grow naturally anywhere else in the world! Fynbos plants are especially adapted to survive the climatic conditions and frequent fires. The low bushes can survive the harsh windy conditions and the plants produce seeds that can very often only germinate once they had been scorched by fire.

The Fynbos biome in South Africa has a huge biodiversity in plants and animals.

5.2 Living and non-living things in ecosystems

In an ecosystem, there are certain relationships between the living things and the non-living things in a particular area.

A healthy ecosystem is one in which there is a balance between the non-living and living things. a healthy ecosystem also depends on sufficient biodiversity of plants, animals and their habitats.

We saw at the beginning of the term that plants depend on air, water and sunlight in order to make their food. Do you remember what this process is called?!

QUESTIONS

1. What are some of the non-living things in an ecosystem?
   air, sunlight, water, soil
2. What does biodiversity mean?
   Biodiversity refers to the variety in the species of organisms (plants and animals) in a given habitat.

Animals also depend on the non-living things in their ecosystem. All animals need to breathe (oxygen from the air around them) and they need to drink water. Some animals also use the non-living things to make their shelters. For example, ants rely on the soil and sand to build their nests in.

ACTIVITY: Assessing the balance between living and non-living things

INSTRUCTIONS:

1. Look at each of the following photographs of different ecosystems in which the balance between living and non-living things has become upset.
2. Answer the questions on each picture.

A dried river bed.

In this river ecosystem, the water has dried up due to a drought. How does this affect the biodiversity of the plants and animals in this ecosystem?

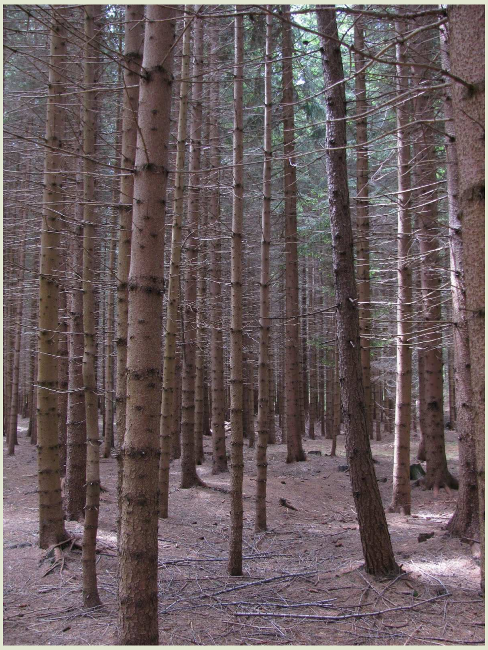
Many animals which relied on the water as their habitat would have died, such as fish, frogs, etc. In turn the birds which ate these animals would have left. Plants which relied on very moist soil would have died, such as reeds and water lilies.

However, many of these ecosystems also have animals adapted to dry seasons (fish and amphibians go dormant, elephants dig for water). Although, long periods of drought are still detrimental to these animals.

The soil has started to erode. [3]

In this photograph the soil has started to erode. Why do you think this happened?

This may be a difficult question to answer. It could be because the land was farmed and so the naturally occurring plants were removed. There are now no roots holding the soil together. When the rain comes, it washes the soil away causing erosion.



A pine tree plantation

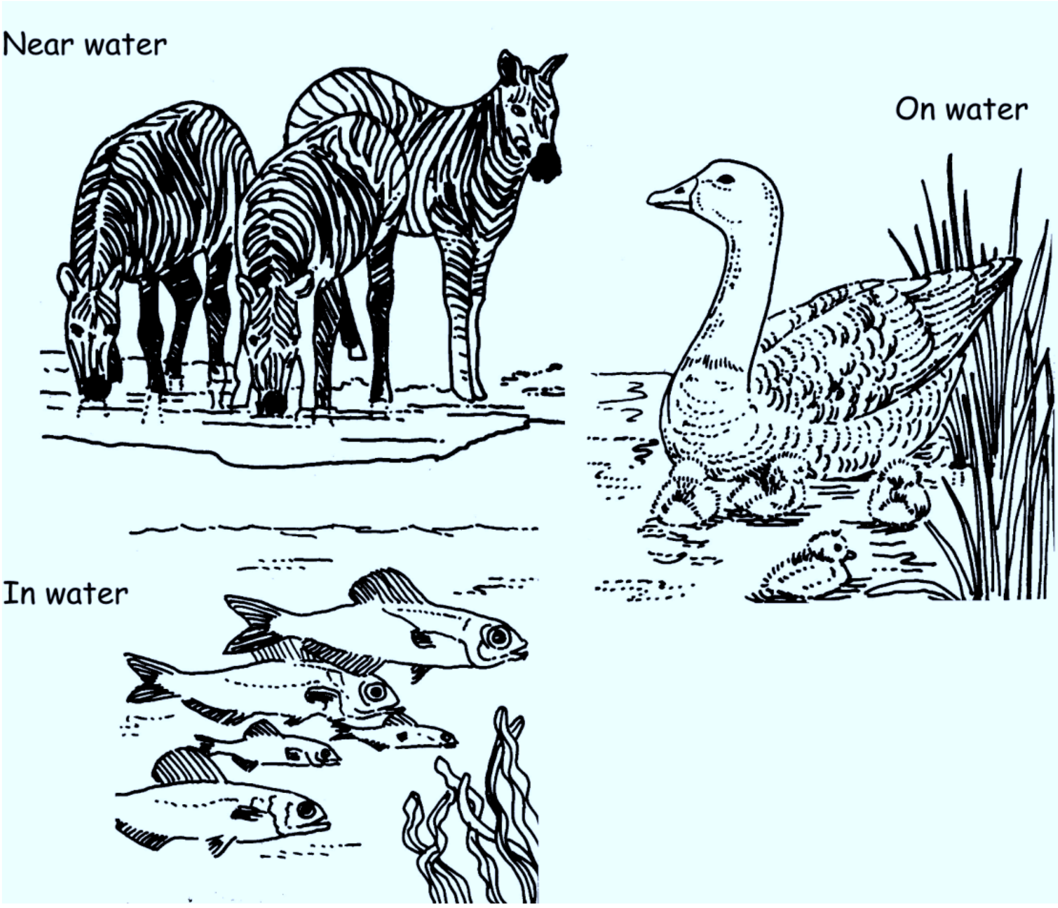
In this man-made forest, there is not much life under the canopy of the trees. Why do you think this is so?

This is because the trees block a lot of the sunlight which plants and animals need, so they do not live there. Also, the pine trees use a lot of the water in the ground, meaning there is not much left for other plants.

As you have seen from this activity, the living things depend on the non-living things in an ecosystem. There is also a very fine balance, and if something is upset, then the ecosystem will begin to deteriorate.

The importance of water in an ecosystem

Without water life as we know it cannot exist.



Animals depend on water in their ecosystems

- Water provides a habitat for many different organisms and allows plants and animals to survive and breed.
- Water is a universal solvent and allows important chemical reactions to take place. It is a key ingredient for

photosynthesis where plants create glucose (sugars) from sunlight, water and carbon dioxide.
- Water plays an important role in plant reproduction as some seeds need to be dispersed by water. (Try and remember which seeds get dispersed by water?)

New Words

- food web
- microorganism

5.3 Food webs

We have now learnt what makes up an ecosystem. We now know that there are relationships between living and non-living things. In an ecosystem, plants and animals are also connected to each other due to their feeding relationships. The plants in an ecosystem are called the producers and the animals are the consumers.

QUESTIONS

Do you remember what a producer and a consumer does in an ecosystem (from Gr. 5 work but also from the photosynthesis work you started this term with)? Write an answer below.

A producer produces food through photosynthesis from sunlight, water and carbon dioxide while a consumer cannot produce its own food and therefore eats the producer or other consumers.

There are different types of consumers:

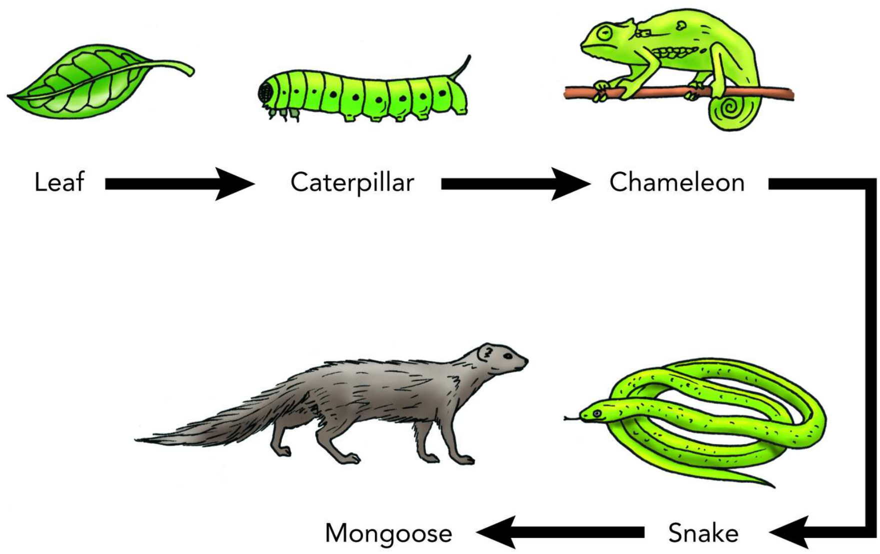
- herbivores only eat plants and plant products.
- carnivores only eat meat and meat products (eggs).
- omnivores eat plant and animal products.
- insectivores only eat ... can you guess what?
- scavengers eat dead animal matter.
- decomposers are microorganisms like bacteria and fungi, as well as mushrooms, that break down animal and plant material into tiny particles and recycle it into the ground ready for the plant to use.

QUESTIONS

What do you call a human herbivore?

Vegetarian

Do you remember in Gr. 5 when we looked at food chains? Here is an example of a food chain:



A simple food chain

QUESTIONS

Turn to a friend and design your own food chain consisting of four organisms. Remember a food chain always starts with plants (producers) and ends with scavengers or decomposers.

In a whole ecosystem, the feeding relationships between plants and animals are much more complex than a simple food chain.

In the above food chain, for example, the chameleon might also eat flies or butterflies, the snake does not only eat chameleons, but also lizzards and mices, and the mongoose also eats small birds and eggs.

VISIT

Food webs (video)

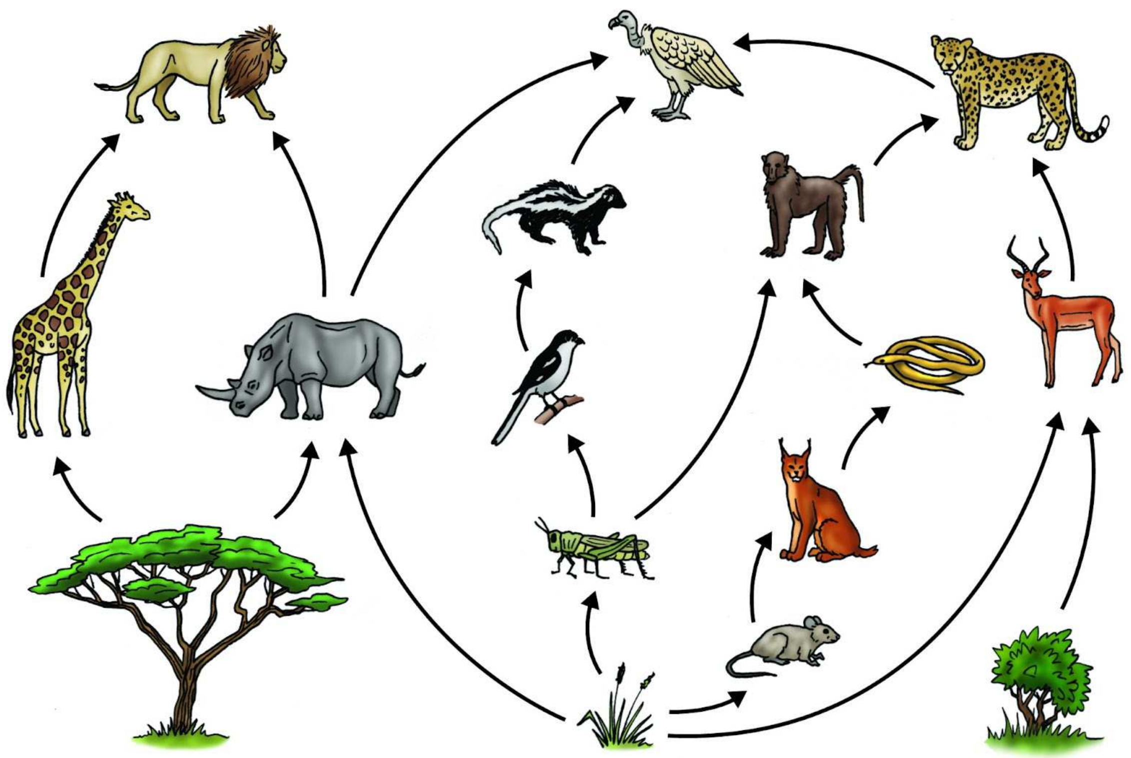
goo.gl/qbccF

So what is a food web?

When we put many different food chains in an ecosystem together, we get a **food web.**

A food web consists of many thousands and thousands of food chains that are connected to each other.

Below is a food web in a savanna ecosystem.



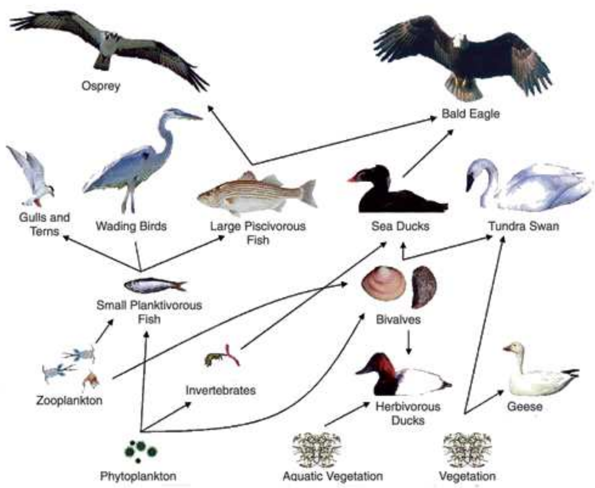
A food web in a savanna

There are also different levels of consumers in an ecosystem:

- Primary consumers are the herbivores which eat the plants, such as the mice and grass in this savanna food web.
- Secondary consumers eat primary consumers.
- Tertiary consumers eat the secondary or primary consumers.

QUESTIONS

1. Study the food web and identify the producers and the consumers. Distinguish between the primary, secondary and tertiary consumers. You can write your answers (in pencil in case you make a mistake) on the food web illustration.
2. Below is another food web consisting of plants, fish and birds. What kind of ecosystem do you think this food web describes?



A food web consisting of plants, fish and birds.

Aquatic - wetland, river, lake, pond, etc

ACTIVITY: Drawing food webs

INSTRUCTIONS:

1. Use the following lists of organisms in a sea and forest ecosystem to draw a food web for each ecosystem.

- Sea ecosystem: phytoplankton, sea weed, zooplankton, crab, lobster (scavenger), prawn, small fish, large fish, turtle, seal, dolphin, killer whale.
- Forest ecosystem: grass, small plants, seeds, beetle (herbivore), butterfly, tree frog, rabbit, mouse, seed-eating bird, insectivorous bird, snake, fox, owl.

Now that we have learned about the living and nonliving things in an ecosystem, and the relationships that exist, let's investigate an ecosystem in or near the school.

Woohoo! I love going outside to study the world around us! Come on, let's go!

DID YOU KNOW?

When a scientist, such as a botanist, zoologist or ecologist, goes outside to do their work and experiments, this is called "field work".

ACTIVITY: Studying an ecosystem

For this activity, the teacher can identify some possible areas in or near the school before the lesson. Then when it comes to the lesson, time is not wasted finding appropriate spots. learners can either all study the same spot, or there can be several spots covering different ecosystems. Encourage learners to take notes on their scrap paper and clipboards whilst they are outside to practise their observation and note-taking skills.

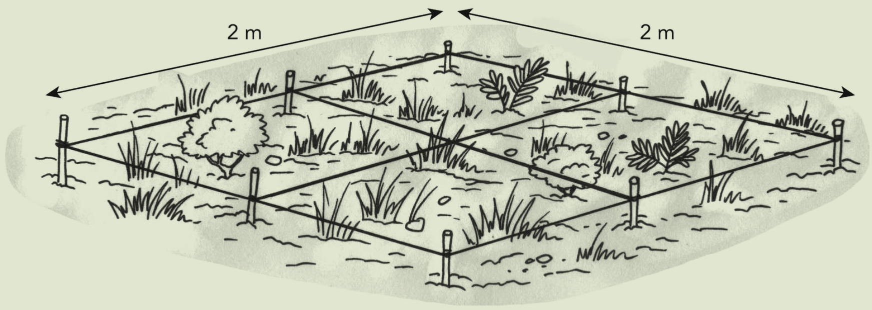
MATERIALS:

- 8 sticks

- string (about 30 m)
- clipboard
- scrap paper
- pen and pencil
- reference books for identifying species names

INSTRUCTIONS:

1. You will work in groups for this activity.
2. Go outside with your teacher and identify an ecosystem in your school grounds, or near to the school which you can study
3. You will need to mark out the area with the sticks and string using the quadrant method.
4. Look at the picture below to get an idea of how to set up your quadrants.
5. The area must be about 5m x 5m.
6. Once you have marked out the square, divide it up into 4 smaller squares with the string so that you have a quadrant with 4 squares as shown in the picture.



A 5m x 5m quadrant

7. When marking out your ecosystem to study, be careful not to damage any of the plants and animals that are there as this is what you will be studying.
8. For each of the 4 quadrants in your ecosystem, count the number of different species of plants and animals.
9. See if you can identify the names of the different plant and animal species using reference books. Fill this out in the table below when you get back to class.
10. Study the non-living things in your ecosystem. For example, what type of soil is present? Are there any rocks? Is there perhaps a stream running through your ecosystem? What is the sunlight like, shady or full sun? Are there any animal shelters present? Make notes about this as you will have to answer questions when you get back to class.

QUESTIONS:

1. What type of ecosystem are you studying?
   Activity-dependent (ie. grass ecosystem, stream/river ecosystem, forest ecosystem, etc)
2. What is the total area of your square?
   Dependent on learner's square, but if the square had 5m sides, then the area is 5mx5m = 25m.
3. Fill out the table below for each quadrant:

	Quadrant 1	**Quadrant 2**	**Quadrant 3**	**Quadrant 4**
Number of plant species				
Number of animal species				
Total organisms in each quadrant				

4. What is the average number of plant species in the whole square? (Hint: To work out the average, add up the number of plant species for each quadrant and divide by the number of quadrant).
5. What is the average number of animal species?
6. What is the average number of total organisms in your ecosystem?
7. What is the number of organisms per unit of area? This is quite tricky - your teacher might need to help you!

To work out number of organisms per unit area, divide the total number of organisms by the total area of the square. The answer will be in number of organisms/m^2. Do this calculation on the board for your learners to see and then repeat with their own numbers.

8. Fill in the names of 3 species of plants and 3 species of animals that you identified in the table below. Do a simple drawing of each organism and write a short description of each species.

Names of species	Drawing	Description
Plant species:		
1:		
2:		
3:		
Animal species:		
1:		
2:		
3:		

9. Write a description of the non-living things in your ecosystem. Explain the availability of food for the animals, the water availability, the type of soil (sandy or rich organic, soil, for example) the amount of sunlight (shady or full sun for example), and describe if there are any natural shelters for animals.

Encourage learners to investigate and explain some possible reasons for observed phenomena, for example, presence of a particular insect, colour of soil, presence of a certain type of plant, etc.

10. Your ecosystem will contain animals and plants which are interdependent and they are connected by their feeding relationships. Use the space below to draw a food web for your ecosystem.

11. Ecosystems are often destroyed due to the impact of humans or other environmental disasters, such as a flood or drought. Identify some possible threat to your ecosystem and write about them below and why they could destroy your ecosystem.
12. Brainstorm possible ways to prevent these threats to your ecosystem from destroying it. Record your ideas below.

KEY CONCEPTS

- There are different ecosystems where living and nonliving things depend on each other.
- Living and nonliving things share an ecosystem.
- Food webs show how plants and animals are connected by their feeding relationship.
- Plants are **producers** of their own food.
- Animals are **consumers** and eat plants or other animals.
- Microorganisms are **decomposers** and break down dead plant and animal material and return the nutrients to the soil.

REVISION:

1. Provide a definition for an ecosystem.
   An ecosystem is an area where living and non-living things depend on each other in many different ways. It consists of all the organisms and their habitats in a given area.
2. Why do you think the feeding relationships between plants and animals in an ecosystem is called a food ***web?***
   This is because when you draw all the links in between all the organisms, it looks like a spider's web as each organism has multiple relationships with other organisms.
3. What is the term given to animals which break down dead plant and animal material?
   Decomposers (microorganisms)
4. Read this blog entry made by a Gr. 6 pupil in Limpopo province reporting on their environment.
   "I live in the Waterberg area in north Limpopo province. This is the first area in South Africa to be named a **biosphere reserve.** During the Stone Age indigenous people lived in this area. They brought in cattle that overgrazed the grasslands and caused a terrible outbreak of tsetse flies. Then in the 1900s Dutch farmers brought in more cattle. All the cattle, goats and sheep of the Dutch farmers and the indigenous people almost destroyed the natural bushveld vegetation. Luckily the people realised the problems in time and started to reintroduce and protect original species of animals and plants to the area. White rhino, giraffe, hippopotamuses and different species of antelope and smaller buck returned. Ecotourism is now very popular and farmers try really hard to stop soil erosion, and to introduce original grass species. Farmers also started to take away fences between their farms to allow animals to walk free."

5. Described what happened to the land when all the cattle, sheep and goats were grazing on it.
   The animals over-grazed the land which means most of the natural vegetation was eaten and did not have enough time to regenerate, so the soil was left without protection and started to erode.
6. Explain what happened to the original, indigenous animals that lived on the land after the cattle farmers arrived?
   Because the original animals could no longer find the natural vegetation they were used to, they either starved or moved out of the area.
7. Can you predict what would have happened if the people did not change the way they used the land?
   The land would become a barren and desolate place with no vegetation left, which means very little rain will also fall there. The precious topsoil would erode and the landscape would become a desert.
8. What factors did they have to change to protect and conserve their land?
   They removed the many cattle herds that were over-grazing and replaced them with the original animals that used to live in that area. They also replanted the natural, original plant species that grew well in that area to provide food for the animals. They then advertised this area as a eco-friendly tourist attraction and made lots of money from tourists rather than from destroying the countryside.
9. If the farmers instead of removing the cattle and goats, rather planted crops on the land, what do you think would have eventually happened?
   The soil would probably not have sustained the crops for many years, so the farmers would spray lots of fertilizers and probably poisonous pest controls which would have further destroyed the environment.

It was so interesting to learn about how everything in an ecosystem is interdependant. And I know more about healthy living, too! Now it's time to join Tom to learn about Matter and Materials.


HOT
WET
CEMENT


Matter and Materials
and Structures

1 Solids, liquids and gases

KEY QUESTIONS

- How are the 3 states of matter different from each other?
- How can we draw pictures of the 3 different states of matter, that show how the particles in the matter behave?
- When matter changes from one state to another, do the particles themselves change, or only their behaviour?
- What is needed to make matter change from one state to another and back again?

1.1 Arrangement of particles

Only 1.75 hours is allocated to this section in CAPS which is quite short. If you do not have time to do all the activities, then leave out the third activity on the states of water.

We have learnt that matter can exist in 3 different states: solids, liquids and gases. All the materials around us are in one or more of these three states. For example, you have all three states in your body! There is bone in your skeleton. There is water in your blood. There is air in your lungs. We have also learnt that each of the states (solids, liquids and gases) has unique properties:

New Words

- state (of matter)
- particle
- vacuum

- Solids keep their shape.
- Liquids flow and take the shape of their container. They fill up a container from the bottom up to a certain level. They take up a fixed amount of space in the container.
- Gases also flow and take the shape of their container. They always fill up the whole space of the container and will escape if the container is open.

We know when we have a solid or a liquid. It is easy to see a solid or a liquid. We cannot normally see gases. We can still check that gases are present by seeing their effects.

Why do solids keep their shape but liquids and gases flow? Why does a liquid stay inside an open container (unless it is poured out), but a gas escapes?

We have to look deep inside each state for the answers to these questions. We will have to use our imaginations like never before!

Did you know that all matter is actually made up of very small particles? These particles are called atoms and molecules, and we will learn more about them much later. For now, we are going to use the term *particle* to describe the smallest 'building blocks' that matter is made of.

The particles that matter is made of are very, very small. Much, much smaller than a tiny grain of sand. Much, much smaller even than a speck of dust! Do you have any idea how small that is?

Mmm, that is quite hard to imagine. I am not so sure.

It is hard to imagine, isn't it Tom? Most people find it very hard to think about, so do not worry, we will go through it slowly.

The particles that matter is made of are much too small to see with the naked eye. They are even too small to see with a strong microscope. So how do we know they exist? Scientists, with special microscopes and other special scientific instruments, have collected evidence that they exist. It is now a well-known and accepted fact that all matter is made up of particles.

VISIT

Particles of Matter (video)

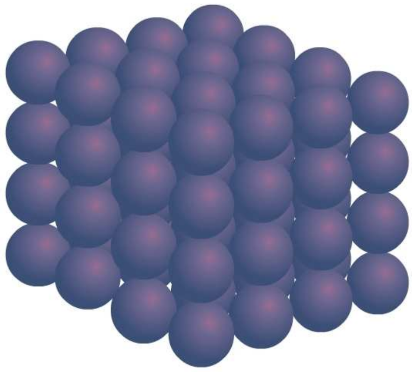
goo.gl/IPhul

The particles in a solid

Let's imagine that we can shrink ourselves down to the size of such a 'matter particle'. What would we see if we could look around inside a solid?

We would see the particles in the solid are **packed tightly together**. This explains why solids cannot be squeezed into a smaller shape - solids **cannot be*compressed***.

We would also see that the particles in the solid have **fixed positions**; they cannot move from their positions. This explains why solids **keep their shape**.



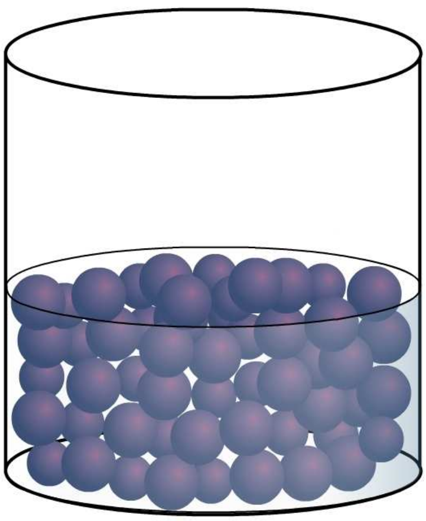
The particles in a solid.

The particles in a liquid

If we could shrink ourselves down to the size of a 'matter particle', and we could look around inside a liquid, what would we see?

We would see that the particles in the liquid are also very **close together**. Like solids, liquids **cannot be compressed** either.

Unlike solids, the particles in a liquid **do not have fixed positions**. They are always moving around. This explains why **liquids flow**, to take the shape of their container.



The particles in a liquid.

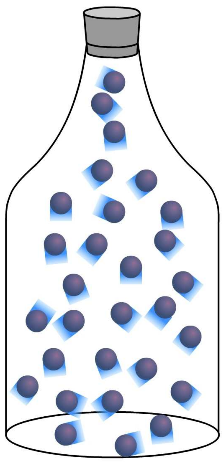
The particles in a gas

If we could shrink ourselves down to the size of a 'matter particle', and we could look around inside a gas, what would we see?

We would see that the particles in the gas are **far apart**. The spaces between the particles are huge compared to the size of the particles themselves. These spaces are empty! We call this a vacuum. This explains why gases **can be compressed** - they can be squeezed into a smaller shape by pushing them closer together. We can make the spaces between them smaller.

The "space" between the particles is empty. It is a vacuum. It is not filled with "air" which is actually a mixture of other gases. If learners ask "There can't just be nothing?", that is just the answer - there is nothing. There is empty space between the particles, just as in outer Space, there is a vacuum. A vacuum is a space entirely devoid of matter. Note that the space between atoms, regardless of the state of matter, or even inside atoms, is vacuum as well. Even the spaces between particles (atoms) in a solid is a vacuum, but these spaces are just much, much smaller compared to the spaces in a gas.

The particles of a gas are always **moving freely**. If they are in a closed container, they will **spread out** to fill the whole container. If they are in an open container they will not stay inside for long. They will **flow out** of the container, and disperse (disperse means to spread out over an area or space.)



The particles in a gas

DID YOU KNOW?

Even when it looks like the water inside a glass is still, the water particles are constantly moving!

VISIT

Acting out the states of matter (video)
goo.gl/dN8NX

ACTIVITY: Pretending to be particles!

This activity would be best performed in a big space, possibly outside on a field. Divide the class into groups. Each group should have enough learners to be able to do the activity meaningfully (ie. 3 is too little in a group, but 8-10 would be ideal). Each group will pretend to be all 3 states so that they get an idea of the difference. There are two key issues here: the submicroscopic behavior of individual particles and the bulk or aggregate effect.

This activity should also be used to revise the role that adding and removing of energy play in changing states. Change of state was dealt with in Gr. 4 and Gr. 5, but not in Gr. 6, so this activity does present an opportunity to revise the concept. An idea is to go through each of the states first so that they can all have a chance being a particle in a different state and you can correct their movements/behaviour. And once they have done this, you can then do the activity again and they can then do the transitions between the states. This emphasises that it is the **same particles in each state**, just their behaviour changes as energy is removed or added.

NB. Another aspect to be aware of when doing this activity, is that this activity may introduce the idea that the particles make decisions. This need not be addressed with the learners, but it is important to be aware of the possible misconceptions which could be introduced with any metaphors used in science education.

In this activity we are going to pretend to be particles! We are going to behave in the same way that particles do in the 3 different states of matter.

Your teacher will divide the class into groups and then we will go through the different states pretending to be the particles!

INSTRUCTIONS:

Solid:

1. Since you are the particles in a **solid**, you should sit or stand as closely as possible to (touching) each other, in neat rows, and move your body, but without moving your feet.

The particles must bump around independently, not sway in unison (as happens once or twice in the video).

2. If we wanted to move these particles from their fixed positions, what should we give them?
   The particles should be given energy.
3. If we wanted these particles to move into fixed positions again and not move around, what must we take away from them?
   We should take away some of their energy.

When you get learners to change state from a solid to a liquid, it is VERY important to stress the point that the particles remain the same on the solid, liquid or gas state - it is just their behaviour which changes. A common misconception is that solids have particles that are solid; liquids, particles that are liquid, and gases have particles that are gases. This is not true as the particles are the same in each state. By getting learners to act out each state they will see that it is the same group of people in each state - just their behaviour and movement changes.

Liquid:

4. Now let's pretend to be the particles in a liquid. Stay in the same group.
5. Since you are the particles in **liquid**, you should now move around but stay in contact with each other all the time.
6. a) If we wanted to move these particles further away from each other, what should we give them?
   The particles should be given energy.
7. a) If we wanted these particles to move into fixed positions and not move around, what must we take away from them?
   We should take away some of their energy.

Teacher note: For the gas state, you could provide each group with a "container" that they have to remain within, such as placing a piece of string out on the ground in a square.

Gas:

8. Now let's pretend to be the particles in a liquid. Stay in the same group.
9. Since you are the particles in **gas**, you should now move around and be as far from each other as possible.
10. If you should come into contact, you must move away from each other immediately.

11. If we wanted these particles to move more slowly and come closer to each other, what should we take away from them?

We should take away some of their energy.

12. If we wanted these particles to move into fixed positions and not move around, what must we take away from them?
    We should take away even more of their energy.

How do we decide whether a material is a solid, a liquid or a gas? The next activity will help us answer that question. We are going to think about some everyday materials. We will use our skills of observation to decide whether they are liquids, solids or gases.

QUESTIONS

Can you remember what your skills of observation are?

Skills of observation are the skills that involve our senses. In today's activity we will be looking at materials and thinking about how their particles might be behaving.

Once we have decided whether a material is a solid, a liquid or a gas, we can make some predictions about the behaviour of the particles in each material. For this we will need our **imagination**, as particles are much too small to see with the naked eye.

I can definitely use my imagination to think about this!

VISIT

Solids, liquids and gas particles (video)

goo.gl/CcDTr

In the video on "Solids, liquids and gases", forces are mentioned (attraction and repulsion), but have not been dealt with yet at this stage. Be aware too that the animation of the two molecules in the solid chocolate as it melts better reflects the situation in a transition to the gaseous state (they bump around in a rectangular box). But this video still provides some sort of animation of a difficult concept.

ACTIVITY: The three states of matter in everyday life

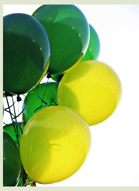
Here you should try to make the link between the observable (macroscopic) and imagined (submicroscopic) worlds that is so important in conceptual development for science. What we see (what we observe on a macroscopic level) tells us more about what is occurring on a submicroscopic level. For instance, the fact that a solid keeps its shape tells us that the molecules in the solid stay in their respective places. Conversely, a submicroscopic understanding helps us to explain what we observe on a macroscopic level. For instance, the knowledge that there are large empty spaces between the particles of a gas helps to explain why two gases mix so easily (a process called diffusion). Remember that this empty space is just that - there is a vacuum between the particles. Also, diffusion occurs relatively easily in miscible liquids. It's not just spaces but also particle speed and freedom to change position that play roles here.

INSTRUCTIONS:

The table below contains a list of containers:

1. Say what material is usually kept in each container. Write your answers in the middle column.

2. Say whether the material is a solid, a liquid or a gas. Write your answers in the column on the right.

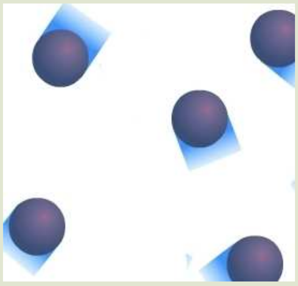
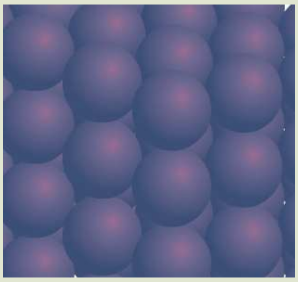
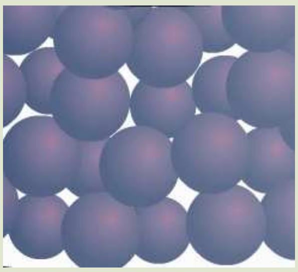
Container	What material is inside?	Is this material a solid, liquid or gas?
	Air (actually helium gas as they are floating)	Gas
	Water, and if boiling then steam (which escapes from the container)	Liquid inside the kettle, steam is a gas
	Ice	Solid
	Air	Gas
	Milk	Liquid

NB. In the above example of a kettle it is very important to take note of what steam is. Steam IS NOT the suspension of very fine water droplets which you are able to see coming out of the kettle. This is actually water in the liquid state, but the droplets are so fine that they are suspended in the air. This misconception arises as in common language, it is often used to refer to the visible mist of water droplets formed as water vapour condenses in the presence of cooler air. People talk about the steam coming out of the kettle or off a mug of coffee which you can see. This is incorrect in terms of physics and chemistry as true steam is invisible. Steam is rather the transparent mixture of gaseous water and air, which is not visible. Steam is the technical term for water vapour, the gaseous phase of water, which is formed when water boils. Water vapour cannot be seen.

In the table below there are 3 pictures.

1. Look at how the particles are arranged in each picture and say whether it represents a solid, a liquid or a gas. Write your answer in the *middle* column.

2. For each picture, choose 2 examples from the previous table and write them in the column *on the right*.

Pictures of particles	Solid, liquid or gas?	Examples of materials
	Gas	Air, steam
	Solid	Ice, ice cream
	Liquid	Water, milk, oil

Draw a picture of the particles inside each of the following examples:

1. bar of soap
2. cup of tea
3. balloon

In the previous activities we learnt about the behaviour of the particles inside materials. In the next activity we will learn about the particles in different states of the same material.

QUESTIONS

1. In the first activity, the learners in your class acted out the behaviour of particles in a solid, liquid and gas. When the 'liquid' learners changed to 'solid' learners, did the learners themselves change as they changed from solid to liquid?
   (Did John, Sarah and Thandi change into different people?) No, they did not change.
2. Did they behave differently?
   Yes.

What happens to the particles inside a material when it changes from one state to another? The next activity will help us to answer that question.

QUESTIONS

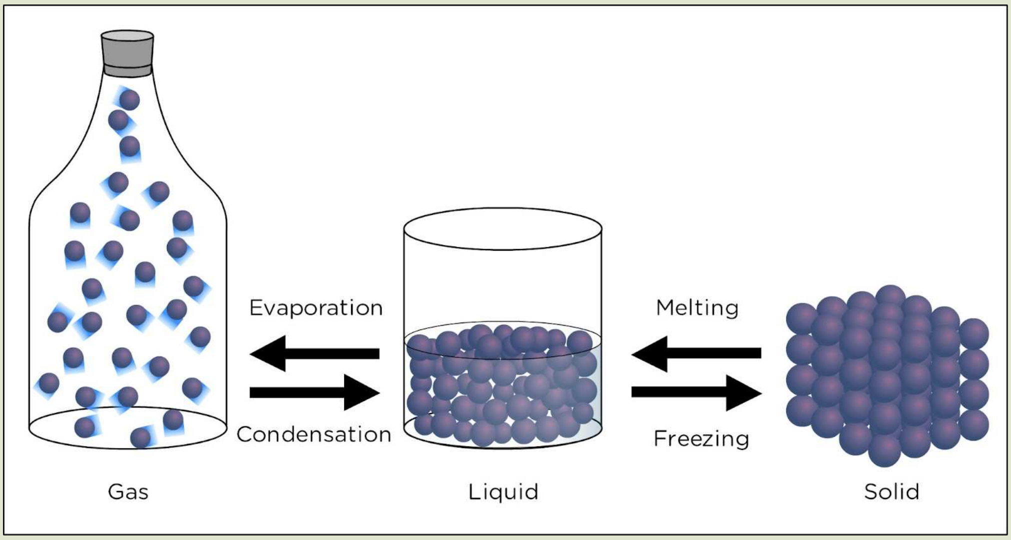
1. In what ways did their behaviour change?
   They slowed down. They moved into fixed positions and stayed in those positions.
2. We know that materials can change from one state to another and back again. Can you think of an example of this?
   Ice melting and then freezing again.

ACTIVITY: The states of water

The objective of this extension activity is to establish that a change in state does not change the characteristics of the particles of a material, they only change the behaviour of the particles. If you cannot watch the video, then use the images supplied below. Although "State Changes" is not specified for Gr. 6 in CAPS, if you have time, it could be a good idea to do this again and refresh what learners did in Gr. 4 as they might not remember and these are important concepts for Physical Science in the higher grades.

INSTRUCTIONS:

1. In this activity we will watch a video about water in 3 different states: solid, liquid and gas.
2. Follow the link below and watch the video, then answer the questions that follow. `goo.gl/ya8f3`
3. If you cannot watch the video, do not worry! Study the picture below instead.



QUESTIONS:

1. What do we call the solid state of water?
   Ice
2. What do we call the liquid state of water?
   Water

3. What do we call the gas state of water?
   Water vapour or steam
4. What do we call the process of ice changing to liquid water?

   Melting
5. What do we call the process of liquid water changing to ice?
   Freezing
6. What do we call the process of liquid water changing to water vapour (steam)?
   Evaporation
7. What do we call the process when steam (water vapour) changes to water?
   Condensation
8. Do the particles in the ice change when the ice melts?
   No, the particles stay the same. They are still water particles.
9. If ice and liquid water have the same particles, why do ice and liquid water have different properties? (Ice is solid and water is liquid.)
   The particles of water behave differently in ice and in water. In ice the particles are packed and stay in position. In liquid water the particles are still very close together but they can move around.
10. How can the water particles in ice be made to move freely? (Think of the 'solid' learners. What did we give them to make them move?)
    We should give the particles some energy.

VISIT

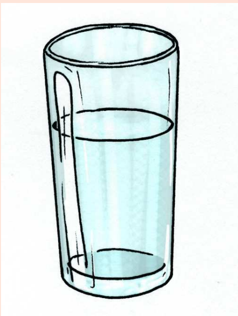
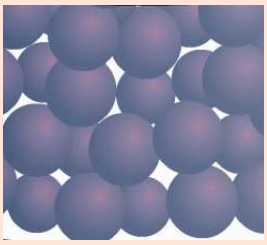
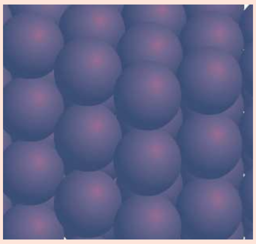
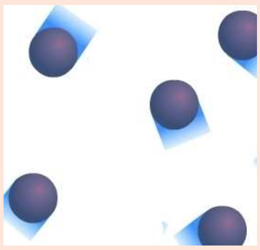
A fun website with activities about materials [1]

KEY CONCEPTS

- Matter can exist as 3 states, namely solids, liquids and gases.
- The particles in solids are closely packed and have fixed positions.
- The particles in liquids are also closely packed but they can move around each other.
- The particles in gases have large empty spaces between them.

REVISION:

1. How can we change water to steam?
   We must heat the water (give it more energy).
2. How can we change water to ice?
   We must make it cold (take away some of its energy).
3. How do the particles in a gas behave?
   The particles in a gas are moving around all the time, and they are far apart. They fill all the space available to them.
4. Below are three images of water in the different states of matter and three images of the arrangement of the particles. Match the image of water with the arrangement of particles by drawing lines between them, to pair them up.

2 Mixtures

KEY QUESTIONS

- What is a mixture?
- When is a mixture also a solution?
- How can mixtures be separated into different materials?

2.1 Mixtures of materials

What is a mixture? A mixture is two or more different materials that have been mixed together.

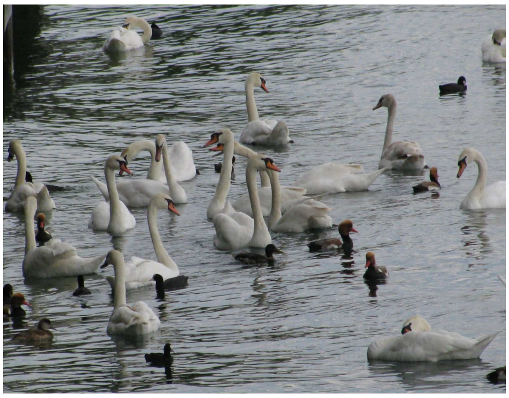
In some mixtures, the different materials are still clearly visible after mixing. A mixture of peanuts and raisins would be an example of such a mixture. How would we separate the peanuts and the raisins? Well, we could simply pick the raisins out of the peanuts!

A mixture of peanuts and raisins

Can you think of other mixtures in which the different materials are still clearly visible after mixing? Look at the pictures below for some ideas.

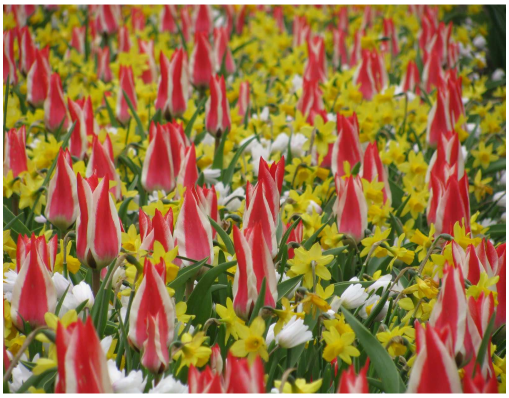
A mixture of different coloured jelly beans

A mixture of different fruits in a fruit salad



A mixture of swans and ducks on a lake

A mixture of red, green, yellow and orange sweet peppers



A mixture of pink, yellow and white flowers

A mixture of different shells from the beach

In other mixtures, the materials are mixed so thoroughly that it seems one material has 'disappeared' into the other. Such mixtures are called solutions. We will learn more about solutions shortly.

Making mixtures

First, we will have some fun making mixtures.

ACTIVITY: Mixing solids

MATERIALS:

- 500g bag of barley (beans or lentils will also do)
- 500g bag of rice
- Small packet of sugar
- Clean sand (from the beach or from a building site)
- Plastic spoons for scooping
- Small yoghurt tubs or paper cups for mixing
- Sieve (the type used for sieving flour)

You need a sieve (or strainer) that is coarse enough to let all the sugar through. A suggestion is to sieve the sugar first. Whatever passes through the sieve can be used in class.

INSTRUCTIONS (Part 1):

1. Place 10 scoops of barley in the mixing tub.
2. Place 10 scoops of rice in the mixing tub.
3. Stir the barley and rice until they are mixed.
4. Answer the questions below.

QUESTIONS:

1. Can you still see the individual rice and barley grains?
   Yes.
2. Draw a picture of the mixture.
3. Separate the mixture into a pile of rice grains and a pile of barley grains. Write a sentence to explain how you separated the mixture.
   The learners may answer: 'I picked the barley grains out of the rice' or 'I picked the rice grains out of the barley'.
4. Did the barley and rice grains change in any way, or do they still look the same as before they were mixed?
   The grains still look the same.

INSTRUCTIONS (Part 2):

1. Place 10 scoops of rice in the mixing tub.
2. Place 10 scoops of sugar in the mixing tub.

3. Stir the sugar and rice until they are mixed.
4. Answer the questions below.

QUESTIONS:

1. Can you still see the individual rice and sugar grains?
   Yes.
2. Draw a picture of the mixture.
3. Separate the mixture into a pile of rice grains and a pile of sugar grains. Write a sentence to explain how you separated the mixture.
   The learners may answer: 'I picked the rice grains out of the sugar'.
4. Can you think of a quick way to separate the mixture, using a sieve? Describe what you would do to separate the mixture. Describe what would happen to the mixture.
   I would put the mixture in the sieve. The sugar grains will fall through the sieve and the rice grains will stay behind.
5. Did the sugar and rice grains change in any way, or do they still look the same as before they were mixed?
   The grains still look the same.

INSTRUCTIONS (Part 3):

Teacher note: This part of the activity needs to be planned-for by the teacher. The sand and sugar must be of the same average grain size and should be sieved in advance to ensure this is so. The impact of the uselessness of sieving will be partially or totally lost otherwise.

1. Place 10 scoops of sand in the mixing tub.
2. Place 10 scoops of sugar in the mixing tub.
3. Stir the sugar and sand until they are mixed.
4. Answer the questions below.

QUESTIONS:

1. Draw a picture of the mixture.
2. Can you separate the mixture into a pile of sand grains and a pile of sugar grains? How long would it take if you picked the sand grains out of the sugar one by one?
   The learners may answer: 'It would be possible but it would take a very long time.'
3. Do you think that it would be possible to separate the mixture using a sieve? Why do you think so?
   It would not be possible to separate the mixture with the sieve, because the sugar grains and the sand grains are both small enough to fall through the sieve.

In the previous activity we mixed solid materials with different sized grains and learnt that:

- when the grains are large enough, we can separate them by hand; and
- when the two materials have grains of different sizes they can be separated by sieving.

In the next activity we will explore mixtures of solids and liquids.

ACTIVITY: Mixing a solid and a liquid

MATERIALS:

- clean sand (from the beach or from a building site)
- plastic spoons for scooping
- small yoghurt tubs or paper cups for mixing
- sieve (the type used for sieving flour)
- kitchen towel or paper towel

INSTRUCTIONS:

1. Place 5 scoops of sand in the mixing tub.
2. Pour water into the mixing tub until it is half-full.
3. Stir the sand and water until they are mixed.
4. Answer the questions below.

QUESTIONS:

1. Can you still see the individual sand grains?
   Yes.
2. Draw a picture of the mixture.
3. Can you separate the mixture into a pile of sand grains and water?. How long would it take if you picked the sand grains out of the water one by one?
   The learners may answer: 'It would be possible but it would take a very long time'.
4. Would it be possible to separate the sand from the water using the sieve? Say why or why not.
   No, it would not be possible, because the grains and the water would both pass through the sieve.
5. Would it be possible to separate the sand from the water using the paper towel? If you think it would be possible, explain what you would do.
   Yes, it would be possible. I would pour the mixture through

the towel. The sand will stay behind on the towel, while the water will pass through it.

6. Do you think it would be possible to separate sugar and water in the same way (by filtering the mixture through a towel)? Say why or why not.
   I think it would not be possible because the sugar will dissolve in the water and also pass through the towel.

In the previous activity we mixed a solid material (sand) with a liquid (water) and learnt that sometimes a mixture of liquid and solid can be separated by filtering. In the activity the towel was used as a filter.

Is it possible to mix liquids? Can you think of examples of mixtures of liquids? Look at the picture below for some ideas.

Juice is a mixture of liquids. [1]

So when I pour juice concentrate into water to make my favourite drink, I am making a mixture of liquids!

That is right Tom. Let's look at some liquids which are not so easy to mix together.

ACTIVITY: Mixing liquids

MATERIALS:

- water
- cooking oil
- plastic spoons for scooping
- small glass or transparent plastic cup for mixing

INSTRUCTIONS:

1. Place 10 scoops of water in the mixing tub.
2. Place 10 scoops of cooking oil in the mixing tub.
3. Stir the oil and water until they are mixed.
4. Let the mixture stand for a few minutes, then answer the questions below.

QUESTIONS:

1. Did the liquids mix? Describe what the mixture looks like.
   The two liquids did not mix. There are two liquid layers.
2. Draw a picture of the mixture.

3. Do you think it would be possible to scoop all the oil out of the water? How long do you think it would take?
   The learners may answer: 'It would be possible to scoop out some of the oil but it would take a very long time. I don't think it would be possible to get all the oil out of the water'.
4. Would it be possible to separate the liquids using a sieve or a filter? Say why or why not.
   No, it would not be possible, because the oil and the water would both pass through the sieve and the filter.

5. Can you think of another way to separate the mixture into oil and water? If you think it would be possible, explain what you would do.
   Learners may suggest pouring (decanting) the oil from the water.
6. Do you think it would be possible to separate a mixture of juice and water using any of the methods that we have used so far (hand-separating, sieving, filtering or decanting)? Say why or why not.
   I don't think it will be possible because the juice and water will be mixed too thoroughly.

The real reason is that the juice will be dissolved in the water, which means the substances are mixed on a level of individual particles, but learners may not be able to put this into words yet.

In the previous activity we mixed two liquids (water and oil) and learned that sometimes a mixture of two liquids can be separated by decanting.

Separating mixtures

In the next section we will summarise all the different ways of separating mixtures. We have made different mixtures and tried to separate them using a variety of methods. In this section we will revise all these separation methods.

ACTIVITY: Separating mixtures

INSTRUCTIONS (Part 1)

The table below contains pictures of mixtures.

1. For each of the mixtures in the table, write which materials it is made up of in the middle column.
2. Write how you would separate the mixture in the column on the right.

Picture of mixture	Materials in the mixture	How the mixture could be separated
	Peanuts and raisins	Pick the raisins out of the mixture. The peanuts will remain.
	Spaghetti and meatballs	Pick the spaghetti out of the sauce, which will remain behind.
	Peach, plum, banana and berries	Pick out the berries, followed by the banana pieces, etc. until all the ingredients have been separated.
	Boys and girls	Tell the boys to stand on one side of the class and the girls to stand on the other side.

INSTRUCTIONS (Part 2)

The table below contains descriptions of mixtures.

1. For each of the mixtures in the table, write which states it is made of in the middle column (solid, liquid or gas).
2. Write how you would separate the mixture in the column on the right.

Description of mixture	States in the mixture	How the mixture could be separated
Water and oil	Liquid and liquid	Decant the oil off the top.
Water and sand	Liquid and solid	Decant the water off the sand, or filter the mixture.
Sugar and rice	Solid and solid	Pick the rice out of the sugar, or sieve the mixture through a sieve with holes that are small enough to let the sugar through but not the rice grains.

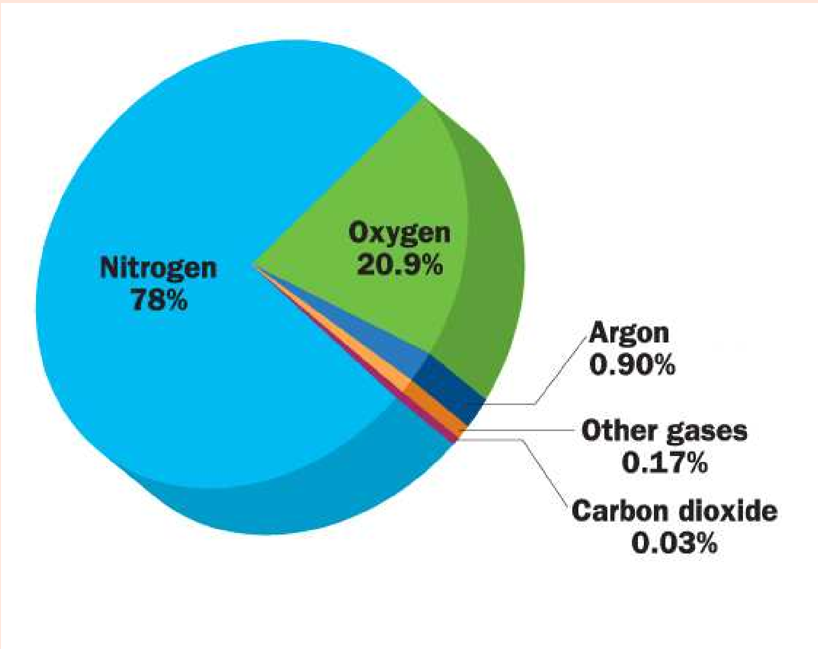
It is possible to mix materials in many different combinations. In a mixture, the materials that have been mixed do not change. They keep their individual properties. Sometimes it is possible to separate a mixture into the individual materials again.

KEY CONCEPTS

- A mixture consists of two or more different materials mixed together.
- Sometimes mixtures can be separated into the individual materials again.
- Some of the ways in which mixtures can be separated are: sieving, filtering, hand sorting, and settling followed by decanting.
- When a material changes from a solid to a liquid, the process is called melting.
- When a material forms a solution in another material, the process is called dissolving.
- Melting and dissolving are two different processes.

REVISION:

1. What is a mixture?
   A mixture is made when we mix two or more materials together.
2. List six different ways in which solids, liquids and gases can be combined to form mixtures.
   Combine a solid with a solid.
   Combine a solid with a liquid.
   Combine a solid with a gas.
   Combine a liquid with a liquid.
   Combine a liquid with a gas.
   Combine a gas with a gas.
3. Did you know that the air we breathe is actually a mixture of many gases? The pie chart below shows all the different gases in clean air.



   a) Use the information in the pie chart and make a list of all the gases that are found in clean air.
   b) Which gas is the most abundant in air? (Which gas is found in the largest amount?) What percentage of this gas is present in clean air?
   c) What percentage of oxygen is present in air?
   d) If you had 5000 air particles, how many of these particles would be oxygen particles?
   a) Nitrogen, oxygen, argon, carbon dioxide, and other gases.

b) *Nitrogen, 78%.*
c) *20.9%*
d) *20.9% of 5000 particles are oxygen particles.*
Therefore, no. of oxygen particles = 20.9 % of 5000
= (20.9 / 100) x 5000
= 1045 oxygen particles.

We have learnt that materials exist as solids, liquids or gases. What will happen when we mix different materials together? Let's find out!

3 Solutions as special mixtures

KEY QUESTIONS

- When is a mixture also a solution?
- Do all substances dissolve in water?
- Is there a limit to how much of a substance can be dissolved in a given amount of water?
- How can the components of a solution be separated?

The important message to convey in this section is that solutions ARE mixtures, albeit of a special type. The word mixture is used to describe any combination of two or more substances. A mixture can only be a solution if the particles (and here we are referring to the smallest possible particles, namely molecules) of the two substances are separate from each other and mingle freely with each other. Solutions are mixtures even at the level of molecules (or other fundamental particles).

The CAPS document includes the following two statements that are somewhat problematic:

when substances dissolve, solute particles become dispersed in the spaces between the solvent particles

a solution becomes saturated when enough solid solute has been added to fill up all the spaces in the solvent

The use of the following alternative statements is recommended:

when substances dissolve, solute particles become dispersed (spread) throughout the solvent particles

a solution is saturated when the maximum amount of solute has been dissolved in the solvent

The important idea to convey is that the particles of solute and solvent are closely mixed, in other words they are mixed on the level of atoms and molecules (particles is the preferred term here for learners at this level of development).

One possible challenge with this chapter and the one following (*Dissolving*) is that the concepts (solution, dissolving, soluble vs insoluble etc.) are almost inextricably linked, which makes it difficult to explain one concept without using words that are only explained in a later section. For instance, it is really difficult to explain the concept of a solute dispersing into a solvent without using the word *dissolve* (which is covered conceptually in *Solutions*, but is only *named* much later in the chapter *Dissolving*). The word *dissolve* will be introduced in this chapter, but used sparingly and only towards the end, so as to sensitise learners to its use, and the way in which the concept links with others in this chapter.

3.1 Solutions

Take note of the following definitions of the new words.

- Solution: A homogeneous mixture of two or more substances, which may be solids, liquids, gases, or a combination of these.
- Solvent: A substance in which other substances can dissolve.
- Solute: A substance that dissolves.

In the last chapter we looked at mixtures. We are now going to look at a special case of mixtures, which are called solutions.

When is a mixture also a solution?

New Words

- solution
- solvent
- solute

When two substances are mixed it will be possible to still see each substance in the mixture. Is sugar and sand a mixture? Yes!

A solution is a special type of mixture. What makes a solution so special? When is a mixture also a solution?

Often, the best way to answer a question is to ask it in a different way: When is a mixture NOT a solution?

In the next activity we are going to make a few mixtures and then decide which of them are solutions, and which of them are not. That should help us find the answer to the question: When is a mixture also a solution?

ACTIVITY: When is a mixture also a solution?

In this activity we are going to mix substances with water to see which ones make solutions.

How do you think will we know when a substance has made a solution with the water?

It will look as if it has disappeared. We will not be able to see the particles of the substance in the water.

MATERIALS:

- small quantities of the following substances:
  - sugar
  - salt
  - sand
  - oil
  - vinegar
  - flour
  - copper sulfate
- tap water
- clean yoghurt tubs (small)
- plastic spoons for scooping and stirring

The accepted spelling is 'sulfate' but very few people are aware of this, and most textbooks still use the old spelling 'sulphate'. When working with copper sulfate, as with most chemicals, safety precautions must be adhered to, such as wearing safety goggles and avoiding contact with the skin, eyes and nasal passages. This is a good opportunity to discuss safety precautions in general when doing science investigations, including wearing protective clothing (lab coats, goggles, gloves), as well as acting cautiously and carefully when around chemicals, and especially not drinking or inhaling any substances.

INSTRUCTIONS:

1. Half-fill a yoghurt cup with tap water.
2. Place one small scoop of sugar in the water and stir it well.
3. Look at the mixture and discuss what it looks like.
4. At the top of the table below, a few possible observations are given. Choose the one that is the best description for what you observed, by making a cross in the matching column. (You may also choose more than one column.) The first substance (sugar) has been filled in to show you what you should do.
5. Once you have recorded your observation, you can empty the yoghurt tub.
6. Repeat steps 1 - 4 until you have tested all the substances on the list.

Table: Mixing substances with water

Substance	**Observations**	
	It looks as though **none** of the substance has disappeared	It looks as if **all or most** of the substance has disappeared
sugar		X
salt		X
sand	X	
oil	X	
vinegar		X
copper sulfate		X

QUESTIONS:

1. Which of the substances seemed to disappear when they were mixed with the water?
   Sugar, salt, vinegar and copper sulfate
2. Which of the substances in this activity did NOT form solutions with water? (Hint: which ones did not look as if they 'disappeared' into the water?)
   Sand and oil

What is a solution?

When two substances make a solution, it will look as if the one substance has disappeared into the other:

- The substance that looks as if it has disappeared is called the

solute.

- The substance that we can still see is called the **solvent**.
- The solvent and solute together are called the **solution**.

The definitions provided here for solute and solvent may be a suitable distinction at this level for learners, but in general the distinction is not so clear. We tend to call the one there is more of the solvent, for example, brass is zinc dissolved in copper, and air is oxygen and other gasses dissolved in nitrogen.

QUESTIONS

Is sugar and sand a solution? (You may want to page back to Part 3 of the activity *Mixing solids* to remind yourself.)

No, because if we look carefully we can still see the individual sugar and sand grains.

Teacher note: One way to explain this would be as follows: If we could shrink ourselves down to the size of molecules (or 'particles', to use the language at this level) we would see clumps of sugar and sand, even if the sugar and sand crystals are really small.

ACTIVITY: Which mixtures are solutions?

In this activity we will use our observations from the previous activity (*When is a mixture also a solution?*) to decide which of the mixtures we made were solutions.

QUESTIONS:

In the activity *When is a mixture also a solution?*, we mixed different substances with water. We saw that some of the substances looked as if they had disappeared in the water.

1. What name do we give to the substance that looks as if it has disappeared?
   Solute

2. What name do we give to the substance that we can still see?
   Solvent
3. What name do we give to these mixtures?
   These mixtures are solutions

Complete the table using the information about the sugar - water mixture as an example.

Mixture	**Is the mixture a solution after stirring? (Yes or No)**
Sugar and water	Yes
Salt and water	Yes
Sand and water	No
Oil and water	No
Vinegar and water	Yes
Copper sulfate and water	Yes

In the activity above, we mixed different substances with water.

1. Which substance is the **solvent** in all the mixtures?
   Water
2. From the mixtures above, choose an example of a solution that consists of a **solid solute** and a **liquid solvent**.
   Any one of the following examples: Sugar in water, salt in water or copper sulfate in water.
3. From the mixtures above, choose an example of a solution that consists of a **liquid solute** and a **liquid solvent**.
   Vinegar and water
4. From the mixtures above, choose an example of a **mixture of two liquids** that is NOT a solution.
   Oil and water

Wait! How is it possible for one substance to 'disappear' into another?

Good question Tom. We know that science is not magic, and that it is not possible for something to disappear!

How do we explain the observation that one substance (the solute) 'disappears' into the other (the solvent)?

In the next activity we will look more closely at a solution, in order to understand how it is possible for the solute to look as if it disappears into the solvent.

To emphasise the logic so far, we make observations of things around us and we try to explain them using the models we develop. The learners need to get the message that the particle view is not only a description of a reality we cannot directly observe, but also a tool to explain things that we can observe.

ACTIVITY: What is a solution?

MATERIALS:

- copper sulfate crystals
- tap water
- clear container, such as a glass beaker or test tube (a water glass will also do)
- plastic spoon for scooping and stirring

INSTRUCTIONS:

1. Look at the copper sulfate crystals and the water. Write one sentence to describe each substance in the table below.
2. Mix one small scoop of the copper sulfate with enough water

to dissolve it completely (half a cup of water should be enough). Let it stand for a few minutes until it clears.

Teacher note: ensure that all of the copper sulfate has dissolved, or learners will be confused by some of the results of this activity.

3. Look at the copper sulfate solution and write a sentence to describe it in the table below. Save it for answering the questions that follow.

Table: Description of a copper sulfate solution in water

Substance or mixture	**Description (what it looks like)**
Water	The water is a clear, colourless liquid.
Copper sulfate crystals	The copper sulfate is a blue solid.
Copper sulfate solution	The solution is a clear, blue liquid.

QUESTIONS:

VISIT

How water mixes with a solute to make a solution (video)

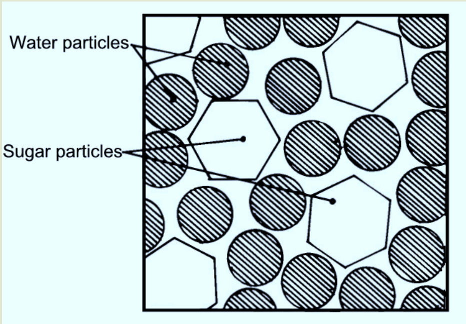
goo.gl/zH7FY

1. Look at the solution. How can you tell that there is copper sulfate in the water? Another way to ask this question would be: What **evidence** do you have that there is copper sulfate in the water?
   The water is blue. The water is the same colour as the copper sulfate crystals.
2. Can you see any copper sulfate crystals moving about in the water?
   No.
3. Explain your answer to question 2.

The crystals separated into their individual particles that are too small to see with the naked eye.

4. What do you think happened to the copper sulfate particles? Where are they now?
   The copper sulfate particles have been mixed up with the water particles.
5. Draw a picture of the particles in the copper sulfate solution in the space. You can use the following symbols to represent each substance:
   - shaded circles to represent water particles
   - white hexagons to represent copper sulfate particles

   Teacher note: The sketch should show the container with liquid particles at the bottom. In the liquid the black dots should be homogeneously dispersed among the clear ones, in the same way as the sugar particles are dispersed among the water particles in the following diagram:



In the video clip on "How water mixes with a solute to make a solution", the language may be a bit difficult to understand, but if you watch the clip you will get the general idea. However, there is no problem with selling this (and other) clips on the grounds that it uses ideas and language that they (the learners) can access when they get older. You, the teacher, can even challenge the learners to find out about some of the new ideas in this clip and report back to you personally or in class. Forces are also dealt with again in this video - this can be introduced by asking "What keeps the particles of a solid or liquid from moving away from each other?" The answer is that there are forces between the particles.

3.2 Soluble substances

NB: A very common misconception is that sugar or salt "melts" away when added to water. Dissolving (in the case of sugar and salt in water) requires two materials to be mixed together (a solute will dissolve in a solvent), whereas in melting (in the case of ice), there is heating of one material to change its state. A single substance melts when it changes from one state to another. In order to avoid introducing this misconception which then sticks with learners into the later grades, never use the word "melt" when describing dissolving. Emphasise to learners that the sugar does not melt and that melting is different - it is a change of state.

New Words

- soluble substance
- insoluble substance

We have a word for substances that form solutions when they are mixed with water. These substances are called **soluble** substances.

Substances that do NOT form solutions when they are mixed with water are called **insoluble** substances.

In the next activity we are going to use some findings from a previous activity (*Which mixtures are solutions?*) to link this new idea to what we know about **solutions**.

ACTIVITY: Soluble or insoluble?

INSTRUCTIONS:

1. The table from the activity *Which mixtures are solutions?* has been copied below, and an extra column has been added.
2. Use the extra column to say whether the substance that was mixed with water in the activity is soluble or insoluble.

Table: Soluble and insoluble substances.

Mixture	Is the mixture a solution? (Yes or No)	Is the substance that was mixed with the water soluble or insoluble?
Sugar and water	Yes	Soluble
Salt and water	Yes	Soluble
Sand and water	No	Insoluble
Oil and water	No	Insoluble
Vinegar and water	Yes	Soluble
Copper sulfate and water	Yes	Soluble

QUESTIONS:

Complete the following sentences by writing **soluble** or **insoluble** in the open spaces.

1. Substances that do NOT form solutions when they are mixed with water are called __________ substances.
   insoluble
2. Substances that form solutions when they are mixed with water are called __________ substances.
   soluble

In the previous chapter, we saw how to separate mixtures. For example, we could hand sort the objects, sieve the larger grains out of the mixture and decant the oil from the top of the water. But what about a solution? Do you think you can separate the sugar from the solution once it has been dissolved? Let's try to find out the answer to this question!

INVESTIGATION: How can we recover a solute (sugar) from the solution?

Prepare the sugar solution beforehand (or at the beginning of the class so that learners see you mixing) by mixing sugar into water and making sure it is dissolved. You can prepare enough for the whole class to use or do this experiment as a demonstration. Start off by asking learners if they can see the sugar. Revise the concept that it has dissolved into the water to form a solution. Before starting the investigation, ask the learners how they think you could separate or recover the sugar from the solution.

- Ask learners if they think you could separate by sieving or filtering. After they answer you, demonstrate filtering by pouring the sugar solution through filter paper placed in a funnel into another beaker. Show the learners the filter paper so that they can then see that there is no sugar left behind on the filter paper. They can fill in their observations in the table.
- Ask learners if they think settling will work. You could prepare a sugar solution the day before the class and then leave it overnight in the classroom and tell learners you want to see the next day whether the sugar has settled out of the solution. They can then see for themselves the next day during the next lesson that it has not settled out and that this technique cannot be used to separate a sugar solution. They can fill in their observations in the table.

Continued...

- The next step is to see what will happen if we evaporate the water. This probably will not be a logical step for the learners to take. So ask leading questions such as, what do they think will happen to a dish of water if you leave it outside in the sun. Answer: It will evaporate. Note though, that evaporation does not need heat to take place, but the heat from the sun will speed up the process.
- Ask learners what they think will happen to the sugar solution if you leave it outside in a dish to evaporate? Will the water evaporate? What will happen to the sugar? The learners should see the need to perform the investigation from asking these questions as the answer might not be obvious.
- While you are waiting for the water to evaporate and leave behind the sugar crystals, you can demonstrate another way of recovering the sugar (solute) which is by boiling the sugar solution. Set up a beaker of the sugar solution on a stand over a Bunsen burner. Light the Bunsen burner and allow the solution to boil. Do not put a lot of the sugar solution into the beaker otherwise the demonstration will take too long. Boiling speeds up the process and the last remaining water can be left to evaporate until only sugar crystals are left at the bottom of the beaker. This is called crystallisation.

AIM (What do you want to find out?):

MATERIALS AND APPARATUS:

- sugar solution
- 2 beakers
- funnel
- filter paper
- evaporating dish
- stand
- Bunsen burner
- matches

METHOD:

1. Pour a small amount of the sugar solution into an evaporating dish.
2. Place the dish outside, or on a windowsill, in a sunny spot.

Remind learners that evaporation does not require additional heat to take place, but heating speeds up the process.

3. Leave the dish outside and check regularly to observe what is happening to the sugar solution.
4. Your teacher will demonstrate whether you can also recover the sugar by boiling the solution.
5. Record all your observations in the table below.

RESULTS AND OBSERVATIONS:

Method	Result - Could you recover the sugar from the solution?
Sieving or filtering	
Settling overnight	
Evaporation	

1. Which methods worked to recover the sugar from the solution?
   Boiling and evaporation.
2. What was left at the bottom after completing these methods?

   Sugar crystals.
3. Why do you think this happens?
   This is because the water evaporates or boils and turns into water vapour. The sugar cannot evaporate and is left behind as a solid in the form of crystals.
4. Which method do you think works best and why?
   Learner dependent answer: They could say boiling as it is faster, or they could say evaporation as it does not require much equipment such as a Bunsen burner, etc.

CONCLUSION:

What can you conclude from this investigation?

Now that we have looked at how to separate a solute from a solution, have you ever wondered just how much sugar you could dissolve in the water? Do you drink tea, for example, and put sugar in? How many teaspoons of sugar do you think you can dissolve in a cup of tea? In the next section we will explore this idea.

3.3 Saturated solutions

New Words

- dissolve
- saturated solution

Explanation of new words

- Dissolve: When the particles of a solute spread throughout the particles of a solvent, we say the solute dissolves in the solvent to make a solution.
- Saturated solution: When so much solute has dissolved that no more of it will dissolve, we say the solution is saturated.

Suppose we were to make a cup of tea and we put in 3 teaspoons of sugar. Mmm... lovely sweet, warm tea!

QUESTIONS

Now imagine you add three more teaspoons of sugar to the tea. How many teaspoons of sugar did we add?

Six, in total.

When the particles of a solute spread throughout the particles of a solvent, we say the solute **dissolves** in the solvent to make a solution.

Do you think 6 spoons of sugar will dissolve in the tea? Who has tried this at home? What did you find?

Now let us imagine 3 more teaspoons of sugar is added to the tea. Very sweet tea! Do you think all the sugar will dissolve?

How much sugar do you think we will be able to dissolve in the tea? An infinite amount? A cupful or less? Let's try it out.

ACTIVITY: How much solute will dissolve?

This investigation makes the ideal demonstration, and could even be given as a homework experiment. It also allows for the extension of learners' understanding of the concept of solubility and saturated solutions. You could heat the saturated sugar solution for the learners to show that more solute will dissolve when the solvent is at a higher temperature (this is mostly true, but not always!). If more sugar is added to the heated solution until it is saturated at the higher temperature, then the solution will be supersaturated when cooled. A sugar crystal can be suspended in the solution before it cools down and more sugar crystals will grow on the crystal and on the thread used to suspend the crystal. The less the solution is disturbed, the larger the crystals will grow.

MATERIALS:

- clear container (a glass beaker would be best, although a large yoghurt tub would also work, but not if you decide to heat it later)
- tap water
- small packet of sugar
- plastic spoon for scooping and stirring

INSTRUCTIONS:

1. Measure half a cup of water into the container.
2. Add a teaspoon of sugar to the water. Stir until all the sugar has dissolved.
3. Add another teaspoon and stir again.
4. Keep adding teaspoons of sugar until no more sugar can dissolve.

QUESTIONS:

1. How many spoons did you add until no more sugar dissolved?
2. How did you know that no more sugar could dissolve?
   The sugar stopped dissolving and sank to the bottom of the container.
3. Complete the following sentences by writing **saturated** or **unsaturated** in the open spaces.
   a) When no more solute can dissolve in a solution, we say it is a __________ solution.
   b) When more solute can be dissolved in a solution, we say the solution is __________.

   a) saturated
   b) unsaturated

VISIT
Growing sugar crystals (video)
goo.gl/1UP5w

Now let's have some fun with saturated solutions!

ACTIVITY: Making sugar crystals

Sugar crystals can take a few days to a week to "grow", so set up this experiment and then leave the jars on the windowsill where they will not be disturbed. You can use different coloured food colouring so that learners have brightly coloured crystals at the end. Each learner can make their own or you can scale up the quantities below and make it in one big beaker, or possibly three different ones with different colours. The quantities listed below are for one crystal to grow in one jar. However, it would be ideal for each learner to have their own crystal.

MATERIALS:

- 1/2 cup water
- 1 cup table sugar
- clean glass jar
- food colouring
- pencil
- rough string (cooking twine works great)
- beaker or pan for boiling water and making solution
- spoon
- stove or Bunsen burner and stand

INSTRUCTIONS:

1. Tie a length of string onto a pencil. The string should be long enough to reach almost to the bottom of your glass jar.
2. Make a saturated sugar solution by boiling the water in the pan, slowly adding sugar a teaspoon at a time. If you have a Bunsen burner and stand, you can do this in a beaker over the flame.
3. Stir after each spoonful and keep adding sugar until the sugar won't dissolve any more in the water. If you do not add enough sugar, your crystals will not grow quickly. If you use too much sugar, your crystals will grow on the undissolved crystals and not on the string.
4. Pour some food colouring into your saturated solution to give the crystals a colour.
5. Pour your solution into the clear glass jar. If you have undissolved sugar at the bottom of your container, avoid getting it in the jar.
6. Place your sting inside the glass jar.

A tip is to weight the string with something heavy so that it does not touch the sides of the glass jar.

7. Place your jar where it will not be disturbed and check on your string each day and observe the crystal growth.
8. Allow the crystals to grow until they have reached a size that you desire, or until they have stopped growing. You can pull the string out and allow the crystals to dry. You can eat them or keep them!

The best crystals form when the process happens slowly and the water cools down slowly. The cooled solution has a concentration above the saturation point and is said to be **supersaturated.** Crystal will more easily form when they have a place to start growing, like on the string.

QUESTIONS:

VISIT

Copper sulfate crystal time lapse (video)

goo.gl/71L35

1. How long did it take for crystals to start forming on the string?
   Learner dependent answer.
2. What are the crystals made of?
   Sugar
3. Why do you think we boiled the water when dissolving the sugar in the solution?
   This might be quite difficult for learners to answer but have this question as a class discussion. Boiling the water allows

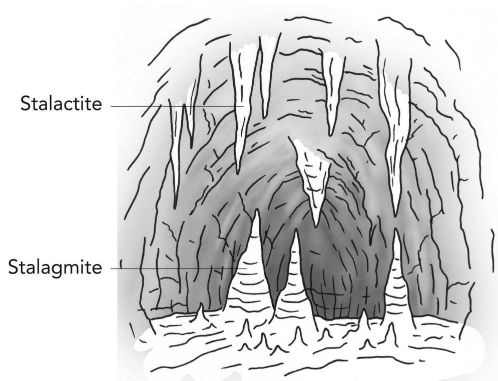
one to dissolve more solute than if the water was cool or at room temperature. This results in a supersatured solution.

An example of crystals in nature

Have you ever visited a cave? Inside, you may have seen crystal formations called stalactites and stalagmites. Stalactites and stalagmites form inside limestone caves. Stalactites hang down like icicles and stalagmites grow from the floor of the cave upwards. Stalactites and stalagmites always occur in pairs. Caves form when water slowly dissolves the limestone underground. The dissolved limestone can crystallise again when the water evaporates. This is also a slow process and it happens when water drips down from the ceiling of the cave over a long period of time. The water drops that land on the floor of the cave evaporate over time, and where they fall on the same spot repeatedly, a stalagmite eventually forms. Over many thousands of years, the stalactite and stalagmite may connect to become a column.

New Words

- insoluble substance



Stalactites and stalagmites forming in a cave.

Cango Caves in Oudtshoorn in South Africa[1]

Insoluble substances

We have a word for substances that do NOT form solutions when they are mixed with water. These substances are called **insoluble** substances.

QUESTIONS

Can you remember what substances are called that DO form solutions when they are mixed with water? Write the term below.

Soluble substances

Some substances that are insoluble in water may be soluble in other solvents! Think about this for a moment: Is nail polish soluble in water? No, of course not, or it would be possible to wash it off! What would be a good solvent for nail polish?

Nail polish remover will be a good solvent.

What have we learnt about solutions as special mixtures?

Soluble substances dissolve in water and insoluble substances do not dissolve in water.

Water is not the only solvent. Some substances which are not soluble in water are soluble in other solvents. When no more solute can dissolve in a solution, we say it is a **saturated solution**. An **unsaturated solution** is one where it is possible to dissolve more solute in the solvent.

Solutions are special kinds of mixtures. When we want to decide whether a mixture is also a solution, we can use the following questions to decide:

Question about the mixture	The mixture is a solution	The mixture is NOT a solution
Can you see the solute in the solvent?	No	Yes
Does the solute settle out?	No	Yes
Can the mixture be separated using filtration?	No	Yes
Can the mixture be separated by evaporation?	Yes	No

KEY CONCEPTS

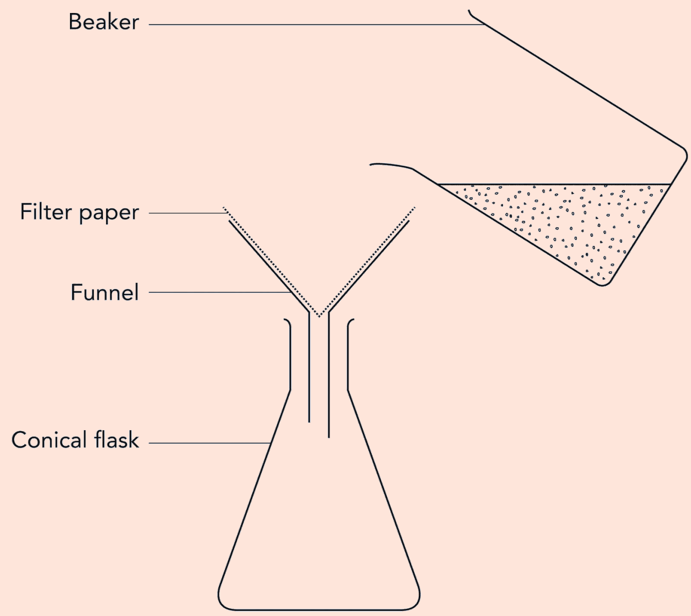
- A solution is a special kind of mixture. Like all mixtures it consists of two (or more) substances mixed together.
- A solution is made up of a solvent (such as water) in which one or more solutes have been dissolved.
- In a solution, the solute looks as if it disappears into the solvent. This is because the particles of the solute and the solvent become closely mixed.
- There are many kinds of solutions, but the most well-known ones are mixtures of a solid and a liquid, such as sugar and water.
- Not all substances dissolve in water. Those that dissolve are called soluble substances; those that do not dissolve are called insoluble substances.
- Solutions cannot be separated by sieving, filtering, hand sorting, or settling and decanting. This is because solute particles are dispersed between the solvent particles.
- Solutions can be separated by heating so that the solvent evaporates. The dry solute will be left behind.
- When we have dissolved so much solute in the solvent that no more solute can possibly dissolve, we say that the solution is saturated.

REVISION:

In the activity *Soluble or insoluble?* we explored some substances, and found that sand is **insoluble** in water.

In the same activity we found that sugar is **soluble** in water.

1. Can you remember how to separate sand and water? (Hint: Look at the activity *Mixing a solid and a liquid.*) Write it down below.
   In the activity 'Mixing a solid and a liquid' we saw that a mixture of sand and water can be separated by passing the mixture through a towel.
2. In the picture below a mixture of sand and water is poured through a filter. What is this process called?



   Filtering/filtration
3. Why do the sand grains stay behind on the filter paper, but the water passes through it?
   The sand grains are too large to pass through the paper. The water particles are very small and can easily pass through the filter paper.
4. What was the mixture of sugar and water called? (Hint: It was a special kind of mixture called a.. ?)
   Solution

5. What would happen if the mixture of sugar and water is poured through a filter? Would it be possible to separate the water and the sugar?
   The sugar and water would pass through the filter and it would not be possible to separate them in this way.
6. What happens to the sugar when it dissolves in the water?
   The sugar crystals separate into individual particles that mix with the particles of the water.
7. Why is it not possible to separate a solution through a filter?
   Because the particles of the solute and the solvent are thoroughly mixed and are of roughly the same size.
8. Describe how you can get the solid sugar back from the sugar solution.
   Learners must describe the process of evaporation or boiling which leaves behind the sugar crystals.
9. Draw a flow diagram to show how a mixture of salt and sand can be separated. Each step must be clear. Your first step will be to mix the salt and sand with water.
   These two substances cannot be separated by sieving as they will mostly have the same grain size. The first step is to mix the the salt and sand with water so that the salt dissolves. You then filter the mixture so that the salt solution passes through the filter paper whereas the sand remains behind. Then to regain the salt crystals, you evaporate or boil off the water to be left with the salt crystals at the end.

4 Dissolving

KEY QUESTIONS

- What does rate of dissolving mean?
- How does temperature affect the rate of dissolving of a substance?
- How does stirring affect the rate of dissolving of a substance?
- How does the size of the solute grains affect the rate of dissolving of a substance?

4.1 What is dissolving?

In this section we are going to make more solutions. We will perform some experiments to see if we can make our solutes dissolve faster. Before we do that, we have to answer an important question: is melting and dissolving the same? What do you think?

The difference between melting and dissolving is very relevant, and mistaking dissolving for melting is a pervasive misconception at this stage of the learners' development.

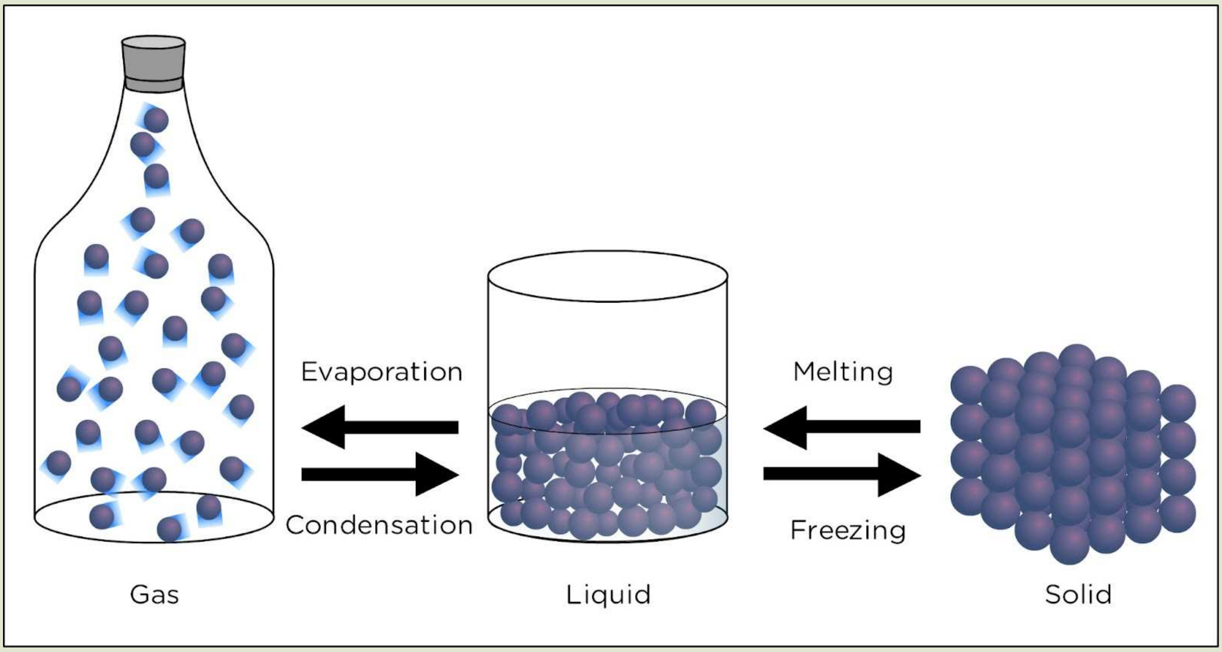
ACTIVITY: Is melting and dissolving the same?

In this activity we are going to explore the differences between melting and dissolving. We have learnt that matter can exist as 3 different states: solid, liquid and gas.

INSTRUCTIONS (Part 1)

Watch the following short video clip to remind yourself how a solid, liquid and gas are different from each other. You should look out for the part where the states change. The solid changes to a liquid and then the liquid changes into a gas. Remember that a state change is when a substance changes from one state (i.e. solid) to another state (i.e. liquid). goo.gl/gf7Ck

The following picture shows how the different states of matter are related to each other. It also shows what the different state changes are called.



QUESTIONS:

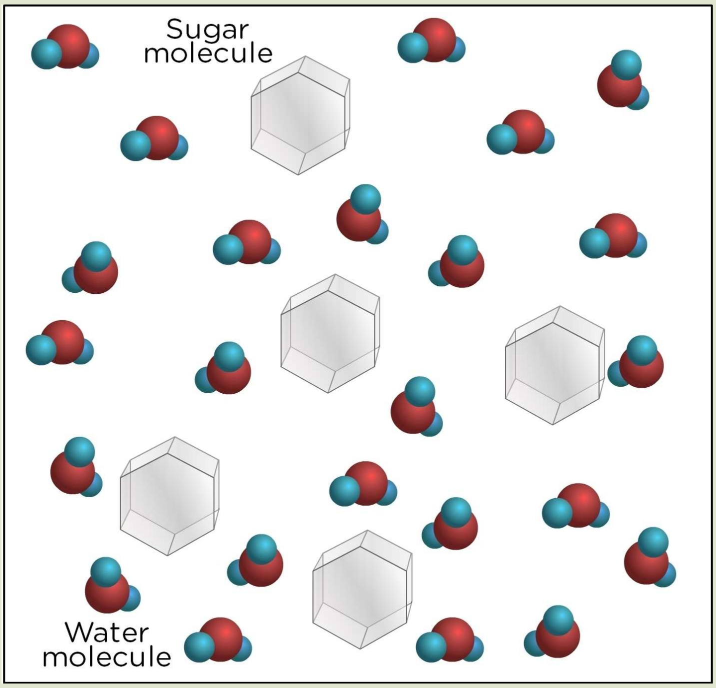
1. What is needed to change a solid into a liquid?
   Energy or heat
2. What is the process called when a solid changes into a liquid?

   Melting
3. Fill in the missing words:
   The particles in a _________ have fixed positions. When the solid melts, the particles are free to move from their positions. The state in which particles are close to each other but free to move around is called the _________ state.
   Answers: solid, liquid

INSTRUCTIONS (Part 2)

Do you remember dissolving sugar in water in the previous chapter?

The following picture shows what we would see if we could shrink ourselves down to the size of water and sugar particles (molecules).

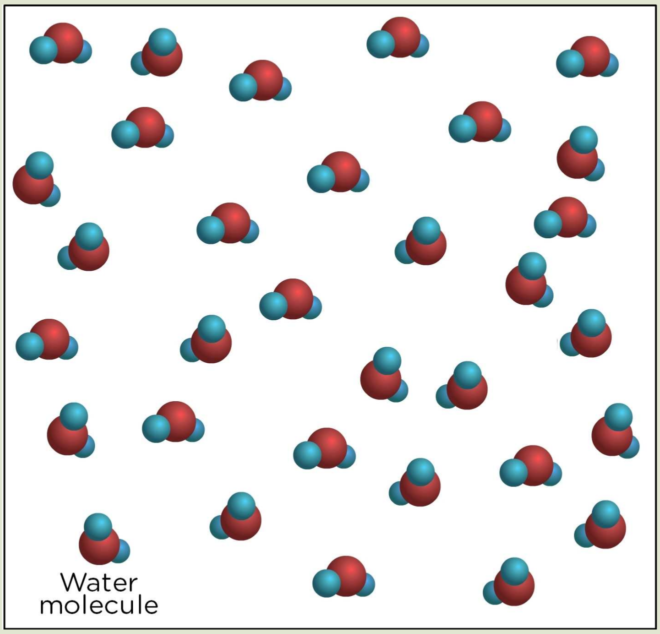


A solution of water and sugar molecules (particles)

Look carefully at the picture and then answer the following questions.

QUESTIONS:

1. Why is the sugar no longer visible? Give a reason.
   The sugar does not disappear. It is not visible anymore as the sugar crystals have broken up into the individual sugar molecules, which we cannot see with the naked eye.
2. How can we be sure the sugar has not "disappeared" and that it is still there?
   We can get the sugar back in crystal form by evaporating all the water away.
3. How is the picture of the sugar and water mixture different from the picture of the liquid which is shown below?
   The picture of the sugar and water has two kinds of particles. The picture of the liquid only has one kind of particle.



The particles in liquid water.

4. What do we call it when we have two or more substances combined?
   A mixture.
5. Can we say that the sugar melts? Give a reason.
   No, the sugar does not melt. The sugar particles are free, but they are mixed with the water.

4.2 Rates of dissolving

Explanation of new words:

- Temperature: tells us how hot or cold an object is. We measure temperature with a thermometer.
- Grain size: the size of the particles of the substance. A big lump has a large grain size while powder has a small grain size.
- Variable: something (an aspect of the investigation) that we change during an experiment. For instance, in an experiment to compare how fast a solute dissolves at different temperatures, we would change the temperature of the solvent. This means temperature is a variable in this experiment.

This section offers a great opportunity for learners to experience aspects of scientific experimentation that are a little more advanced than what they have done thus far. You could talk about **controlling variables** (changing just one variable in a set, and keeping all the others constant), and how to identify the **independent** and **dependent** variables. They will also be introduced to coming to a **conclusion** at the end of an investigation. Finally, they are introduced to the kinetic molecular model of matter when they learn that particles move faster when they are given energy (just like children!) and when they are moving faster they collide more, which speeds up dissolving. All of this provides a solid foundation for building a more complex understanding of these concepts in later years.

The rate of dissolving refers to how quickly a solute dissolves in a solvent. The word "rate" has many meanings. In science, when we use the word "rate" we usually mean how fast or how slow.

New Words

- temperature
- grain size
- variable
- rate

Tom likes his coffee sweet, with 3 teaspoons of sugar. For the coffee to taste sweet, the sugar must be dissolved. Here is a picture of a cup of coffee. Answer the questions that follow.

A cup of coffee [1]

QUESTIONS

1. Is the cup of coffee a mixture? Give a reason.
   Yes, because it is a combination of different substances.
2. Is the cup of coffee a solution? Give a reason.
   No, it is not a solution as a whole. The milk is suspension, as it is cloudy, and does not dissolve in the water. The coffee granules are an infusion in the water. However, the sugar does dissolve in the water and this forms a solution. Teacher note: This might be hard for learners to answer, but it is important to note here that "cloudiness" implies that tiny aggregates or globules are suspended in the liquid or gas base. Transparency implies the particles of the substances are separated from each other and dissolved. So the milk is a suspension and not a solution in the water.
3. Make a list of the components in the coffee mixture.
   Coffee, sugar and milk in water
4. Which component is the solvent?
   Water
5. Is the sugar a solute or a solvent?
   Solute
6. What could Tom do to make sure that the sugar dissolves quickly?
   Tom could stir the coffee, Tom could use finer sugar, or Tom could stir in the sugar before the milk is added (assuming the milk is not heated).

Stirring a solution is just one of the things we can do to make a solute dissolve faster. We are going to perform 3 investigations to explore the factors that affect the rate of dissolving of sugar (a solute) in water (a solvent).

In the first investigation, we will explore whether salt dissolves faster in hot or cold water. What do you expect?

INVESTIGATION: Does salt dissolve faster in hot or cold water?

AIM:

To investigate how temperature affects the rate of dissolving

MATERIALS AND APPARATUS:

- 3 clear containers (glass beakers are ideal, but small yoghurt tubs will also be suitable)
- table salt
- very hot water (not boiling)
- tap water (at room temperature)
- ice water
- teaspoon
- stopwatch or clock with second hand

Try to use sea salt (or any brand without "free flowing agent" - This is usually cornflour and obscures observations by forming a cloudy suspension). Alternatively, one can just use sugar here.

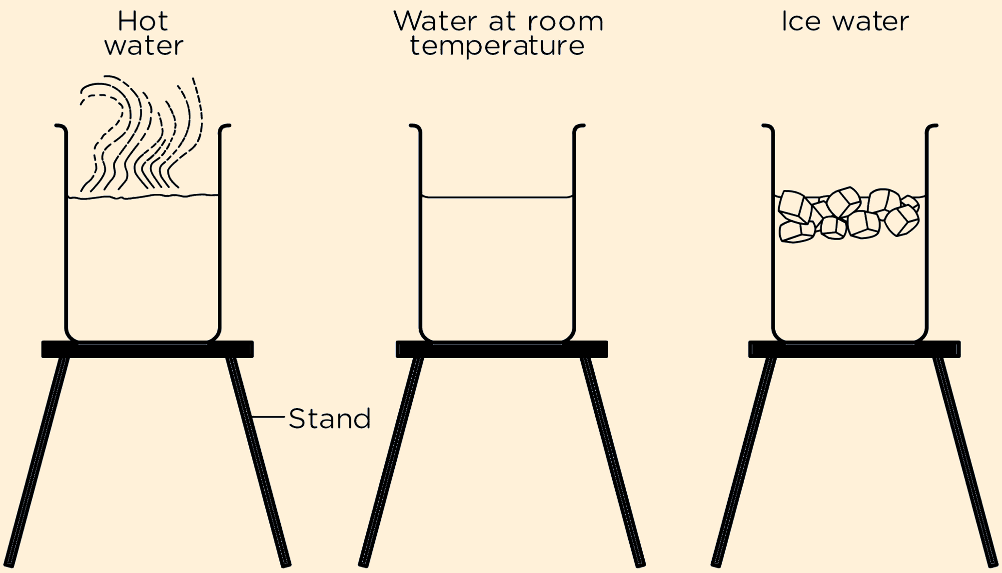
METHOD:

1. Measure the same quantity (100 ml) of tap water, hot water and ice water respectively into the three containers. Look at the diagram of the setup.
2. Place one teaspoon (5 ml) of salt into the container with the hot water.
3. Stir the solution by moving the teaspoon once back and forth through the water.

Stirring must occur at the same, regular rate for comparisons to be drawn. Let each group agree on a way to ensure this (perhaps by counting each full "stir" of the spoon).

4. Measure the time it takes for the salt to dissolve completely. Record the time in the table below.
5. Repeat steps 3-5 with the tap water and record the time it takes for the salt to dissolve in the table.
6. Repeat steps 3-5 with the ice water, and record the time it takes for the salt to dissolve in the table.

This step should be done with the ice OUTSIDE the water used for mixing. Either very cold water from a fridge can be used, or the mixing container should be placed on a bed of crushed ice. The presence of the ice in the mixing water obviously has nothing to do with the rate of dissolution. Additionally, some of the salt may end up on top of the ice and freeze there, creating a situation where it may appear that the salt dissolved quicker in the cold water than the room temperature water.



RESULTS:

The effect of temperature on dissolving

Situation	**Time to dissolve (in seconds)**
Salt in hot water	
Salt in tap water	
Salt in ice water	

QUESTIONS:

1. What did we compare in this investigation?
   We compared how fast salt dissolved in hot water, water at room temperature, and ice water.

2. Name three things that were the same about the three situations.
   The amount of water we used
   The amount of salt we added to the water
   The amount of stirring
3. What did we change in this investigation?
   The temperature of the water.
   Teacher note: This is an opportunity to introduce the term variable (see New Words above). The variable that we change (manipulate) is called the ***independent*** *variable.*
4. We measured the temperature of the water. What else did we measure?
   We measured the time it took for the salt to dissolve.
   Teacher note: The variable that we measure is called the ***dependent*** *variable. In this case time is the dependent variable.*
5. In which situation did the salt dissolve the fastest?
   The salt dissolved fastest in the hot water

CONCLUSION:

The salt crystals dissolved __________ in the hot water than the cold water. Temperature affects the rate of dissolving. When we increase the temperature of the solvent, the rate at which the solute dissolves __________.

Answer: faster, increases.

Extension question: Why do you think the salt dissolves faster in the hot water?

Teacher note: This is an opportunity to bring the energy concept into the conversation. Children move faster when they have more energy! Particles also move faster when they have more energy. When a solute dissolves in a solvent, the solute particles spread out among the solvent particles. This process happens much faster when all the particles are moving faster.

In the second investigation we will explore whether coarse salt dissolves faster than fine salt. What do you expect?

INVESTIGATION: Does fine salt dissolve faster than rock salt?

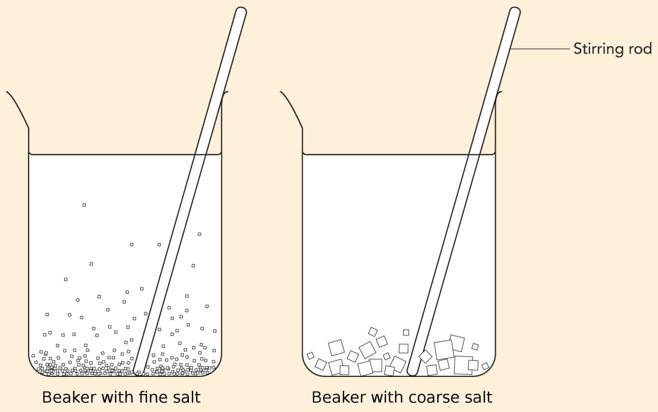
To investigate how grain size affects the rate of dissolving

MATERIALS AND APPARATUS:

- 2 clear containers (glass beakers are ideal, but small yoghurt tubs will also be suitable)
- fine table salt
- coarse rock salt
- teaspoon
- tap water
- stopwatch

METHOD:

1. Measure the same quantity (100 ml) of tap water into each container.
2. Place one teaspoon (5 ml) of fine table salt into the first container.
3. Stir the solution and measure the time it takes for the salt to dissolve completely. Record the time in the table below.
4. Repeat steps 2-3 with the coarse rock salt.



RESULTS:

The effect of grain size on dissolving

Situation	Time to dissolve (in seconds)
Fine salt in water	
Coarse salt in water	

QUESTIONS:

1. What did we **compare** in this investigation?
   We compared which dissolved faster in water, fine salt or coarse salt.
2. Name three things that were the same about the three situations.
   The amount of water we used
   The temperature of the water
   The amount of stirring
3. What did we change in this investigation?
   The grain size of the salt
   Teacher note: Here, you should explain the term 'grain size' by pointing out the differences in the sizes of the salt crystals. You should also try to convey that the same quantity (mass) of table salt would contain more grains if the grains were smaller.

Another opportunity to introduce the term *variable* (see *New Words* above). The variable that we change (manipulate) is called the **independent** variable.

4. What did we measure?
   We measured the time it took for each type of salt to dissolve.
   Teacher note: The variable that we measure is called the dependent variable. In this case the dependent variable is time, and the independent variable is grain size.
5. Which type of salt dissolved faster?
   The fine salt dissolved faster.
6. Complete the conclusion below by filling in the missing word or words.

CONCLUSION:

The fine salt dissolved __________ than the coarse salt. Grain size affects the rate of dissolving. When we increase the grain size of the solute, the rate at which the solute dissolves __________.

Answer: faster, decreases.

Extension question: Why do you think the fine salt dissolves faster than the coarse salt?

Teacher note: This is an opportunity to bring the concept of **surface area** into the conversation.

Ask the learners to say which would contain more grains, a teaspoon of fine salt or a teaspoon of coarse salt.

Sketch the following two scenarios:

1. In the first scenario there are 30 stones and 30 children. Each child should pick up one stone, and carry it away. Only once the child has moved out of the way can the next child in line pick up a stone. If all the stones are in one large pile it will take a long time for all the stones to be picked up and carried away. This scenario can be compared to the larger grain size particles dissolving in the water.
2. In the second scenario there are also 30 stones and 30 children, but this time the stones are in 10 small piles of 3 stones each. In this scenario it is possible to carry 10 stones away at a time, because there are many more small piles. This scenario can be compared to the smaller grains size particles dissolving in the water.

This is roughly similar to the effect of smaller grain size, the more grains we have, the faster the solute particles can be 'carried away' by the solvent particles.

In the third investigation we will explore whether salt dissolves faster in water when it is stirred. What do you expect?

INVESTIGATION: Does stirring increase the rate of dissolving?

In this investigation, the learners must come up with their own method (experimental design) to test whether stirring has an effect. You must provide the equipment. They can then look at the diagram of the setup and note what materials and apparatus they will need. After completing the investigation, they must also write out a method themselves. Learners can work in groups to do this.

In this investigation, you are going to design your own experiment to answer the question. Use your knowledge of the previous two investigations to help you. Look at the materials and apparatus that have been provided, as well as the diagram, to design your investigation and then write it out in the spaces below.

To investigate how stirring affects the rate of dissolving

MATERIALS AND APPARATUS:

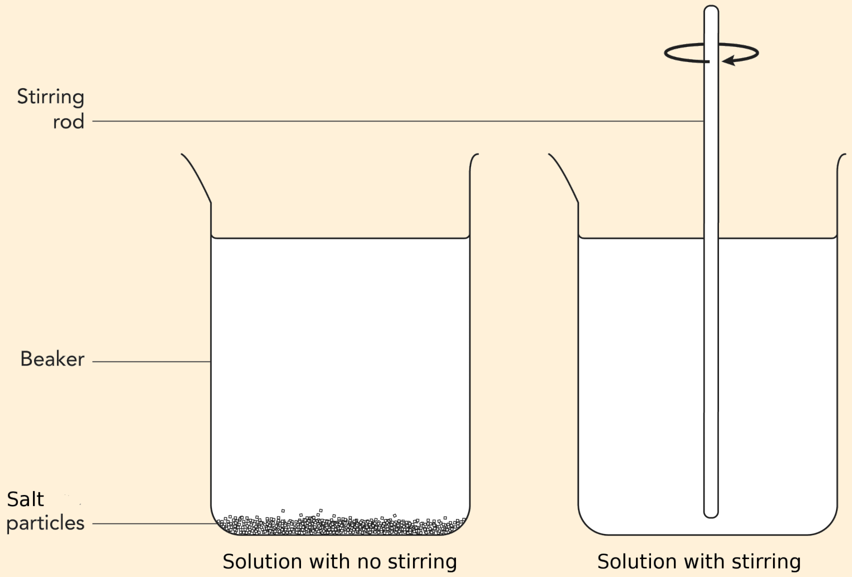
Make a list of what you will need to complete this investigation:

- 2 clear containers (glass beakers are ideal, but small yoghurt tubs will also be suitable)
- fine table salt
- tap water
- teaspoon

METHOD:

Write out the steps that you will follow to complete the investigation. Remember to include measurements.

1. Place a teaspoon of salt in each container.
2. Add the same amount of water (half a cup) to each container.
3. Stir the mixture in the first beaker but not the mixture in the second beaker.
4. Record your observations in the table.



RESULTS:

The effect of stirring on dissolving

Situation	**Time to dissolve (in seconds)**
Salt in water (with stirring)	
Salt in water (without stirring)	

QUESTIONS:

1. What did we **compare** in this investigation?
   We compared which dissolved faster in water, a salt solution that is stirred or a salt solution that is not stirred.
2. Name 3 things that were the same about the 3 situations.
   The amount of water we used
   The temperature of the water
   The amount of salt we used
3. What did we change in this investigation?
   We investigated whether or not the mixture was stirred.
4. What made the salt dissolve faster: stirring, or not stirring?
   The salt in the stirred solution dissolved faster.

CONCLUSION:

The mixture that was stirred dissolved __________ than the mixture that was not stirred. Stirring affects the rate of dissolving.

Answer: faster

Extension question: Why do you think stirring makes the salt dissolve faster?

Particles move faster when they are stirred. When a solute dissolves in a solvent, the solute particles spread out among the solvent particles. This process happens much faster when all the particles are moving faster.

KEY CONCEPTS

- The time it takes for a substance to dissolve is called the dissolving rate or the rate of dissolution.
- The rate at which a substance dissolves can be affected by 3 factors, namely:
  - the temperature of the solution;
  - whether or not the solution is stirred (or shaken); and
  - the grain size of the solute.
- A solute will generally dissolve faster if the solvent in which it dissolves is warm.
- A solute will dissolve faster when the solution is stirred or shaken.
- A solute will dissolve faster if the size of its grains is small.

REVISION:

1. What are the three factors that affect solubility? Write a sentence describing how they affect solubility.
   The three factors that affect solubility are temperature, grain size and stirring. Increasing the temperature increases solubility, decreasing the grain size increases solubility and stirring increases solubility.
2. Write 3 examples where we use the factors that affect dissolving in our daily lives.
   Any appropriate examples will do, for instance:
   stirring tea or coffee to make the sugar dissolve
   heating water to make salt dissolve when cooking; and
   using fine salt as opposed to coarse grains when dissolving in water to make a salt solution for cooking or rinsing, etc.
3. Complete the following crossword puzzle:
   Use the words in the box below, and the clues that are given underneath.

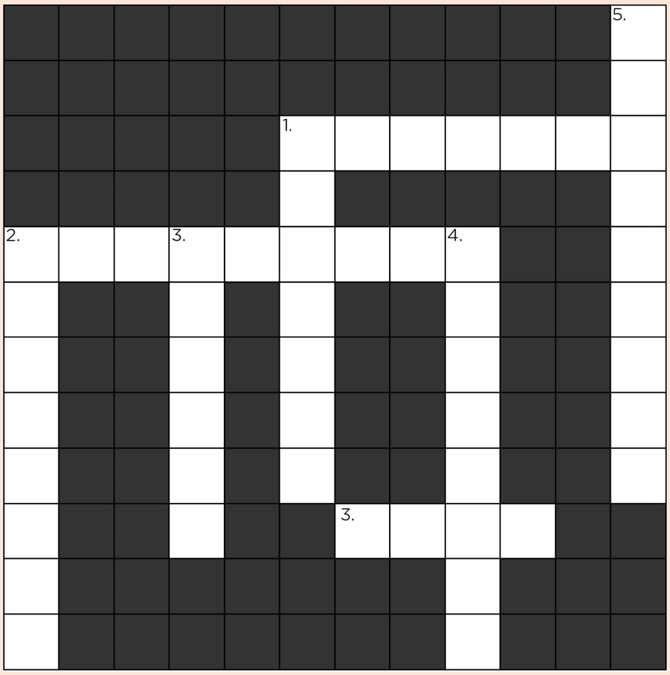
soluble solute solvent dissolves stir decrease solution saturated

DOWN:

a) When a solute can dissolve in a solvent we say it is ... (7 letters)
b) When we lower the temperature of the solvent, the rate of dissolving of the solute will ... (8 letters)
c) The substance that dissolves in the solvent is called the ... (6 letters)
d) The mixture of solute and solvent is called the ... (8 letters)
e) When we cannot dissolve any more solute in a solution, we say the solution is ... (9 letters)

ACROSS:

a) The substance that dissolves the solute is called the ... (7 letters)
b) The solute ... in the solvent. (9 letters)
c) When we want the solute to dissolve more quickly we should ... the solution. (4 letters)



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KEY QUESTIONS

- Why is it important for humans, plants and animals to have access to clean water?
- What is the difference between clean water and polluted water?
- What are the different things that pollute water?
- Why should wetlands be protected?

We have learnt that water can dissolve many substances - water is a good *solvent*. When water has unhealthy substances in it, we say the water is *polluted*. Polluted water is not clean.

New Words

- pollution
- effluent
- sewage

5.1 Water pollution

When is water clean? We could say that clean water is free of pollutants.

What are pollutants? Pollutants are substances (or objects) that do not naturally belong in the water and are harmful to us and to the environment.

Pollutants may be any of the following:

- Insoluble pollutants: these are things that do not dissolve in the water but make it dirty, such as oil, garbage and toilet waste (sewage).
- Soluble pollutants: these are chemicals (eg. soaps, fertilisers) and poisons (eg. insecticides).
- Living germs (bacteria) that can cause people or animals to get sick.

VISIT

Water pollution (video)

goo.gl/07xDe

There is an interesting term in the video clip on Water Pollution: "natural pollutants". It is a nice topic for a short discussion. Even things that are quite natural can act as pollutants when released in large quantities. Human sewage is an extreme example. Most ecosystems are "buffered" against abnormal amounts of such substances, but only up to a certain point.

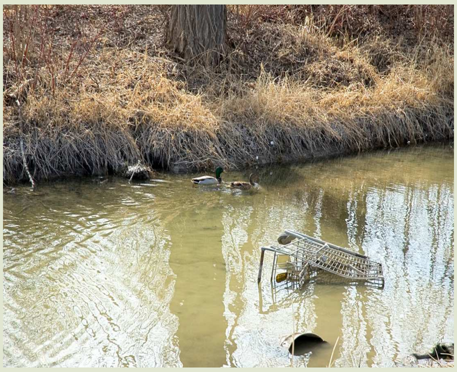
In the next activity we will discuss pollution and where it comes from.

ACTIVITY: Thinking about pollution

INSTRUCTIONS:

1. We are going to discuss pollution.
2. The following pictures of different polluted water sources, and the questions that follow, are meant to guide the discussion.

Pollution in a pond



A polluted river

Pollution on the coast

People have been using this stream to dump rubbish.

An oil spill

QUESTIONS:

1. Look at the pictures above and make a list of all the objects that do not belong in the water.
   Plastic bags, tyres, paper, polystyrene, bottles, shopping trolley, tins, metal rubbish bin, oil
2. What are the three main categories of pollutants found in water?
   Insoluble pollutants
   Soluble pollutants
   Disease-causing bacteria (germs)
3. Which category of pollutants would you be able to see with the naked eye?
   Insoluble pollutants
4. Which categories of pollutants would you not be able to see with the naked eye?
   Soluble pollutants and germs
5. How do you think insoluble pollutants end up in water?
   People allow garbage to fall into the water instead of placing it in a garbage bag for collection, and may even use the water as a toilet releasing germs into the water.
6. How do you think soluble pollutants end up in water?
   There are many examples:
   Rainwater can wash fertilisers and pesticides from farm lands into the rivers and other water sources.
   People can allow their household water (that contain soap and detergents) to run directly into the rivers.
   Industries can release polluted effluent into the rivers. (Effluent is the term for liquid waste or sewage discharged into a river or the sea.)
7. How do you think bacteria that cause illness like diarrhoea and cholera end up in water?
   Bacteria get into the water mainly through people and animals using the water sources as a toilet. People and animals have bacteria that occur naturally in the digestive tract, but outside of this environment, they can be harmful.
8. How do you think oil ends up in the water, especially in oceans?
   Cars drop oil and other chemical pollutants everywhere. These wash into the rainwater collection system and straight into rivers and seas. More dramatic disasters also pollute the ocean with oil. Oil may spill from a faulty oil rig in the ocean, or from a ship carrying oil which can leak or burst open.
9. What do all 3 categories of pollutants have in common?
   Learners may say: 'They do not belong in clean water'. Help them to see that it is mainly through ***human activity*** *that water sources become polluted.*

VISIT

BP oil spill in Gulf of Mexico (video)
goo.gl/0CmEG

Have you noticed that **humans and their activities** are often the reason why water becomes polluted?

As humans, we often forget that we are sharing this natural resource with many other organisms. Many of our activities can change the quality of the water in a way that affects the health and behaviour of other organisms.

So, as humans, we have a very important responsibility to look after our water resources.

5.2 Importance of wetlands

Nature has special methods of cleaning polluted water. In nature, water is purified in natural environments called *wetlands*. Wetlands are very efficient natural 'water treatment' facilities, and in this section we will learn how they work.

New Words

- wetland
- water table
- waterlogged

What are wetlands?

Some useful documents are available at these links and are free to use as long as you acknowledge them as the source. A suggestion is to get your school to print them in colour.

[1] and [2]

An area is a wetland if it has the following:

- waterlogged soil,
- water-loving plants and
- a high water table.

If soil is waterlogged, it means that it is full of water. The water table refers to the level in the ground where all the soil below this level is waterlogged (full of water). If an area has a high water table, then this level is close to the surface. This means water will

VISIT

Wetlands in South Africa

goo.gl/PQvKw

not filter down into the ground but remain on the surface forming a wetland.

Examples of wetlands are:

- marshes
- floodplains
- swamps
- lakes and pans
- seeps and springs
- estuaries
- river banks

Look at the pictures of different wetlands.

VISIT

Isimangaliso Wetland Park (website)

goo.gl/2RT6H

Wetlands are not necessarily wet throughout the year.

- A *temporary wetland* is wet between 1 and 4 months of the year.
- A *seasonal wetland* is wet during the rainy season. This means it will be wet between 5 and 11 months of the year, depending on the length of the rainy season.
- A *permanent wetland* is wet throughout the year.

DID YOU KNOW?

In South Africa, the most well-known wetlands are the St. Lucia wetlands in KwaZulu-Natal.

Why are wetlands so important?

Wetlands are very special places that should be protected. Why are they so important?

Three unique abilities of wetlands make them very important.

1. *Wetlands are like giant sponges*:

Wetlands **soak up water** and **store** it. During a drought, when there is not much rain, this stored water can help to keep rivers and streams flowing so that animals and plants can stay alive.

2. *Wetlands slow down flood waters*:

Water that is 'in flood' flows so strongly and quickly that it becomes dangerous. It can drown people and animals and it can cause damage to property and also to the environment, through soil erosion. Floodwater slows down when it flows into a wetland, because the wetland is a large area that can hold a large amount of water.

3. *Wetlands are natural filtration systems for purifying water*:

As water flows through the wetland, it is filtered. Plants in the wetland trap soil particles and sediments, nutrients, as well as pollutants and disease-causing organisms which make the water unsafe.

With regards to the pollutants being filtered from wetlands, it is only certain kinds, and only in certain loads. Insoluble wastes such as plastics should not end up in a wetland. Bacteria and other germs are neutralized. Chemical pollutants such as heavy metals are trapped, but if they become concentrated in too large amounts, they need to be taken out by removing plant matter that has absorbed them.

ACTIVITY: Making a model of a wetland

Teacher note: The reason for doing this activity is to help learners understand how different surfaces, especially those covered in plants, allow water to drain at different rates allowing soil to retain much of the water, and other surfaces to lose a lot of water. This will also show how wetlands help to slow down water and filter it.

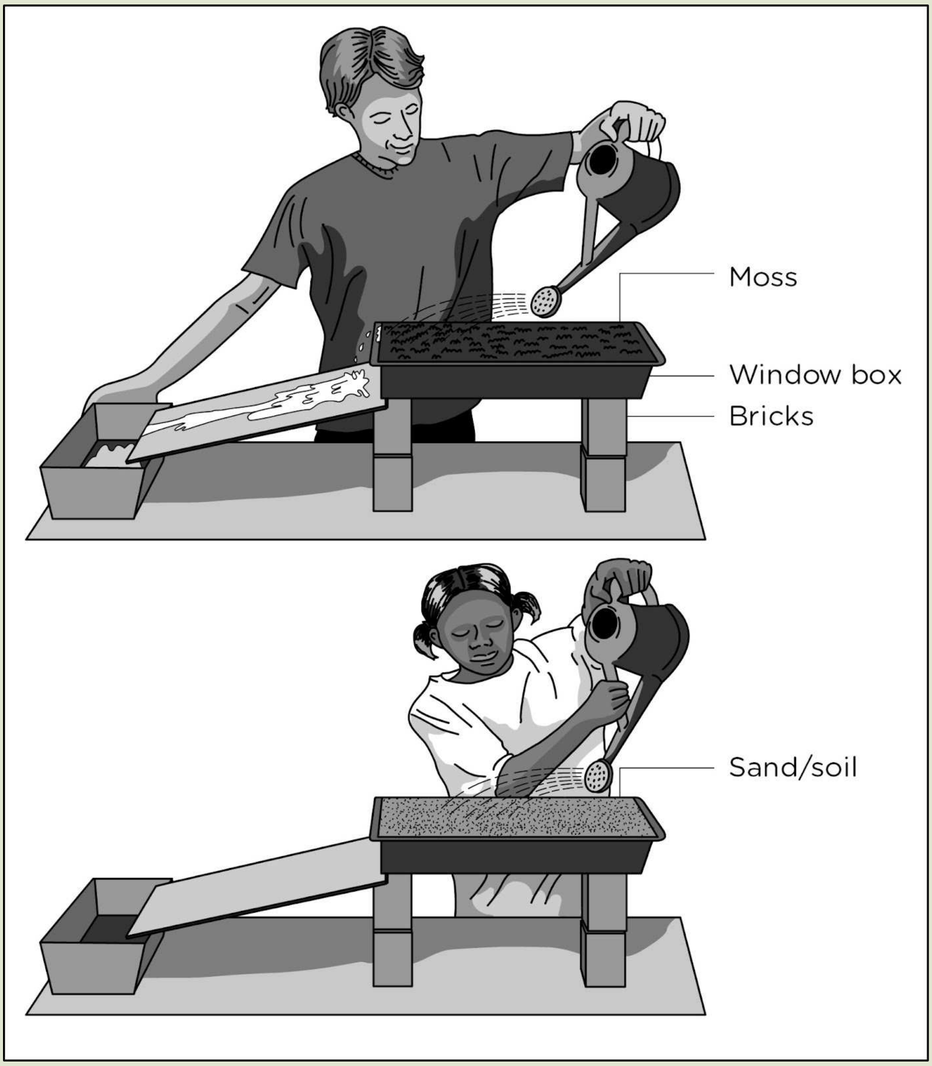
MATERIALS:

- grass moss or other garden moss
- bricks
- sand
- soil
- shallow plastic trays (about 7-10 cm deep)
- hardboard
- watering can
- measuring tool to measure 2 litres of water
- hand or electric drill (to be used only under STRICT ADULT SUPERVISION)
- watch or stopwatch
- plastic window box

The watering can must be the kind with a 'shower-type head' at the front that will simulate rain falling

INSTRUCTIONS:

1. Drill a hole in the middle and at the bottom of one side of the plastic box.
2. Pack 2 layers of bricks, the window box, and the hardboard as shown in the illustration.
3. Position the hole you drilled in the tray over the centre of the hardboard so you do not accidentally lose water over the sides that should run into the window box.
4. Fill your watering can with 2 litres of water.



Setup for the drainage experiment

5. Moss is found in many wetland areas like marshes, bogs and waterways. Place the moss inside the tray over moist soil. Pour the 2 litres of water slowly and evenly over the moss. Time how long it takes for the water to filter through the moss and run into the window box.
   a) How long did it take the water to run into the window box?
   b) Why do you think it took the water this long to drain off?

Moss holds water very well and that is why it took so long for the water to drain off.

Perhaps someone should remain timing that experiment while the rest move on to the others.

6. Repeat this experiment with sand - this is what happens to rainwater in the Namib or Sahara Deserts.

a) How long did it take the water to run into the window box?
b) Why do you think it took the water this long to drain off?

Sand does not hold water very well at all. That is why the water drained off so quickly.

QUESTION:

1. What did you learn from doing this experiment about the relationship between plants and water drainage in a wetland?

   Learner-dependent answer.

Wetlands are also important as they provide a habitat to many different plant and animal species. Wetlands are important because of their biodiversity.

Ask the learners why biodiversity is important. This is a link back to what they did in Life and Living.

QUESTIONS

1. Do you remember studying habitats in Gr. 4 and Gr. 5? What does a habitat provide to an organism?
   A habitat provides food, water, shelter, a place to raise young, a place to hide from predators.
2. Discuss with your partner what you understand by the term 'biodiversity' and write it down below
   Biodiversity refers to the variety of organisms (plants and animals) in a specific area. An area with a high biodiversity will have many different species of plants and animals.

Let's now do some research about the wetlands in South Africa and their importance.

Before doing the following activity, it is recommended that you show this Powerpoint presentation to the learners:

3

If this is not possible, the presentation could be given to the learners in printed format.

ACTIVITY: Researching the different wetlands in South Africa

MATERIALS:

- pamphlets, posters and any other reading material on wetlands
- books or other reading material from home, or printed pages from the internet
- poster material: cardboard, glue, colour pencils, scissors, pictures, etc

Arrange a visit to a nature reserve to study a wetland area firsthand. Or invite a speaker from a nature conservation site (such as SANParks) to talk to your class about wetlands. **BEFORE the visit:** tell learners to read through the information brought to school and some of the books and reading material in your class. From this information, set at least 5 questions that you could ask the Nature Conservation Officer when s/he comes to visit your class, or when you go on the outing to the nature reserve. At least 2 of these questions should focus on the dangers to wetlands.**DURING the visit:** Tell learners to REMEMBER to take many notes while listening to the Nature Conservation Officer.**AFTER the visit:** In their groups, learners must make a poster about wetlands, using the questions to guide them. **NB.** If you do not manage to visit a wetland, learners must still complete the research task by reading up on the internet and in books to answer the questions and present a poster.

INSTRUCTIONS:

1. You might get to visit a wetland near your school or hear a talk by a conservationist.
2. If you do not get this opportunity, you must still complete the project by doing research in books, pamphlets and on the internet and answer the questions below.
3. Present your report as a poster.

QUESTIONS TO ANSWER IN YOUR REPORT:

- What is a wetland?

- What does a wetland do for the environment?
- What does a wetland do for plants and animals?
- What does a wetland provide for humans?
- What are the environmental dangers that wetlands face?
- Choose a specific wetland and assess the habitats, biodiversity and water quality of this wetland.
- What would the impact be to biodiversity and water quality if this wetland was lost?

Wetlands should be protected because:

- they are natural water-purification systems;
- they act like sponges to store water in the wet season and supply water in the dry season; and
- they slow down flood water to prevent damage to property and the environment.

KEY CONCEPTS

- Clean water is vitally important to ensure the health of humans, animals and plants.
- Water can be polluted by insoluble substances, soluble substances and disease-causing germs.
- Wetlands act as natural water purifiers because they can absorb soluble and insoluble impurities from water and they regulate water flow across the landscape.

REVISION:

Look at the picture below of the bird covered in oil and answer the questions.

A bird covered in oil. [4]

1. How do you think the oil got into the water that this bird lives in?
   An oil spill from a ship or oil rig
2. Is oil a soluble or insoluble water pollutant?
   Oil is insoluble as it floats on top of the water.
3. How will the oil damage this bird and other sea animals?
   The oil coats their feathers or skin making it hard for them to fly. It is very sticky and very difficult to remove. The oil can get into their lungs and stomachs which will kill them. Oil also kills fish (possibly the bird's food source) because it prevents oxygen from the air dissolving in the water (oxygen is insoluble in oil).

4. List some of the dangers that wetlands face.
   Learners could list any of the following:
   - *drainage of wetlands for pastures and crops*
   - *overgrazing that leads to soil erosion*
   - *incorrect burning that leads to soil erosion*
   - *timber production*
   - *incorrect siting of dams*
   - *pollution*
   - *mining activities in wetlands*
   - *urban development*

   All the above human activities can affect the water flow and water quality of the wetland and this can ultimately destroy the wetland.
5. Search the wordsearch puzzle for the types of animals found in wetlands.
   See if you can find:
   - clam
   - crayfish
   - mosquito
   - heron
   - frog
   - egret
   - dragonfly
   - turtle
   - fish
   - shrimp
   - crab
   - salamander
   - duck

A	O	O	T	X	B	Z	T	D	A	Q	L	X	A	T	L	M
T	H	C	U	W	O	O	D	D	U	C	K	X	T	S	X	C
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B	N	T	E	O	Q	R	S	T	A	O	C	U	X	N	N	F
E	L	R	T	S	O	P	X	P	P	A	B	E	A	R	F	I
A	C	C	X	T	S	H	R	I	M	P	L	L	N	A	I	S
V	D	R	A	G	O	N	F	L	Y	N	T	S	S	C	S	H
E	T	V	V	U	Q	Q	R	L	U	I	V	I	L	C	H	O
R	E	G	R	E	T	X	O	T	V	N	Z	A	T	O	X	O
V	X	S	G	N	A	Z	G	X	T	V	M	V	S	O	A	O
X	S	A	L	A	M	A	N	D	E	R	N	Q	X	N	N	L
N	L	T	F	L	O	U	N	D	E	R	L	I	T	T	O	L

Water is very important for all living things. But what happens if water is not clean? I really want to try and build something to make water clean again. Let's find out how!

6 Processes to purify water

KEY QUESTIONS

- Why is a clean water supply so important?
- How can water be cleaned?
- How is water cleaned by municipalities to ensure that we have clean water in our homes?

6.1 Clean water

Have you ever seen a sign like the one in the picture? This sign is a warning that the water is not clean and humans should not drink it as it could be dangerous to your health. If it is unsafe for consumption, it is also unsafe for swimming.

New Words

- purify / purification
- sewage: waste matter carried away in sewers or drains
- raw water
- still

A warning against drinking polluted water

QUESTIONS

1. What does 'clean water' mean to you?
   Clean water is water that is free of pollutants.
2. Can you remember what pollutants are? Write it down below.
   Pollutants are things that do not belong in the water. Insoluble substances (oil, rubbish and waste), soluble substances (chemicals and poisons) and germs are all pollutants.

We have also learned that nature has special methods of cleaning polluted water. Water purification happens in special natural environments called wetlands. Wetlands are very efficient natural 'water treatment' facilities, but they work slowly. Humans, animals and plants need fresh water every day, and for this reason we have to clean our dirty water so that it can be reused. Cleaning dirty water is what this section is all about.

Why do we need clean water?

Why is it so important for humans, plants and animals to have clean water?

- Our bodies are contain a lot of water. In fact you are mostly water! We need water every day because we lose water everyday with the waste our bodies produce. The water we drink must be clean to prevent us from becoming sick or being poisoned.
- Plants and animals need clean water too, so that they can grow and be healthy. We need healthy plants and animals in our environment because they provide an ecological balance and food.
- Water is also used for fun. Water sports are a very popular recreational activity and include things like swimming, surfing and waterskiing. We want clean water in our seas and lakes so we can enjoy being in the water without becoming ill.

DID YOU KNOW?

Water is needed for humans to avoid dehydration; the amount you need each day depends on the temperature, how much activity you are involved in and other factors.

How can water be cleaned?

Imagine you are in a place without clean water. The only water around is a muddy stream. How can the dirty water be made clean enough to drink? When thinking about how to purify water, we need to consider what it is that we need to do to separate the contaminating particles from the water. The muddy water is actually a mixture of sand and water, and possibly other contaminants.

QUESTIONS

1. Do you remember in the beginning of the term we looked at different ways to separate out mixtures? What are some of these ways?
   Filtering/filtration, hand sorting, sieving, evaporation, distilling/distillation, decanting, boiling
2. Which methods do you think would be useful to separate the large impurities from the dirty water?
   Filtering, sieving (possibly hand sorting)
3. Which methods would be useful to remove the soluble impurities from the dirty water?
   Evaporation, boiling, distilling

DID YOU KNOW?

Water purification tablets can be used in emergencies such as a flood or earthquake when you do not have access to clean water. The tablets remove microscopic impurities and chemicals that could harm you.

Let's investigate some different ways to clean water at home or at school.

ACTIVITY: Cleaning water in a still

MATERIALS:

- clean, dry small pot/container
- muddy water
- big, deep cooking pot
- ruler
- 1 marble or clean stone
- plastic cling wrap

INSTRUCTIONS:

1. Pour the muddy water into the big pot until it is about 5 cm deep (you can use the ruler to measure the depth of the water).
2. Place the smaller pot/container inside the bigger pot.

The rim of the smaller pot/container must be lower than the rim of the bigger pot so that the water which condenses on the cling wrap has space to run down to the centre where the stone/marble is weighing it down and drip into the smaller pot/container.

3. Cover the bigger pot with plastic cling wrap.
4. Place a marble or stone in the middle of the plastic wrap so that it is above the small pot/container inside the pot. You have now made a still for purifying water.
5. Leave the still out in the sun for a day.

You should continue with the activity after the still has been out in the sun for some time.

6. Look carefully at the still and answer the questions below.
7. If you have a phone with a camera, you could take pictures of the still and show them to your class.

QUESTIONS:

1. What do you notice about the inside of the smaller container? Is it wet or dry?
   The small container is wet on the inside.
2. What do you notice about the cling wrap? Is it wet or dry?
   The cling wrap is wet.
3. Write a paragraph to explain how the water got inside the yoghurt tub. You can use words from the following list, but you can also add your own words:

energy, sun, evaporate, water, water vapour, condense, drip, clean

   Learners may write:
   Energy from the sun caused the water in the pot to evaporate. Since the pot was sealed with cling wrap, the water vapour condensed against the cling wrap. The marble made the cling wrap dip in the middle. The condensed water slid down and dripped into the smaller container. The water inside the cup was clean.
4. Why is there no dirt inside the small container/pot?
   Dirt does not evaporate.
5. Where was the dirt at the end of the experiment?
   The dirt stayed in the big pot.
6. Make a poster of the process. You can draw pictures or use the photos you took of the experiment.

QUESTIONS

Can you remember what method we used to remove sand from water in the activity: *Mixing a solid and a liquid* in the chapter *Mixtures*?

We filtered the water and sand through a paper towel to remove the sand.

Filtering is a good way of removing insoluble substances from water. Large pieces of insoluble substances can also be **sieved** out of the water.

ACTIVITY: Design, make and evaluate a filter

This is the first time that learners are doing a Technology project this year, in Gr. 6, so you will probably need to remind them of the Design Process which is followed in Technology Projects. The first part is identifying the **need** and in this project a scenario has been set where the Thunderbolt Kids are planning a camping trip and have invited the Gr. 6 class to come with them. However, there is no clean drinking water at the campsite they want to go to and they cannot carry enough water for everyone for the whole trip. Use this scenario to construct the need to design a filter to take with them on the camping trip.

We follow the pattern IDMEC in the Design Process.

I stands for Investigating the problem which some people have, investigating existing products, and investigating concepts and skills that you will need to solve the problem, i.e. purifying water. Encourage learners to investigate filtering methods such as using sand, cotton wool and charcoal.

D stands for Designing. That means using what you have learnt from investigations to think of good ways to design a filter.

M stands for Making. When you make your filter, you use the materials and tools to make the filter according to the design. Notice that most children design with their hands, not only with pencil and paper. As they work with materials they get more ideas, and their design improves. So we should think of designing and making as more or less the same stage of a project.

E stands for Evaluating. After you have made your filter to solve the problem, you have to ask, does it work? Could we do a better one? During this phase, take all the learners outside and get them to hang their filters up and test them out by pouring a cup of muddy water through.**NB. Make sure learners DO NOT drink the water.** Rather compare the water before and after filtering to see if it has been purified. Prepare a big bucket of muddy water which you can scoop cups of water out of to purify. That way you will have some water left over to compare the filtered water to, to see if the learners' filters did purify the water.

C stands for Communicating. You must show other people how you decided on your solution to the problem. You need to write and draw your ideas. (The learners should be drawing and writing all through the project. Do not leave the writing until the end, because they find it boring at that stage. When they are getting new ideas they often enjoy writing because they are writing about their own ideas; this is a great strength of Technology in school. A Technology project gives the learners reasons for reading and reasons for writing. As a result, we can address the literacy problem through the subject of Natural Science and Technology.)

The Thunderbolt Kids are planning a camping trip and they have invited you and your classmates to come with them. They have all the equipment such as tents, sleeping bags and mats. The only problem is that there is no clean drinking water at the campsite. For such a large group, the Thunderbolt Kids cannot take enough bottles of clean water. So, Tom has decided that the group should build a filter to purify the muddy water from the nearby stream. But, they do not know how! We need to help them design and build a filter to purify the water on the camping trip.

DESIGN BRIEF:

A Design brief for a Technology project is a short statement of what you are going to make, why you are going to make it and what you are going to make it for.

Write a short statement where you state what you are going to be designing and why.

Your filter has the following specifications:

- The filter must be able to filter a cup of muddy water and the water which comes out must be cleaner than the water that went in.
- The filter must be able to hang up, for example from the branch of a tree.
- You must be able to use it outside.

Your filter has the following constraints:

- You cannot make the filter at home, you must make it in class.
- You are confined to using as many recyclable materials as possible, such as 2 litre plastic bottles, plastic bags, etc.

INVESTIGATE:

We now need to do some more investigating about how to purify water. We saw how to purify water using a still and evaporation. But what are the ways to purify water using a filter. Do some research on the internet and in books and answer the following questions.

1. What types of filters can you make?
2. What materials do these filters make use of?
3. What is the purpose of each of the materials used to filter? For example, are some materials there for filtering large particles and some for filtering small particles? If so, which one is which?

DESIGN:

Now start designing your filter! Answer these questions before you start drawing your design.

1. What kind of filter are you going to design?

2. What size and shape will your filter be?
3. What recyclable materials could you use?
4. How are you going to hang it up, for example from the branch of a tree?
5. How will you collect the water that has been filtered?

Use the space below to draw a design for your filter. Remember to label the different parts and show which materials you are going to use. Leave some space to do a second drawing as you might come up with a better design as you are making your filter and see ways to improve it.

MAKE:

Now that you have a design, it is time to make your filter according to the specifications and constraints. Once you have all made your filters, you need to test them out to see if they work.

Do the testing outside. Show the class how your filter works and pour a cup of muddy water through the filter and collect the water which comes out.

DO NOT DRINK THE WATER as you do not know if you have completely purified the water. To further purify the water from the filters, you can also do a solar distillation using the still you made in the last activity to remove solids, and finally followed by boiling.

EVALUATE:

After you have made your filter, you have to ask, does it work and could you do a better one?

1. Compare the water before and after filtering. Was the water cleaner after filtering?
2. Which impurities did your filter remove - big or small or both?
3. How much filtered water were you able to collect from your filter? Was it the same amount that you poured in?
4. Did your filter leak anywhere? If so, how could you prevent it from leaking?
5. Do you think you could further purify the water you filtered by passing it through your filter again? Try it out and see if this makes a difference.
6. How could you improve your design?
7. What further steps could you take to purify the water which comes out of your filter.

VISIT

Fun activity to get you thinking about water, and where it goes once we have used it

goo.gl/eh8ke

You could do a distillation using the still made in the previous activity, and finally followed by a boiling step.

COMMUNICATE:

The last part in the Design Process is to communicate what you designed and made to others so that they can also learn about what you did, and learn from you. Write a paragraph below where you tell Tom about the filter that you designed and made to take on the camping trip to purify the muddy water in the stream. Tell Tom what you found that worked and what did not work and anything that you would change.

How is water cleaned by municipalities?

Do you have running water in your home? If you have, you are very fortunate, because many South Africans do not.

Clean water coming out of the tap [1]

South African municipal water is generally clean and fresh, and safe to drink. How does it get that way? This section tells the story of how water is treated.

The water from a tap does not start out clean and fresh. It may come from a river or a dam, or it may even be waste water that was used by a community or in a factory.

The process of cleaning the water is called *water treatment*, and the place where it happens is called a *water treatment plant*.

So what exactly happens at a typical water treatment plant?

There are five steps (or processes) in the treatment of water. The five processes commonly used to treat water are **screening**, **sedimentation, aeration, settling**, and **disinfection**.

Let us look at them in turn.

STEP 1: SCREENING

The raw water that arrives at the plant may contain dirt, fish, rubbish, plants and even sewage.

These things are **screened** out as the water flows into the plant. This means that the water passes through a screen (which is very much like a large sieve), and the solid matter stays behind on the screen.

After the screening step the water is still dirty, but the large pieces of rubbish have been removed.

STEP 2: SETTLING

During this step the raw water is allowed to stand in a large tank called a **settlingtank**.

QUESTIONS

What happens to the dirt when muddy water stands for a long time?

It sinks to the bottom.

When the raw water stands in the settling tank, the medium-sized pieces of solid matter (called **sludge**) sink to the bottom of the tank.

The raw water at the top is still dirty but now it only contains small pieces of solid matter. The bits of solid matter left are small enough for small organisms (such as bacteria) to eat. This is what happens in the next step of the treatment process.

STEP 3: AERATION

The raw water now flows into a special tank that contains bacteria. These are useful bacteria, because they help to break down the last little bits of solid matter as well as breaking down any natural soluble pollutants.

Since bacteria need oxygen to stay alive and healthy, air is bubbled through the water. This process is called **aeration**, because the name comes from the word 'air'.

STEP 4: FILTERING

Next, the water flows through a special **filter** made of layers of sand and gravel, just like the one you designed, only much bigger. The gravel layer of the filter is about 30 cm deep and the sand layer is about 1 m deep! The filtering step removes any remaining particles and most of the bacteria left in the water.

After this step the water is clear, but some germs and bacteria from STEP 3 may still be in the water. Remember that germs and bacteria are small enough to pass between the gaps between sand and gravel.

STEP 5: DISINFECTION

During **disinfection**, chemicals are added to the water to kill any surviving germs.

Resources about water [2]

KEY CONCEPTS

- Clean water is important for people, plants and animals.
- Water can be cleaned by processes such as sieving, filtering, settling, decanting, boiling and adding chemicals to kill germs.
- The water we use in our homes is cleaned before and after we use it.

REVISION:

1. What does it mean to purify water?
   It means to clean water; to remove pollutants from the water.
2. What is clean water?
   Clean water does not contain any pollutants.
3. Why do humans, animals and plants need clean water? Write a paragraph where you describe some of these needs.
   Learner dependent answer. Water is necessary for life. We need clean drinking water for metabolic processes in our bodies and to replace water which is lost due to urination and excretion. We use water for washing and cooking and need clean water so that we do not become ill. Many animals make their homes/shelters in and around water and need clean water so that they do not become ill.
4. If you were not sure about the water that came out of the tap and you had a kettle, what would you do to the water to purify it? Why do you think this method of purifying works?
   You could boil the water. This would kill any living microorganisms or bacteria in the water.
5. The woman in the picture is drinking water from the edge of a dam. What possible threats could she face from drinking this water without doing anything to purify it?

   

   The water could contain disease-causing bacteria such as cholera, hookworm, bilharzia, typhoid, and it could contain chemicals or fertilisers from surrounding farmlands, etc.
6. Name the 5 steps in the water treatment process.
   The five steps are screening, sedimentation, aeration, settling, and disinfection.
7. Do you think it is important to conserve water? Why do you think so? Write a paragraph to justify your answer.
   Learner dependent answer.

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