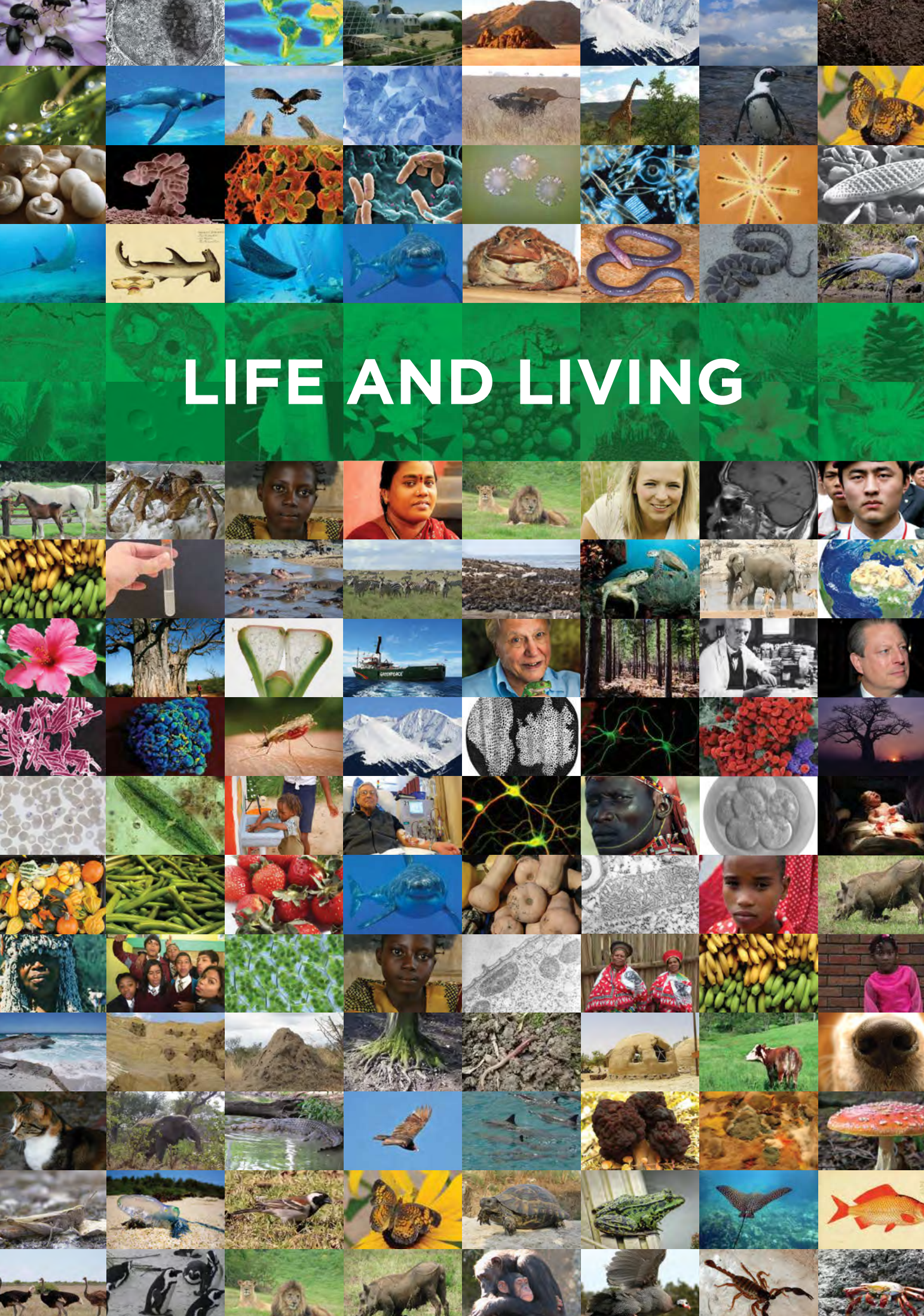

LIFE AND LIVING

1 Photosynthesis and respiration

KEY QUESTIONS:

- What drives life on Earth and in ecosystems?
- How do green plants photosynthesise when no other organism can make its own food?
- What do plants do with the food that they produce?
- Why do we need to eat food? What does it provide us with?
- We know respiration is one of the seven life processes, but what happens during respiration in organisms?

Energy is needed to sustain life and without it nothing would be able to live on Earth. Our most important source of energy is the Sun. In this chapter we are going to investigate the processes involved in transferring the Sun's energy to our bodies to allow us to read this text! These two important processes are **photosynthesis** and **respiration**.

1.1 Photosynthesis

Energy sustains life

All life on Earth depends on energy to sustain the seven life processes.

ACTIVITY: The seven life processes

INSTRUCTIONS:

1. Do you remember what the seven life processes are? Do you remember using the letters from MRS GREN to help you remember these?
2. Write down the seven life processes below.

M _____

R _____

S _____

G _____

R _____

E _____

N _____

The form of energy that the Sun produces is called **radiant energy**. Although the Sun provides us with both light and warmth, plants only use the light energy from the Sun to photosynthesise.

The Sun provides us with energy in the form of light and heat.

NEW WORDS

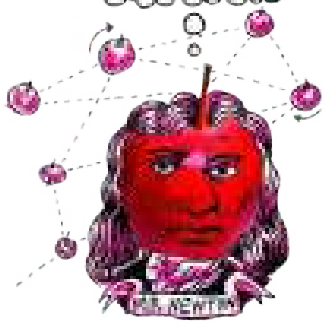
- chemical potential energy
- chlorophyll
- chloroplast
- glucose
- photosynthesis
- radiant energy
- respiration
- starch
- soluble
- insoluble
- pigment

Most organisms cannot directly use the energy from the sun to perform the seven life processes. For example, a reptile can lie in the Sun to warm up from the heat energy, but this does not provide the necessary energy for that animal to move, reproduce or excrete waste.

Except for a few sea slugs, plants are the only organisms on Earth that can absorb the Sun's radiant energy and convert it into food for themselves and for other living organisms.

DID YOU KNOW?

All the **New words** listed in the boxes in the margin are defined in the glossary at the end of this strand.



Radiant energy to chemical potential energy

What is potential energy? Do you remember that we spoke about energy for movement (kinetic energy) and energy that is stored (potential energy) in Energy and Change in Gr. 6 and 7? What are some things that have kinetic energy and some that have potential energy? Remember to take down some notes in the margins of your workbook as you discuss things in class.

All living organisms can use energy in the form of **chemical potential energy** for the life processes. This is the energy that is stored in the food that organisms eat. Plants are able to capture the radiant energy from the Sun and transfer it to chemical potential (stored) energy for other organisms to use. They do this through the process of photosynthesis. All organisms release the stored potential energy from the food that they eat to support their life processes. This process is called **respiration**.

VISIT

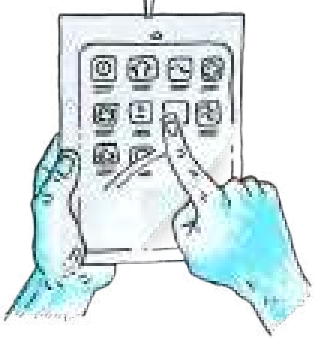
Find out why plants that photosynthesise are green.

bit.ly/18cAb2v

Photosynthesis takes place in small structures called **chloroplasts**, which are inside the cells of the leaves and stems of green plants. Inside the chloroplasts are green **pigments** called **chlorophyll**.This is what gives plants their green colour. Photosynthesis is the process in which chlorophyll molecules absorb the radiant energy from the sun and transfers it into chemical potential energy. The only function of chlorophyll is to trap the sunlight energy; chlorophyll is not produced or used up during photosynthesis.

TAKE NOTE

Chloroplasts are a type of organelle found only in plant cells. A cell is the basic unit of all living things. We will learn more about the structure and functioning of cells next year in Gr. 9.

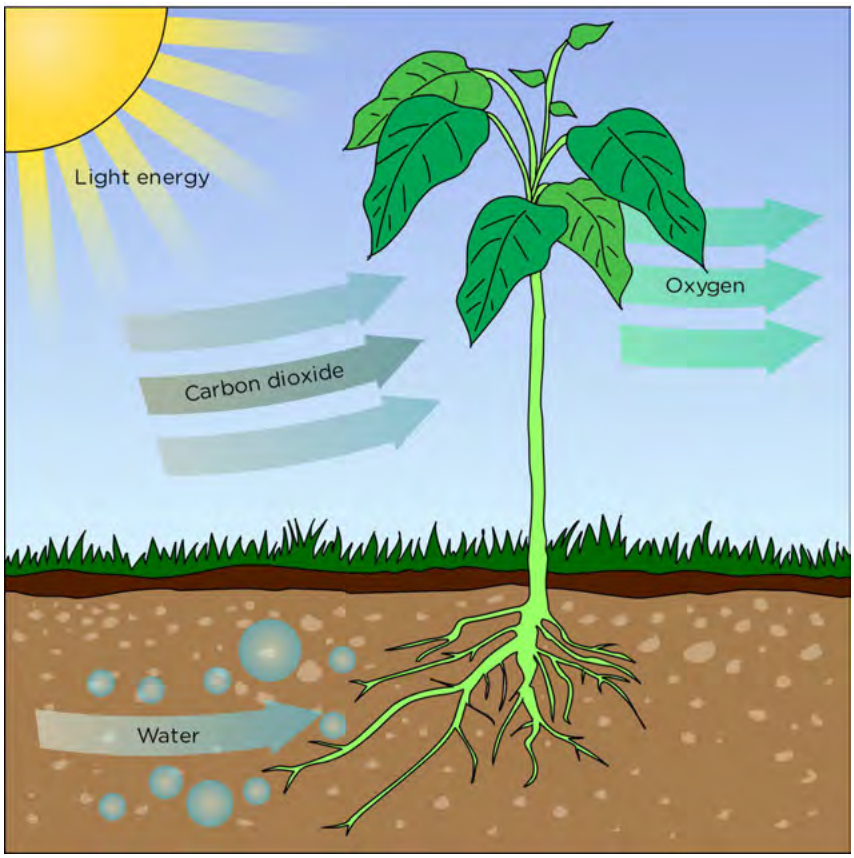


Elysia chlorotica, a sea slug, has evolved to absorb the chloroplasts from the green algae it eats and use them to photosynthesise! This animal can produce its own food and is green.

Photosynthesis has other requirements besides light energy from the Sun. What are these? Look at the following diagram which summarises the process of photosynthesis.

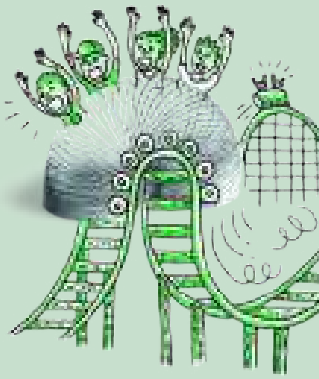
DID YOU KNOW?

Chloroplasts are only present in plants. However some sea slugs have learnt to absorb the chloroplasts from the green algae that they eat into their bodies and can actually photosynthesise themselves!



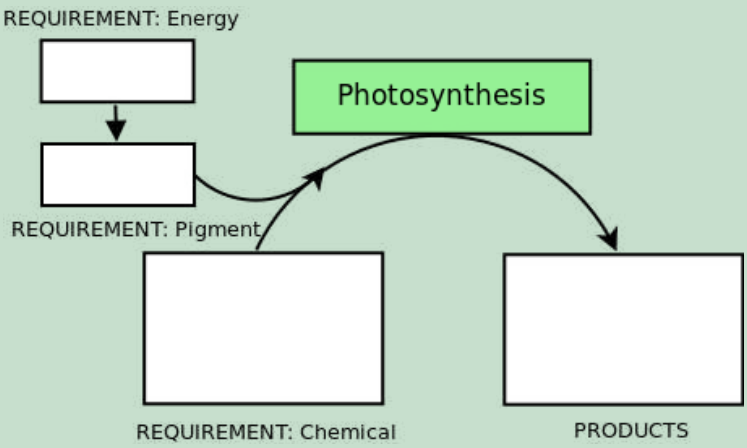
Plants use radiant energy from the Sun in a series of chemical reactions to change carbon dioxide from the air and water from the soil into **glucose**. The process releases oxygen.

ACTIVITY: Requirements and products of photosynthesis



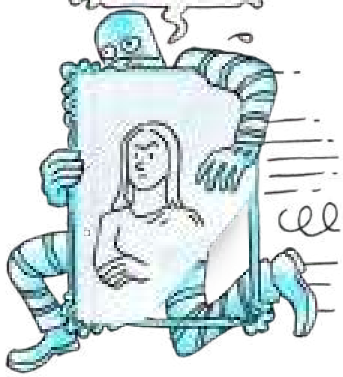
INSTRUCTIONS:

1. Summarise what you have learnt about photosynthesis in the diagram below.
2. Fill in the requirements of photosynthesis in the block on the left and fill in what type of energy is needed and the name of the pigment that absorbs the energy.
3. Fill in the products of photosynthesis in the block on the right.



TAKE NOTE

Plants use sugars (glucose) as a basic molecule from which to make hundreds of other compounds, such as proteins, oils, vitamins, colourful pigments in flowers, strong tasting chemicals (hot chilli plant), sweet tasting nectar and sweet smelling fragrances.



The process of photosynthesis can be presented in the form of an equation:

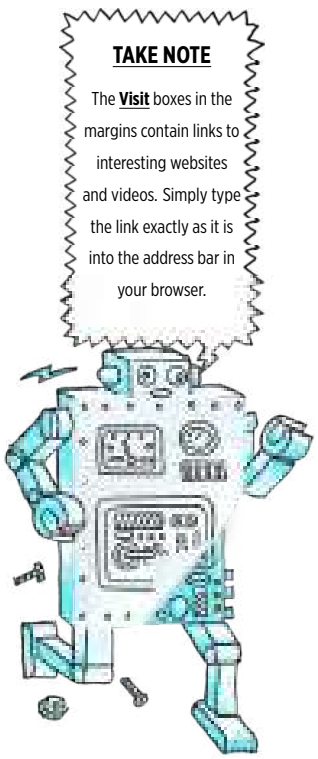
carbon dioxide + **water** $\xrightarrow{\text{chlorophyll and sunlight}}$ **glucose** + **oxygen**

What happens to the glucose that plants produce during photosynthesis?

Glucose storage and use

The glucose that a plant produces when it photosynthesises is the food for the plant. The plant can use this glucose directly, and release the energy during its own respiration or it can store the glucose or convert it into other chemical compounds.

Glucose is **soluble** in water. As we learnt in Matter and Materials in Gr. 6, this means that glucose can dissolve in water. This is useful to the plant as it means it can transport the glucose in water to where it is needed elsewhere in the plant. However, in order to store large amounts of glucose, plants need to convert it into compounds which are **insoluble** in water. Therefore the plant converts glucose into **starch**, which is insoluble in water. Why do you think the plant might need to store some glucose?



In addition to starch, plants also convert glucose into cellulose. Cellulose is used to support and strengthen plants. Animals do not have cellulose for support. Instead animals have something else to provide support and protect the body. Do you remember what this is?

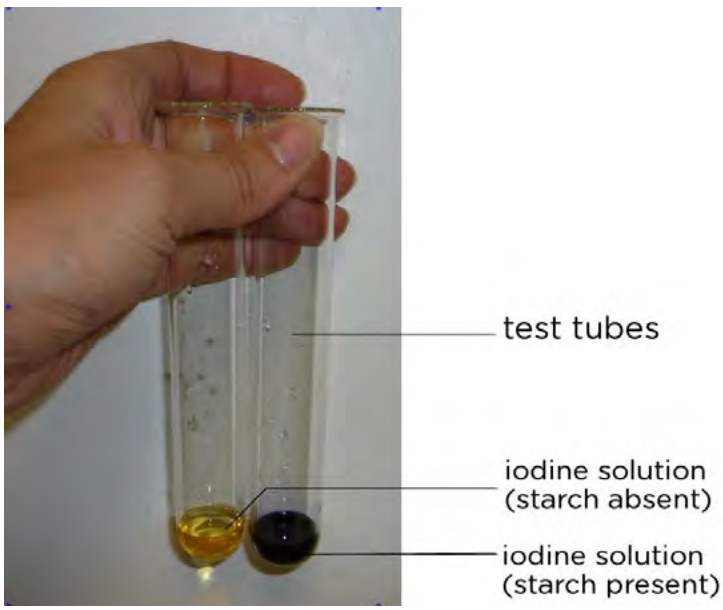
Glucose is also converted into other chemical compounds that enable processes in the plant such as reproduction and growth.

We have now learnt about how plants produce glucose and store it as starch, but how do we know for sure? As young scientists we also need to question whether this explanation of photosynthesis is accurate. Is there an investigation we can do to test for the presence of these compounds? Let's find out!

We have learnt that plants produce glucose during photosynthesis and store this in the form of starch. Therefore, to see if a plant photosynthesises, we can test to see if the plant produced starch.

Study the following properties of starch and glucose with your class. Think of possible tests that can be done to determine whether a plant has produced either starch or glucose. Record some of your discussion points.

- Glucose tastes sweet but starch does not taste sweet at all.
- Glucose will dissolve in water while starch will not dissolve in water.
- Iodine changes from brownish-orange to dark blue-black when it comes into contact with starch. Have a look at the following photos which illustrate this.



The left tube contains only diluted iodine solution and the right tube contains diluted iodine solution with starch.

Now that we know that plants produce glucose and change this into starch, we can find out if all leaves produce the same amount of starch through photosynthesis.

INVESTIGATION: Which leaves photosynthesise?

There are two parts to this investigation. First, we want to find out which leaves are able to photosynthesise. We will place some pot plants in the light for a day, and some other pot plants in a dark cupboard for a day, and then perform the investigation on the leaves of plants from both groups.

In the second part of the investigation, we will use what we have learnt to investigate which parts of variegated leaves photosynthesise.

Part 1: Leaves in light and dark

AIM:

1. What do you wish to establish by conducting this investigation?

_____

HYPOTHESIS:

1. What do you think or predict will happen when you conduct this investigation?

_____

_____

MATERIALS AND APPARATUS:

- gloves
- a range of pot plants that can be easily moved around
- 100 ml beaker or glass jar in a saucepan with water
- bunsen burner, spirit lamp or a stove
- tweezers
- ethyl alcohol (or methylated spirits)
- glass petri dishes, white saucer or white tile
- stopwatch or timer
- glass pipette or dropper
- iodine solution

METHOD:

1. Work in groups of three or four.
2. Place half of the plants in the dark for at least 24-48 hours and the others in a well-lit area of the class that is exposed to lots of natural sunlight.
3. After 24 hours, pour 50 ml of the ethyl alcohol into the beaker and place it in the saucepan with water. Heat the saucepan over the bunsen burner or the stove. The water in the saucepan will distribute the heat evenly to warm the ethyl alcohol evenly.
4. Remove one healthy looking leaf from the pot plants that were in the well-lit area exposed to direct sunlight.
5. Using the tweezers, dip a leaf into the boiling water for 1-2 minutes. This helps to remove the waxy cuticle that covers the leaf and breaks down the cell walls.

6. After this, place the leaf into the beaker with the ethyl alcohol.
7. Leave the leaf in the alcohol until all the chlorophyll has been removed from the leaf and the alcohol turns green.
8. Place the leaf into warm water to soften it.
9. Remove the leaf from the warm water and place it on a white tile or a petri dish on top of a white surface.
10. Use the pipette or dropper to carefully drop 2 or 3 drops of iodine solution on the leaf in the petri dish and record your observations.
11. Repeat this process for two more leaves that were in the well-lit area.
12. Remove the plants that were in the dark for at least 24 hours. Use the test above to test whether there is starch present in the leaves from the plants that were kept in the dark.
13. Record your observations.

RESULTS AND OBSERVATIONS:

Keep a record of your observations. Draw a table to record and compare your results.

CONCLUSION:

1. What did you learn from doing this investigation?

QUESTIONS:

1. Why were some plants placed in a well-lit area with direct sunlight and others in the dark?

_____

_____

_____

2. Explain what the results of the iodine test indicates.

_____

_____

Part 2 : Which parts of variegated leaves photosynthesise?

Have a look at the following photos of different plants. What do you notice about the leaves?

Ivy leaves.

Geranium leaves.

We call these leaves variegated as they have green and white sections. We want to find out which parts of these leaves photosynthesise in this part of the investigation.

INSTRUCTIONS:

1. You need to design this investigation yourself.
2. First decide what question you are trying to answer and the aim of your investigation.
3. Make a hypothesis for your investigation.
4. You then need to think back to part 1 and design the method for your investigation.
5. After conducting the investigation, you need to write up an experimental report of your findings.
6. In your report, you must have the following headings:
   a) Aim
   b) Hypothesis
   c) Materials and apparatus
   d) Method
   e) Results
   f) Discussion
   g) Conclusion

7. In your results section you need to record your observations in a scientific way. You can do this using a table, diagrams or a combination of both. Think carefully about what information you need to record in order to come to conclusions at the end of your experiment.
8. In your discussion, you need to explain your results and what they mean. You also need to evaluate your investigation and explain if there were any unusual results and suggest ways that you could have improved your investigation for future researchers who might want to repeat what you have done.
9. Present your report on separate paper.

Leaves are not the only parts of plants that store starch. Starch is also stored in the stems, roots and fruit. Have you ever wondered why fruit becomes sweeter as it ripens? Think of an unripe green banana and a ripe yellow banana. Which one is sweeter? Let's find out why.

INVESTIGATION: Why do bananas become sweeter as they ripen?

In this investigation we will taste the bananas to determine if they have more glucose or more starch. We will also conduct a starch test on the ripe and unripe bananas to see which contain more starch.

Ripe yellow bananas and unripe green bananas.

AIM:

1. What do you wish to establish by conducting this investigation?

HYPOTHESIS:

1. What do you think or predict will happen when you conduct this investigation?

MATERIALS AND APPARATUS:

- ripe and unripe bananas cut into discs
- petri dish or saucer
- iodine solution
- dropper

METHOD:

1. Work in groups of three or four. Take a piece of the ripe banana and a piece of the unripe banana and compare the tastes and textures of each. Record your observations in a table. Which banana do you think contains the most starch and the least glucose (a sugar) based on the taste test?

2. Use the iodine starch test identify which banana, the ripe or the unripe one, contains the most starch. Record your observations in the table.

3. Compare this test to the results from your taste and texture test to identify which banana contained the most starch.

OBSERVATIONS:

1. Draw a table to record your observations from the taste and iodine test for starch.

QUESTIONS:

1. Compare your observations of ripe and unripe bananas with those of the other learners in the class. Did you all make the same observations?

2. What do you conclude from these results? Which method of testing is better to use and why do you say so?

3. Explain what you think happens to the starch as the bananas ripen.

Now that we have looked at how green plants produce their own food, let's find out how all living things release the energy stored in food in order to perform the life processes.

1.2 Respiration

NEW WORDS
- limewater
- respiration

We have now seen how plants produce food during photosynthesis. The energy from this food needs to be used by plants and by all the animals who eat those plants. In fact, all organisms need to break down food in order to release its chemical potential energy for life processes. So how does this happen? Let's find out.

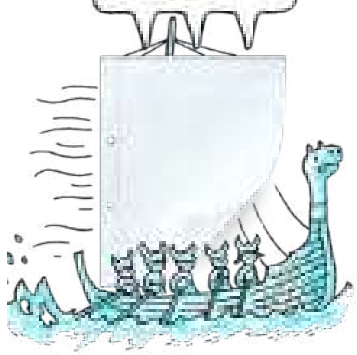
Energy from food

Our bodies need energy to move and do work. Where do we get our energy from? The energy is obtained from the food that we and all other organisms eat.

If you think back to the work you did on fuel and energy in previous grades in Energy and Change, you will remember that fuels, such as wood, coal, and oil, contain **chemical potential energy**. When this fuel is burned in the presence of oxygen, the chemical potential energy is transferred into light and heat energy. In the same way, the glucose from the food that you eat is combined with oxygen in a series of chemical reactions to release the energy. The glucose is broken down and the energy is released. This energy is then used to drive all the other processes in your body. This process is called **respiration**. We can define respiration in all living organisms as the process by which energy is released from glucose in a series of chemical reactions.

TAKE NOTE

We will learn more about chemical reactions next term in Matter and Materials. You will also learn more about respiration in later grades.



Respiration takes place in all organisms, even plants. However, plants do not need to eat any food as they make their own food during photosynthesis.

Products of respiration

Do you remember how we represented photosynthesis as an equation to show what goes in and what comes out? We can represent respiration as an equation in the same way as we did for photosynthesis.

We know what is required for respiration to take place in all organisms. List the two ingredients for respiration.

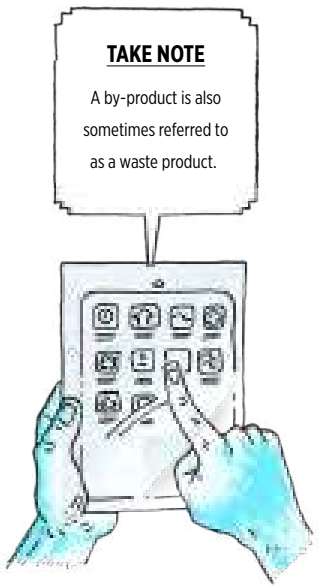
However, respiration does not only produce energy. It also produces water and carbon dioxide as by-products. We can write an equation for respiration as follows:

glucose + **oxygen** → **carbon dioxide** + **water** + **energy**

During photosynthesis in plants, oxygen is produced as a by-product. We call it a by-product as it is not the main product that is wanted from the process. In photosynthesis, the main product that is required from the process is glucose. What are the by-products in respiration?

TAKE NOTE

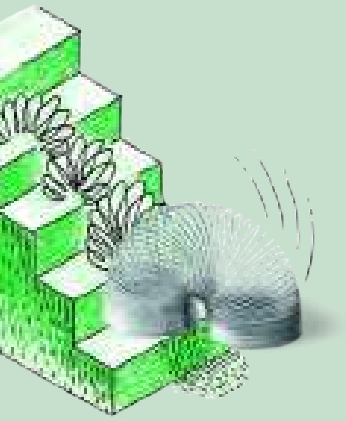
A by-product is also sometimes referred to as a waste product.



The carbon dioxide that is produced in the body of an organism during respiration needs to be removed. In humans, we do this by breathing out carbon dioxide-rich air. We will learn more about the whole respiratory system next year in Gr. 9, and how breathing, our blood circulation system and respiration all work together as one system within our bodies.

We can test for the products of respiration using our own breath. So how do we test that our breath contains carbon dioxide? It is a colourless gas, so we cannot see it directly.

There is a very well known test for detecting carbon dioxide using clear limewater. To test if a gas contains carbon dioxide, simply bubble the gas through **limewater**. If the clear limewater turns milky, then the gas contains carbon dioxide. Next term in Matter and Materials, we will look at this again and find out about the chemical reaction taking place in the test. For now, let's use this test to show that our breath contains carbon dioxide.



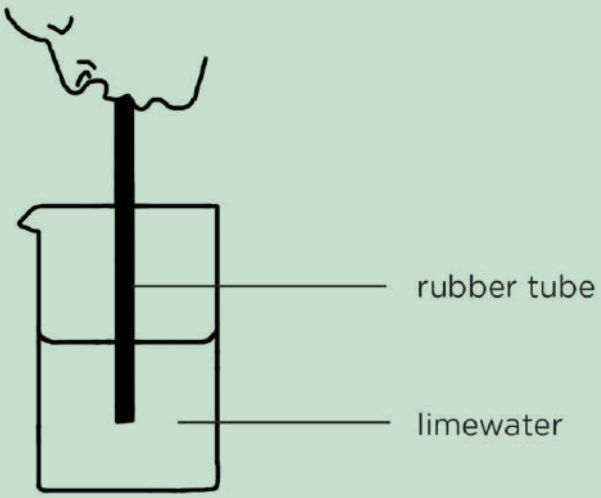
ACTIVITY: Does our breath contain carbon dioxide?

MATERIALS:

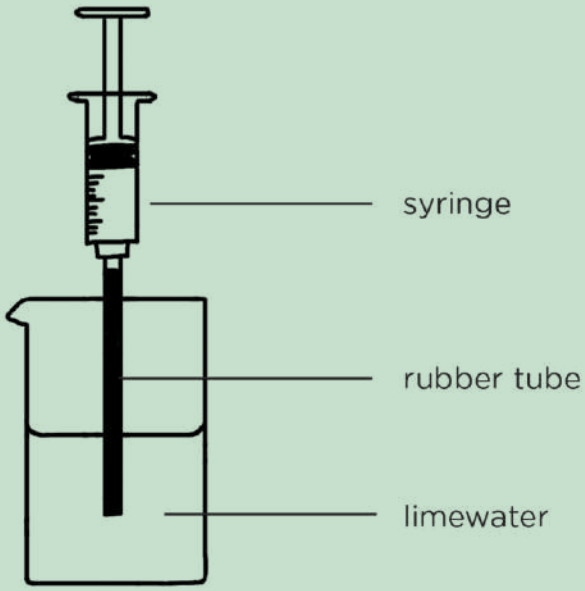
- small beakers (or test tubes)
- rubber tubes or drinking straws
- limewater
- 20 ml syringe (or larger if available)

INSTRUCTIONS

1. Work in groups of three.
2. Mark one beaker AIR and the other BREATH.
3. Pour clear limewater into each beaker until they are half full.
4. Blow bubbles through the rubber tube into the beaker marked BREATH, as shown in the diagram. Do this for at least 1 minute. Notice what happens to the clear limewater.



5. Attach a rubber tube to the front of a syringe. Draw air into the syringe from the atmosphere.
6. Place this rubber tube into the beaker marked AIR and push out the air inside the syringe slowly and carefully into the limewater as shown in the diagram. Notice what happens to the clear limewater.



QUESTIONS

1. Describe what you observed when you blew air from your lungs through the limewater. What does this mean?

2. Describe what you observed when you used the syringe to bubble air from the atmosphere through clear limewater.

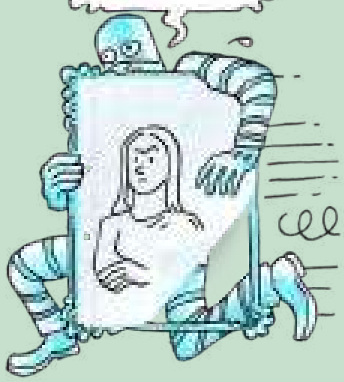
3. A very small percentage of atmospheric air is carbon dioxide gas (0.03). Why do you think you observed the result you did when you pushed air from the atmosphere through the limewater?

4. Think about respiration.
   a) What are the requirements for respiration?

   b) What are the products of respiration?

TAKE NOTE

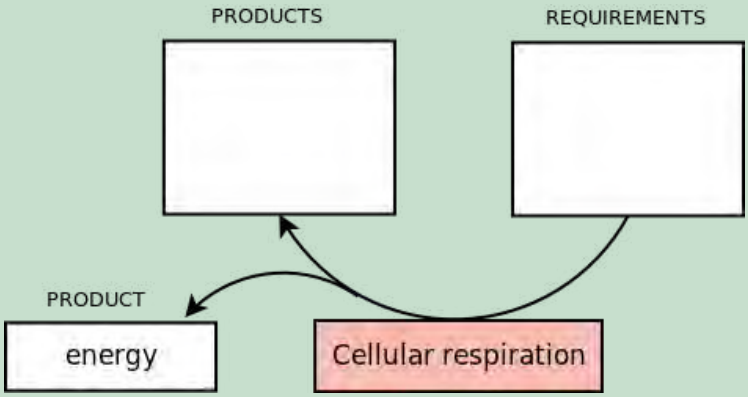
Do not confuse breathing with respiration! Breathing is the act of inhaling and exhaling air into and out of the lungs. Respiration is the metabolic process that uses oxygen to release energy and releases carbon dioxide as a by-product.

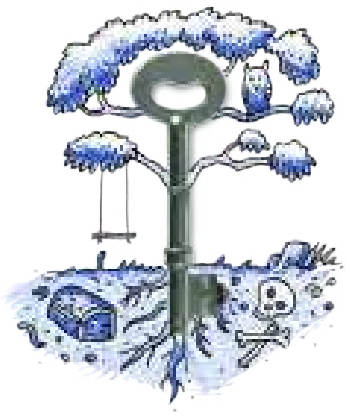


ACTIVITY: Requirements and products of respiration

INSTRUCTIONS:

1. Summarise what you have learnt about respiration in the summary diagram below.
2. Fill in the requirements of respiration in the block on the right.
3. Fill in the products of respiration in the block on the left.





SUMMARY:

Key Concepts

- The need for energy drives the interactions and interdependence in an ecosystem.
- The Sun provides energy to the Earth in the form of radiant (light) energy and heat energy.
- Photosynthesis is the process whereby green plants use carbon dioxide from the air, water from the soil and radiant energy from the Sun in a series of chemical reactions to produce glucose (food) and oxygen.
- Plants are able to photosynthesise because they contain chlorophyll, a green pigment that can capture light energy from the Sun.
- Plants change the glucose that they produce into starch that can be stored more easily.
- Plants also produce cellulose fibres that give plants strength and support and are important to our digestive systems as roughage.
- The food that a plant produces is used by animals when they eat the plant and by other animals that eat them.
- This food contains chemical potential energy that needs to be released from the food.
- Respiration is the process in all living organisms by which energy is released from glucose in a series of chemical reactions.
- Respiration uses oxygen while carbon dioxide and water are given off as by-products.

Concept Map

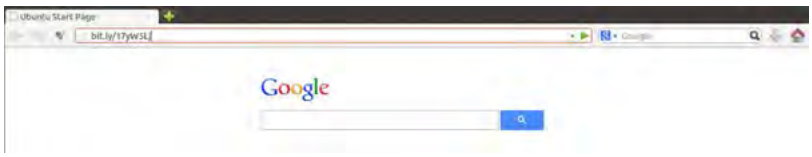
This year in Natural Sciences, we are going to learn more about how to make our own concept maps.

In the summary, we first have the "Key concepts" for this chapter. This is a written summary where the information from this chapter is summarised using words. We can also create a concept map of this chapter. This is a map of how all the concepts (ideas and topics) in this chapter fit together and are linked to each other. A concept map gives us a more visual way of summarizing information.

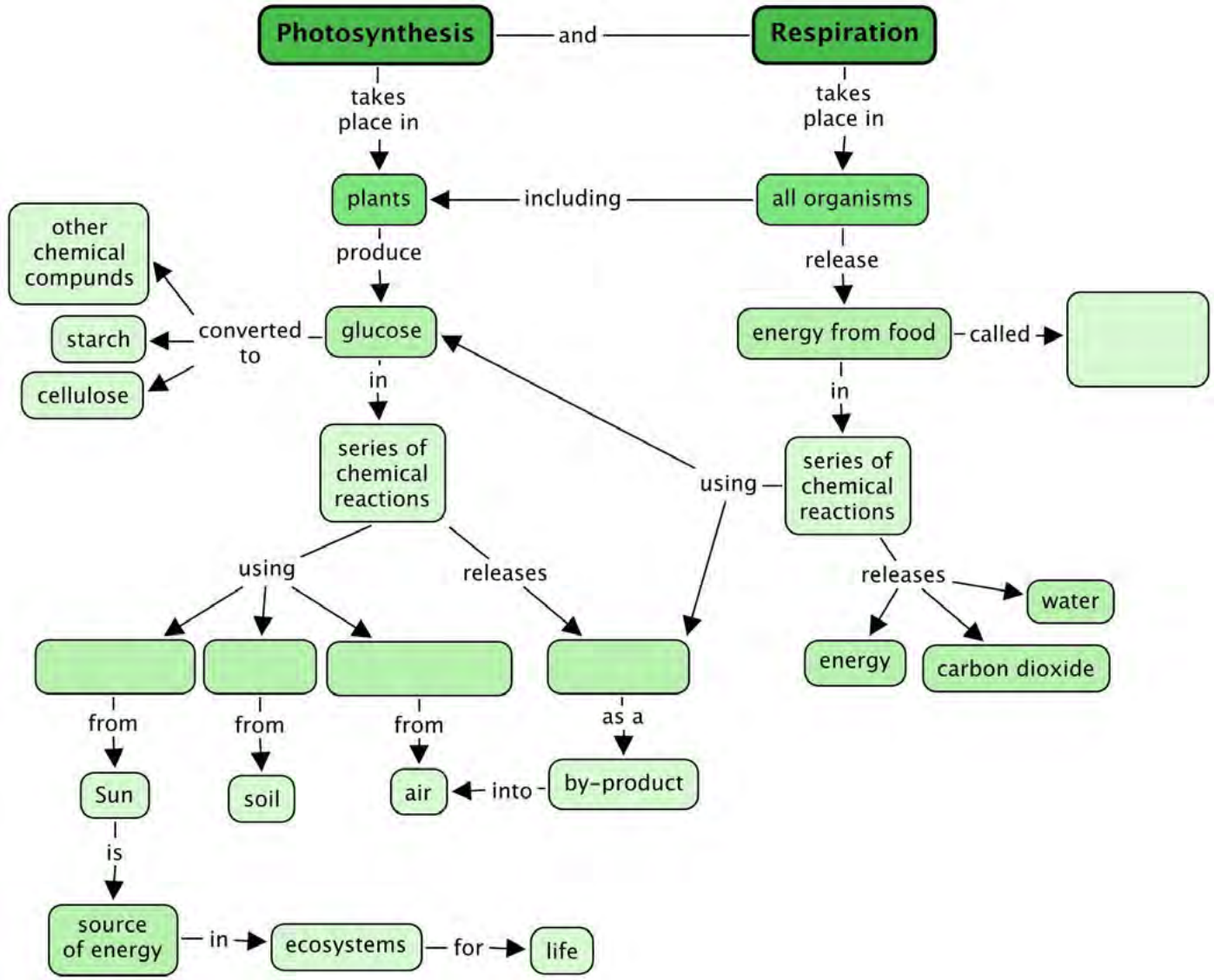
Different people like to learn and study in different ways; some people like to make written summaries, whilst others like to draw their own concept maps when studying and learning. Others like to make things even more visual, using pictures and diagrams to form their summaries. Figuring out the study method that works best for you, and developing these skills is very useful, especially for later in high school and after school!

Have a look at the concept map below for 'Photosynthesis and Respiration'. Do you see that there are some empty spaces? You need to complete the concept map by filling these in. To do this you need read the map from top to bottom and have a look at the concepts which come before. For example, read the concept map as follows, "Respiration takes place in all organisms. All organisms release energy from food, called ....." What type of energy does food contain? Remember, food is the fuel for our bodies. You also need to fill in the three things that plants use to photosynthesise. You need to look at what concepts link from these in order to know where to put each one. Finally, what does photosynthesis release as a by-product? You also need to fill this in.

Have you noticed the **VISIT** boxes in the margins which contain links? You simply need to type this whole link into the address bar in your internet browser, either on your PC, tablet or mobile phone, and press enter, like this:



It will direct you to our website where you can watch the video or visit the webpage online. **Be curious and discover more online at our website!**


Photosynthesis
and
Respiration
takes place in
takes place in
plants
including
all organisms
other chemical compunds
starch
cellulose
converted to
produce
glucose
release
energy from food
called
in
in
series of chemical reactions
using
series of chemical reactions
using
releases
releases
water
energy
carbon dioxide
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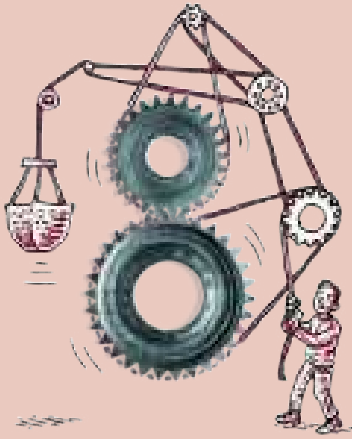
ecosystems
for
life

REVISION:



1. A Gr. 4 learner wanted to grow some beans and carefully planted them in a yoghurt tub and watered them. He was scared that his little brother would knock his tub over, so he hid the tub in his cupboard.
   a) Explain what he would have noticed a few days after planting the beans. [2 marks]

   b) Predict what would have happened after another few days with the beans hidden in his cupboard. [2 marks]

   c) Explain why you predicted this outcome for his beans. [2 marks]

   d) What should he have done to make his bean plants grow tall and strong? [2 marks]

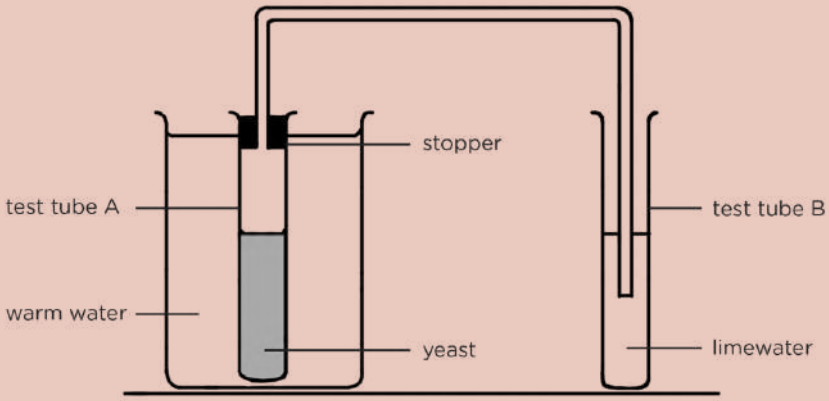
2. What are the requirements for photosynthesis to occur? [3 marks]

3. A farmer is growing some tomatoes. He heard from his daughter that plants produce glucose during photosynthesis, so he decided to see for himself. However, when he tested the leaves, he did not find much glucose, but he did find a lot of starch present.
   a) Why did the farmer see this result? [2 marks]

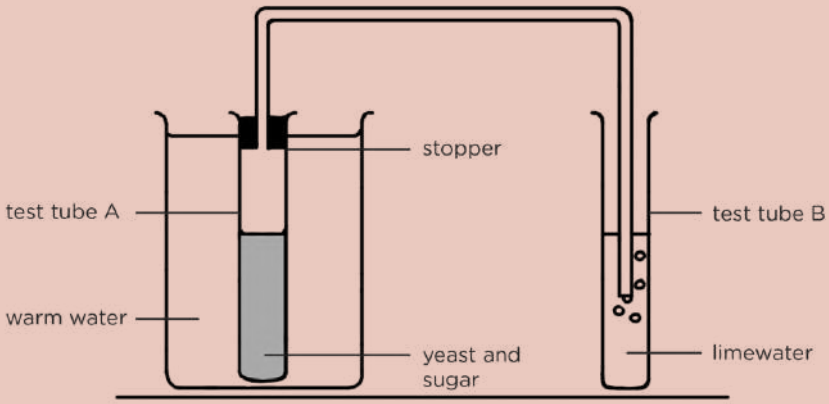
   b) Describe the test that the farmer conducted to show that the leaf contained starch. [5 marks]

4. Do plants undergo photosynthesis and respiration all day and all night? Give reasons for your answer. [4 marks]

5. A group of Gr. 7 learners wanted to show that carbon dioxide is used to make bread rise because the yeast and sugar that is added to the bread mix produces the carbon dioxide. They set up the following two experiments. The gas that they collected from each test tube was run through limewater.



Setup 1

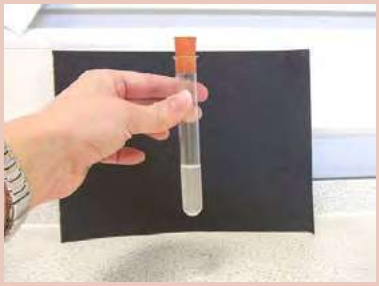


Setup 2

a) Why did they run the rubber tube from Test Tube A to Test Tube B? [3 marks]

b) Explain why they added a stopper into the top of Test Tube A. [1 mark]

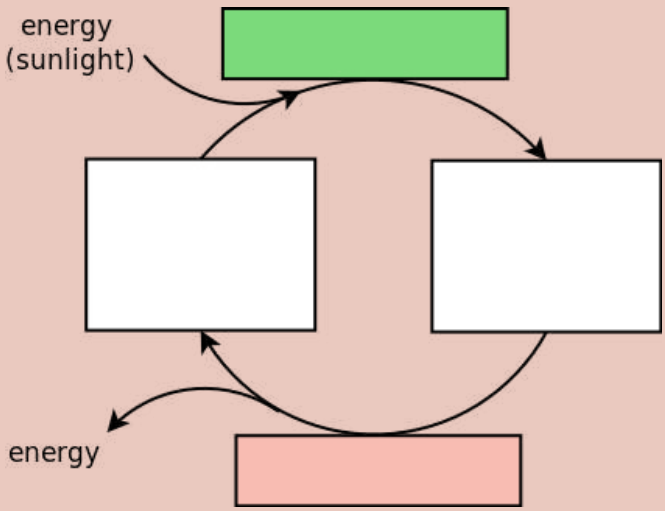
c) The following photo shows one of the test tubes after the experiment. Which test tube do you think it is and from which set-up. Give reasons for your answer. [2 marks]



Which test tube is this?

d) Why do you think the yeast solution in Setup 1 did not produce carbon dioxide. [2 marks]

6. Study the following diagram and fill in the missing information. [6 marks]



7. Draw a table in the following space to show the differences between the two processes, photosynthesis and respiration. You table should highlight the differences in requirements, the differences in the products, which organisms the processes takes place in, and when. [8 marks]

Total [44 marks]

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