MY PALS ARE HERE!

Science

Systems

Primary 5&6

Teacher's Guide

Wang Ing Ching
Science Education Consultant: Dr Charles Chew

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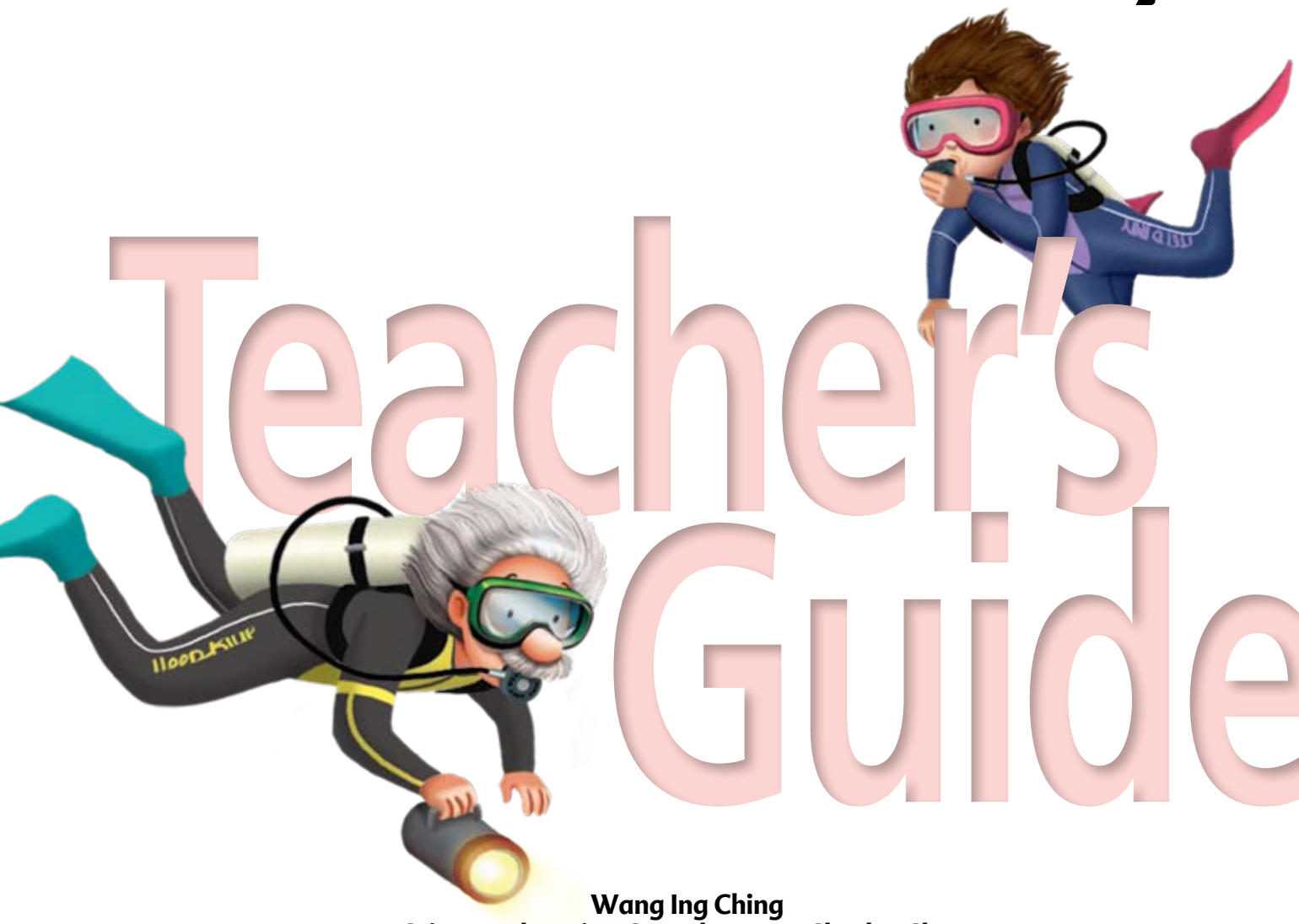

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Contents

Systems

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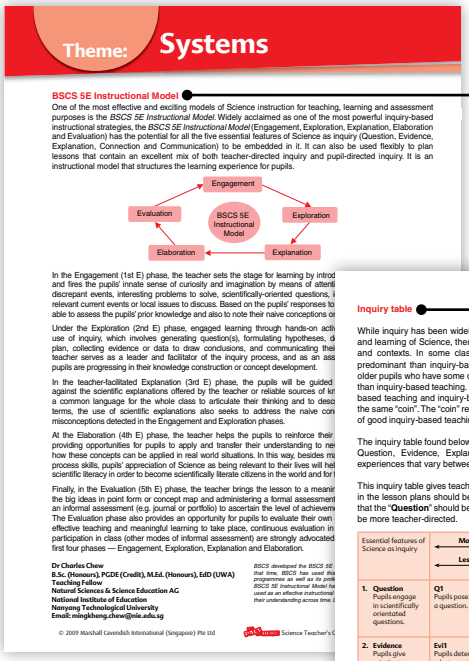
Preface

MY PALS ARE HERE! Science Teacher's Guide serves as a detailed and comprehensive guide to equip teachers for inquiry-based teaching. During the inquiry process, teachers take on the role of facilitators. They spark curiosity, cultivate the skills needed for inquiry and guide pupils along the way.


Theme: Systems

BSCS 5E Instructional Model

One of the most effective and exciting models of Science instruction for teaching, learning and assessment purposes is the *BSCS 5E Instructional Model*. Widely acclaimed as one of the most powerful inquiry-based instructional strategies, the *BSCS 5E Instructional Model* (Engagement, Exploration, Explanation, Elaboration and Evaluation) has the potential for all the five essential features of Science as inquiry (Question, Evidence, Explanation, Connection and Communication) to be embedded in it. It can also be used flexibly to plan lessons that contain an excellent mix of both teacher-directed inquiry and pupil-directed inquiry. It is an instructional model that structures the learning experience for pupils.

Engagement
Exploration
Explanation
Elaboration
Evaluation
BSCS 5E Instructional Model

In the Engagement (1st E) phase, the teacher sets the stage for learning by introd
and fires the pupils' innate sense of curiosity and imagination by means of attenti
discrepant events, interesting problems to solve, scientifically-oriented questions,
relevant current events or local issues to discuss. Based on the pupils' responses to
able to assess the pupils' prior knowledge and also to note their naive conceptions o

Under the Exploration (2nd E) phase, engaged learning through hands-on acti
use of inquiry, which involves generating question(s), formulating hypotheses,
plan, collecting evidence or data to draw conclusions, and communicating thei
teacher serves as a leader and facilitator of the inquiry process, and as an ass
pupils are progressing in their knowledge construction or concept development.

In the teacher-facilitated Explanation (3rd E) phase, the pupils will be guided
against the scientific explanations offered by the teacher or reliable sources of kr
a common language for the whole class to articulate their thinking and to desc
terms, the use of scientific explanations also seeks to address the naive con
misconceptions detected in the Engagement and Exploration phases.

At the Elaboration (4th E) phase, the teacher helps the pupils to reinforce their
providing opportunities for pupils to apply and transfer their understanding to ne
how these concepts can be applied in real world situations. In this way, besides m
process skills, pupils' appreciation of Science as being relevant to their lives will hel
scientific literacy in order to become scientifically literate citizens in the world and for t

Finally, in the Evaluation (5th E) phase, the teacher brings the lesson to a meanir
the big ideas in point form or concept map and administering a formal assessment
an informal assessment (e.g. journal or portfolio) to ascertain the level of achievem
The Evaluation phase also provides an opportunity for pupils to evaluate their own
effective teaching and meaningful learning to take place, continuous evaluation in
participation in class (other modes of informal assessment) are strongly advocated
first four phases — Engagement, Exploration, Explanation and Elaboration.

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BSCS developed the BSCS 5E... that time. BSCS has used the... programmes as well as its prede... BSCS 5E Instructional Model ha... used as an effective instructional... their understanding across time, t...

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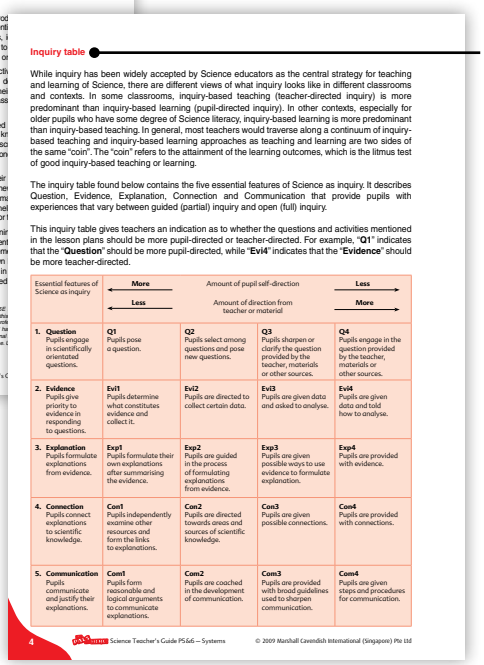
BSCS 5E Instructional Model

The BSCS 5E Instructional Model (Engagement, Exploration, Explanation, Elaboration and Evaluation) is used to highlight the key aspects of teaching an inquiry-based curriculum. It provides a direction on how teachers can effectively carry out inquiry-based teaching.


Inquiry table

While inquiry has been widely accepted by Science educators as the central strategy for teaching and learning of Science, there are different views of what inquiry looks like in different classrooms and contexts. In some classrooms, inquiry-based teaching (teacher-directed inquiry) is more predominant than inquiry-based learning (pupil-directed inquiry). In other contexts, especially for older pupils who have some degree of Science literacy, inquiry-based learning is more predominant than inquiry-based teaching. In general, most teachers would traverse along a continuum of inquiry-based teaching and inquiry-based learning approaches as teaching and learning are two sides of the same "coin". The "coin" refers to the attainment of the learning outcomes, which is the litmus test of good inquiry-based teaching or learning.

The inquiry table found below contains the five essential features of Science as inquiry. It describes Question, Evidence, Explanation, Connection and Communication that provide pupils with experiences that vary between guided (partial) inquiry and open (full) inquiry.

This inquiry table gives teachers an indication as to whether the questions and activities mentioned in the lesson plans should be more pupil-directed or teacher-directed. For example, "**Q1**" indicates that the "**Question**" should be more pupil-directed, while "**Evi4**" indicates that the "**Evidence**" should be more teacher-directed.

Essential features of Science as inquiry	More ← Amount of pupil self-direction → Less Less ← Amount of direction from teacher or material → More			
1. **Question** Pupils engage in scientifically orientated questions.	**Q1** Pupils pose a question.	**Q2** Pupils select among questions and pose new questions.	**Q3** Pupils sharpen or clarify the question provided by the teacher, materials or other sources.	**Q4** Pupils engage in the question provided by the teacher, materials or other sources.
2. **Evidence** Pupils give priority to evidence in responding to questions.	**Evi1** Pupils determine what constitutes evidence and collect it.	**Evi2** Pupils are directed to collect certain data.	**Evi3** Pupils are given data and asked to analyse.	**Evi4** Pupils are given data and told how to analyse.
3. **Explanation** Pupils formulate explanations from evidence.	**Exp1** Pupils formulate their own explanations after summarising the evidence.	**Exp2** Pupils are guided in the process of formulating explanations from evidence.	**Exp3** Pupils are given possible ways to use evidence to formulate explanation.	**Exp4** Pupils are provided with evidence.
4. **Connection** Pupils connect explanations to scientific knowledge.	**Con1** Pupils independently examine other resources and form the links to explanations.	**Con2** Pupils are directed towards areas and sources of scientific knowledge.	**Con3** Pupils are given possible connections.	**Con4** Pupils are provided with connections.
5. **Communication** Pupils communicate and justify their explanations.	**Com1** Pupils form reasonable and logical arguments to communicate explanations.	**Com2** Pupils are coached in the development of communication.	**Com3** Pupils are provided with broad guidelines used to sharpen communication.	**Com4** Pupils are given steps and procedures for communication.

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Inquiry Table

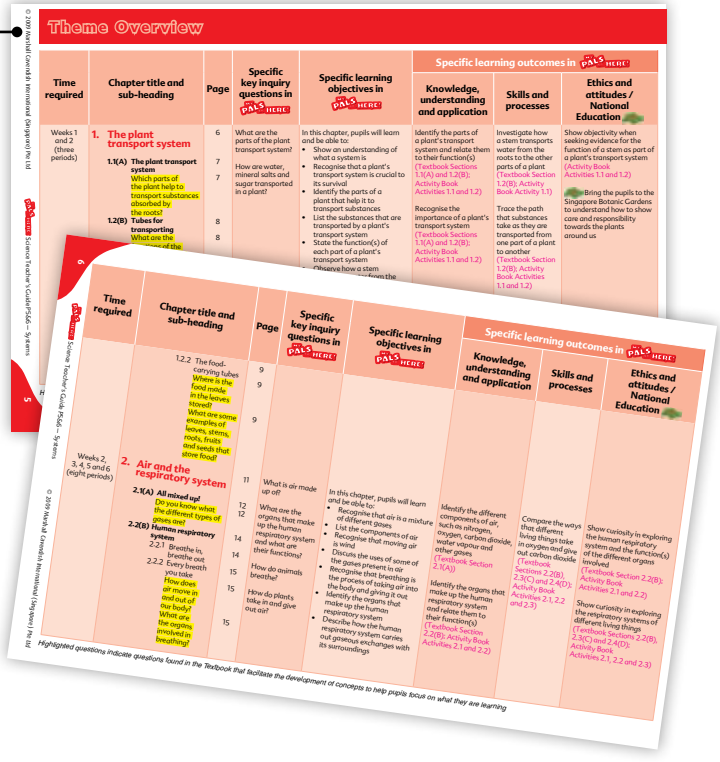
The Inquiry Table consists of the five essential features of Science as inquiry, where it describes Question, Evidence, Explanation, Connection and Communication. By complementing the Lesson Plans, it helps teachers to identify whether the questions or activities are more pupil-directed or teacher-directed.

Theme Overview

In the Theme Overview, teachers are provided with information to enable them to have a better grasp of the content to be discussed in the theme.

The Theme Overview consists of detailed descriptions of the time required, Specific Instructional Objectives (SIOs) and specific key inquiry questions. The links to sections in the Textbook and Activity Book, where the SIOs are covered, have also been added. In addition, highlighted questions indicate the questions found within the Textbook, which facilitate the development of concepts to help pupils focus on what they are learning.

Special emphasis has also been placed on helping pupils understand more about Singapore through the National Education activities, which are pegged to relevant chapters in the theme.


Theme Overview

Time required	Chapter title and sub-heading	Page	Specific key inquiry questions in PALS HERE	Specific learning objectives in PALS HERE	Specific learning outcomes in PALS HERE: Knowledge, understanding and application	Specific learning outcomes in PALS HERE: Skills and processes	Specific learning outcomes in PALS HERE: Ethics and attitudes / National Education
Weeks 1 and 2 (three periods)	**1. The plant transport system** 1.1(A) **The plant transport system** Which parts of the plant help to transport substances absorbed by the roots? 1.2(B) **Tubes for transporting** What are the	6 7 7 8 8	What are the parts of the plant transport system? How are water, mineral salts and sugar transported in a plant?	In this chapter, pupils will learn and be able to: • Show an understanding of what a system is • Recognise that a plant's transport system is crucial to its survival • Identify the parts of a plant that help it to transport substances • List the substances that are transported by a plant's transport system • State the function(s) of each part of a plant's transport system Observe how a stem	Identify the parts of a plant's transport system and relate them to their function(s) (Textbook Sections 1.1(A) and 1.2(B); Activity Book Activities 1.1 and 1.2) Recognise the importance of a plant's transport system (Textbook Sections 1.1(A) and 1.2(B); Activity Book Activities 1.1 and 1.2)	Investigate how a stem transports water from the roots to the other parts of a plant (Textbook Section 1.2(B); Activity Book Activity 1.1) Trace the path that substances take as they are transported from one part of a plant to another (Textbook Section 1.2(B); Activity Book Activities 1.1 and 1.2)	Show objectivity when seeking evidence for the function of a stem as part of a plant's transport system (Activity Book Activities 1.1 and 1.2) Bring the pupils to the Singapore Botanic Gardens to understand how to show care and responsibility towards the plants around us

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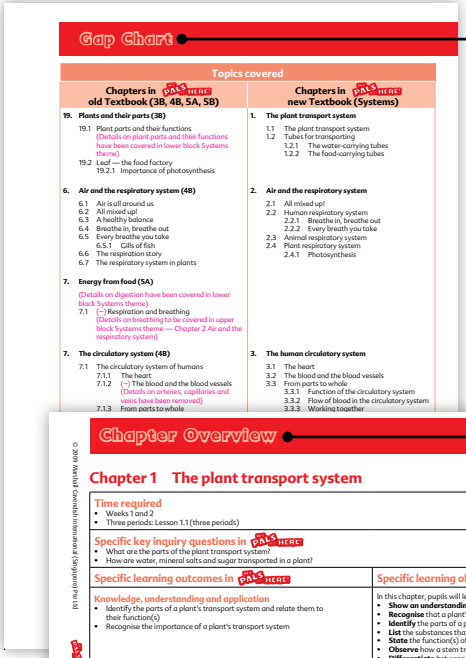
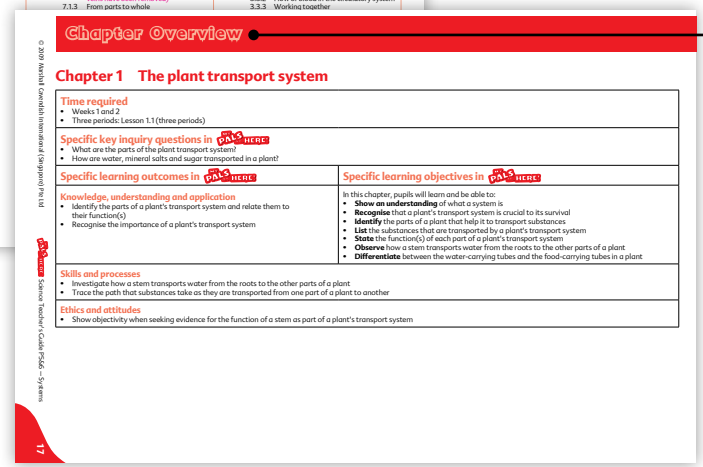

Gap Chart

Topics covered

Chapters in old Textbook (3B, 4B, 5A, 5B)	Chapters in new Textbook (Systems)
19. Plants and their parts (3B) 19.1 Plant parts and their functions (Details on plant parts and their functions have been covered in lower block Systems theme) 19.2 Leaf — the food factory 19.2.1 Importance of photosynthesis	**1. The plant transport system** 1.1 The plant transport system 1.2 Tubes for transporting 1.2.1 The water-carrying tubes 1.2.2 The food-carrying tubes
6. Air and the respiratory system (4B) 6.1 Air is all around us 6.2 All mixed up! 6.3 A healthy balance 6.4 Breathe in, breathe out 6.5 Every breathe you take 6.5.1 Gills of fish 6.6 The respiration story 6.7 The respiratory system in plants	**2. Air and the respiratory system** 2.1 All mixed up! 2.2 Human respiratory system 2.2.1 Breathe in, breathe out 2.2.2 Every breath you take 2.3 Animal respiratory system 2.4 Plant respiratory system 2.4.1 Photosynthesis
7. Energy from food (5A) (Details on digestion have been covered in lower block Systems theme) 7.1 (—) Respiration and breathing (Details on breathing to be covered in upper block Systems theme — Chapter 2 Air and the respiratory system)	
7. The circulatory system (4B) 7.1 The circulatory system of humans 7.1.1 The heart 7.1.2 (—) The blood and the blood vessels (Details on arteries, capillaries and veins have been removed) 7.1.3 From parts to whole	**3. The human circulatory system** 3.1 The heart 3.2 The blood and the blood vessels 3.3 From parts to whole 3.3.1 Function of the circulatory system 3.3.2 Flow of blood in the circulatory system 3.3.3 Working together

Gap Chart

In order to provide teachers with a platform on which to understand how the first and second editions of the Textbook differ, new Textbook content and Textbook content that has been removed from the latest Primary Science syllabus are indicated in the Gap Chart. Furthermore, the Gap Chart serves as a bridge to link the topics covered in the first and second editions of the Textbook.


Chapter Overview

Chapter 1 The plant transport system

Time required
- Weeks 1 and 2
- Three periods: Lesson 1.1 (three periods)

Specific key inquiry questions in PALS HERE
- What are the parts of the plant transport system?
- How are water, mineral salts and sugar transported in a plant?

Specific learning outcomes in PALS HERE	Specific learning objectives in PALS HERE
Knowledge, understanding and application • Identify the parts of a plant's transport system and relate them to their function(s) • Recognise the importance of a plant's transport system	In this chapter, pupils will learn and be able to: • **Show an understanding** of what a system is • **Recognise** that a plant's transport system is crucial to its survival • **Identify** the parts of a plant that help it to transport substances • **List** the substances that are transported by a plant's transport system • **State** the function(s) of each part of a plant's transport system • **Observe** how a stem transports water from the roots to the other parts of a plant • **Differentiate** between the water-carrying tubes and the food-carrying tubes in a plant

Skills and processes
- Investigate how a stem transports water from the roots to the other parts of a plant
- Trace the path that substances take as they are transported from one part of a plant to another

Ethics and attitudes
- Show objectivity when seeking evidence for the function of a stem as part of a plant's transport system

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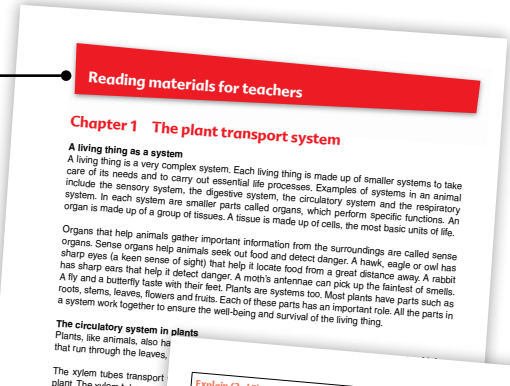
Chapter Overview

In the Chapter Overview, teachers are given an indication of what is expected in the latest syllabus so that they can better plan their lessons. Besides the detailed descriptions of SIOs, essential learning points have also been listed in a structured format, which is easy for teachers to refer to.

Reading Materials For Teachers

Within the Reading Materials For Teachers, more information has been provided to further aid the teacher's understanding of each topic. The knowledge would also equip teachers with answers for more challenging questions posed by pupils.


Reading materials for teachers

Chapter 1 The plant transport system

A living thing as a system

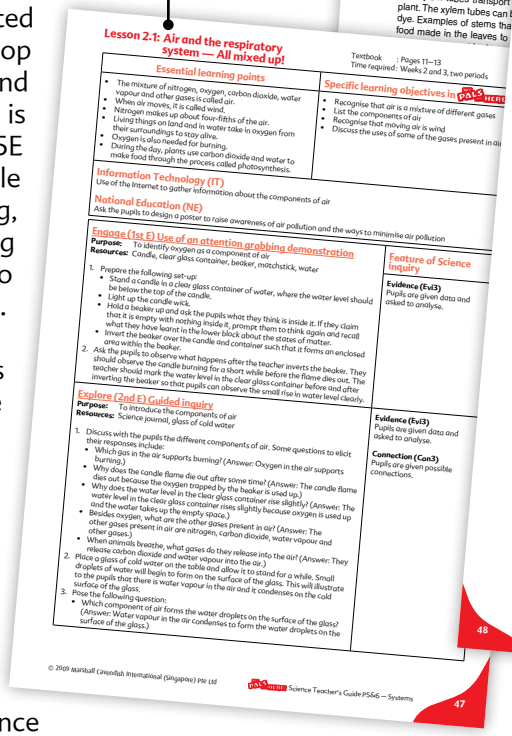
A living thing is a very complex system. Each living thing is made up of smaller systems to take care of its needs and to carry out essential life processes. Examples of systems in an animal include the sensory system, the digestive system, the circulatory system and the respiratory system. In each system are smaller parts called organs, which perform specific functions. An organ is made up of a group of tissues. A tissue is made up of cells, the most basic units of life.

Organs that help animals gather important information from the surroundings are called sense organs. Sense organs help animals seek out food and detect danger. A hawk, eagle or owl has sharp eyes (a keen sense of sight) that help it locate food from a great distance away. A rabbit has sharp ears that help it detect danger. A moth's antennae can pick up the faintest of smells. A fly and a butterfly taste with their feet. Plants are systems too. Most plants have parts such as roots, stems, leaves, flowers and fruits. Each of these parts has an important role. All the parts in a system work together to ensure the well-being and survival of the living thing.

The circulatory system in plants

Plants, like animals, also ha
that run through the leaves.

The xylem tubes transport
plant. The xylem tubes can b
dye. Examples of stems tha
food made in the leaves to


Lesson 2.1: Air and the respiratory system — All mixed up!

Textbook : Pages 11–13
Time required : Weeks 2 and 3, two periods

Essential learning points
- The mixture of nitrogen, oxygen, carbon dioxide, water vapour and other gases is called air.
- When air moves, it is called wind.
- Nitrogen makes up about four-fifths of the air.
- Living things on land and in water take in oxygen from their surroundings to stay alive.
- Oxygen is also needed for burning.
- During the day, plants use carbon dioxide and water to make food through the process called photosynthesis.

Specific learning objectives in PALS HERE
- Recognise that air is a mixture of different gases
- List the components of air
- Recognise that moving air is wind
- Discuss the uses of some of the gases present in air

Information Technology (IT)
Use of the Internet to gather information about the components of air

National Education (NE)
Ask the pupils to design a poster to raise awareness of air pollution and the ways to minimise air pollution

Engage (1st E) Use of an attention grabbing demonstration
Purpose: To identify oxygen as a component of air
Resources: Candle, clear glass container, beaker, matchstick, water

1. Prepare the following set-up:
   - Stand a candle in a clear glass container of water, where the water level should be below the top of the candle.
   - Light up the candle wick.
   - Hold a beaker up and ask the pupils what they think is inside it. If they claim that it is empty, with nothing inside it, prompt them to think again and recall what they have learnt in the lower block about the states of matter.
   - Invert the beaker over the candle and container such that it forms an enclosed area within the beaker.
2. Ask the pupils to observe what happens after the teacher inverts the beaker. They should observe the candle burning for a short while before the flame dies out. The teacher should mark the water level in the clear glass container before and after inverting the beaker so that pupils can observe the small rise in water level clearly.

Feature of Science inquiry
Evidence (Evi3)
Pupils are given data and asked to analyse.

Explore (2nd E) Guided inquiry
Purpose: To introduce the components of air
Resources: Science journal, glass of cold water

1. Discuss with the pupils the different components of air. Some questions to elicit their responses include:
   - Which gas in the air supports burning? (Answer: Oxygen in the air supports burning.)
   - Why does the candle flame die out after some time? (Answer: The candle flame dies out because the oxygen trapped by the beaker is used up.)
   - Why does the water level in the clear glass container rise slightly? (Answer: The water level in the clear glass container rises slightly because oxygen is used up and the water takes up the empty space.)
   - Besides oxygen, what are the other gases present in air? (Answer: The other gases present in air are nitrogen, carbon dioxide, water vapour and other gases.)
   - When animals breathe, what gases do they release into the air? (Answer: They release carbon dioxide and water vapour into the air.)
2. Place a glass of cold water on the table and allow it to stand for a while. Small droplets of water will begin to form on the surface of the glass. This will illustrate to the pupils that there is water vapour in the air and it condenses on the cold surface of the glass.
3. Pose the following question:
   - Which component of air forms the water droplets on the surface of the glass? (Answer: Water vapour in the air condenses to form the water droplets on the surface of the glass.)

Evidence (Evi3)
Pupils are given data and asked to analyse.

Connection (Con3)
Pupils are given possible connections.

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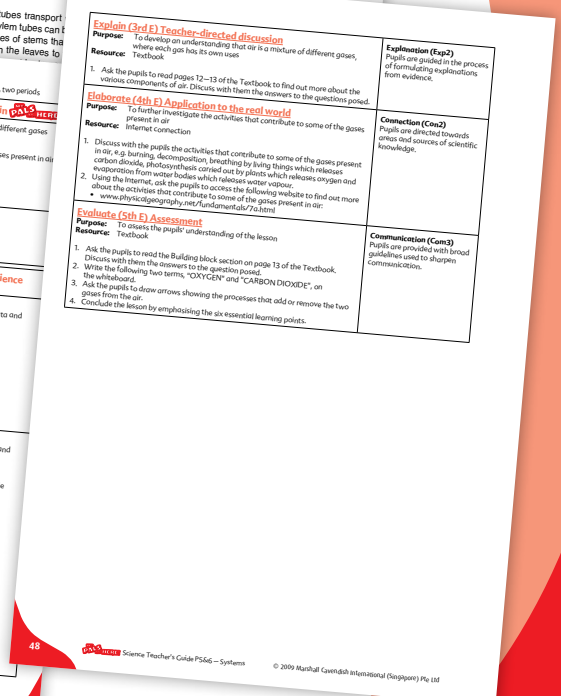
Explain (3rd E) Teacher-directed discussion
Purpose: To develop an understanding that air is a mixture of different gases, where each gas has its own uses
Resource: Textbook

1. Ask the pupils to read pages 12–13 of the Textbook to find out more about the various components of air. Discuss with them the answers to the questions posed.

Explanation (Exp2)
Pupils are guided in the process of formulating explanations from evidence.

Elaborate (4th E) Application to the real world
Purpose: To further investigate the activities that contribute to some of the gases present in air
Resource: Internet connection

1. Discuss with the pupils the activities that contribute to some of the gases present in air, e.g. burning, decomposition, breathing by living things which releases carbon dioxide, photosynthesis carried out by plants which releases oxygen and evaporation from water bodies which releases water vapour.
2. Using the Internet, ask the pupils to access the following website to find out more about the activities that contribute to some of the gases present in air:
   - www.physicalgeography.net/fundamentals/7o.html

Connection (Con2)
Pupils are directed towards areas and sources of scientific knowledge.

Evaluate (5th E) Assessment
Purpose: To assess the pupils' understanding of the lesson
Resource: Textbook

1. Ask the pupils to read the Building block section on page 13 of the Textbook.
2. Discuss with them the answers to the question posed.
3. Write the following two terms, "OXYGEN" and "CARBON DIOXIDE", on the whiteboard.
4. Ask the pupils to draw arrows showing the processes that add or remove the two gases from the air.
5. Conclude the lesson by emphasising the six essential learning points.

Communication (Com3)
Pupils are provided with broad guidelines used to sharpen communication.

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Lesson Plans

Teachers are also assisted in lesson planning as the Lesson Plans contain suggested strategies on ways to develop lessons. The purpose behind each of these strategies is closely linked to the BSCS 5E Instructional Model, while questions for scaffolding, initiating inquiry and assessing pupils' understanding are also provided wherever applicable.

In order to tie the various components of the package together, links to the relevant sections in the Textbook, Activity Book, Homework Book, Tests and Higher Order Thinking Skills (HOTS) have been included. This allows a more seamless transition between the various components to provide a more holistic learning experience for the pupils.

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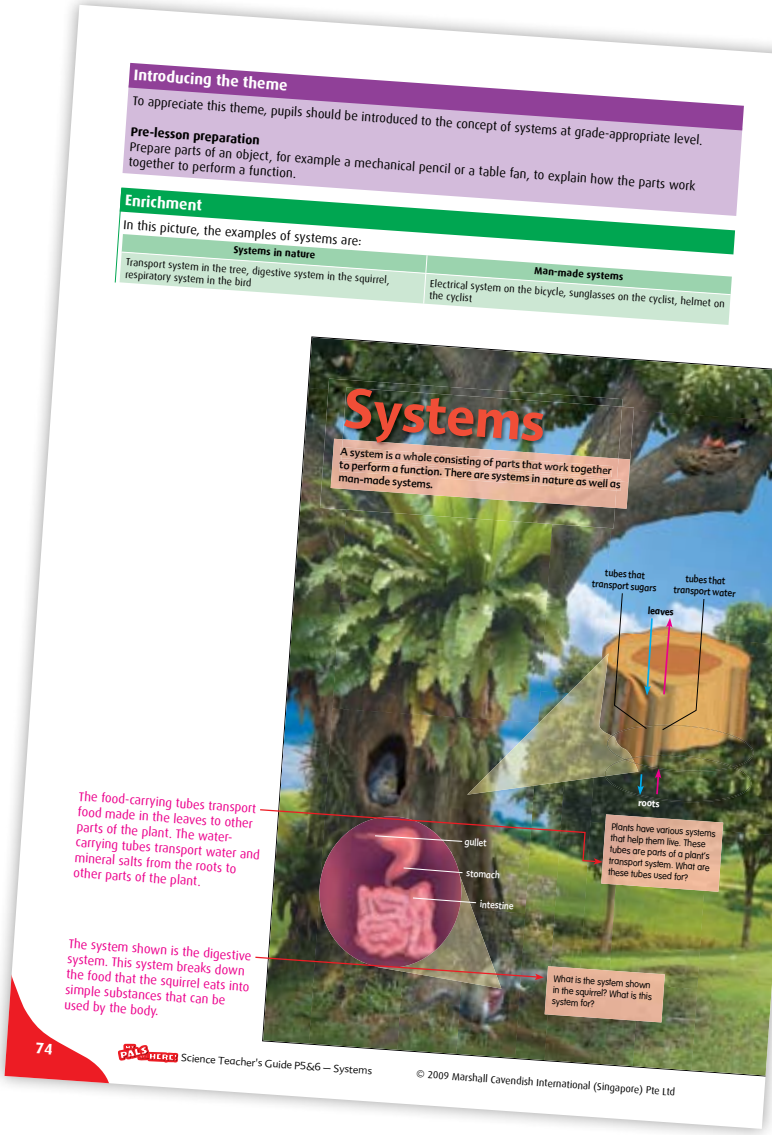
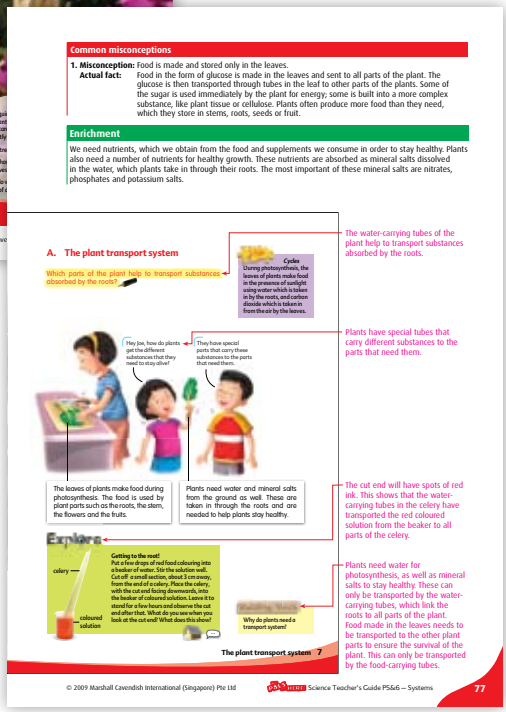
Textbook Wraparound

The Textbook Wraparound consists of several features, which help teachers to spark pupils' curiosity about the topics.

- On the theme pages of every theme, 'Introducing the theme' provides teachers with activities to help pupils appreciate the theme at a grade-appropriate level.
- Teachers may also refer to 'Background information for teachers' for additional information on the topics being taught.
- General misconceptions and learning difficulties that pupils may encounter are highlighted where possible and suggestions on how teachers can tackle these to prevent disruption of the flow of learning are provided in 'Common misconceptions'.
- Activities or interesting information to stretch a lesson, extend knowledge and provide a deeper understanding of concepts are included in 'Enrichment', while some are specially designed for high ability pupils in 'Enrichment for high ability pupils'.





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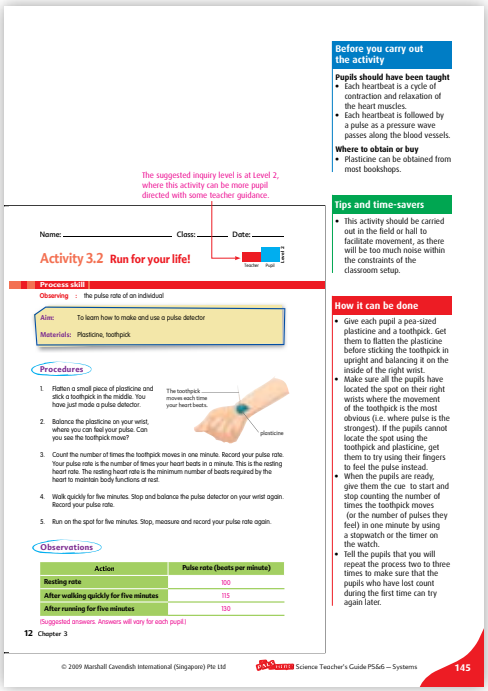

Before you carry out the activity

Pupils should have been taught
- Each heartbeat is a cycle of contraction and relaxation of the heart muscles.
- Each heartbeat is followed by a pulse as a pressure wave passes along the blood vessels.

Where to obtain or buy
- Plasticine can be obtained from most bookshops.

The suggested inquiry level is at Level 2, where this activity can be more pupil directed with some teacher guidance.

Tips and time-savers
- This activity should be carried out in the field or hall to facilitate movement, as there will be too much noise within the constraints of the classroom setup.

Name: _____ Class: _____ Date: _____

Activity 3.2 Run for your life!

Process skill
Observing : the pulse rate of an individual

Aim: To learn how to make and use a pulse detector

Materials: Plasticine, toothpick

How it can be done
- Give each pupil a pea-sized plasticine and a toothpick. Get them to flatten the plasticine before sticking the toothpick in upright and balancing it on the inside of the right wrist.
- Make sure all the pupils have located the spot on their right wrists where the movement of the toothpick is the most obvious (i.e. where pulse is the strongest). If the pupils cannot locate the spot using the toothpick and plasticine, get them to try using their fingers to feel the pulse instead.
- When the pupils are ready, give them the cue to start and stop counting the number of times the toothpick moves (or the number of pulses they feel) in one minute by using a stopwatch or the timer on the watch.
- Tell the pupils that you will repeat the process two to three times to make sure that the pupils who have lost count during the first time can try again later.

Procedures

1. Flatten a small piece of plasticine and stick a toothpick in the middle. You have just made a pulse detector.
2. Balance the plasticine on your wrist, where you can feel your pulse. Can you see the toothpick move?
3. Count the number of times the toothpick moves in one minute. Record your pulse rate. Your pulse rate is the number of times your heart beats in a minute. This is the resting heart rate. The resting heart rate is the minimum number of beats required by the heart to maintain body functions at rest.
4. Walk quickly for five minutes. Stop and balance the pulse detector on your wrist again. Record your pulse rate.
5. Run on the spot for five minutes. Stop, measure and record your pulse rate again.

The toothpick moves each time your heart beats.

plasticine

Observations

Action	Pulse rate (beats per minute)
Resting rate	100
After walking quickly for five minutes	115
After running for five minutes	130

(Suggested answers. Answers will vary for each pupil.)

12 Chapter 3

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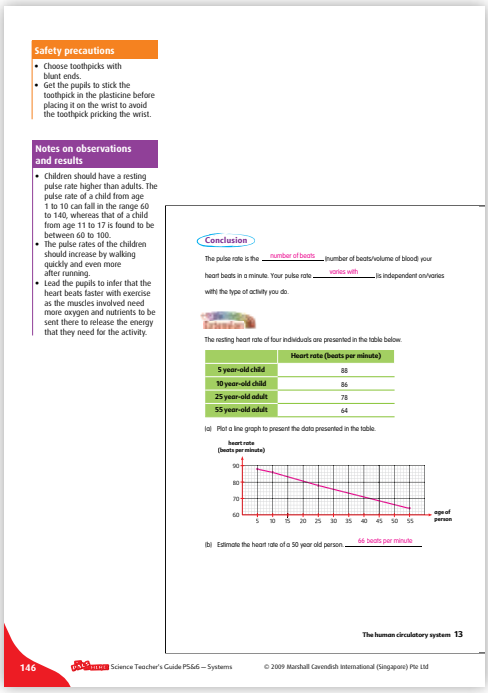

Safety precautions
- Choose toothpicks with blunt ends.
- Get the pupils to stick the toothpick in the plasticine before placing it on the wrist to avoid the toothpick pricking the wrist.

Notes on observations and results
- Children should have a resting pulse rate higher than adults. The pulse rate of a child from age 1 to 10 can fall in the range 60 to 140, whereas that of a child from age 11 to 17 is found to be between 60 to 100.
- The pulse rates of the children should increase by walking quickly and even more after running.
- Lead the pupils to infer that the heart beats faster with exercise as the muscles involved need more oxygen and nutrients to be sent there to release the energy that they need for the activity.

Conclusion

The pulse rate is the number of beats (number of beats/volume of blood) your heart beats in a minute. Your pulse rate varies with is independent on/varies with the type of activity you do.

The resting heart rate of four individuals are presented in the table below.

	Heart rate (beats per minute)
5 year-old child	88
10 year-old child	86
25 year-old adult	78
55 year-old adult	64

(a) Plot a line graph to present the data presented in the table.

heart rate (beats per minute)

90 80 70 60

5 10 15 20 25 30 35 40 45 50 55 age of person

(b) Estimate the heart rate of a 50 year old person. 66 beats per minute

The human circulatory system 13

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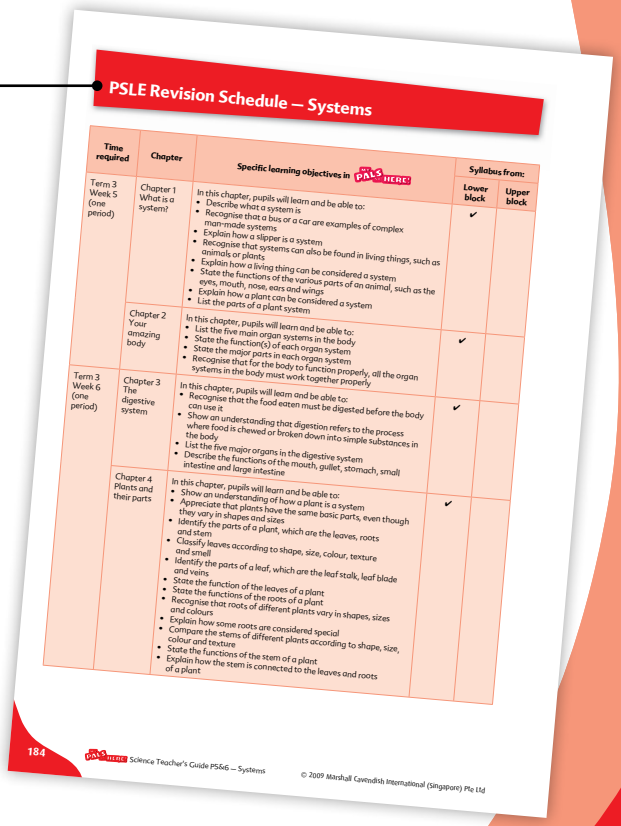
Activity Book Wraparound

The Activity Book Wraparound also consists of several features, which help teachers to prepare for the activities, as well as provide tips on how to carry out the activities successfully and save time. In addition, answers to the questions are overprinted to serve as a guide for teachers on what the expected answers are.

- Before each activity, teachers should read 'Before you carry out the activity' for pre-activity advice and also to understand the prior knowledge that pupils should possess.
- 'Tips and time-savers' provides information on how teachers can reduce the time required for each activity.
- In order to ensure the safety of pupils, 'Safety precautions' highlights several danger zones that teachers should look out for whenever an activity is being carried out.
- 'How it can be done' consists of additional procedures to help teachers carry out each activity smoothly in tandem with the pupils.
- Based on the information contained within 'Notes on observations and results', teachers are equipped to inform pupils of how they can better carry out an activity or to guide the pupils towards the correct conclusions.

PSLE Revision Schedule

The PSLE Revision Schedule provides teachers with a guide on how they can utilise the time with their pupils to revise the content in the latest Primary Science syllabus. All the specific learning objectives that pupils should be familiar with before the PSLE are listed in a structured format for each theme (Diversity, Cycles, Systems, Interactions and Energy).



PSLE Revision Schedule — Systems

Time required	Chapter	Specific learning objectives in MY PALS ARE HERE!	Syllabus from: Lower block	Syllabus from: Upper block
Term 3 Week 5 (one period)	Chapter 1 What is a system?	In this chapter, pupils will learn and be able to: • Describe what a system is • Recognise that a bus or a car are examples of complex man-made systems • Explain how a slipper is a system • Recognise that systems can also be found in living things, such as animals or plants • Explain how a living thing can be considered a system • State the functions of the various parts of an animal, such as the eyes, mouth, nose, ears and wings • Explain how a plant can be considered a system • List the parts of a plant system	✔	
	Chapter 2 Your amazing body	In this chapter, pupils will learn and be able to: • List the five main organ systems in the body • State the function(s) of each organ system • State the major parts in each organ system • Recognise that for the body to function properly, all the organ systems in the body must work together properly	✔	
Term 3 Week 6 (one period)	Chapter 3 The digestive system	In this chapter, pupils will learn and be able to: • Recognise that the food eaten must be digested before the body can use it • Show an understanding that digestion refers to the process where food is chewed or broken down into simple substances in the body • List the five major organs in the digestive system • Describe the functions of the mouth, gullet, stomach, small intestine and large intestine	✔	
	Chapter 4 Plants and their parts	In this chapter, pupils will learn and be able to: • Show an understanding of how a plant is a system • Appreciate that plants have the same basic parts, even though they vary in shapes and sizes • Identify the parts of a plant, which are the leaves, roots and stem • Classify leaves according to shape, size, colour, texture and smell • Identify the parts of a leaf, which are the leaf stalk, leaf blade and veins • State the function of the leaves of a plant • State the functions of the roots of a plant • Recognise that roots of different plants vary in shapes, sizes and colours • Explain how some roots are considered special • Compare the stems of different plants according to shape, size, colour and texture • State the functions of the stem of a plant • Explain how the stem is connected to the leaves and roots of a plant	✔	

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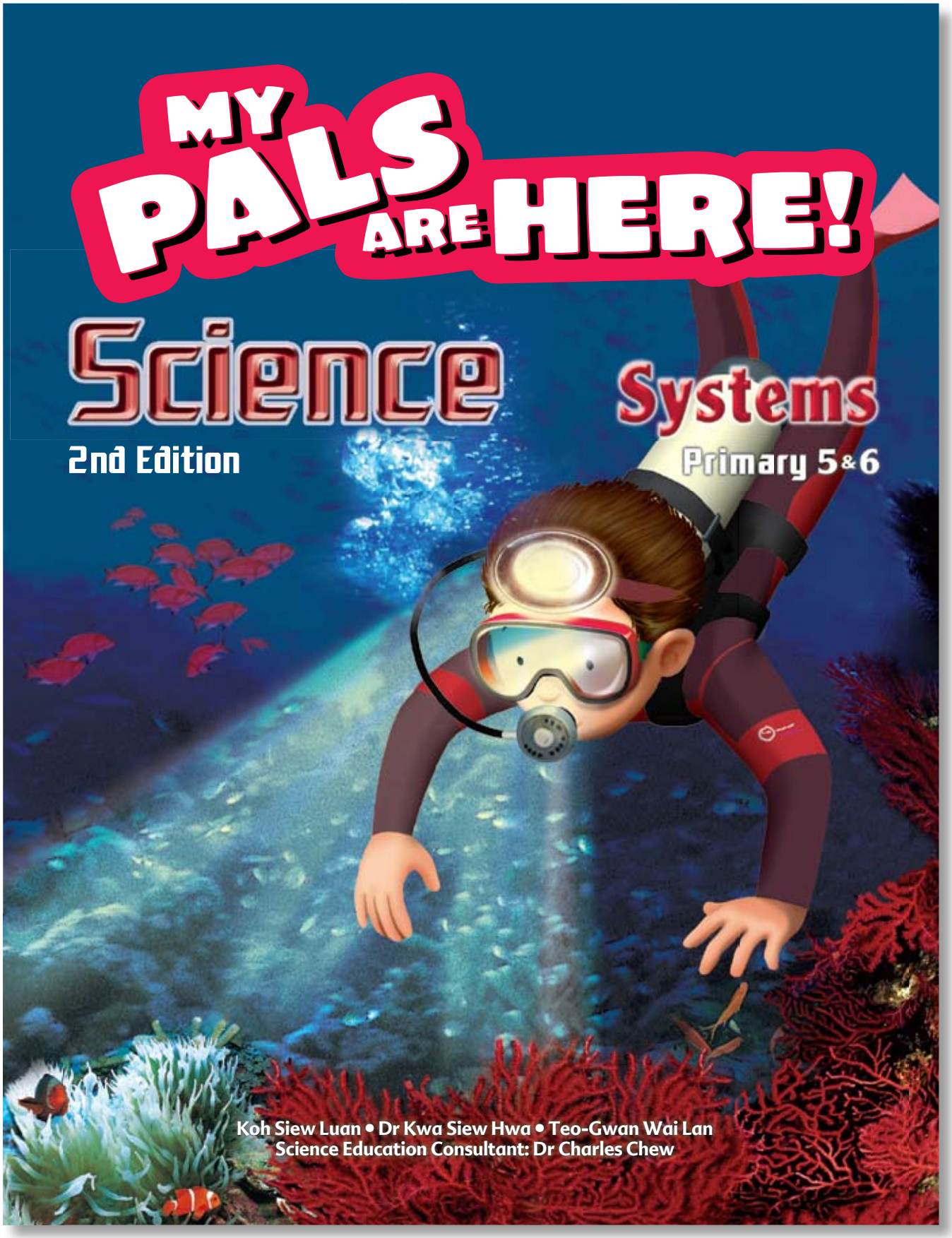

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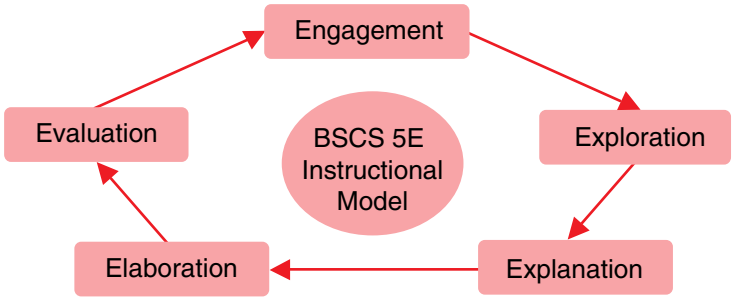
BSCS 5E Instructional Model

One of the most effective and exciting models of Science instruction for teaching, learning and assessment purposes is the *BSCS 5E Instructional Model*. Widely acclaimed as one of the most powerful inquiry-based instructional strategies, the *BSCS 5E Instructional Model* (Engagement, Exploration, Explanation, Elaboration and Evaluation) has the potential for all the five essential features of Science as inquiry (Question, Evidence, Explanation, Connection and Communication) to be embedded in it. It can also be used flexibly to plan lessons that contain an excellent mix of both teacher-directed inquiry and pupil-directed inquiry. It is an instructional model that structures the learning experience for pupils.



In the Engagement (1st E) phase, the teacher sets the stage for learning by introducing the topic of the lesson and fires the pupils' innate sense of curiosity and imagination by means of attention grabbing demonstrations, discrepant events, interesting problems to solve, scientifically-oriented questions, ideas or natural phenomena, relevant current events or local issues to discuss. Based on the pupils' responses to these triggers, the teacher is able to assess the pupils' prior knowledge and also to note their naive conceptions or misconceptions of Science.

Under the Exploration (2nd E) phase, engaged learning through hands-on activities occurs with the pupils' use of inquiry, which involves generating question(s), formulating hypotheses, designing and carrying out a plan, collecting evidence or data to draw conclusions, and communicating their results. In this phase, the teacher serves as a leader and facilitator of the inquiry process, and as an assessor to determine how the pupils are progressing in their knowledge construction or concept development.

In the teacher-facilitated Explanation (3rd E) phase, the pupils will be guided to check their explanations against the scientific explanations offered by the teacher or reliable sources of knowledge. Besides promoting a common language for the whole class to articulate their thinking and to describe their results in scientific terms, the use of scientific explanations also seeks to address the naive conceptions and remediate the misconceptions detected in the Engagement and Exploration phases.

At the Elaboration (4th E) phase, the teacher helps the pupils to reinforce their scientific concepts either by providing opportunities for pupils to apply and transfer their understanding to new contexts or showing them how these concepts can be applied in real world situations. In this way, besides mastering Science content and process skills, pupils' appreciation of Science as being relevant to their lives will help them grow towards greater scientific literacy in order to become scientifically literate citizens in the world and for the world.

Finally, in the Evaluation (5th E) phase, the teacher brings the lesson to a meaningful closure by summarising the big ideas in point form or concept map and administering a formal assessment (e.g. test or presentation) or an informal assessment (e.g. journal or portfolio) to ascertain the level of achievement of the learning outcomes. The Evaluation phase also provides an opportunity for pupils to evaluate their own learning. Having said this, for effective teaching and meaningful learning to take place, continuous evaluation in the form of observation and participation in class (other modes of informal assessment) are strongly advocated and encouraged even in the first four phases — Engagement, Exploration, Explanation and Elaboration.

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BSCS developed the BSCS 5E Instructional Model in the 1980s. Since that time, BSCS has used this model in its curriculum development programmes as well as its professional development programmes. The BSCS 5E Instructional Model has been widely disseminated and widely used as an effective instructional model that allows the pupils to construct their understanding across time. Used with permission from BSCS.

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Inquiry table

While inquiry has been widely accepted by Science educators as the central strategy for teaching and learning of Science, there are different views of what inquiry looks like in different classrooms and contexts. In some classrooms, inquiry-based teaching (teacher-directed inquiry) is more predominant than inquiry-based learning (pupil-directed inquiry). In other contexts, especially for older pupils who have some degree of Science literacy, inquiry-based learning is more predominant than inquiry-based teaching. In general, most teachers would traverse along a continuum of inquiry-based teaching and inquiry-based learning approaches as teaching and learning are two sides of the same "coin". The "coin" refers to the attainment of the learning outcomes, which is the litmus test of good inquiry-based teaching or learning.

The inquiry table found below contains the five essential features of Science as inquiry. It describes Question, Evidence, Explanation, Connection and Communication that provide pupils with experiences that vary between guided (partial) inquiry and open (full) inquiry.

This inquiry table gives teachers an indication as to whether the questions and activities mentioned in the lesson plans should be more pupil-directed or teacher-directed. For example, "**Q1**" indicates that the "**Question**" should be more pupil-directed, while "**Evi4**" indicates that the "**Evidence**" should be more teacher-directed.

Essential features of Science as inquiry	**More** ← Amount of pupil self-direction → **Less** **Less** ← Amount of direction from teacher or material → **More**			
1. Question Pupils engage in scientifically orientated questions.	**Q1** Pupils pose a question.	**Q2** Pupils select among questions and pose new questions.	**Q3** Pupils sharpen or clarify the question provided by the teacher, materials or other sources.	**Q4** Pupils engage in the question provided by the teacher, materials or other sources.
2. Evidence Pupils give priority to evidence in responding to questions.	**Evi1** Pupils determine what constitutes evidence and collect it.	**Evi2** Pupils are directed to collect certain data.	**Evi3** Pupils are given data and asked to analyse.	**Evi4** Pupils are given data and told how to analyse.
3. Explanation Pupils formulate explanations from evidence.	**Exp1** Pupils formulate their own explanations after summarising the evidence.	**Exp2** Pupils are guided in the process of formulating explanations from evidence.	**Exp3** Pupils are given possible ways to use evidence to formulate explanation.	**Exp4** Pupils are provided with evidence.
4. Connection Pupils connect explanations to scientific knowledge.	**Con1** Pupils independently examine other resources and form the links to explanations.	**Con2** Pupils are directed towards areas and sources of scientific knowledge.	**Con3** Pupils are given possible connections.	**Con4** Pupils are provided with connections.
5. Communication Pupils communicate and justify their explanations.	**Com1** Pupils form reasonable and logical arguments to communicate explanations.	**Com2** Pupils are coached in the development of communication.	**Com3** Pupils are provided with broad guidelines used to sharpen communication.	**Com4** Pupils are given steps and procedures for communication.

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Theme Overview

Time required	Chapter title and sub-heading	Page	Specific key inquiry questions in MY PALS ARE HERE!	Specific learning objectives in MY PALS ARE HERE!	Specific learning outcomes in MY PALS ARE HERE!		
					Knowledge, understanding and application	Skills and processes	Ethics and attitudes / National Education NE
Weeks 1 and 2 (three periods)	**1. The plant transport system** **1.1(A) The plant transport system** Which parts of the plant help to transport substances absorbed by the roots? **1.2(B) Tubes for transporting** What are the functions of the different tubes in the plant transport system? 1.2.1 The water-carrying tubes How do plants transport the useful materials absorbed by the roots to all parts of the plant?	6 7 7 8 8 9 9	What are the parts of the plant transport system? How are water, mineral salts and sugar transported in a plant?	In this chapter, pupils will learn and be able to: • Show an understanding of what a system is • Recognise that a plant's transport system is crucial to its survival • Identify the parts of a plant that help it to transport substances • List the substances that are transported by a plant's transport system • State the function(s) of each part of a plant's transport system • Observe how a stem transports water from the roots to the other parts of a plant • Differentiate between the water-carrying tubes and the food-carrying tubes in a plant	Identify the parts of a plant's transport system and relate them to their function(s) (Textbook Sections 1.1(A) and 1.2(B); Activity Book Activities 1.1 and 1.2) Recognise the importance of a plant's transport system (Textbook Sections 1.1(A) and 1.2(B); Activity Book Activities 1.1 and 1.2)	Investigate how a stem transports water from the roots to the other parts of a plant (Textbook Section 1.2(B); Activity Book Activity 1.1) Trace the path that substances take as they are transported from one part of a plant to another (Textbook Section 1.2(B); Activity Book Activities 1.1 and 1.2)	Show objectivity when seeking evidence for the function of a stem as part of a plant's transport system (Activity Book Activities 1.1 and 1.2) NE Bring the pupils to the Singapore Botanic Gardens to understand how to show care and responsibility towards the plants around us

Highlighted questions indicate questions found in the Textbook that facilitate the development of concepts to help pupils focus on what they are learning

Time required	Chapter title and sub-heading	Page	Specific key inquiry questions in My Pals are Here!	Specific learning objectives in My Pals are Here!	Specific learning outcomes in My Pals are Here!		
					Knowledge, understanding and application	Skills and processes	Ethics and attitudes / National Education
	1.2.2 The food-carrying tubes Where is the food made in the leaves stored? What are some examples of leaves, stems, roots, fruits and seeds that store food?	9 9 9					
Weeks 2, 3, 4, 5 and 6 (eight periods)	**2. Air and the respiratory system**	11	What is air made up of? What are the organs that make up the human respiratory system and what are their functions? How do animals breathe? How do plants take in and give out air?	In this chapter, pupils will learn and be able to: • Recognise that air is a mixture of different gases • List the components of air • Recognise that moving air is wind • Discuss the uses of some of the gases present in air • Recognise that breathing is the process of taking air into the body and giving it out • Identify the organs that make up the human respiratory system • Describe how the human respiratory system carries out gaseous exchanges with its surroundings	Identify the different components of air, such as nitrogen, oxygen, carbon dioxide, water vapour and other gases (Textbook Section 2.1(A)) Identify the organs that make up the human respiratory system and relate them to their function(s) (Textbook Section 2.2(B); Activity Book Activities 2.1 and 2.2)	Compare the ways that different living things take in oxygen and give out carbon dioxide (Textbook Sections 2.2(B), 2.3(C) and 2.4(D); Activity Book Activities 2.1, 2.2 and 2.3)	Show curiosity in exploring the human respiratory system and the function(s) of the different organs involved (Textbook Section 2.2(B); Activity Book Activities 2.1 and 2.2) Show curiosity in exploring the respiratory systems of different living things (Textbook Sections 2.2(B), 2.3(C) and 2.4(D); Activity Book Activities 2.1, 2.2 and 2.3)
	2.1(A) All mixed up! Do you know what the different types of gases are?	12 12					
	2.2(B) Human respiratory system 2.2.1 Breathe in, breathe out	14 14					
	2.2.2 Every breath you take How does air move in and out of our body? What are the organs involved in breathing?	15 15 15					

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	What are the functions of the organs in our respiratory system? **2.3(C) Animal respiratory system** How do other animals breathe? Do they all take in air the same way that Man does? **2.4(D) Plant respiratory system** How do plants take in and give out air? What special parts do they have to do this? How are these similar to or different from the organs that animals have? 2.4.1 Photosynthesis	15 16 16 16 18 18 18 18 18		• Observe the respiratory system of a fish • Compare the respiratory systems of humans and other animals • Recognise that plants keep a healthy balance of oxygen and carbon dioxide in the air • Describe how a plant carries out gaseous exchanges with its surroundings • Explain why stomata are usually found on the underside of the leaves, away from direct sunlight	Recognise that plants have an important role in keeping a healthy balance of oxygen and carbon dioxide in the air (Textbook Section 2.4(D))		Show an appreciation for the importance of plants in keeping a healthy balance of oxygen and carbon dioxide in the air (Textbook Section 2.4(D)) Show care and responsibility towards plants around us (Textbook Section 2.4(D)) NE Ask the pupils to design a poster to raise awareness of air pollution and the ways to minimise air pollution NE Ask the pupils to design a poster to discourage smoking NE Ask the pupils to carry out a "Plant a tree" project in order to gain an appreciation for the importance of plants in our environment

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					Knowledge, understanding and application	Skills and processes	Ethics and attitudes / National Education NE
Weeks 6, 7, 8 and 9 (six periods)	**3. The human circulatory system** **3.1(A) The heart** What is the function of the heart? Where is your heart? What is the heart made of? **3.2(B) The blood and the blood vessels** How does blood flow through your body? **3.3(C) From parts to whole** 3.3.1 Function of the circulatory system How do the heart, blood and blood vessels work together? 3.3.2 Flow of blood in the circulatory system How does the circulatory system circulate blood? How fast does your heart beat? 3.3.3 Working together	22 23 23 24 24 25 25 25 25 25 26 26 27 29	What is the function of the heart? How does the blood transport food and oxygen to the body cells? What are the different systems that work together with the circulatory system?	In this chapter, pupils will learn and be able to: • Recognise that the heart is the vital organ of the human circulatory system that pumps blood all the time, to all parts of the body • Describe how the heart works • State the function(s) of the blood • Recognise that the heart is made of a special muscle called the heart muscle • State the function(s) of the blood vessels • Identify the organs that make up the human circulatory system • State the functions of the human circulatory system • List the substances that are transported by the human circulatory system • Trace the flow of blood and the path that substances take as they are transported by the human circulatory system • Show an understanding that each heartbeat is a cycle of contraction and relaxation of the heart muscles	Identify the organs that make up the human circulatory system and relate them to their function(s) (Textbook Sections 3.1(A), 3.2(B) and 3.3(C); Activity Book Activity 3.1) Show an understanding of how the human respiratory and digestive systems work together with the human circulatory system to carry out life processes (Textbook Section 3.3(C); Activity Book Activities 3.2 and 3.3)	Communicate the details of how blood flows to different parts of the human body through a pictorial form (Textbook Section 3.3(C); Activity Book Activity 3.1) Communicate the details of the flow of substances between different human body systems through a pictorial form (Textbook Section 3.3(C))	Show curiosity in exploring the human circulatory system and the function(s) of the different organs involved (Textbook Sections 3.1(A), 3.2(B) and 3.3(C); Activity Book Activity 3.1) Show objectivity when seeking data and information about how the rate of our heartbeat changes with age, health and type of activity (Textbook Section 3.3(C); Activity Book Activities 3.2 and 3.3) NE Bring the pupils to the Lifestyle and Diseases Area in Health Promotion Board's Health Zone to raise awareness of the link between unhealthy lifestyle habits and various lifestyle-related diseases, such as cancer, diabetes, heart disease, hypertension and stroke

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					Knowledge, understanding and application	Skills and processes	Ethics and attitudes / National Education
				• Investigate how the rate of our heartbeat changes with age, health and type of activity • Recognise that the human respiratory and digestive systems work together with the human circulatory system to carry out life processes		Predict how the rate of our heartbeat changes with the type of activity, then find out the answers through an investigation (Textbook Section 3.3(C); Activity Book Activities 3.2 and 3.3) Compare the ways in which substances are transported within plants through tubes and within humans through blood vessels (Textbook Sections 3.1(A), 3.2(B) and 3.3(C))	
Weeks 9, 10, 11 and 12 (six periods)	**4. The unit of life** **4.1(A) Cells** What are living things made up of? Can you think of other organisms that are made up of only one cell?	32 33 33 33	What is a cell? What are some of the different types of cells?	In this chapter, pupils will learn and be able to: • Recognise that a cell is the smallest unit of life in the body • List some organisms that are made up of only one cell	Recognise that cells are the smallest units of life (Textbook Section 4.1(A); Activity Book Activity 4.1)	Identify the similarities and differences between a plant cell and an animal cell (Textbook Section 4.2(B); Activity Book Activities 4.2, 4.3 and 4.4)	Show curiosity in finding out what the eye cannot see in the world around us (Textbook Sections 4.1(A) and 4.2(B); Activity Book Activities 4.1, 4.2, 4.3 and 4.4)

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	4.2(B) Different types of cells How are the cells in our bodies different from one another? What about plants? What are their cells like? What are the different types of cells found in a plant? What about non-living things? Are these objects made up of cells like living things? 4.2.1 Parts of a cell What are the parts of a cell? Do animal cells and plant cells have the same parts? 4.2.2 Producing new cells What happens when cells grow old?	34 34 35 35 36 36 36 37 37 37 38 38		• Recognise that the cells in an organism differ in shape, size and function • State the relationship between a cell, a tissue and an organ • Identify the parts of a plant cell and relate them to their function(s) • Identify the parts of an animal cell and relate them to their function(s) • Compare a plant cell and an animal cell • Show an understanding that new cells are produced to replace the dead or damaged cells and to enable living things to grow	Identify the parts of a plant cell and relate them to their function(s) (Textbook Section 4.2(B); Activity Book Activities 4.2, 4.3 and 4.4) Identify the parts of an animal cell and relate them to their function(s) (Textbook Section 4.2(B); Activity Book Activities 4.2 and 4.4) Differentiate between a plant cell and an animal cell (Textbook Section 4.2(B); Activity Book Activities 4.2, 4.3 and 4.4) Recognise that new cells are produced to replace the dead or damaged cells and to enable living things to grow (Textbook Section 4.2.2)		Value the ability to work independently, as well as together as a team (Activity Book Activities 4.1, 4.2, 4.3 and 4.4) NE Ask the pupils to find out how smoking can lead to cell damage, which may result in lung cancer

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Weeks 12, 13 and 14 (four periods)	**5. Electric circuits** **5.1(A) Electrical systems** 5.1.1 Battery 5.1.2 Wire 5.1.3 Bulb 5.1.4 Switch **5.2(B) Symbols in an electric circuit** **5.3(C) Closed and open circuits**	40 41 41 42 42 43 44 45	What is an electrical system made up of? How can we construct a simple electric circuit? When does an electric current flow in a circuit?	In this chapter, pupils will learn and be able to: • Recognise that an electric circuit is an electrical system because it is made up of components that work together, where each has its own function • Recognise that an electric current is a flow of electricity along an electric circuit • Identify the different components of an electric circuit and relate them to their function(s) • Communicate the set-up of an electric circuit through a circuit diagram, using the symbols of electrical components, such as a battery, wire, bulb and switch • Construct a simple electric circuit based on a circuit diagram • Differentiate between a closed circuit and an open circuit • Observe that an electric current flows only when an electric circuit is closed	Recognise that an electric circuit is an electrical system because it is made up of components that work together (Textbook Section 5.1(A); Activity Book Activities 5.1 and 5.2) Recognise that an electric current can only flow through a closed circuit (Textbook Section 5.3(C); Activity Book Activity 5.2)	Communicate the set-up of an electric circuit using a circuit diagram (Textbook Section 5.2(B)) Construct a simple electric circuit using different components (Activity Book Activities 5.1 and 5.2)	Value the ability to work together as a team to complete a task (Activity Book Activities 5.1 and 5.2) NE Bring the pupils to the Singapore Science Centre's Amazing Electron Exhibition to learn more about different electronic devices and their applications

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Time required	Chapter title and sub-heading	Page	Specific key inquiry questions in MY PALS ARE HERE!	Specific learning objectives in MY PALS ARE HERE!	Specific learning outcomes in MY PALS ARE HERE!		
					Knowledge, understanding and application	Skills and processes	Ethics and attitudes / National Education NE
Weeks 14, 15 and 16 (five periods)	**6. Using electricity** **6.1(A) Number of batteries in series** **6.2(B) Number of bulbs in series** How does the number of bulbs in a circuit affect the brightness of the bulbs? **6.3(C) Arrangement of bulbs in series and in parallel** If we change the arrangement of the bulbs in a circuit, will their brightness be affected? What can affect the brightness of a bulb in a circuit? **6.4(D) Saving energy** 6.4.1 Where do we get electricity from? 6.4.2 Using electricity wisely	47 48 49 49 50 50 50 51 51 52	What is the effect of changing the number of batteries in a circuit? What is the effect of changing the number of bulbs in series in a circuit? What is the effect of changing the arrangement of bulbs in a circuit? How can we use electricity wisely?	In this chapter, pupils will learn and be able to: • Recognise that a series connection of batteries involves connecting the positive terminal of one battery to the negative terminal of another battery • Investigate how the number of batteries in an electric circuit can affect the brightness of a bulb • Recognise what a fused bulb is • Recognise that a series connection of bulbs involves connecting the bulbs one after another • Investigate how the number of bulbs in an electric circuit can affect their brightness • Recognise that a parallel connection of bulbs involves connecting the bulbs such that an electric current flows along separate paths to each bulb • Investigate how the arrangement of bulbs in an electric circuit can affect their brightness • Investigate which arrangement of bulbs in an electric circuit allows the bulbs to work independently of one another	Show an understanding of how the number and arrangement of batteries and bulbs in an electric circuit can affect the brightness of bulbs (Textbook Sections 6.1(A), 6.2(B) and 6.3(C); Activity Book Activities 6.1, 6.2 and 6.3) Trace the source of electricity that is used to make electrical appliances work (Textbook Section 6.4.1) List ways in which one can help to conserve electricity (Textbook Section 6.4.2)	Communicate the set-up of an electric circuit using a circuit diagram (Textbook Sections 6.1(A), 6.2(B) and 6.3(C); Activity Book Activities 6.1, 6.2 and 6.3) Investigate how the number and arrangement of batteries and bulbs in an electric circuit can affect the brightness of bulbs (Textbook Sections 6.1(A), 6.2(B) and 6.3(C); Activity Book Activities 6.1, 6.2 and 6.3) Generate suggestions of possible ways in which one can help to conserve electricity (Textbook Section 6.4.2)	Recognise the need to take active steps in order to conserve electricity (Textbook Section 6.4(D)) NE Ask the pupils to find out different ways to conserve electricity (Textbook Section 6.4(D)) NE Bring the pupils to the Singapore Power Ltd headquarters to understand how electricity is brought to us and how we can use electricity efficiently NE Ask the pupils to write a report on the steps that they can take to conserve electricity at home in order to reduce their electricity bills

Highlighted questions indicate questions found in the Textbook that facilitate the development of concepts to help pupils focus on what they are learning

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Time required	Chapter title and sub-heading	Page	Specific key inquiry questions in MY PALS ARE HERE!	Specific learning objectives in MY PALS ARE HERE!	Specific learning outcomes in MY PALS ARE HERE!		
					Knowledge, understanding and application	Skills and processes	Ethics and attitudes / National Education NE
				• List the factors that affect the brightness of a bulb in an electric circuit • Identify electrical appliances that need electricity to work • Trace the source of electricity from an electrical appliance to a power station • Recognise the need to conserve electricity • List ways in which one can help to conserve electricity			
Week 17 (two periods)	**7. Conductors of electricity** **7.1(A) Conductors and insulators** What are electrical conductors and insulators? **7.2(B) Using electricity safely** How can we be careful when we use electricity?	54 55 55 56 56	What are electrical conductors and insulators? Why should we use electricity safely and how can we do it?	In this chapter, pupils will learn and be able to: • Recognise that an electrical conductor is a material that allows electric current to flow through easily • Recognise that an electrical insulator is a material that does not allow electric current to flow through easily • Recognise that metal is a good conductor of electricity, as well as heat • Construct a circuit tester to distinguish between electrical conductors and insulators • Classify different materials as electrical conductors or insulators	Recognise what electrical conductors and insulators are (Textbook Section 7.1(A); Activity Book Activity 7.1) Classify different materials as electrical conductors or insulators (Textbook Section 7.1(A); Activity Book Activity 7.1) Recognise the need to use electricity safely (Textbook Section 7.2(B))	Classify different materials as electrical conductors or insulators (Textbook Section 7.1(A); Activity Book Activity 7.1) Communicate the ways in which one can handle electricity and electrical appliances safely (Textbook Section 7.2(B))	Practise the safe use and handling of electricity and electrical appliances (Textbook Section 7.2(B)) NE Ask the pupils to design a poster to encourage the safe use and handling of electricity and electrical appliances

Highlighted questions indicate questions found in the Textbook that facilitate the development of concepts to help pupils focus on what they are learning

Time required	Chapter title and sub-heading	Page	Specific key inquiry questions in My Pals are Here!	Specific learning objectives in My Pals are Here!	Specific learning outcomes in My Pals are Here!		
					Knowledge, understanding and application	Skills and processes	Ethics and attitudes / National Education NE
				• Recognise the need to handle electricity and electrical appliances safely • Communicate the ways in which one can handle electricity and electrical appliances safely	List ways in which one can handle electricity and electrical appliances safely (Textbook Section 7.2(B))		

Highlighted questions indicate questions found in the Textbook that facilitate the development of concepts to help pupils focus on what they are learning

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Gap Chart

Topics covered

Chapters in old Textbook (3B, 4B, 5A, 5B)	Chapters in new Textbook (Systems)
19. Plants and their parts (3B) 19.1 Plant parts and their functions (Details on plant parts and their functions have been covered in lower block Systems theme) 19.2 Leaf — the food factory 19.2.1 Importance of photosynthesis	**1. The plant transport system** 1.1 The plant transport system 1.2 Tubes for transporting 1.2.1 The water-carrying tubes 1.2.2 The food-carrying tubes
6. Air and the respiratory system (4B) 6.1 Air is all around us 6.2 All mixed up! 6.3 A healthy balance 6.4 Breathe in, breathe out 6.5 Every breathe you take 6.5.1 Gills of fish 6.6 The respiration story 6.7 The respiratory system in plants	**2. Air and the respiratory system** 2.1 All mixed up! 2.2 Human respiratory system 2.2.1 Breathe in, breathe out 2.2.2 Every breath you take 2.3 Animal respiratory system 2.4 Plant respiratory system 2.4.1 Photosynthesis
7. Energy from food (5A) (Details on digestion have been covered in lower block Systems theme) 7.1 (–) Respiration and breathing (Details on breathing to be covered in upper block Systems theme — Chapter 2 Air and the respiratory system)	
7. The circulatory system (4B) 7.1 The circulatory system of humans 7.1.1 The heart 7.1.2 (–) The blood and the blood vessels (Details on arteries, capillaries and veins have been removed) 7.1.3 From parts to whole 7.1.4 Blood circulation 7.1.5 How fast does your heart beat? 7.1.6 Working together 7.2 The circulatory system of plants (Details on the circulatory system of plants to be covered in upper block Systems theme — Chapter 1 The plant transport system) 7.2.1 Tubes for transporting 7.2.2 The xylem tubes 7.2.3 Together in harmony	**3. The human circulatory system** 3.1 The heart 3.2 The blood and the blood vessels 3.3 From parts to whole 3.3.1 Function of the circulatory system 3.3.2 Flow of blood in the circulatory system 3.3.3 Working together
2. The unit of life (5A) (Shifted from upper block Cycles theme) 2.1 The cell 2.2 Parts of a cell 2.3 Producing new cells	**4. The unit of life** 4.1 Cells 4.2 Different types of cells 4.2.1 Parts of a cell 4.2.2 Producing new cells

(+) Indicates a new Textbook content
(–) Indicates a Textbook content that has been removed from the new syllabus

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Topics covered

Chapters in old Textbook (3B, 4B, 5A, 5B)	Chapters in new Textbook (Systems)
9. Electrical circuits (5B) 9.1 The uses of electricity 9.2 Components of a simple electric circuit 9.2.1 Battery — an energy source 9.2.2 Wires 9.2.3 Switch 9.2.4 Bulb 9.3 Circuit diagram	**5. Electric circuits** 5.1 Electrical systems 5.1.1 Battery 5.1.2 Wire 5.1.3 Bulb 5.1.4 Switch 5.2 Symbols in an electric circuit 5.3 Closed and open circuits
10. What makes a bulb brighter? (5B) 10.1 Number of batteries 10.2 Arrangement of batteries 10.3 Number of bulbs	**6. Using electricity** 6.1 Number of batteries in series 6.2 Number of bulbs in series 6.3 Arrangement of bulbs in series and in parallel 6.4 Saving energy 6.4.1 Where do we get electricity from? 6.4.2 Using electricity wisely
12. Using electricity wisely (5B) 12.1 Conserving electrical energy	
11. Conductors of electricity (5B) 11.1 Using electricity safely	**7. Conductors of electricity** 7.1 Conductors and insulators 7.2 Using electricity safely

(+) Indicates a new Textbook content
(–) Indicates a Textbook content that has been removed from the new syllabus

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Chapter 1 The plant transport system

Time required
- Weeks 1 and 2
- Three periods: Lesson 1.1 (three periods)

Specific key inquiry questions in My Pals are Here!
- What are the parts of the plant transport system?
- How are water, mineral salts and sugar transported in a plant?

Specific learning outcomes in My Pals are Here!	Specific learning objectives in My Pals are Here!
Knowledge, understanding and application • Identify the parts of a plant's transport system and relate them to their function(s) • Recognise the importance of a plant's transport system	In this chapter, pupils will learn and be able to: • **Show an understanding** of what a system is • **Recognise** that a plant's transport system is crucial to its survival • **Identify** the parts of a plant that help it to transport substances • **List** the substances that are transported by a plant's transport system • **State** the function(s) of each part of a plant's transport system • **Observe** how a stem transports water from the roots to the other parts of a plant • **Differentiate** between the water-carrying tubes and the food-carrying tubes in a plant

Skills and processes
- Investigate how a stem transports water from the roots to the other parts of a plant
- Trace the path that substances take as they are transported from one part of a plant to another

Ethics and attitudes
- Show objectivity when seeking evidence for the function of a stem as part of a plant's transport system

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Chapter sub-headings	Essential learning points	Specific learning objectives in MY PALS ARE HERE!
The plant transport system	• A system consists of parts that work together to perform a function. • Plants obtain the different substances they need to stay alive through special parts that carry these substances to the parts of the plants that need them.	• Show an understanding of what a system is • Recognise that a plant's transport system is crucial to its survival
Tubes for transporting	• A plant's transport system is made up of two separate sets of fine tubes that run through the leaves, stems and roots. • The food-carrying tubes transport excess sugar made in the leaves during photosynthesis to other parts of the plant. • The water-carrying tubes transport water and mineral salts from the roots to the other parts of the plant.	• Identify the parts of a plant that help it to transport substances • List the substances that are transported by a plant's transport system • State the function(s) of each part of a plant's transport system • Observe how a stem transports water from the roots to the other parts of a plant • Differentiate between the water-carrying tubes and the food-carrying tubes in a plant

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Chapter 2 Air and the respiratory system

Time required

- Weeks 2, 3, 4, 5 and 6
- Eight periods: Lesson 2.1 (two periods), Lesson 2.2 (three periods), Lesson 2.3 (two periods), Lesson 2.4 (one period)

Specific key inquiry questions in MY PALS ARE HERE!

- What is air made up of?
- What are the organs that make up the human respiratory system and what are their functions?
- How do animals breathe?
- How do plants take in and give out air?

Specific learning outcomes in MY PALS ARE HERE!	Specific learning objectives in MY PALS ARE HERE!
Knowledge, understanding and application • Identify the different components of air, such as nitrogen, oxygen, carbon dioxide, water vapour and other gases • Identify the organs that make up the human respiratory system and relate them to their function(s) • Recognise that plants have an important role in keeping a healthy balance of oxygen and carbon dioxide in the air	In this chapter, pupils will learn and be able to: • **Recognise** that air is a mixture of different gases • **List** the components of air • **Recognise** that moving air is wind • **Discuss** the uses of some of the gases present in air • **Recognise** that breathing is the process of taking air into the body and giving it out • **Identify** the organs that make up the human respiratory system • **Describe** how the human respiratory system carries out gaseous exchanges with its surroundings • **Observe** the respiratory system of a fish • **Compare** the respiratory systems of humans and other animals • **Recognise** that plants keep a healthy balance of oxygen and carbon dioxide in the air • **Describe** how a plant carries out gaseous exchanges with its surroundings • **Explain** why stomata are usually found on the underside of the leaves, away from direct sunlight

Skills and processes

- Compare the ways that different living things take in oxygen and give out carbon dioxide

Ethics and attitudes

- Show curiosity in exploring the human respiratory system and the function(s) of the different organs involved
- Show curiosity in exploring the respiratory systems of different living things
- Show an appreciation for the importance of plants in keeping a healthy balance of oxygen and carbon dioxide in the air
- Show care and responsibility towards plants around us

Chapter sub-headings	Essential learning points	Specific learning objectives in MY PALS ARE HERE!
All mixed up!	• The mixture of nitrogen, oxygen, carbon dioxide, water vapour and other gases is called air. • When air moves, it is called wind. • Nitrogen makes up about four-fifths of the air. • Living things on land and in water take in oxygen from their surroundings to stay alive. • Oxygen is also needed for burning. • During the day, plants use carbon dioxide and water to make food through the process called photosynthesis.	• Recognise that air is a mixture of different gases • List the components of air • Recognise that moving air is wind • Discuss the uses of some of the gases present in air
Human respiratory system	• Breathing is the process of taking air into the body and giving it out. • When we breathe, we take in oxygen and give out carbon dioxide. • The parts of a living thing that help it to breathe form the respiratory system. • The human respiratory system consists of the nose, windpipe, lungs and air sacs. • When the air we breathe in reaches our air sacs, oxygen passes through the walls of the air sacs into the blood vessels. • At the same time, carbon dioxide carried in the blood vessels of our body passes into the air sacs.	• Recognise that breathing is the process of taking air into the body and giving it out • Identify the organs that make up the human respiratory system • Describe how the human respiratory system carries out gaseous exchanges with its surroundings
Animal respiratory system	• Different animals have different parts in their respiratory systems. • Insects have openings that lead to tubes, which carry oxygen to their internal organs. • Earthworms breathe through their moist skin. • Frogs breathe through their lungs on land and breathe through their moist skin in water. • Birds and mammals have lungs and they take in air through their nostrils. • Some mammals, such as whales and dolphins, have lungs and they breathe through blowholes on the top of their heads. • Fish take in oxygen through their gills.	• Observe the respiratory system of a fish • Compare the respiratory systems of humans and other animals
Plant respiratory system	• Plants help to maintain the balance of oxygen and carbon dioxide in the air. • Plants take in carbon dioxide from their surroundings during photosynthesis. • At the same time, oxygen is produced and released into the surroundings. • Plants exchange gases with their surroundings through tiny openings called stomata. • Stomata are usually found on the underside of the leaves, away from direct sunlight. • This is to prevent water inside the plant from evaporating too fast through the stomata.	• Recognise that plants keep a healthy balance of oxygen and carbon dioxide in the air • Describe how a plant carries out gaseous exchanges with its surroundings • Explain why stomata are usually found on the underside of the leaves, away from direct sunlight

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Chapter 3 The human circulatory system

Time required
- Weeks 6, 7, 8 and 9
- Six periods: Lesson 3.1 (three periods), Lesson 3.2 (three periods)

Specific key inquiry questions in MY PALS ARE HERE!
- What is the function of the heart?
- How does the blood transport food and oxygen to the body cells?
- What are the different systems that work together with the circulatory system?

Specific learning outcomes in MY PALS ARE HERE!

Knowledge, understanding and application
- Identify the organs that make up the human circulatory system and relate them to their function(s)
- Show an understanding of how the human respiratory and digestive systems work together with the human circulatory system to carry out life processes

Specific learning objectives in MY PALS ARE HERE!

In this chapter, pupils will learn and be able to:
- **Recognise** that the heart is the vital organ of the human circulatory system that pumps blood all the time, to all parts of the body
- **Describe** how the heart works
- **State** the function(s) of the blood
- **Recognise** that the heart is made of a special muscle called the heart muscle
- **State** the function(s) of the blood vessels
- **Identify** the organs that make up the human circulatory system
- **State** the functions of the human circulatory system
- **List** the substances that are transported by the human circulatory system
- **Trace** the flow of blood and the path that substances take as they are transported by the human circulatory system
- **Show an understanding** that each heartbeat is a cycle of contraction and relaxation of the heart muscles
- **Investigate** how the rate of our heartbeat changes with age, health and type of activity
- **Recognise** that the human respiratory and digestive systems work together with the human circulatory system to carry out life processes

Skills and processes
- Communicate the details of how blood flows to different parts of the human body through a pictorial form
- Communicate the details of the flow of substances between different human body systems through a pictorial form
- Predict how the rate of our heartbeat changes with the type of activity, then find out the answers through an investigation
- Compare the ways in which substances are transported within plants through tubes and within humans through blood vessels

Ethics and attitudes
- Show curiosity in exploring the human circulatory system and the function(s) of the different organs involved
- Show objectivity when seeking data and information about how the rate of our heartbeat changes with age, health and type of activity

Chapter sub-headings	Essential learning points	Specific learning objectives in MY PALS ARE HERE!
The heart	• Our heart is the vital organ of the human circulatory system that pumps blood all the time, to all parts of our body. • The heart receives blood rich in oxygen from the lungs, and then pumps this blood rich in oxygen to the body cells. • Blood also transports water and digested food to all parts of the body. • Blood carries waste substances from all parts of the body to organs, such as kidneys, lungs and skin. • Our heart is made of a special muscle called the heart muscle. • This amazing heart muscle contracts and relaxes continuously without ever getting tired.	• Recognise that the heart is the vital organ of the human circulatory system that pumps blood all the time, to all parts of the body • Describe how the heart works • State the function(s) of the blood • Recognise that the heart is made of a special muscle called the heart muscle
The blood and the blood vessels	• Blood flows through many tubes called blood vessels to get to the different parts of the body.	• State the function(s) of the blood vessels
From parts to whole	• Our heart, together with our blood vessels and the blood they contain, form the parts of the circulatory system. • These parts work together to form a system to carry out two important functions: — First, they transport oxygen, digested food and water to all parts of the body. — Second, they carry carbon dioxide and waste materials away from different parts of the body to be released. • The circulatory system circulates blood in two parts: — Blood is pumped to all the cells in the body before moving back to the heart. — Blood is then pumped to the lungs before returning to the heart. • Each heartbeat is a cycle of contraction and relaxation of the heart muscles. • The heart of an average healthy adult beats about sixty to seventy times in a minute. • The rate of our heartbeat changes with age and health, as well as the type of activity we are doing. • When we exercise, our heart rate increases because the heart needs to supply more digested food and oxygen carried in the blood to the various parts of the body to produce more energy. • Our circulatory system works very closely with all parts of our body, especially our respiratory and digestive systems.	• Identify the organs that make up the human circulatory system • State the functions of the human circulatory system • List the substances that are transported by the human circulatory system • Trace the flow of blood and the path that substances take as they are transported by the human circulatory system • Show an understanding that each heartbeat is a cycle of contraction and relaxation of the heart muscles • Investigate how the rate of our heartbeat changes with age, health and type of activity • Recognise that the human respiratory and digestive systems work together with the human circulatory system to carry out life processes

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Chapter 4 The unit of life

Time required
- Weeks 9, 10 , 11 and 12
- Six periods: Lesson 4.1 (two periods), Lesson 4.2 (four periods)

Specific key inquiry questions in MY PALS ARE HERE!
- What is a cell?
- What are some of the different types of cells?

Specific learning outcomes in MY PALS ARE HERE!	Specific learning objectives in MY PALS ARE HERE!
Knowledge, understanding and application • Recognise that cells are the smallest units of life • Identify the parts of a plant cell and relate them to their function(s) • Identify the parts of an animal cell and relate them to their function(s) • Differentiate between a plant cell and an animal cell • Recognise that new cells are produced to replace the dead or damaged cells and to enable living things to grow	In this chapter, pupils will learn and be able to: • **Recognise** that a cell is the smallest unit of life in the body • **List** some organisms that are made up of only one cell • **Recognise** that the cells in an organism differ in shape, size and function • **State** the relationship between a cell, a tissue and an organ • **Identify** the parts of a plant cell and relate them to their function(s) • **Identify** the parts of an animal cell and relate them to their function(s) • **Compare** a plant cell and an animal cell • **Show an understanding** that new cells are produced to replace the dead or damaged cells and to enable living things to grow

Skills and processes
- Identify the similarities and differences between a plant cell and an animal cell

Ethics and attitudes
- Show curiosity in finding out what the eye cannot see in the world around us
- Value the ability to work independently, as well as together as a team

Chapter sub-headings	Essential learning points	Specific learning objectives in My Pals are Here!
Cells	• A cell is the smallest unit of life in the body. • Some living things like bacteria, yeast and paramecium are made up of only one cell.	• Recognise that a cell is the smallest unit of life in the body • List some organisms that are made up of only one cell
Different types of cells	• Cells in an organism differ in shape, size and function. • Cells, which are of the same type, are grouped together to form tissue. • An organ is formed when several tissues work together to form a special function. • A plant cell has a nucleus, cytoplasm, cell membrane, chloroplasts and a cell wall. • An animal cell has a nucleus, cytoplasm and cell membrane. • An animal cell, unlike a plant cell, does not have chloroplasts and a cell wall. • New cells are produced to replace the dead or damaged cells and to enable living things to grow.	• Recognise that the cells in an organism differ in shape, size and function • State the relationship between a cell, a tissue and an organ • Identify the parts of a plant cell and relate them to their function(s) • Identify the parts of an animal cell and relate them to their function(s) • Compare a plant cell and an animal cell • Show an understanding that new cells are produced to replace the dead or damaged cells and to enable living things to grow

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Chapter 5 Electric circuits

Time required
- Weeks 12, 13 and 14
- Four periods: Lesson 5.1 (four periods)

Specific key inquiry questions in MY PALS ARE HERE!
- What is an electrical system made up of?
- How can we construct a simple electric circuit?
- When does an electric current flow in a circuit?

Specific learning outcomes in MY PALS ARE HERE!	Specific learning objectives in MY PALS ARE HERE!
Knowledge, understanding and application • Recognise that an electric circuit is an electrical system because it is made up of components that work together • Recognise that an electric current can only flow through a closed circuit	In this chapter, pupils will learn and be able to: • **Recognise** that an electric circuit is an electrical system because it is made up of components that work together, where each has its own function • **Recognise** that an electric current is a flow of electricity along an electric circuit • **Identify** the different components of an electric circuit and relate them to their function(s) • **Communicate** the set-up of an electric circuit through a circuit diagram, using the symbols of electrical components, such as a battery, wire, bulb and switch • **Construct** a simple electric circuit based on a circuit diagram • **Differentiate** between a closed circuit and an open circuit • **Observe** that an electric current flows only when an electric circuit is closed

Skills and processes
- Communicate the set-up of an electric circuit using a circuit diagram
- Construct a simple electric circuit using different components

Ethics and attitudes
- Value the ability to work together as a team to complete a task

Chapter sub-headings	Essential learning points	Specific learning objectives in My Pals are Here!
Electrical systems	• An electric circuit is a system because it is made up of components that work together, such as a battery, wire, bulb and switch. • When the components are connected together, electricity flows along the circuit and is called an electric current. • The battery is the energy source and it drives an electric current through an electric circuit. • Electrical wires are used to connect one electrical component to another and allow an electric current to flow in a circuit. • In order for a bulb to light up, it has to be properly connected in a circuit. • A switch controls electric current flow in a circuit.	• Recognise that an electric circuit is an electrical system because it is made up of components that work together, where each has its own function • Recognise that an electric current is a flow of electricity along an electric circuit • Identify the different components of an electric circuit and relate them to their function(s)
Symbols in an electric circuit	• The different parts of a circuit are represented by different symbols. • To communicate what an electric circuit looks like, we use a circuit diagram to represent an actual electric circuit.	• Communicate the set-up of an electric circuit through a circuit diagram, using the symbols of electrical components, such as a battery, wire, bulb and switch • Construct a simple electric circuit based on a circuit diagram
Closed and open circuits	• A circuit through which electric current can flow is called a closed circuit. • A circuit through which electric current cannot flow is called an open circuit.	• Differentiate between a closed circuit and an open circuit • Observe that an electric current flows only when an electric circuit is closed

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Chapter 6 Using electricity

Time required

- Weeks 14, 15 and 16
- Five periods: Lesson 6.1 (four periods), Lesson 6.2 (one period)

Specific key inquiry questions in MY PALS ARE HERE!

- What is the effect of changing the number of batteries in a circuit?
- What is the effect of changing the number of bulbs in series in a circuit?
- What is the effect of changing the arrangement of bulbs in a circuit?
- How can we use electricity wisely?

Specific learning outcomes in MY PALS ARE HERE!

Knowledge, understanding and application

- Show an understanding of how the number and arrangement of batteries and bulbs in an electric circuit can affect the brightness of bulbs
- Trace the source of electricity that is used to make electrical appliances work
- List ways in which one can help to conserve electricity

Specific learning objectives in MY PALS ARE HERE!

In this chapter, pupils will learn and be able to:

- **Recognise** that a series connection of batteries involves connecting the positive terminal of one battery to the negative terminal of another battery
- **Investigate** how the number of batteries in an electric circuit can affect the brightness of a bulb
- **Recognise** what a fused bulb is
- **Recognise** that a series connection of bulbs involves connecting the bulbs one after another
- **Investigate** how the number of bulbs in an electric circuit can affect their brightness
- **Recognise** that a parallel connection of bulbs involves connecting the bulbs such that an electric current flows along separate paths to each bulb
- **Investigate** how the arrangement of bulbs in an electric circuit can affect their brightness
- **Investigate** which arrangement of bulbs in an electric circuit allows the bulbs to work independently of one another
- **List** the factors that affect the brightness of a bulb in an electric circuit
- **Identify** electrical appliances that need electricity to work
- **Trace** the source of electricity from an electrical appliance to a power station
- **Recognise** the need to conserve electricity
- **List** ways in which one can help to conserve electricity

Skills and processes

- Communicate the set-up of an electric circuit using a circuit diagram
- Investigate how the number and arrangement of batteries and bulbs in an electric circuit can affect the brightness of bulbs
- Generate suggestions of possible ways in which one can help to conserve electricity

Ethics and attitudes

- Recognise the need to take active steps in order to conserve electricity

Chapter sub-headings	Essential learning points	Specific learning objectives in MY PALS ARE HERE!
Number of batteries in series	• When the positive terminal of one battery is in contact with the negative terminal of another battery, we say that these batteries are arranged in a series connection. • As the number of batteries increases, more electric current flows through the bulb and causes the bulb to light up more brightly. • However, if too many batteries are used, too much electric current flows and the bulb might blow, or we can say the bulb is fused.	• Recognise that a series connection of batteries involves connecting the positive terminal of one battery to the negative terminal of another battery • Investigate how the number of batteries in an electric circuit can affect the brightness of a bulb • Recognise what a fused bulb is
Number of bulbs in series	• When the bulbs are connected one after another in an electric circuit, we say that these bulbs are arranged in a series connection. • If more bulbs are connected in series without increasing the number of batteries, the brightness of the bulbs will decrease. • This is because of the decrease in the current flowing through the bulbs.	• Recognise that a series connection of bulbs involves connecting the bulbs one after another • Investigate how the number of bulbs in an electric circuit can affect their brightness
Arrangement of bulbs in series and in parallel	• When the bulbs are connected such that an electric current flows along separate paths to each bulb, we say that these bulbs are arranged in a parallel connection. • The bulbs arranged in parallel light up more brightly than the bulbs arranged in series. • The bulbs arranged in parallel can work independently of one another. • The brightness of a bulb in a circuit depends on the amount of electric current flowing through it. • The amount of electric current flowing through the bulbs in a circuit is affected by the: – number of batteries; – number of bulbs; – arrangement of bulbs.	• Recognise that a parallel connection of bulbs involves connecting the bulbs such that an electric current flows along separate paths to each bulb • Investigate how the arrangement of bulbs in an electric circuit can affect their brightness • Investigate which arrangement of bulbs in an electric circuit allows the bulbs to work independently of one another • List the factors that affect the brightness of a bulb in an electric circuit
Saving energy	• Electricity is useful because it makes electrical appliances work. • Some common electrical appliances around us include the television set, air-conditioner, fan and computer. • Electricity is produced in a power station and reaches our homes through underground cables. • In Singapore, fuels like coal and oil are burnt in power stations to produce electricity. • Fuels will not last forever and burning fuels causes harm to the environment. • We can help to conserve electricity by switching off electrical appliances that are not in use.	• Identify electrical appliances that need electricity to work • Trace the source of electricity from an electrical appliance to a power station • Recognise the need to conserve electricity • List ways in which one can help to conserve electricity

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Chapter 7 Conductors of electricity

Time required
- Week 17
- Two periods: Lesson 7.1 (two periods)

Specific key inquiry questions in My Pals are Here!
- What are electrical conductors and insulators?
- Why should we use electricity safely and how can we do it?

Specific learning outcomes in My Pals are Here!	Specific learning objectives in My Pals are Here!
Knowledge, understanding and application • Recognise what electrical conductors and insulators are • Classify different materials as electrical conductors or insulators • Recognise the need to use electricity safely • List ways in which one can handle electricity and electrical appliances safely	In this chapter, pupils will learn and be able to: • **Recognise** that an electrical conductor is a material that allows electric current to flow through easily • **Recognise** that an electrical insulator is a material that does not allow electric current to flow through easily • **Recognise** that metal is a good conductor of electricity, as well as heat • **Construct** a circuit tester to distinguish between electrical conductors and insulators • **Classify** different materials as electrical conductors or insulators • **Recognise** the need to handle electricity and electrical appliances safely • **Communicate** the ways in which one can handle electricity and electrical appliances safely

Skills and processes
- Classify different materials as electrical conductors or insulators
- Communicate the ways in which one can handle electricity and electrical appliances safely

Ethics and attitudes
- Practise the safe use and handling of electricity and electrical appliances

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Chapter sub-headings	Essential learning points	Specific learning objectives in MY PALS ARE HERE!
Conductors and insulators	• Materials, such as metals, which allow electric current to flow through easily are called electrical conductors. • Materials, such as glass, wood and plastic, which do not allow electric current to flow through easily are called electrical insulators. • Metal is a good conductor of electricity, as well as heat. • A circuit tester can help to distinguish electrical conductors from electrical insulators.	• Recognise that an electrical conductor is a material that allows electric current to flow through easily • Recognise that an electrical insulator is a material that does not allow electric current to flow through easily • Recognise that metal is a good conductor of electricity, as well as heat • Construct a circuit tester to distinguish between electrical conductors and insulators • Classify different materials as electrical conductors or insulators
Using electricity safely	• Electricity is useful to us. • However, it can cause us harm if we are not careful when using it. • Never touch switches with wet hands. • When using electrical tools, make sure they have plastic or wooden handles. • Do not put too many plugs into one socket (overloading). • Check electrical appliances regularly for exposed wires. • Never repair any electrical equipment yourself.	• Recognise the need to handle electricity and electrical appliances safely • Communicate the ways in which one can handle electricity and electrical appliances safely

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Reading materials for teachers

Chapter 1 The plant transport system

A living thing as a system

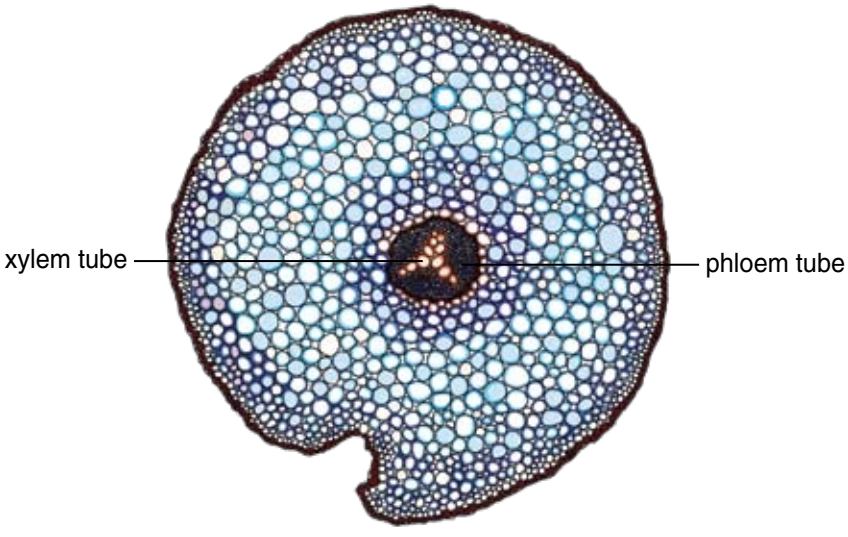
A living thing is a very complex system. Each living thing is made up of smaller systems to take care of its needs and to carry out essential life processes. Examples of systems in an animal include the sensory system, the digestive system, the circulatory system and the respiratory system. In each system are smaller parts called organs, which perform specific functions. An organ is made up of a group of tissues. A tissue is made up of cells, the most basic units of life.

Organs that help animals gather important information from the surroundings are called sense organs. Sense organs help animals seek out food and detect danger. A hawk, eagle or owl has sharp eyes (a keen sense of sight) that help it locate food from a great distance away. A rabbit has sharp ears that help it detect danger. A moth's antennae can pick up the faintest of smells. A fly and a butterfly taste with their feet. Plants are systems too. Most plants have parts such as roots, stems, leaves, flowers and fruits. Each of these parts has an important role. All the parts in a system work together to ensure the well-being and survival of the living thing.

The circulatory system in plants

Plants, like animals, also have a circulatory system. It is made up of two separate sets of tubes that run through the leaves, stems and roots. They are the xylem tubes and the phloem tubes.

The xylem tubes transport water and dissolved mineral salts from the roots to all parts of the plant. The xylem tubes can be seen in the cross-section of stems placed in water containing food dye. Examples of stems that can be used are the celery or the balsam. The phloem tubes carry food made in the leaves to the other parts of the plant. For plants to grow healthily, food made in the leaves must be transported to all parts of the plant to provide energy for all the plant cells. Likewise, water and dissolved mineral salts absorbed by the roots must be carried to all parts of the plant, especially to the leaves where food is made.



Cross-section of a plant stem

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Excess food (sugar)

While a plant makes its own food and uses only what it needs, what happens to the excess food that it produces? The excess food (sugar) made by plants is converted into a different type of sugar and transported to different parts of a plant through the phloem tubes. Starch is formed by a complex biological pathway involving photosynthesis. It is the major carbohydrate reserve in plant tubers and seed endosperm where it is stored in granular storage bodies, each typically containing several million amylopectin molecules accompanied by a much larger number of smaller amylose molecules.

Being insoluble, there is no increase in the osmotic pressure within a cell that contains starch, which would be the case if glucose itself was used. When we consume plants containing starch, it is broken down in the body by a complex process of enzymatic attack. By far, the largest source of starch is corn (maize) with other commonly used sources being wheat, potato, tapioca and rice.

Chapter 2 Air and the respiratory system

Composition of air

The layer of air that surrounds the Earth is called its atmosphere. It is made up of a mixture of gases. The two main gases in the air are nitrogen and oxygen. Together, they make up nearly 99% of the air. The remaining 1% is made up of carbon dioxide, the rare gases and varying amounts of water vapour. The approximate composition of air is shown below:

Gas	Formula	Approximate percentage by volume
Nitrogen	N_2	78.084%
Oxygen	O_2	20.9476%
Argon	Ar	0.934%
Carbon Dioxide	CO_2	0.0314%
Neon	Ne	0.001818%
Helium	He	0.000524%
Methane	CH_4	0.0002%
Krypton	Kr	0.000114%
Hydrogen	H_2	0.00005%
Xenon	Xe	0.0000087%
Water vapour	H_2O	Variable

Oxygen

Oxygen is essential for all living things. Plants and animals take in oxygen to carry out the process of respiration. During respiration, oxygen is used to break down digested food to release energy. Oxygen is not only found in the air but also in water and the soil. Oxygen in water is present in the dissolved form. Aquatic plants and animals use this dissolved oxygen for survival. Oxygen is also needed for burning. When things burn, they combine with oxygen and produce carbon dioxide.

Nitrogen

Although it makes up four-fifths of the air, this gas is not used by most living things. Nitrogen-fixing bacteria in the soil and in the roots of some plants can use the nitrogen directly from the air to form nitrates. Plants then absorb these nitrates to make plant protein.

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Carbon dioxide
Carbon dioxide is essential to green plants for the process of photosynthesis. During photosynthesis, green plants use the energy from sunlight together with carbon dioxide and water to make food or simple sugars. Oxygen is released during this process.

Water vapour
Water vapour in the air plays an important role in the water cycle. From water vapour, clouds are formed. The water vapour returns to the Earth in the form of rain, snow, hale or sleet.

Rare gases
The rare gases in the air include argon, helium, neon, krypton and xenon. These gases are inert. They do not take part in reactions under normal circumstances.

A healthy balance
Respiration and burning use up oxygen and produce carbon dioxide. Yet, we do not find the amount of oxygen decreasing and the amount of carbon dioxide increasing. This is because green plants help to maintain the balance of oxygen and carbon dioxide. During photosynthesis, carbon dioxide is used up and oxygen is replaced in the air. This exchange of gases ensures a healthy balance of oxygen and carbon dioxide.

Differences between respiration and breathing
Respiration is the process whereby energy is released from food. During respiration, cells use up oxygen and give off carbon dioxide. Breathing or gaseous exchange is the process by which these gases move in and out of the body.

(A) External respiration
The gaseous exchange that occurs between the alveoli and the blood as oxygen leaves the lungs and enters the blood, while carbon dioxide leaves the blood and enters the alveoli.

(B) Internal respiration
The gaseous exchange that occurs between the blood and the cells of the body, where oxygen leaves the blood and enters the cells and carbon dioxide leaves the cells and enters the blood to be taken to the lungs.

(C) Cellular respiration
A chemical reaction that occurs inside all body cells, which uses oxygen to break down glucose to produce energy and carbon dioxide.

Breathing is the physical process of gaseous exchange. This involves oxygen and carbon dioxide moving in opposite directions between the lungs and the blood, and also between the blood and the body's cells. In humans, this process involves the respiratory system. When humans breathe, the movement of air in and out of the body involves the rib cage, intercostal muscles and the diaphragm.

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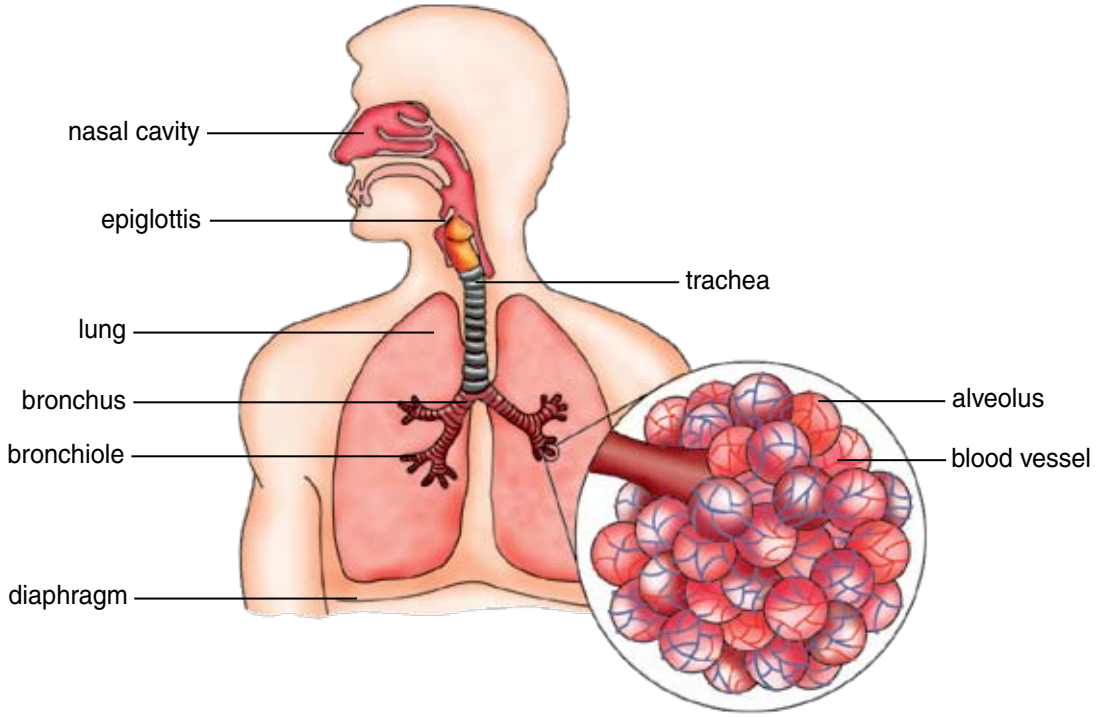

Human respiratory system

How do other animals breathe?

Mammals: Mammals like dolphins and whales that live in water, take in air through their blowholes and breathe through their lungs. Mammals that live on land, take in air through their nostrils and breathe through their lungs.

Birds: Birds have a strong circulatory system with a powerful heart that beats more frequently than human hearts do. Birds breathe differently from other animals with lungs. Their lungs are quite small and tube-like, but air sacs keep the lungs permanently inflated even when the bird is breathing out. Air flows first to the air sacs, which send oxygen-filled air into the lungs. This provides birds with plenty of oxygen.

Fish: Fish breathe through their gills, which contain a rich supply of gill membranes. These membranes provide a large surface area for gaseous exchange in aquatic organisms. As water passes over the gill membranes, fish absorb the dissolved oxygen in water. Gills contain a network of fine blood vessels (capillaries), which take up oxygen that diffuses through the membranes.

Reptiles: Reptiles do not need as much oxygen as humans do and therefore only breathe once in a while. Most of the time, their lungs are not moving. When their body needs energy, they breathe in and out a few times, then stop breathing again.

Insects: Insects breathe or gather oxygen through a branched network of tubes called tracheae. These tubes have openings, called spiracles, located on the thorax and abdomen. Oxygen passively enters spiracles, flows down the tubes, and dissolves in liquid located at the bottom of each tube. This liquid then moves into other cells, to provide oxygen to other cells in the insect's body.

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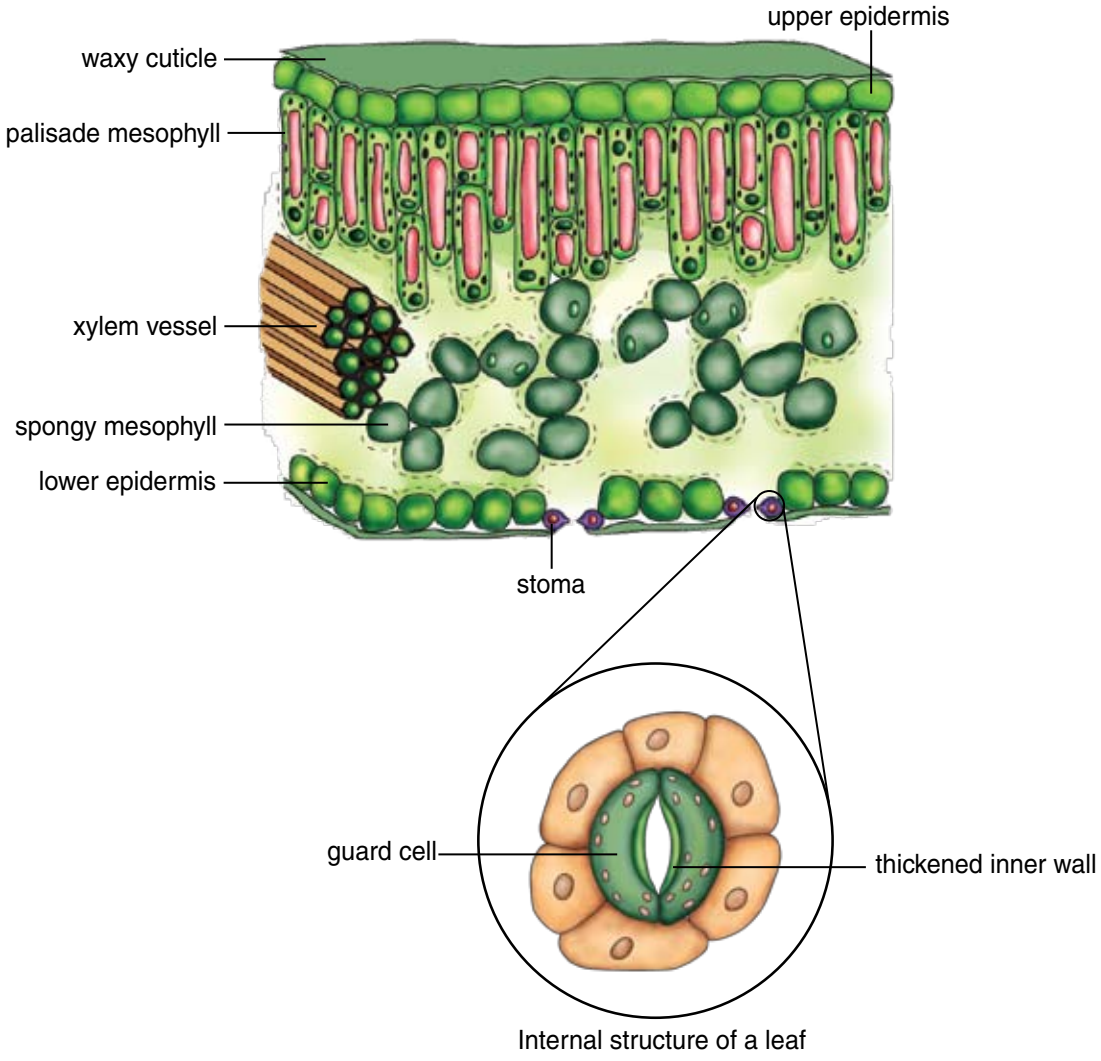
Amphibians: There are more than 6,000 species of amphibians living today, including toads, frogs, salamanders, newts and caecilians. Amphibians are animals that live part of their lives in water and part on land. They are vertebrates and are also ectothermic. When they are young and in water, amphibians breathe through their gills. When they become adults, they breathe through their lungs or moist skin on land. The moist skin of amphibians is thin and allows gases, especially oxygen to pass through easily. Their skin causes them to lose a lot of water, and this is why they are mostly found in moist or humid environments, where they can absorb or lose water whenever required.

Respiration in plants

The exchange of oxygen and carbon dioxide in the leaf (as well as the loss of water vapour in transpiration) occurs through pores called stomata. A stoma is a microscopic pore on the surface (epidermis) of plants. It is surrounded by a pair of specialised epidermal cells called guard cells, which act as turgor-driven valves that open and close the pores in response to given environmental conditions.

The inner wall of each guard cell is thick and elastic. When turgor develops within the two guard cells flanking each stoma, the thin outer walls bulge out and force the inner walls into a crescent shape. This opens the stoma. When the guard cells lose turgor, the elastic inner walls regain their original shape and the stoma closes.



Internal structure of a leaf

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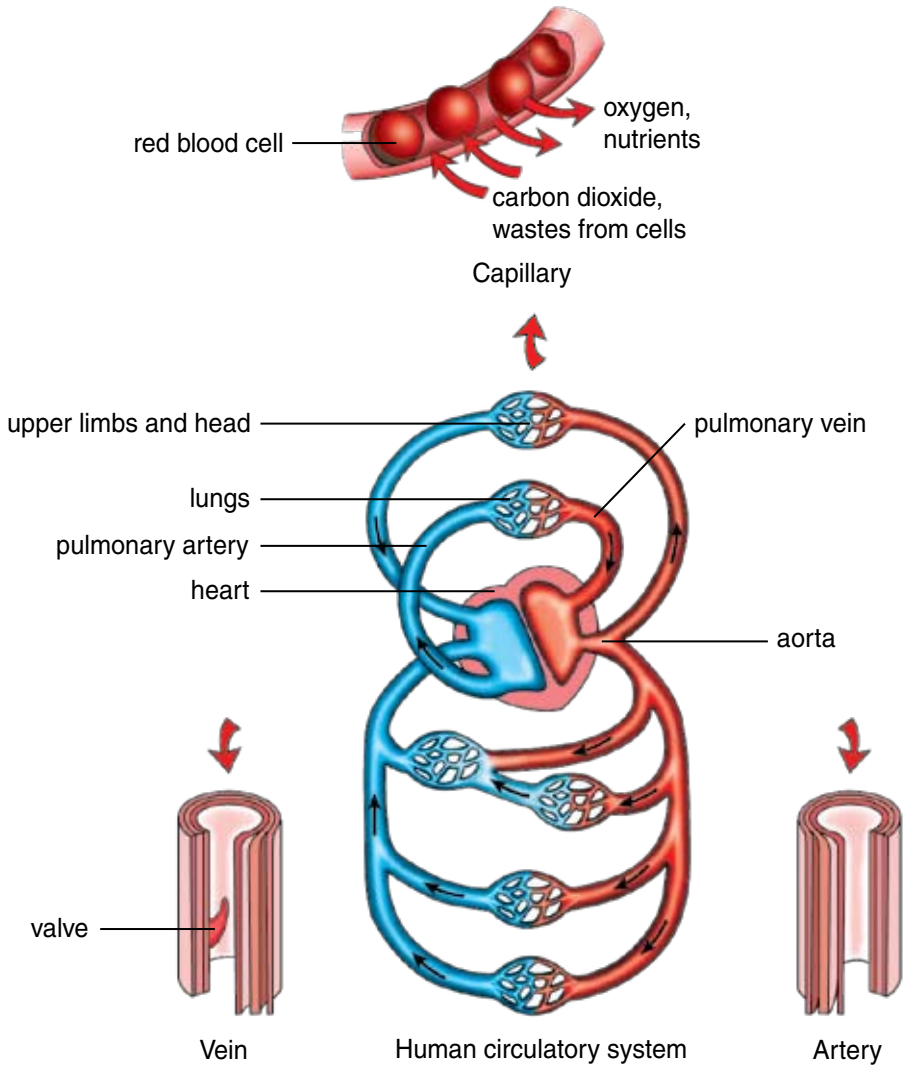
Chapter 3 The human circulatory system

The circulatory system

Our body needs oxygen, food and water to carry out life processes and to keep us alive. In order to do this, these substances must be transported to all parts of our body. Oxygen is used to release the energy stored in the food that we eat. At the same time, carbon dioxide and waste materials must be removed from the body. The human circulatory system carries out these two important functions. The components of the human circulatory system include the heart, blood and the blood vessels



(A) The heart

It is an organ made up of a special kind of muscle. It lies near the middle of our chest and is tilted slightly to the left. It is about the size of our fist and is protected by our rib cage. The heart muscles contract and relax continuously to pump blood to all parts of the body.

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(B) The blood

It is the red fluid flowing in our body. It carries oxygen, water, food substances, carbon dioxide, waste materials and many other dissolved substances. Almost one half of blood is water. There are three types of blood cells — red blood cell, white blood cell and platelet. The red blood cells transport oxygen. The white blood cells defend the body against germs and diseases. The platelets help in the clotting of blood when blood is exposed to the air, for example when you get a cut.

(C) The blood vessels

They are tube-like structures in which blood flows. They are found almost everywhere in our body. Some blood vessels are thick while others are fine. Whenever we cut ourselves, the blood vessels are broken and the blood running through them escapes. This is why we bleed.

There are three types of blood vessels. They are the arteries, the veins and the capillaries. The arteries carry oxygen-rich blood from the heart to all parts of the body. They also transport digested food and water. The veins carry blood that is rich in carbon dioxide and waste materials. The capillaries, which have very thin walls, connect the network of arteries to the veins. The capillaries are the "loading and unloading points" between the circulatory system and parts of our body.

Blood circulation

Step 1: The heart pumps blood rich in oxygen, digested food and water to all the cells in the body. The cells use the oxygen and digested food to produce energy for all our life processes, releasing carbon dioxide and waste materials.

Step 2: As the blood circulates or goes round our body, it picks up the carbon dioxide and waste materials produced by our body cells. These waste materials are passed to organs like the kidneys and liver to be excreted. When the blood reaches the heart again, it is pumped to the lungs. Here, carbon dioxide is removed and oxygen is taken in again.

Our pulse rate

Every cycle of contraction and relaxation of the heart is called a heartbeat. You can feel your pulse at your wrist, your neck or even at your temples. The number of pulses you count in one minute is your pulse rate, i.e. the number of times your heart beats per minute. The average number of beats per minute for an adult under normal conditions is about 70 beats per minute. Our heart rate changes depending on our age, activity level and health condition.

A child usually has a higher heart rate than an adult. When we are resting, our heart rate is lower than when we are exercising vigorously. When we exercise, our heart rate increases because the heart needs to supply more food and oxygen to the various parts of the body to produce more energy.

Working together

The circulatory system works closely with the respiratory and digestive system.

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Chapter 4 The unit of life

The cell is a basic unit of life. One of the most important principles in biology is the Cell Theory:
- All living things are made of one or more cells.
- The cell is the basic unit of life (the smallest thing that has all the properties of life).
- All cells come from pre-existing cells (the division of pre-existing cells).

The Cell Theory was developed over several centuries. Robert Hooke, an English scientist, first coined the term "cell". He used the word because the cork cells he observed looked like compartments. In 1675, Dutch scientist Antonie van Leeuwenhoek discovered micro-organisms in water and bacteria.

Cells

Cells are very small and they are measured in micrometres (10^{-6} μm). Bacteria are about 1–5 micrometres in diameter, while the red blood cell in our body is about 8 micrometres in diameter. Plant cells are on average larger (an Elodea epidermal cell is approximately 65 micrometers). Other micro-organisms, like the Amoeba, is around 700 micrometers.

Cells cannot be seen with an unaided eye and a compound microscope must be used. Good microscope usage and slide preparation skills come only with practice. It is also important to cultivate good habits when using the microscope. These are covered during the lessons.

Main parts of a cell

Animal cell:
- Nucleus (control centre of the cell — stores information for cell functions)
- Cell membrane (thin, controls the substances that enter or exit the cells)
- Cytoplasm (jelly-like, where cell activity takes place)

Plant cell (besides the nucleus, cell membrane and cytoplasm):
- Chloroplasts (contain green pigment chlorophyll, needed in photosynthesis)
- Cell wall (an additional fibrous and stiff wall which gives plant cells their shape)
- Vacuole (a large cavity/structure filled with sap found in the middle of the cell; together with the cell wall, it enables firmness in plant cells, giving them structural strength)

Differences between plant and animal cells

Plant cells have cell wall, central vacuole and chloroplasts, which animal cells do not have. However, plant cells that are not involved in photosynthesis do not contain chloroplasts (e.g. underground parts of plants).

The "extra" cell structures in plant cells give them capabilities that animals do not exhibit:
- Chloroplasts — enable plant cells to make food from solar energy, which animals cannot do.
- Cell wall and the sap-filled central vacuole — enable firmness in plant cells; this rigidity gives plants structural strength, allowing land plants to reach 40–50 m in height; in contrast, the largest animal on land, the African Elephant, can grow to a maximum height of only 3–4 m.

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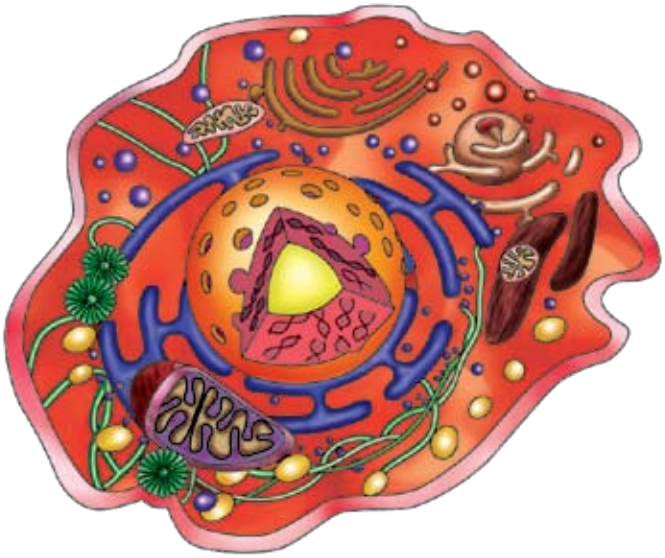
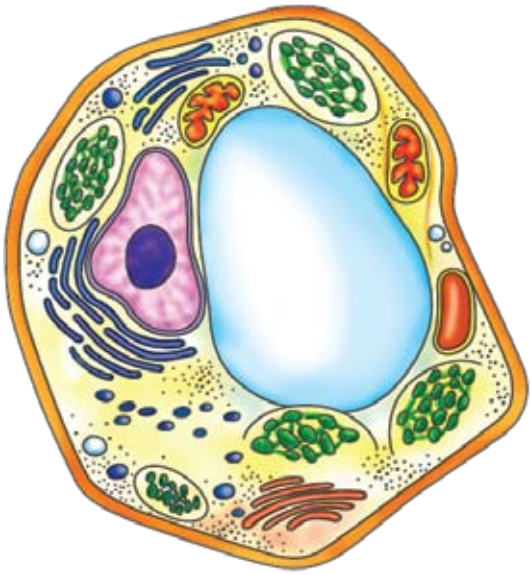


Animal cell



Plant cell

Single-cell and multi-cellular organisms: Some organisms have only one cell (single-cell). These organisms have all the life processes taking place within the cell. Because of their small sizes, they do not need systems to carry out certain processes — they get their oxygen directly from the surrounding medium and excrete their waste directly into it. Most single-cell organisms found in pond water contain chloroplasts and are able to photosynthesise, such as the diatoms and algae.

Other animal-like micro-organisms capable of movement are also found. These animal-like micro-organisms, including paramecium and amoeba, are not animals (Kingdom Animalia). They belong to the Kingdom Protista, which pupils learn as "Micro-organism". Multi-cellular organisms are composed of millions and even billions of cells. There are many kinds of cells of different shapes, and they work together for the organism to function as one.

Different shapes and functions: Cells occur in various shapes. Their shapes are often linked to their functions (e.g. sausage-shaped cells of stomata create an opening for gaseous exchange; brain cells have many hair-like branches called dendrites to make connections with other brain and nerve cells; red blood cells are shaped to have a large surface area for gaseous exchange).

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Cells divide to produce new cells (asexual reproduction): Cells can only be produced from pre-existing cells. A mature cell (parent cell) divides into two (also known as binary fission), resulting in two daughter cells. This kind of reproduction is asexual — only one parent cell is involved and the two daughter cells have identical genetic material. The process of cell division has three continuous overlapping phases:

- Interphase — the time between cell divisions.
- Mitosis — replication and division of the nucleus.
- Cytokinesis — division of the cytoplasm.

Some cell structures, such as chloroplasts, divide during the interphase. Others, like mitochondria, divide at other times. During the last phase of cell division — cytokinesis — the cytoplasm and the cell membrane split into two. Cell division results in a large number of cells after several divisions. After one division, there will be two cells, after two divisions there will be four, then eight, 16 etc. This kind of growth is termed "exponential". Budding in yeast is a special kind of cell division, where a new cell "buds" off the side of a parent cell.

Chapter 5 Electric circuits

What is electricity?

The word "electricity" comes from the Greek word "*electron*", which means "amber". In ancient Greece, a scientist rubbed a piece of amber (a hard fossilised resin) with cloth and observed objects sticking to it. We now know that this is static electricity. We see it when we rub a balloon. Static electricity is caused by an imbalance of charged particles — electrons (negatively charged particles of atoms) as they move to or from objects when rubbed.

The electricity in a circuit is called an electric current. The electric current is a flow of electrons along a continuous path (closed circuit). Please note that batteries or generators do not supply all these electrons. Some electrons are from the atoms of the conductors (copper wire and other components). Batteries and generators help to pump them along the path. The electrons stop flowing when the circuit is open. This understanding of electricity is not in the syllabus. For our scope, pupils need to understand that electrical energy can be stored in batteries and the electric current flows when circuits are closed.

Electricity in nature

Lightning is a big charge of electricity that can reach from clouds to the ground or to other clouds. It can start fires and it is strong enough to hurt or kill people. Lightning also helps nature by changing nitrogen into a form that plants can use.

Some animals can generate electricity, like the electric eel (*Electrophorus electricus*) that is a long, snake-like fish. It can produce a 600 volt electric shock. One shock from an electric eel will not kill a person, but repeated shocks will. Electric eels are found in the Amazon River basin and other parts of South America. It uses the electricity generated to stun prey.

Components of an electrical system

Batteries are the source of energy in an electric circuit. Unlike the electricity from electrical sockets, they can store chemical energy and convert it into electrical energy when needed. Externally a battery has two poles — a positive pole on top and a negative pole below. Between these poles is a mixture of chemicals (called electrolyte).

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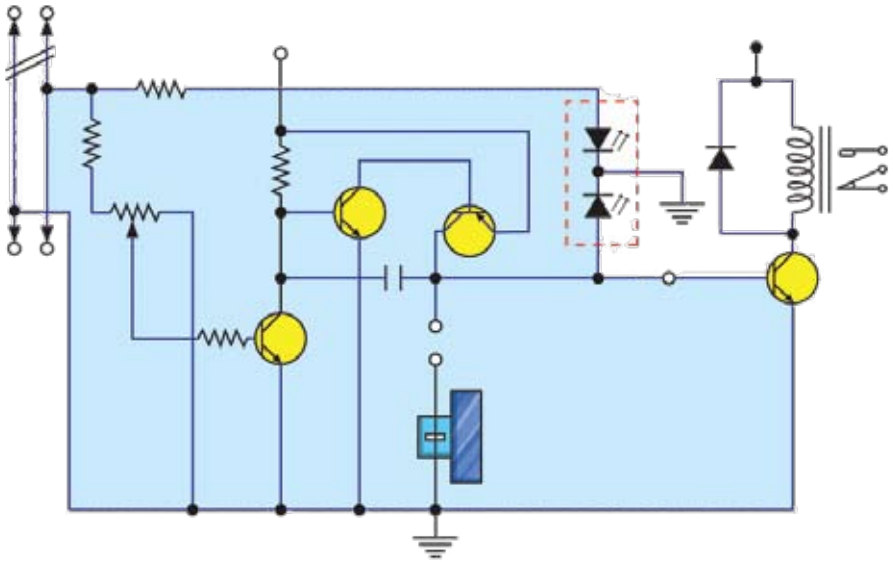
Wires connect all parts of a circuit to each other. The outer part is made of rubber. As it does not allow electric current to pass through, we do not get electric shock. Rubber is flexible. Within it are several pieces of copper wires intertwined together (allows electric current to move faster).

Bulbs convert electrical energy to light and heat energy. The filament in modern bulbs is the metal, tungsten, which remains solid at very high temperatures. The electric current flowing through the filament causes it to heat up and glow due to a concept called resistance. When electricity passes through something, the substance it is passing through tries to hold on to the electrons. The electrons have to be forced through. Some of this force is absorbed by the metal and given off as heat. As the filament heats up, it gives off light. Most of the air in the glass bulb has been sucked out. If the air has not been sucked out, the filament would actually burn up instantly.

Switches are electrical components used to open or close electrical circuits. Other components, such as the receiver, do work for us by converting electrical energy to other forms of energy. Buzzers components convert electrical energy to sound energy. Motors with a propeller convert electrical energy to kinetic energy (movement).

Circuit diagrams

A circuit diagram is used to record the components and connections of a circuit in a simple and clear way.



Circuit diagram of a telephone

Key scientists in electricity

Benjamin Franklin, an American scientist/inventor, was considered the father of electricity. In a very dangerous experiment, he showed that lightning is electricity. He flew a kite during a thunderstorm and electricity passed down the damp string to a key below. There was a spark when he put his hand near the key. (Note: He was not struck by lightning.) He invented the lightning conductor in 1753.

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Alessandro Volta, an Italian scientist who invented the battery or cell, which consisted of a pile of copper discs and a zinc disc with pieces of cloth soaked in salt solution between them.

Thomas Edison, is often recorded as the inventor of the electric light bulb. He did not "invent" the light bulb, but rather he improved upon a 50-year-old idea. Before his light bulb, there was no bulb which was reliable, long-lasting and practical for home use. However, he did invent and develop an electric lighting system that contained all the elements necessary to make the incandescent light practical, safe and economical.

Chapter 6 Using electricity

In a circuit, the brightness of a bulb depends on:
- The number of batteries used — the greater the number of batteries, the brighter the bulb.
- Arrangement of components of the circuit, such as batteries and bulbs.

Arrangement of batteries
When there is more than one battery, the batteries have to be arranged correctly to form a closed circuit. Positive end of one is to be joined to the negative end of another. The bulb in a circuit with batteries arranged in series is brighter than that where batteries are arranged in parallel.

Arrangement of bulbs

	Arrangement of bulbs	
Points for comparison	**Series**	**Parallel**
Number of paths for the electric current to flow	Only one path; current passes through components one after another	Two or more paths; current splits up and passes through each branch at the same time; paths are independent of each other
Brightness of bulbs	Brighter than batteries in parallel	Dimmer than batteries in series
If one bulb is removed or damaged	Electric current cannot flow through the circuit, the remaining bulb will not light up	Electric current can still flow through the other path and the other bulb still lights up
Application	Used in circuit tester	Used in the connection of circuits in houses, twinkling lights, bumper cars in fun fairs

Using electricity wisely
In Singapore, electricity is produced from burning fossil fuel through three main processes. Oil, coal and natural gas are burned to boil water. The steam produced turns turbines attached to generators. As the generator spins, electricity is produced. Also, approximately 3.5% or 240 MW (megawatts) of electricity is produced by our incinerators. Heat produced when refuse is burnt, is used to boil water and produce steam. The steam drives turbines attached to generators.

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Non-renewable and renewable energy sources

Oil, coal and natural gas are "fossil fuels" formed from the remains of plants and animals that lived long ago. Although convenient and power-packed, burning them gives off a lot of carbon dioxide, which is not good for the environment. Fossil fuels are limited and will be used up. We call such a source of energy "non-renewable" or "exhaustible".

A "renewable" source of energy is not in danger of running out for a long time, such as:

- Solar energy — can be converted to electrical energy by solar (or photovoltaic) cells. Widely used in satellites, radio beacons and small appliances like calculators, watches etc.
- Hydroelectric power — electricity from a dam that is built across a river. In a hydroelectric power station, the energy of falling water is used to turn turbines, which in turn drive generators.
- Wind energy — harnessed using windmills.
- Hot springs — geothermal energy in the Earth is a storehouse of heat (core temperatures are as hot as 1,000°C. Water is pumped into the Earth to be heated and then returned to the surface. The heat can be used for heating or generating electricity.
- Tidal power — the rising and ebbing of the sea causes water movement. The tidal stream is made to flow through turbines, which drive generators.

Using too much electricity

Singapore's power consumption is very high. For example, in 1999, demand for electricity stood at 27,082 million kilowatt hours (MKW), an increase of nearly 4% over the previous year. For the family and the country, this increase means increasing costs. For the planet it means that fossil fuels will be used up faster; and there will be increasing pollution, caused by the burning of fossil fuels.

Although there are renewable sources of energy, not all are available to us. It is hard and costly to generate electricity and bring it to our homes and cities — we should appreciate it and not be wasteful. More information about electricity consumption in Singapore households and how to reduce our consumption can be found at www.nccc.gov.sg/Households/es_guide.shtm.

Some practical ideas of conserving electricity

- Switching off lights, fans and air-conditioners when you are leaving the room
- Use energy saving bulbs
- Switching off electrical appliances after use (e.g. heaters, iron, oven)
- Studying and reading during the day (no need for lamps/lights)
- Changing clothes when you are hot
- Using the fan rather than the air-conditioner especially when there are only a few people

More energy saving tips can be found at www.e2singapore.gov.sg/energy-saving-tips.html.

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Chapter 7 Conductors of electricity

Materials can be classified as conductors or insulators of electricity. Conductors are materials that allow electricity to pass through. Most metals, like silver, copper, brass, steel and aluminium are conductors of electricity. Carbon is a non-metal that is a conductor of electricity.

The atoms of conductors have loosely bonded electrons that readily move from atom to atom. Good conductors of electricity have more loosely held electrons to move through the material. Silver is the best conductor, but is not used because it is too expensive and scarce. Copper is used in electric wires because it is a good conductor of electricity, relatively cheap and abundant. Good conductors of electricity are usually good conductors of heat.

Poor conductors of electricity produce a lot of heat when an electric current passes through, such as tungsten (used in light bulbs) and nichrome (used as the heating element in irons and bread toasters).

Non-conductors of electricity or electrical insulators are materials that do not allow electricity to pass through, such as rubber, air, plastic, wood, glass and cloth. Electrical insulators protect us from electric shocks by preventing electric current in wires from passing through our bodies. They can be found in objects, such as wires (rubber or plastic outer covering), electrical plugs, sockets, handles of screw drivers and pliers used by electricians.

A circuit tester is used to find out if a material is a conductor or an insulator. Pupils will construct one and test out common materials.

Electrical safety

While electricity is useful, it can cause harm if not used properly. People may get fatal electric shocks or electrical fires can occur. A fault in an electrical system can cause a surge in current and wires could become heated to high temperatures that a fire starts. To prevent this, we have fuses and circuit breakers installed in our domestic circuits and appliances. Some three-pin plugs have a fuse within them too. Fuses and circuit breakers cut off the current if it increases to dangerous levels. A fuse has a length of wire which forms the weakest link in a circuit. It burns out if the current is too strong. There are various fuses that withstand different currents. The circuit breaker is an electromagnetic switch that cuts off the circuit when the current becomes too strong.

Personal safety

People can prevent getting an electric shock by:

- Not doing any repairs or installation of electrical appliances unless experienced
- Not poking anything into sockets or putting too many plugs into a single socket
- Not touching switches or electrical appliances with wet hands
- Not using electricity from the sockets when conducting experiments
- Repairing or replacing any exposed wires or faulty appliances
- Switching off the power switch before plugging in a plug

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Lesson 1.1: The plant transport system

Textbook : Theme Page, pages 6–9
Activity Book : Pages 1–4 (Activities 1.1 and 1.2)
Time required : Weeks 1 and 2, three periods

Essential learning points	Specific learning objectives in My Pals are Here!
• A system consists of parts that work together to perform a function. • Plants obtain the different substances they need to stay alive through special parts that carry these substances to the parts of the plants that need them. • A plant's transport system is made up of two separate sets of fine tubes that run through the leaves, stems and roots. • The food-carrying tubes transport excess sugar made in the leaves during photosynthesis to other parts of the plant. • The water-carrying tubes transport water and mineral salts from the roots to the other parts of the plant.	• Show an understanding of what a system is • Recognise that a plant's transport system is crucial to its survival • Identify the parts of a plant that help it to transport substances • List the substances that are transported by a plant's transport system • State the function(s) of each part of a plant's transport system • Observe how a stem transports water from the roots to the other parts of a plant • Differentiate between the water-carrying tubes and the food-carrying tubes in a plant

Information Technology (IT)

Use of the Internet to gather information about the train system and a plant's transport system in order for a comparison to be made

National Education (NE)

Bring the pupils to the Singapore Botanic Gardens to understand how to show care and responsibility towards the plants around us

Engage (1st E) Use of a scenario

Purpose: To engage the pupils by illustrating an example of a train system, which cannot function properly because of one part that cannot work

Resource: Diagram of a train system's network map (can be obtained from the website, www.smrt.com.sg/trains/network_map.asp)

1. Show the pupils the diagram of a train system's network map.
2. Read aloud the following story to the pupils verbally or use multimedia presentation slides to further engage them:
   - You were tasked to deliver some home-made tarts to your grandmother's house in Jurong East. You decided to take the train from Bishan but the train had to come to an emergency stop at Woodlands because the train tracks have been damaged.
3. Ask the pupils to predict the result of the damage and discuss with them whether the train system can continue to function properly after the damage has occurred.
4. Lead the pupils to conclude that a system consists of parts that work together to perform a function. If one of the parts cannot work, the whole system cannot function properly.

Feature of Science inquiry

Question (Q4)
Pupils engage in the question provided by the teacher, materials or other sources.

Connection (Con3)
Pupils are given possible connections.

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Explore (2nd E) Guided inquiry

Purpose: To identify the function of a plant's transport system
Resources: Textbook, Science journal

1. Ask the pupils to read the Theme Page of the Textbook and think about the definition of a system.
2. Ask the pupils to compare the train system and a plant's transport system. Some questions to elicit their responses include:
   - What is the function of a train system? (Answer: The function of a train system is to transport people from one location to another.)
   - What is the function of a plant's transport system? (Answer: The function of a plant's transport system is to transport substances from one plant part to another.)
   - What does a train system transport? (Answer: A train system transports people and objects.)
   - What does a plant's transport system transport? (Answer: A plant's transport system transports water and dissolved substances, such as mineral salts, from the roots to other parts of the plant. It also transports food made in the leaves to other parts of the plant.)
   - Why is a plant's transport system important for its survival? (Answer: A plant's transport system transports water to the leaves for photosynthesis to occur and transports the food made in the leaves to other parts of the plant to be used for life processes.)

Evidence (Evi3)
Pupils are given data and asked to analyse.

Connection (Con3)
Pupils are given possible connections.

Explain (3rd E) Teacher-directed discussion

Purpose: To identify the parts of a plant's transport system and their functions
Resource: Textbook

1. Ask the pupils to read pages 8–9 of the Textbook to understand the parts of a plant's transport system and their functions.
2. Inform the pupils that there are two separate sets of fine tubes that run through the leaves, stems and roots. In the stem, the outer tubes transport food, while the inner tubes transport water and dissolved substances, such as mineral salts.
3. Ask the pupils to read the Building block section on page 8 of the Textbook. Discuss with them the answers to the questions posed.

Explanation (Exp3)
Pupils are given possible ways to use evidence to formulate explanation.

Connection (Con3)
Pupils are given possible connections.

Elaborate (4th E) Application to the real world

Purpose: To investigate the movements of water and food in a plant
Resources: Activity Book, stalk of celery, blue food colouring, red food colouring, 1000 mℓ beaker, knife

1. Ask the pupils to turn to Activity 1.1. Guide them to:
   - Carry out the procedures in small groups.
   - Discuss and fill in their best possible answers.
2. Ask the pupils to turn to Activity 1.2. Guide them to group into pairs to discuss and fill in their best possible answers.

Connection (Con2)
Pupils are directed towards areas and sources of scientific knowledge.

Evaluate (5th E) Assessment

Purpose: To assess the pupils' understanding of the lesson
Resources: Activity Book, Homework Book, HOTS

1. Ask the pupils to share their answers to Activities 1.1 and 1.2.
2. Correct and/or refine the pupils' answers to ensure that their answers are scientifically correct.
3. Draw a simplified diagram of a plant on the whiteboard and ask the pupils to trace the movements of water and food in the plant.
4. Conclude the lesson by emphasising the five essential learning points.
5. Ask the pupils to complete Systems Chapter 1 of the Homework Book.
6. Ask the pupils to try Systems Chapter 1 of the HOTS book.

Communication (Com3)
Pupils are provided with broad guidelines used to sharpen communication.

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Lesson 2.1: Air and the respiratory system — All mixed up!

Textbook : Pages 11–13
Time required : Weeks 2 and 3, two periods

Essential learning points	Specific learning objectives in My Pals are Here!
• The mixture of nitrogen, oxygen, carbon dioxide, water vapour and other gases is called air. • When air moves, it is called wind. • Nitrogen makes up about four-fifths of the air. • Living things on land and in water take in oxygen from their surroundings to stay alive. • Oxygen is also needed for burning. • During the day, plants use carbon dioxide and water to make food through the process called photosynthesis.	• Recognise that air is a mixture of different gases • List the components of air • Recognise that moving air is wind • Discuss the uses of some of the gases present in air

Information Technology (IT)

Use of the Internet to gather information about the components of air

National Education (NE)

Ask the pupils to design a poster to raise awareness of air pollution and the ways to minimise air pollution

Engage (1st E) Use of an attention grabbing demonstration

Purpose: To identify oxygen as a component of air
Resources: Candle, clear glass container, beaker, matchstick, water

1. Prepare the following set-up:
   - Stand a candle in a clear glass container of water, where the water level should be below the top of the candle.
   - Light up the candle wick.
   - Hold a beaker up and ask the pupils what they think is inside it. If they claim that it is empty with nothing inside it, prompt them to think again and recall what they have learnt in the lower block about the states of matter.
   - Invert the beaker over the candle and container such that it forms an enclosed area within the beaker.
2. Ask the pupils to observe what happens after the teacher inverts the beaker. They should observe the candle burning for a short while before the flame dies out. The teacher should mark the water level in the clear glass container before and after inverting the beaker so that pupils can observe the small rise in water level clearly.

Feature of Science inquiry

Evidence (Evi3)
Pupils are given data and asked to analyse.

Explore (2nd E) Guided inquiry

Purpose: To introduce the components of air
Resources: Science journal, glass of cold water

1. Discuss with the pupils the different components of air. Some questions to elicit their responses include:
   - Which gas in the air supports burning? (Answer: Oxygen in the air supports burning.)
   - Why does the candle flame die out after some time? (Answer: The candle flame dies out because the oxygen trapped by the beaker is used up.)
   - Why does the water level in the clear glass container rise slightly? (Answer: The water level in the clear glass container rises slightly because oxygen is used up and the water takes up the empty space.)
   - Besides oxygen, what are the other gases present in air? (Answer: The other gases present in air are nitrogen, carbon dioxide, water vapour and other gases.)
   - When animals breathe, what gases do they release into the air? (Answer: They release carbon dioxide and water vapour into the air.)
2. Place a glass of cold water on the table and allow it to stand for a while. Small droplets of water will begin to form on the surface of the glass. This will illustrate to the pupils that there is water vapour in the air and it condenses on the cold surface of the glass.
3. Pose the following question:
   - Which component of air forms the water droplets on the surface of the glass? (Answer: Water vapour in the air condenses to form the water droplets on the surface of the glass.)

Feature of Science inquiry

Evidence (Evi3)
Pupils are given data and asked to analyse.

Connection (Con3)
Pupils are given possible connections.

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Explain (3rd E) Teacher-directed discussion **Purpose:** To develop an understanding that air is a mixture of different gases, where each gas has its own uses **Resource:** Textbook 1. Ask the pupils to read pages 12—13 of the Textbook to find out more about the various components of air. Discuss with them the answers to the questions posed.	**Explanation (Exp2)** Pupils are guided in the process of formulating explanations from evidence.
Elaborate (4th E) Application to the real world **Purpose:** To further investigate the activities that contribute to some of the gases present in air **Resource:** Internet connection 1. Discuss with the pupils the activities that contribute to some of the gases present in air, e.g. burning, decomposition, breathing by living things which releases carbon dioxide, photosynthesis carried out by plants which releases oxygen and evaporation from water bodies which releases water vapour. 2. Using the Internet, ask the pupils to access the following website to find out more about the activities that contribute to some of the gases present in air: • www.physicalgeography.net/fundamentals/7a.html	**Connection (Con2)** Pupils are directed towards areas and sources of scientific knowledge.
Evaluate (5th E) Assessment **Purpose:** To assess the pupils' understanding of the lesson **Resource:** Textbook 1. Ask the pupils to read the Building block section on page 13 of the Textbook. Discuss with them the answers to the question posed. 2. Write the following two terms, "OXYGEN" and "CARBON DIOXIDE", on the whiteboard. 3. Ask the pupils to draw arrows showing the processes that add or remove the two gases from the air. 4. Conclude the lesson by emphasising the six essential learning points.	**Communication (Com3)** Pupils are provided with broad guidelines used to sharpen communication.

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Lesson 2.2: Air and the respiratory system — Human respiratory system

Textbook : Pages 14—15
Activity Book : Pages 5—8 (Activities 2.1 and 2.2)
Time required : Weeks 3 and 4, three periods

Essential learning points	Specific learning objectives in My Pals are Here!
• Breathing is the process of taking air into the body and giving it out. • When we breathe, we take in oxygen and give out carbon dioxide. • The parts of a living thing that help it to breathe form the respiratory system. • The human respiratory system consists of the nose, windpipe, lungs and air sacs. • When the air we breathe in reaches our air sacs, oxygen passes through the walls of the air sacs into the blood vessels. • At the same time, carbon dioxide carried in the blood vessels of our body passes into the air sacs.	• Recognise that breathing is the process of taking air into the body and giving it out • Identify the organs that make up the human respiratory system • Describe how the human respiratory system carries out gaseous exchanges with its surroundings

Information Technology (IT)

Use of the Internet to gather information about breathing (inhalation and exhalation)

National Education (NE)

Ask the pupils to design a poster to discourage smoking

Engage (1st E) Use of an attention grabbing demonstration

Purpose: To enthuse the pupils by using a model to simulate the human lung
Resource: Pre-constructed lung model as shown in Activity 2.1 (transparent plastic cup, straw, balloon, plasticine)

1. Show the pupils the pre-constructed lung model and inform them that it is a model of the human lung.
2. Gently pull down and release balloon B alternately and ask the pupils to observe what happens.

Feature of Science inquiry

Evidence (Evi3)
Pupils are given data and asked to analyse.

Explore (2nd E) Guided inquiry

Purpose: To explore how the human lungs work
Resources: Science journal, pre-constructed lung model as shown in Activity 2.1

1. Challenge the pupils to explain their observations. Allow them to turn to their classmates to check each other's answers and if need be, to refine or adjust their answers before the teacher goes through the answers. Some questions to elicit their responses include:
   - What happens to the space inside the plastic cup when balloon B is pulled down? (Answer: The space inside the plastic cup increases.)
   - What is implied when balloon A inflates? (Answer: When balloon A inflates, it implies that air has entered the balloon.)
   - Where does the air to inflate balloon A come from? (Answer: The air to inflate balloon A comes from the surroundings.)
   - What happens to the space inside the plastic cup when balloon B is released? (Answer: The space inside the plastic cup decreases.)
   - What is implied when balloon A deflates? (Answer: When balloon A deflates, it implies that air has left the balloon.)
   - Where does the air from balloon A go? (Answer: The air from balloon A goes back to the surroundings.)
2. Lead the pupils to conclude that air is drawn into balloon A when the space inside the plastic cup increases. Air is then forced out of balloon A when the space inside the plastic cup decreases.

Question (Q4)
Pupils engage in the question provided by the teacher, materials or other sources.

Connection (Con3)
Pupils are given possible connections.

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Explain (3rd E) Teacher-directed discussion

Purpose: To apply the concepts learnt to the actual working processes of the human lungs

Resources: Activity Book, pre-constructed lung model as shown in Activity 2.1, measuring tape

1. Ask the pupils to turn to Activity 2.1. Demonstrate the procedures and guide them to fill in their best possible answers on their own.
2. Ask the pupils to share their answers to Activity 2.1.
3. Correct and/or refine the pupils' answers to ensure that their answers are scientifically correct.
4. Guide the pupils to recognise the similarities and differences between the lung model and the human lungs, e.g. the plastic cup in the lung model does not behave like the ribs in a human.

Explanation (Exp3)
Pupils are given possible ways to use evidence to formulate explanation.

Elaborate (4th E) Application to the real world

Purpose: To further reinforce the concepts learnt about how the human respiratory system works

Resources: Textbook, Activity Book, 100 mℓ beaker, 1.5 ℓ plastic bottle with a cap, permanent marker, trough, 50 cm long rubber tube, Internet connection

1. Ask the pupils to read pages 14—15 of the Textbook to understand more about the human respiratory system.
2. Explain to the pupils how the human respiratory system works.
3. Using the Internet, access the following website to show the pupils two videos about what happens in our respiratory system when we breathe:
   - library.thinkquest.org/28807/data/resp.htm
4. Using the Internet, ask the pupils to access the following website to find out more about the human respiratory system:
   - www.biology4kids.com/files/systems_respiratory.html
5. Challenge the pupils to think of a way to measure the volume of air that their lungs can hold.
6. Ask the pupils to turn to Activity 2.2. Demonstrate the procedures and guide them to fill in their best possible answers on their own.
7. Ask the pupils to share their answers to Activity 2.2.
8. Correct and/or refine the pupils' answers to ensure that their answers are scientifically correct.

Connection (Con2)
Pupils are directed towards areas and sources of scientific knowledge.

Evaluate (5th E) Assessment

Purpose: To assess the pupils' understanding of the lesson

Resources: Textbook, Science journal

1. Group the pupils into two groups.
2. Ask the pupils of the first group to write a story in their journal of themselves as oxygen in the air and their journey through the human respiratory system.
3. Ask the pupils of the second group to write a story in their journal of themselves as carbon dioxide produced in the body and their journey through the human respiratory system.
4. Read a few interesting and scientifically accurate journal entries to the class.
5. Discuss with the pupils the question posed by Sue on page 15 of the Textbook:
   - Why do you think air sacs need to have a rich supply of blood vessels? (Answer: Air sacs need to have a rich supply of blood vessels in order to increase the surface area for absorption of oxygen and release of carbon dioxide.)
6. Pose the following question:
   - Why are there so many small air sacs instead of a big air sac inside each human lung? (Answer: A larger number of small air sacs greatly increases the surface area for absorption of oxygen and release of carbon dioxide as compared to a single big air sac.)
7. Conclude the lesson by emphasising the six essential learning points.

Communication (Com2)
Pupils are coached in the development of communication.

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Lesson 2.3: Air and the respiratory system — Animal respiratory system

Textbook : Pages 16—17
Activity Book : Pages 9—10 (Activity 2.3)
Time required : Week 5, two periods

Essential learning points	Specific learning objectives in My Pals are Here!
• Different animals have different parts in their respiratory systems. • Insects have openings that lead to tubes, which carry oxygen to their internal organs. • Earthworms breathe through their moist skin. • Frogs breathe through their lungs on land and breathe through their moist skin in water. • Birds and mammals have lungs and they take in air through their nostrils. • Some mammals, such as whales and dolphins, have lungs and they breathe through blowholes on the top of their heads. • Fish take in oxygen through their gills.	• Observe the respiratory system of a fish • Compare the respiratory systems of humans and other animals

Information Technology (IT)

Use of the Internet to gather information about the respiratory systems of animals in order for a comparison to be made

Engage (1st E) Use of an interesting question

Purpose: To introduce and arouse the pupils' curiosity about a fish's respiratory system
Resource: Science journal

1. Pose the following question:
   - Why do fish often open and close their mouths? (Answer: Fish often open and close their mouths to bring water, which contains dissolved oxygen, into their respiratory system.)

Feature of Science inquiry

Question (Q4)
Pupils engage in the question provided by the teacher, materials or other sources.

Explore (2nd E) Guided inquiry

Purpose: To investigate how a fish takes in oxygen and gives out carbon dioxide
Resources: Activity Book, Science journal, small fish (e.g. ikan kuning), hand lens, big bowl of crushed ice

1. Ask the pupils to turn to Activity 2.3.
2. Bring some small fish packed in ice to the class. The teacher can either demonstrate to the pupils or allow them to observe the fish in small groups.
3. Point to the gill cover of the fish and ask the pupils whether they know what can be found below it.
4. Show the pupils the fish's gills by pulling back the gill cover.
5. Pose the following questions:
   - What is the colour of the fish's gills? (Answer: The colour of the fish's gills is red.)
   - Why is the colour of the fish's gills red? (Answer: The colour of the fish's gills is red because they are filled with blood.)
   - How do you know whether the fish is fresh? (Answer: The fish is fresh if the fish's gills are bright red in colour.)
   - What is the function of the fish's gills? (Answer: The function of the fish's gills is to allow the taking in of oxygen and giving out of carbon dioxide.)
   - Where is the oxygen that a fish needs found? (Answer: The oxygen that a fish needs is found as dissolved oxygen in water.)

Question (Q4)
Pupils engage in the question provided by the teacher, materials or other sources.

Evidence (Evi3)
Pupils are given data and asked to analyse.

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Explain (3rd E) Teacher-directed discussion

Purpose: To further understand a fish's respiratory system and compare it with the human respiratory system
Resource: Activity Book

1. Inform the pupils that a fish often opens and closes its mouth to bring water into its respiratory system. The water, which contains dissolved oxygen, passes over the gills before leaving the fish from under the gill cover. The dissolved oxygen is absorbed into the blood, while carbon dioxide passes from the blood, through the walls of the gills and into the water. The oxygen absorbed is transported by blood to different parts of the fish's body to be used.
2. Ask the pupils to identify the similarities and differences between the respiratory systems of a fish and a human. Similarities include a large surface area for the exchange of oxygen and carbon dioxide between the surroundings and the blood. Differences include the place of gaseous exchange, which is in the gills in fish and lungs in humans, a fish's respiratory system contains less organs and is less complex than a human's respiratory system.
3. Ask the pupils to turn to Activity 2.3. Guide them to group into pairs to discuss and fill in their best possible answers.
4. Ask the pupils to share their answers to Activity 2.3.
5. Correct and/or refine the pupils' answers to ensure that their answers are scientifically correct.

Explanation (Exp2)
Pupils are guided in the process of formulating explanations from evidence.

Elaborate (4th E) Application to the real world

Purpose: To compare the respiratory systems of different animals
Resources: Textbook, big sheet of paper, Internet connection

1. Using the Internet, ask the pupils to access the following websites to find out more about the respiratory systems of different animals:
   - www.sk.lung.ca/content.cfm?edit_realword=compare
   - www.estrellamountain.edu/faculty/farabee/biobk/BioBookRESPSYS.html
2. Group the pupils into small groups and ask each group to select a different animal to research on.
3. Ask the pupils to become "knowledge experts" of the respiratory system of the animal they have selected by gathering information from the Textbook and other sources.
4. Ask each group to present the respiratory system of the animal they have selected, using a poster that contains the information and supporting photographs or pictures.
5. Correct and/or refine the pupils' information on their posters to ensure that their information is scientifically correct.

Connection (Con1)
Pupils independently examine other resources and form the links to explanations.

Evaluate (5th E) Assessment

Purpose: To assess the pupils' understanding of the lesson
Resource: Textbook

1. Ask the pupils to read pages 16–17 of the Textbook to understand more about the respiratory systems in different animals.
2. Write the following four terms, "BREATHE THROUGH LUNGS", "BREATHE THROUGH GILLS", "BREATHE THROUGH SKIN" and "BREATHE THROUGH BREATHING HOLES", on the whiteboard.
3. Ask the pupils to classify different animals according to the way they breathe. Correct and/or refine their classification on the whiteboard to ensure that their information is scientifically correct.
4. Conclude the lesson by emphasising the seven essential learning points.

Communication (Com3)
Pupils are provided with broad guidelines used to sharpen communication.

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Lesson 2.4: Air and the respiratory system — Plant respiratory system

Textbook : Pages 18–19
Time required : Week 6, one period

Essential learning points	Specific learning objectives in My Pals are Here!
• Plants help to maintain the balance of oxygen and carbon dioxide in the air. • Plants take in carbon dioxide from their surroundings during photosynthesis. • At the same time, oxygen is produced and released into the surroundings. • Plants exchange gases with their surroundings through tiny openings called stomata. • Stomata are usually found on the underside of the leaves, away from direct sunlight. • This is to prevent water inside the plant from evaporating too fast through the stomata.	• Recognise that plants keep a healthy balance of oxygen and carbon dioxide in the air • Describe how a plant carries out gaseous exchanges with its surroundings • Explain why stomata are usually found on the underside of the leaves, away from direct sunlight

Information Technology (IT)

Use of the Internet to gather information about the kelp and find out why it cannot live in muddy and deep waters

National Education (NE)

Ask the pupils to carry out a "Plant a tree" project in order to gain an appreciation for the importance of plants in our environment

	Feature of Science inquiry
Engage (1st E) Use of an interesting demonstration **Purpose:** To introduce and arouse the pupils' curiosity about the concept of stomata **Resources:** Leaves, beaker of hot water 1. Bring some leaves and a beaker of hot water to the class. 2. Ask the pupils to observe carefully as the leaf is placed into the beaker of hot water.	**Evidence (Evi3)** Pupils are given data and asked to analyse.
Explore (2nd E) Guided inquiry **Purpose:** To show the presence of openings on leaves that allow a plant to carry out gaseous exchange with its surroundings **Resource:** Science journal 1. Ask the pupils to state their observations. Some questions to elicit their responses include: • What do you observe on the leaf surface? (Answer: Bubbles are observed forming on the leaf surface.) • What can be found inside the bubbles? (Answer: Air is found inside the bubbles.) • Where did the air inside the bubbles come from? (Answer: The air inside the bubbles came from inside the leaf.) • How did the air escape from the leaf? (Answer: When the leaf was placed into the beaker of hot water, the air inside the leaf expanded and escaped from the leaf through tiny openings.) • These tiny openings are usually found on the underside of the leaves, away from direct sunlight. Why? (Answer: This is to prevent water inside the plant from evaporating too fast through the tiny openings.)	**Question (Q4)** Pupils engage in the question provided by the teacher, materials or other sources. **Evidence (Evi3)** Pupils are given data and asked to analyse.
Explain (3rd E) Teacher-directed discussion **Purpose:** To find out more about stomata **Resource:** Textbook 1. Inform the pupils that plants exchange gases with their surroundings through tiny openings called stomata. 2. Ask the pupils to turn to page 18 of the Textbook to observe the microscopic view of the stomata.	**Explanation (Exp4)** Pupils are provided with evidence.

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Elaborate (4th E) Application to the real world **Purpose:** To relate the function of the stomata to the processes of respiration and photosynthesis **Resources:** Textbook, Science journal, Internet connection 1. Ask the pupils to read pages 18—19 of the Textbook to understand the importance of stomata during gaseous exchange. 2. Using the Internet, ask the pupils to access the following website to find out more about the processes of respiration and photosynthesis: • www.vtaide.com/png/photosynthesis.htm 3. Ask the pupils to imagine what it would be like if plants slowly became extinct. Some questions to elicit their responses include: • How will different living things be affected? • How can I help to conserve plants?	**Explanation (Exp3)** Pupils are given possible ways to use evidence to formulate explanation. **Connection (Con1)** Pupils independently examine other resources and form the links to explanations. **Communication (Com2)** Pupils are coached in the development of communication.
Evaluate (5th E) Assessment **Purpose:** To assess the pupils' understanding of the lesson **Resources:** Textbook, Homework Book, Tests, HOTS 1. Ask the pupils to read the Explore section and the Building block section on page 19 of the Textbook. Discuss with them the answers to the questions posed. 2. Conclude the lesson by emphasising the six essential learning points. 3. Ask the pupils to complete Systems Chapter 2 of the Homework Book. 4. Ask the pupils to attempt Test 1 of the Tests book. 5. Ask the pupils to try Systems Chapter 2 of the HOTS book.	**Communication (Com1)** Pupils form reasonable and logical arguments to communicate explanations.

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Lesson 3.1: The human circulatory system — The heart, blood and blood vessels

Textbook : Pages 22–27
Activity Book : Page 11 (Activity 3.1)
Time required : Weeks 6 and 7, three periods

Essential learning points

- Our heart is the vital organ of the human circulatory system that pumps blood all the time, to all parts of our body.
- The heart receives blood rich in oxygen from the lungs, and then pumps this blood rich in oxygen to the body cells.
- Blood also transports water and digested food to all parts of the body.
- Blood carries waste substances from all parts of the body to organs, such as kidneys, lungs and skin.
- Our heart is made of a special muscle called the heart muscle.
- This amazing heart muscle contracts and relaxes continuously without ever getting tired.
- Blood flows through many tubes called blood vessels to get to the different parts of the body.
- Our heart, together with our blood vessels and the blood they contain, form the parts of the circulatory system.
- These parts work together to form a system to carry out two important functions:
  - First, they transport oxygen, digested food and water to all parts of the body.
  - Second, they carry carbon dioxide and waste materials away from different parts of the body to be released.
- The circulatory system circulates blood in two parts:
  - Blood is pumped to all the cells in the body before moving back to the heart.
  - Blood is then pumped to the lungs before returning to the heart.

Specific learning objectives in My Pals are Here!

- Recognise that the heart is the vital organ of the human circulatory system that pumps blood all the time, to all parts of the body
- Describe how the heart works
- State the function(s) of the blood
- Recognise that the heart is made of a special muscle called the heart muscle
- State the function(s) of the blood vessels
- Identify the organs that make up the human circulatory system
- State the functions of the human circulatory system
- List the substances that are transported by the human circulatory system
- Trace the flow of blood and the path that substances take as they are transported by the human circulatory system

Information Technology (IT)

Use of the Internet to gather information about the human circulatory system

Engage (1st E) Use of an interesting activity

Purpose: To engage the pupils by using an activity to simulate the human heart
Resource: Stopwatch

1. Instruct the pupils to place their hands with their palms facing upwards on their desks.
2. Ask the pupils to count the number of times they can open and close their hands for one minute.
3. Challenge the pupils to continue the activity and identify the winning pupil who can continue for the longest period of time.
4. Inform the pupils that the activity they had carried out is similar to the pumping of the heart when it sends blood to all parts of the body. The only difference is that the heart can work without stopping, while their hands become tired after some time.

Feature of Science inquiry

Connection (Con3)
Pupils are given possible connections.

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Explore (2nd E) Guided inquiry

Purpose: To introduce the parts of the human circulatory system
Resources: Science journal, photograph of a human heart

1. Show the pupils the photograph of a human heart.
2. Pose the following questions:
   - What is the function of the heart? (Answer: The heart pumps blood all the time to all parts of the body.)
   - What substances does the blood transport? (Answer: The blood transports oxygen, carbon dioxide, water, digested food and waste substances.)
   - How is the blood carried to all parts of the body? (Answer: The blood is carried to all parts of the body through blood vessels.)
   - In which parts of the body are blood vessels visible to us? (Answer: Blood vessels are visible to us in parts like the white parts of our eyes, under our tongue and in our wrist.)

Question (Q4)
Pupils engage in the question provided by the teacher, materials or other sources.

Evidence (Evi3)
Pupils are given data and asked to analyse.

Explain (3rd E) Teacher-directed discussion

Purpose: To further understand the functions of each part of the human circulatory system
Resources: Textbook, Science journal, Internet connection

1. Ask the pupils to read pages 23–25 of the Textbook to understand the functions of each part of the human circulatory system.
2. Inform the pupils that the heart is made of a special muscle called the heart muscle, which is beyond our control. It contracts and relaxes continuously to pump blood around the body.
3. Highlight to the pupils that different substances are carried by the blood to different parts of the body.
4. Introduce to the pupils that the blood vessels are tubes in which blood flows to reach different parts of the body.
5. Group the pupils into pairs to look for visible blood vessels in parts like the white parts of the eyes, under the tongue and in the wrist.
6. Using the Internet, ask the pupils to access the following websites to find out more about the three types of blood vessels found in the human circulatory system (for high ability pupils):
   - library.thinkquest.org/22016/circ/
   - library.thinkquest.org/C003758/Structure/vessels.htm
7. Pose the following question (for high ability pupils):
   Why are the walls of capillaries much thinner than the walls of arteries and veins? (Answer: The walls of capillaries are much thinner so as to allow substances to pass through easily between the blood and the different parts of the body.)

Explanation (Exp3)
Pupils are given possible ways to use evidence to formulate explanation.

Elaborate (4th E) Application to the real world

Purpose: To illustrate how different parts of the human circulatory system work together
Resource: Internet connection

1. Using the Internet, ask the pupils to access the following websites to learn how the heart pumps blood to different parts of the body:
   - www.medtropolis.com/VBody.asp
   - www.pbs.org/wgbh/nova/heart/heartmap.html
2. Ask the pupils to draw a diagram to map out the path of blood flow from the heart to the lungs, head and the rest of the body.

Explanation (Exp1)
Pupils formulate their own explanations after summarising the evidence.

Connection (Con2)
Pupils are directed towards areas and sources of scientific knowledge.

Evaluate (5th E) Assessment

Purpose: To assess the pupils' understanding of the lesson
Resources: Textbook , Activity Book

1. Ask the pupils to turn to Activity 3.1. Guide them to group into pairs to discuss and fill in their best possible answers.
2. Ask the pupils to share their answers to Activity 3.1.
3. Correct and/or refine the pupils' answers to ensure that their answers are scientifically correct.
4. Ask the pupils to read the Building block section on page 27 of the Textbook. Discuss with them the answers to the questions posed.
5. Conclude the lesson by emphasising the ten essential learning points.

Communication (Com1)
Pupils form reasonable and logical arguments to communicate explanations.

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Lesson 3.2: The human circulatory system — From parts to whole

Textbook : Pages 27–29
Activity Book : Pages 12–16 (Activities 3.2 and 3.3)
Time required : Weeks 8 and 9, three periods

Essential learning points	Specific learning objectives in My Pals are Here!
• Each heartbeat is a cycle of contraction and relaxation of the heart muscles. • The heart of an average healthy adult beats about sixty to seventy times in a minute. • The rate of our heartbeat changes with age and health, as well as the type of activity we are doing. • When we exercise, our heart rate increases because the heart needs to supply more digested food and oxygen carried in the blood to the various parts of the body to produce more energy. • Our circulatory system works very closely with all parts of our body, especially our respiratory and digestive systems.	• Show an understanding that each heartbeat is a cycle of contraction and relaxation of the heart muscles • Investigate how the rate of our heartbeat changes with age, health and type of activity • Recognise that the human respiratory and digestive systems work together with the human circulatory system to carry out life processes

Information Technology (IT)

Use of the Internet to gather information about the factors that affect our heart rate

National Education (NE)

Bring the pupils to the Lifestyle and Diseases Area in Health Promotion Board's Health Zone to raise awareness of the link between unhealthy lifestyle habits and various lifestyle-related diseases, such as cancer, diabetes, heart disease, hypertension and stroke

Engage (1st E) Use of an interesting activity	Feature of Science inquiry
Purpose: To introduce the concept of a heartbeat **Resource:** Empty toilet roll 1. Group the pupils into pairs and ask one pupil of each pair to place an empty toilet roll over the centre of his or her classmate's chest. Through the empty toilet roll, they should be able to hear the beating of the heart. 2. Inform the pupils that when the heart beats, it produces "lub-dub" sounds. Each "lub-dub" sound corresponds to one heartbeat. 3. Share with the pupils that the earliest stethoscope was invented by a French doctor named René-Théophile-Hyacinthe Laennec. The stethoscope was actually a wooden tube that was used to listen to the heartbeat.	**Evidence (Evi4)** Pupils are given data and told how to analyse.
Explore (2nd E) Guided inquiry **Purpose:** To introduce how the blood flows in the human circulatory system **Resource:** Science journal 1. Ask the pupils to gently press the inside of the wrist or the side of the neck to feel the pulse. The pulse is more easily felt where the blood vessels run over a bone or a hard surface, such as at the wrist and neck. 2. Inform the pupils that a pulse is a pressure wave that passes along the blood vessels. 3. Ask the pupils to write down the questions they may have about the pulse they feel in a journal. Some possible questions include: • What causes the pulse? (Answer: The beating of the heart causes the pulse.) • Is the pulse at regular intervals? (Answer: Yes, the pulse should be at regular intervals when we are resting.) • What is the average heart rate? (Answer: The average heart rate should be sixty to seventy in a minute.) • What affects the heart rate? (Answer: The heart rate is affected by age, health and type of activity.)	**Question (Q1)** Pupils pose a question. **Evidence (Evi3)** Pupils are given data and asked to analyse.

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Explain (3rd E) Teacher-directed discussion **Purpose:** To develop a better understanding of the heart and blood circulation **Resources:** Textbook, Science journal 1. Inform the pupils that the heart of an average healthy adult beats about sixty to seventy times in a minute. 2. Explain to the pupils that each heartbeat is a cycle of contraction and relaxation of the heart muscles, which pushes blood through the blood vessels, generating a pulse. 3. Ask the pupils to read pages 27—28 of the Textbook to understand more about the heartbeat and try to answer the questions they wrote down earlier. 4. Correct and/or refine the pupils' answers to ensure that their answers are scientifically correct.	**Explanation (Exp2)** Pupils are guided in the process of formulating explanations from evidence.
Elaborate (4th E) Application to the real world **Purpose:** To investigate how the heart rate changes with the type of activity **Resources:** Activity Book, plasticine, toothpick, photographs of medical equipment like the stethoscope, sphygmomanometer, electrocardiograph and defibrillator 1. Show the pupils the photographs of medical equipment like the stethoscope, sphygmomanometer, electrocardiograph and defibrillator. Ask them whether they know the function of each medical equipment: • Stethoscope is used for listening to heart sounds and breathing. • Sphygmomanometer is used for measuring the blood pressure, which is the pressure wave that passes along the blood vessels when the heart beats. • Electrocardiograph is used for measuring the activity of the heart over time. • Defibrillator is used to restart the heart if it stops beating. 2. Inform the pupils that the heart is such an important organ that there are several equipment designed to check its activity, or in the case of the defibrillator, to restart it if it stops beating. 3. Ask the pupils to turn to Activity 3.2. Guide them to: • Carry out the procedures in small groups. • Discuss and fill in their best possible answers. 4. Ask the pupils to share their answers to Activity 3.2. 5. Correct and/or refine the pupils' answers to ensure that their answers are scientifically correct. 6. Lead the pupils to conclude that the heart rate changes with the type of activity. Inform them that it is also affected by age and health.	**Connection (Con2)** Pupils are directed towards areas and sources of scientific knowledge.
Evaluate (5th E) Assessment **Purpose:** To assess the pupils' understanding of the lesson **Resources:** Textbook, Activity Book, Homework Book, HOTS 1. 1. Ask the pupils to turn to Activity 3.3. Guide them to group into pairs to discuss and fill in their best possible answers. 2. Ask the pupils to share their answers to Activity 3.3. 3. Correct and/or refine the pupils' answers to ensure that their answers are scientifically correct. 4. Ask the pupils to read the Building block section on page 29 of the Textbook. Discuss with them the answers to the question posed. 5. Ask the pupils to draw arrows showing the links between the different body systems. 6. Reinforce the concept that different body systems work closely together to ensure that our body functions properly. 7. Conclude the lesson by emphasising the five essential learning points. 8. Ask the pupils to complete Systems Chapter 3 of the Homework Book. 9. Ask the pupils to try Systems Chapter 3 of the HOTS book.	**Communication (Com2)** Pupils are coached in the development of communication.

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Lesson 4.1: The unit of life (part one)

Textbook : Pages 32–34
Activity Book : Pages 17–18 (Activity 4.1)
Time required : Weeks 9 and 10, two periods

Essential learning points	Specific learning objectives in MY PALS ARE HERE!
• A cell is the smallest unit of life in the body. • Some living things like bacteria, yeast and paramecium are made up of only one cell. • Cells in an organism differ in shape, size and function. • Cells, which are of the same type, are grouped together to form tissue. • An organ is formed when several tissues work together to perform a special function.	• Recognise that a cell is the smallest unit of life in the body • List some organisms that are made up of only one cell • Recognise that the cells in an organism differ in shape, size and function • State the relationship between a cell, a tissue and an organ

Information Technology (IT)

Use of the Internet to gather information about cells

Engage (1st E) Use of an interesting question

Purpose: To introduce the concept of micro-organisms
Resources: Science journal, clear glass container containing pond water

1. Show the pupils a clear glass container containing pond water.
2. Pose the following question:
   - Are there any micro-organisms in the pond water? (Answer: Yes, there are micro-organisms found in the pond water.)

Feature of Science inquiry

Question (Q4)
Pupils engage in the question provided by the teacher, materials or other sources.

Evidence (Evi3)
Pupils are given data and asked to analyse.

Explore (2nd E) Guided inquiry

Purpose: To observe pond micro-organisms using a microscope
Resources: Activity Book, prepared slides, microscope

1. Inform the pupils that they will be using a microscope to observe pond micro-organisms.
2. Guide the pupils on how to use a microscope before distributing the prepared slides to them.
3. Ask the pupils to turn to Activity 4.1. Guide them to:
   - Carry out the procedures in small groups.
   - Discuss and fill in their best possible answers.
4. Inform the pupils of the identity of the micro-organisms that are found in the pond water.
5. Ask the pupils to share their answers to Activity 4.1.
6. Correct and/or refine the pupils' answers to ensure that their answers are scientifically correct.

Evidence (Evi2)
Pupils are directed to collect certain data.

Explain (3rd E) Teacher-directed discussion

Purpose: To recognise that micro-organisms can be made up of only one cell or a few cells
Resources: Science journal, Internet connection

1. Introduce to the pupils that a cell is the smallest unit of life and provide more examples of micro-organisms that are made up of only one cell.
2. Using the Internet, access the following website to show the pupils a video of micro-organisms that are made up of only one cell:
   - www.teachersdomain.org/resources/tdc02/sci/life/stru/singlecell/index.html
3. Highlight to the pupils that micro-organisms can be made up of only one cell or a few cells, unlike humans who are made up of millions of cells.
4. Pose the following question:
   - Can you name some types of cells found in our body? (Answer: Some types of cells found in our body include nerve cells, muscle cells, skin cells, red blood cells and white blood cells.)

Explanation (Exp3)
Pupils are given possible ways to use evidence to formulate explanation.

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Elaborate (4th E) Application to the real world

Purpose: To apply the concepts learnt to the cells found in the tissues and organs in our body

Resources: Science journal, photographs of different types of cells, Internet connection

1. Using the Internet, access the following websites to obtain photographs of different types of cells:
   - www.nrc-cnrc.gc.ca/eng/education/biology/gallery/index.html
   - www.emc.maricopa.edu/faculty/farabee/BIOBK/BioBookAnimalTS.html
   - www.teachersdomain.org/resources/tdc02/sci/life/cell/cellgallery/index.html
2. Show the pupils the photographs of different types of cells. Discuss with them their appearances and functions.
3. Lead the pupils to conclude that cells can differ in shape, size and function.
4. Select a human body system, such as the circulatory system, to discuss with the pupils the different types of cells present and their different functions, e.g. muscle cells in the heart, red and white blood cells in the blood.
5. Introduce to the pupils that cells of the same type group together to form a tissue and an organ is formed when several tissues work together to perform a special function.
6. Pose the following question:
   - Can you name some tissues and organs found in our body? (Answer: Some tissues and organs found in our body include nerve tissue, muscle tissue, brain, heart, lungs and stomach.)

Connection (Con2)
Pupils are directed towards areas and sources of scientific knowledge.

Evaluate (5th E) Assessment

Purpose: To assess the pupils' understanding of the lesson

Resources: Textbook, big sheet of paper

1. Write the following two terms, "SINGLE-CELLED" and "MANY CELLED", on the whiteboard.
2. Ask the pupils to classify different living things, such as bacteria, yeast, paramecium, fish, cat, algae, moss, rose plant and fern, according to the number of cells they are made up of. Correct and/or refine their classification on the whiteboard to ensure that their information is scientifically correct.
3. Group the pupils into small groups and ask each group to select a different human organ to research on. They should identify the cells and tissues that make up the organ they have selected.
4. Ask the pupils to become "knowledge experts" of the cells and tissues that make up the organ they have selected by gathering information from the Textbook and other sources.
5. Ask each group to present the cells and tissues that make up the organ they have selected using a poster that contains the information and supporting photographs or pictures.
6. Correct and/or refine the pupils' information on their posters to ensure that their information is scientifically correct.
7. Conclude the lesson by emphasising the five essential learning points.

Communication (Com1)
Pupils form reasonable and logical arguments to communicate explanations.

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Lesson 4.2: The unit of life (part two)

Textbook : Pages 35—38
Activity Book : Pages 19—26 (Activities 4.2, 4.3 and 4.4)
Time required : Weeks 10, 11 and 12, four periods

Essential learning points	Specific learning objectives in My Pals are Here!
• A plant cell has a nucleus, cytoplasm, cell membrane, chloroplasts and a cell wall. • An animal cell has a nucleus, cytoplasm and cell membrane. • An animal cell, unlike a plant cell, does not have chloroplasts and a cell wall. • New cells are produced to replace the dead or damaged cells and to enable living things to grow.	• Identify the parts of a plant cell and relate them to their function(s) • Identify the parts of an animal cell and relate them to their function(s) • Compare a plant cell and an animal cell • Show an understanding that new cells are produced to replace the dead or damaged cells and to enable living things to grow

Information Technology (IT)

Use of the Internet to gather information about the parts of a plant cell and an animal cell

National Education (NE)

Ask the pupils to find out how smoking can lead to cell damage, which may result in lung cancer

Engage (1st E) Use of an interesting activity

Purpose: To compare a plant cell and an animal cell
Resource: Photographs or pictures of a plant cell and an animal cell

1. Inform the pupils that they will be playing a game, "Spot the difference", with prizes to be won.
2. Show the pupils the photographs of a plant cell and an animal cell without identifying either of them.
3. Ask the pupils to list as many differences they can spot as possible.
4. Award the winning pupil with simple prizes, such as sweets or stationery.

Feature of Science inquiry

Question (Q4)
Pupils engage in the question provided by the teacher, materials or other sources.

Explore (2nd E) Guided inquiry

Purpose: To observe plant and animal cells using a microscope
Resources: Activity Book, Science journal, toothpick, glass slide, iodine solution, cover slip, forceps, Elodea plant, microscope, glass dropper

1. Guide the pupils to identify the parts of a microscope and how to use them.
2. Ask the pupils to turn to Activity 4.2. Guide them to:
   - Carry out the procedures in small groups.
   - Discuss and fill in their best possible answers.
3. Ask the pupils to share their answers to Activity 4.2.
4. Correct and/or refine the pupils' answers to ensure that their answers are scientifically correct.
5. Ask the pupils to turn to page 37 of the Textbook to compare their drawings with the diagrams of a plant cell and an animal cell.
6. Pose the following questions:
   - Can you name and identify the common parts of a plant cell and an animal cell? (Answer: The common parts of a plant cell and an animal cell are the nucleus, cytoplasm and cell membrane.)
   - What are the functions of the common parts of a plant cell and an animal cell? (Answer: The nucleus controls all the activities in the cell and contains genetic information that is passed on from one generation to the next. The cytoplasm is a jelly-like substance containing many cell parts that perform other functions. The cell membrane is a soft, thin membrane that surrounds the cytoplasm and controls the movement of substances into and out of the cell.)
   - Which of the cells is surrounded by a cell wall? (Answer: The plant cell is surrounded by a cell wall.)
   - Which of the cells contains green structures in the cytoplasm? (Answer: The plant cell contains green structures in the cytoplasm.)
   - What are the green structures called? (Answer: The green structures are called chloroplasts.)

Evidence (Evi2)
Pupils are directed to collect certain data.

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Explain (3rd E) Teacher-directed discussion **Purpose:** To gain a better understanding of plant and animal cells **Resources:** Textbook, Science journal, Internet connection 1. Ask the pupils to read pages 35—37 of the Textbook to understand more about plant cells and the parts of a plant cell and an animal cell. 2. Highlight to the pupils the key parts and functions of a plant cell and an animal cell. 3. Pose the following question: • Why do plant cells contain chloroplasts but animal cells do not? (Answer: Plant cells contain chloroplasts but animal cells do not because plant cells need to carry out photosynthesis.) 4. Ask the pupils to read the Building block section on page 38 of the Textbook. Discuss with them the answers to the question posed. 5. Inform the pupils that new cells are produced to replace the dead or damaged cells and to enable living things to grow. 6. Using the Internet, ask the pupils to access the following website to find out more about cell division: • www.aboutkidshealth.ca/HowTheBodyWorks/Cell-Division.aspx?articleID=10171&categoryID=XG-nh2	**Explanation (Exp3)** Pupils are given possible ways to use evidence to formulate explanation. **Explanation (Exp1)** Pupils formulate their own explanations after summarising the evidence.
Elaborate (4th E) Application to the real world **Purpose:** To observe leaf cells and apply the concepts learnt to make a cell model **Resources:** Activity Book, microscope, glass slide, cover slip, nail polish, leaf, forceps, resealable plastic bag, honey or syrup, assortment of edible objects to represent the parts of the cell 1. Ask the pupils to turn to Activities 4.3 and 4.4. Guide them to: • Carry out the procedures in small groups. • Discuss and fill in their best possible answers.	**Connection (Con1)** Pupils independently examine other resources and form the links to explanations.
Evaluate (5th E) Assessment **Purpose:** To assess the pupils' understanding of the lesson **Resources:** Activity Book, Homework Book, Tests, HOTS 1. Ask the pupils to share their answers to Activities 4.3 and 4.4. 2. Correct and/or refine the pupils' answers to ensure that their answers are scientifically correct. 3. Ask the pupils to draw a concept map to compare a plant cell and an animal cell and identify the similarities and differences between the two types of cells. 4. Conclude the lesson by emphasising the four essential learning points. 5. Ask the pupils to complete Systems Chapter 4 of the Homework Book. 6. Ask the pupils to attempt Test 2 of the Tests book. 7. Ask the pupils to try Systems Chapter 4 of the HOTS book.	**Communication (Com3)** Pupils are provided with broad guidelines used to sharpen communication.

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Lesson 5.1: Electric circuits

Textbook : Pages 40—45
Activity Book : Pages 27—30 (Activities 5.1 and 5.2)
Time required : Weeks 12, 13 and 14, four periods

Essential learning points	Specific learning objectives in My Pals are Here!
• An electric circuit is a system because it is made up of components that work together, such as a battery, wire, bulb and switch. • When the components are connected together, electricity flows along the circuit and is called an electric current. • The battery is the energy source and it drives an electric current through an electric circuit. • Electrical wires are used to connect one electrical component to another and allow an electric current to flow in a circuit. • In order for a bulb to light up, it has to be properly connected in a circuit. • A switch controls electric current flow in a circuit. • The different parts of a circuit are represented by different symbols. • To communicate what an electric circuit looks like, we use a circuit diagram to represent an actual electric circuit. • A circuit through which electric current can flow is called a closed circuit. • A circuit through which electric current cannot flow is called an open circuit.	• Recognise that an electric circuit is an electrical system because it is made up of components that work together, where each has its own function • Recognise that an electric current is a flow of electricity along an electric circuit • Identify the different components of an electric circuit and relate them to their function(s) • Communicate the set-up of an electric circuit through a circuit diagram, using the symbols of electrical components, such as a battery, wire, bulb and switch • Construct a simple electric circuit based on a circuit diagram • Differentiate between a closed circuit and an open circuit • Observe that an electric current flows only when an electric circuit is closed

Information Technology (IT)

Use of the Internet to gather information about electric circuits

National Education (NE)

Bring the pupils to the Singapore Science Centre's Amazing Electron Exhibition to learn more about different electronic devices and their applications

Engage (1st E) Use of an activity

Purpose: To raise the pupils' awareness of electrical appliances found around them
Resources: Science journal, stopwatch

1. Ask the pupils to list as many examples of objects found around them as they can, which require electricity to work, within one minute.
2. Identify the winning pupil who can list the most number of examples and ask him or her to read out the list.

Feature of Science inquiry

Question (Q4)
Pupils engage in the question provided by the teacher, materials or other sources.

Explore (2nd E) Guided inquiry

Purpose: To identify the electrical components in an electric circuit
Resources: Activity Book, Science journal, D-sized battery, wire, bulb, magnifying glass

1. Inform the pupils that an electrical appliance will work only when electricity passes through it.
2. Ask the pupils to identify the electrical components that make up the electric circuit in an electric torch.
3. Pose the following questions:
   - Which is the electrical component that gives off light? (Answer: The bulb gives off light.)
   - Which is the electrical component that provides energy for the electric torch to work? (Answer: The battery provides energy for the electric torch to work.)
   - Which is the electrical component that starts or stops the flow of electricity in the electric torch? (Answer: The switch starts or stops the flow of electricity in the electric torch.)
   - Which is the electrical component that connects all the other electrical components together? (Answer: The wire connects all the other electrical components together.)

Question (Q4)
Pupils engage in the question provided by the teacher, materials or other sources.

Evidence (Evi3)
Pupils are given data and asked to analyse.

Evidence (Evi2)
Pupils are directed to collect certain data.

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4. Lead the pupils to conclude that an electric circuit is a system because it is made up of components that work together to perform a function. 5. Ask the pupils to turn to Activity 5.1. Guide them to: • Carry out the procedures in small groups. • Discuss and fill in their best possible answers.	
Explain (3rd E) Teacher-directed discussion **Purpose:** To engage the pupils in the active independent learning of concepts related to an electric circuit **Resources:** Activity Book, Internet connection 1. Ask the pupils to share their answers to Activity 5.1. 2. Correct and/or refine the pupils' answers to ensure that their answers are scientifically correct. 3. Using the Internet, ask the pupils to access the following websites to find out more about electric circuits: • www.andythelwell.com/blobz • www.hyperstaffs.info/work/physics/child/index.html 4. Inform the pupils that different electrical components are represented by different symbols in a circuit diagram. 5. Explain to the pupils the concept of a closed circuit and an open circuit.	**Explanation (Exp3)** Pupils are given possible ways to use evidence to formulate explanation. **Explanation (Exp1)** Pupils formulate their own explanations after summarising the evidence.
Elaborate (4th E) Application to the real world **Purpose:** To familiarise the pupils with the concept of a closed circuit and an open circuit **Resource:** Photographs of actual set-ups of incomplete electric circuits or circuit diagrams 1. Show the pupils the photographs of actual set-ups of incomplete electric circuits or circuit diagrams. 2. Inform the pupils that the electric circuits shown do not allow an electric current to flow because they are incomplete, e.g. a bulb holder does not have a bulb attached, there is a gap in the electric circuit or a switch is opened. 3. Ask the pupils to identify the reason why there is no current flow for each incomplete electric circuit.	**Connection (Con3)** Pupils are given possible connections.
Evaluate (5th E) Assessment **Purpose:** To assess the pupils' understanding of the lesson **Resources:** Activity Book, D-sized battery, wire, wire with clips at the ends, bulb in a bulb holder, stiff cardboard, steel paper clip, masking tape, Homework Book, HOTS 1. Prepare an electric circuit by connecting actual electrical components and ask the pupils to draw a circuit diagram that corresponds to the set-up. 2. Ask the pupils to turn to Activity 5.2. Guide them to: • Carry out the procedures in small groups. • Discuss and fill in their best possible answers. 3. Ask the pupils to share their answers to Activity 5.2. 4. Correct and/or refine the pupils' answers to ensure that their answers are scientifically correct. 5. Conclude the lesson by emphasising the ten essential learning points. 6. Ask the pupils to complete Systems Chapter 5 of the Homework Book. 7. Ask the pupils to try Systems Chapter 5 of the HOTS book.	**Communication (Com1)** Pupils form reasonable and logical arguments to communicate explanations.

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Lesson 6.1: Using electricity — Number and arrangement of batteries and bulbs

Textbook : Pages 47–50
Activity Book : Pages 31–38 (Activities 6.1, 6.2 and 6.3)
Time required : Weeks 14, 15 and 16, four periods

Essential learning points	Specific learning objectives in My Pals are Here!
• When the positive terminal of one battery is in contact with the negative terminal of another battery, we say that these batteries are arranged in a series connection. • As the number of batteries increases, more electric current flows through the bulb and causes the bulb to light up more brightly. • However, if too many batteries are used, too much electric current flows and the bulb will blow, or we can say the bulb is fused. • When the bulbs are connected one after another in an electric circuit, we say that these bulbs are arranged in a series connection. • If more bulbs are connected in series without increasing the number of batteries, the brightness of the bulbs will decrease. • This is because of the decrease in the current flowing through the bulbs. • When the bulbs are connected such that an electric current flows along separate paths to each bulb, we say that these bulbs are arranged in a parallel connection. • The bulbs arranged in parallel light up more brightly than the bulbs arranged in series. • The bulbs arranged in parallel can work independently of one another. • The brightness of a bulb in a circuit depends on the amount of electric current flowing through it. • The amount of electric current flowing through the bulbs in a circuit is affected by the: — number of batteries; — number of bulbs; — arrangement of bulbs.	• Recognise that a series connection of batteries involves connecting the positive terminal of one battery to the negative terminal of another battery • Investigate how the number of batteries in an electric circuit can affect the brightness of a bulb • Recognise what a fused bulb is • Recognise that a series connection of bulbs involves connecting the bulbs one after another • Investigate how the number of bulbs in an electric circuit can affect their brightness • Recognise that a parallel connection of bulbs involves connecting the bulbs such that an electric current flows along separate paths to each bulb • Investigate how the arrangement of bulbs in an electric circuit can affect their brightness • Investigate which arrangement of bulbs in an electric circuit allows the bulbs to work independently of one another • List the factors that affect the brightness of a bulb in an electric circuit

Information Technology (IT)

Use of the Internet to gather information about the factors that affect the amount of electric current flowing through a circuit

	Feature of Science inquiry
Engage (1st E) Use of a scenario **Purpose:** To further develop the concept that a battery is a source of energy **Resource:** Science journal 1. Pose the following questions: • Why does a torch become dimmer when we leave it on for a very long period of time? (Answer: The amount of energy stored in the batteries in the torch is slowly being used up.) • What happens if we continue to use the torch when the batteries in it have very little energy? (Answer: The torch may eventually stop working.) • If the torch stops working, how can we solve the problem? (Answer: We can solve the problem by replacing the batteries or recharging the batteries if they are rechargeable.)	**Question (Q4)** Pupils engage in the question provided by the teacher, materials or other sources.
Explore (2nd E) Guided inquiry **Purpose:** To relate the battery to a water pump **Resource:** Science journal 1. Ask the pupils to compare the functions of a battery and a water pump. Some questions to elicit their responses include: • How can we make the water in a water hose flow faster? (Answer: We can use a water pump of greater power.)	**Question (Q4)** Pupils engage in the question provided by the teacher, materials or other sources. **Connection (Con3)** Pupils are given possible connections.

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• What will happen if we use a water pump that has too high a power? (Answer: If we use a water pump that has too high a power, the pressure produced may cause the water hose to burst.) • How can we make the bulb in an electric circuit shine brighter? (Answer: We can increase the power of the batteries or use more batteries.) • If we have more than one battery, how can we connect them to make the bulb shine the brightest? (Answer: If we have more than one battery, we can connect them in series to make the bulb shine the brightest.) • What will happen if we use too many batteries? (Answer: If we use too many batteries, the bulb may blow.)	
Explain (3rd E) Teacher-directed discussion **Purpose:** To find out how the number of batteries in an electric circuit can affect the brightness of a bulb **Resources:** Activity Book, D-sized battery in a battery holder, bulb in a bulb holder, wire, magnifying glass 1. Ask the pupils to turn to Activity 6.1. Guide them to: • Carry out the procedures in small groups. • Discuss and fill in their best possible answers. 2. Ask the pupils to observe whether the bulb will light up when two batteries are connected with their positive terminals facing each other. 3. Show the pupils what happens when four or more batteries are connected in series to a bulb. Ask them to observe the filament carefully after the bulb blows. 4. Ask the pupils to share their answers to Activity 6.1. 5. Correct and/or refine the pupils' answers to ensure that their answers are scientifically correct.	**Explanation (Exp1)** Pupils formulate their own explanations after summarising the evidence.
Elaborate (4th E) Application to the real world **Purpose:** To find out how the number and arrangement of bulbs in an electric circuit can affect their brightness **Resources:** Activity Book, Science journal, D-sized battery in a battery holder, bulb in a bulb holder, wire 1. Draw two circuit diagrams on the whiteboard, one with the bulbs connected in series and the other with the bulbs connected in parallel. 2. Explain to the pupils the concept of bulbs in series and in parallel. 3. Ask the pupils to turn to Activities 6.2 and 6.3. Guide them to: • Carry out the procedures in small groups. • Discuss and fill in their best possible answers. 4. Ask the pupils to share their answers to Activities 6.2 and 6.3. 5. Correct and/or refine the pupils' answers to ensure that their answers are scientifically correct. 6. Pose the following questions: • How is the brightness of bulbs affected when they are connected in series without increasing the number of batteries? (Answer: When the bulbs are connected in series without increasing the number of batteries, the brightness of the bulbs will decrease.) • How is the brightness of bulbs affected when they are connected in parallel without increasing the number of batteries? (Answer: When the bulbs are connected in parallel without increasing the number of batteries, the brightness of the bulbs will increase as compared to bulbs connected in series.)	**Explanation (Exp2)** Pupils are guided in the process of formulating explanations from evidence. **Connection (Con2)** Pupils are directed towards areas and sources of scientific knowledge.
Evaluate (5th E) Assessment **Purpose:** To assess the pupils' understanding of the lesson **Resource:** Textbook 1. Ask the pupils to read page 50 of the Textbook to find out more about how the arrangement of bulbs in an electric circuit can affect their brightness. Discuss with them the answers to the question posed. 2. Ask the pupils to read the Building block section on page 50 of the Textbook. Discuss with them the answers to the question posed. 3. Draw a circuit diagram on the whiteboard, with three bulbs connected in parallel, to represent the fluorescent lights in the classroom. 4. Ask the pupils to decide where switches can be inserted in the circuit diagram and support their decision with reasons. The switches should be inserted besides each bulb in the circuit diagram so that each bulb can be switched on and off independently and if one blows, the other bulbs can still function. 5. Conclude the lesson by emphasising the eleven essential learning points.	**Communication (Com1)** Pupils form reasonable and logical arguments to communicate explanations.

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Lesson 6.2: Using electricity — Saving energy

Textbook : Pages 51–52
Time required : Week 16, one period

Essential learning points	Specific learning objectives in My Pals are Here!
• Electricity is useful because it makes electrical appliances work. • Some common electrical appliances around us include the television set, air-conditioner, fan and computer. • Electricity is produced in a power station and reaches our homes through underground cables. • In Singapore, fuels like coal and oil are burnt in power stations to produce electricity. • Fuels will not last forever and burning fuels causes harm to the environment. • We can help to conserve electricity by switching off electrical appliances that are not in use.	• Identify electrical appliances that need electricity to work • Trace the source of electricity from an electrical appliance to a power station • Recognise the need to conserve electricity • List ways in which one can help to conserve electricity

Information Technology (IT)

Use of the Internet to gather information about the amount of electricity each electrical appliance in our homes consumes

National Education (NE)

- Ask the pupils to find out different ways to conserve electricity
- Bring the pupils to the Singapore Power Ltd headquarters to understand how electricity is brought to us and how we can use electricity efficiently
- Ask the pupils to write a report on the steps that they can take to conserve electricity at home in order to reduce their electricity bills

Engage (1st E) Use of an interesting question	Feature of Science inquiry
Purpose: To relate the power of an electrical appliance to the amount of electricity it consumes **Resource:** Science journal 1. Pose the following question: • Which electrical appliance in your home uses the most electricity? (Answer: Answer varies. The electrical appliance that has the highest power will consume the greatest amount of electricity, such as the air-conditioner.) 2. Inform the pupils that the higher the power of an electrical appliance (measured in watts), the greater the amount of electricity it will consume.	**Question (Q4)** Pupils engage in the question provided by the teacher, materials or other sources.
Explore (2nd E) Guided inquiry **Purpose:** To compare the power of different electrical appliances **Resource:** Internet connection 1. Using the Internet, ask the pupils to access the following website to find out more about the power of different electrical appliances: • www.southerncompany.com/learningpower/energyuse.asp 2. Inform the pupils that an air-conditioner has an average power of 800 watts and advise them to use less of the air-conditioner to conserve electricity.	**Evidence (Evi2)** Pupils are directed to collect certain data.
Explain (3rd E) Teacher-directed discussion **Purpose:** To reinforce the usefulness and importance of electricity **Resources:** Textbook, Science journal 1. Discuss with the pupils the frequency of usage, duration of usage and the energy consumption of different electrical appliances. 2. Ask the pupils to imagine what it would be like if there were no electricity in the whole of Singapore and write a story in their journal. 3. Read the most interesting and scientifically accurate journal entry to the class. 4. Ask the pupils to read page 51 of the Textbook to understand how we get our electricity.	**Explanation (Exp2)** Pupils are guided in the process of formulating explanations from evidence.

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Elaborate (4th E) Application to the real world **Purpose:** To develop a better understanding of how electricity is produced **Resources:** Textbook, Science journal, Internet connection 1. Using the Internet, ask the pupils to access the following website to find out more about the production of electricity in power stations: • www.southerncompany.com/learningpower/powerinfo.asp 2. Ask the pupils to read page 52 of the Textbook to understand that electricity is produced in power stations in Singapore by burning fuels, such as coal and oil. 3. Pose the following question: • What is likely to happen if we continue to produce electricity by burning fuels? (Answer: If we continue to produce electricity by burning fuels, we may run out of fuels and also cause air pollution.) 4. Discuss with the pupils some possible ways to conserve electricity at home, such as buying energy efficient electrical appliances and switching off electrical appliances that are not in use, instead of leaving them switched on or in the standby mode.	**Connection (Con3)** Pupils are given possible connections.
Evaluate (5th E) Assessment **Purpose:** To assess the pupils' understanding of the lesson **Resources:** Homework Book, HOTS 1. Challenge the pupils to organise a "Save electricity" campaign at home. 2. Ask the pupils to submit their electricity bills for two consecutive months, one for the month before the campaign and the other for the month after the campaign. 3. Identify the winning pupil, who should have the greatest difference in his or her electricity bills. 4. Award the winning pupil with simple prizes, such as sweets or stationery. 5. Ask the pupil to share his or her method of saving electricity at home. 6. Conclude the lesson by emphasising the six essential learning points. 7. Ask the pupils to complete Systems Chapter 6 of the Homework Book. 8. Ask the pupils to try Systems Chapter 6 of the HOTS book.	**Communication (Com1)** Pupils form reasonable and logical arguments to communicate explanations.

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Lesson 7.1: Conductors of electricity

Textbook : Pages 54–56
Activity Book : Pages 39–41 (Activity 7.1)
Time required : Week 17, two periods

Essential learning points	Specific learning objectives in My Pals are Here!
• Materials, such as metals, which allow electric current to flow through easily are called electrical conductors. • Materials, such as glass, wood and plastic, which do not allow electric current to flow through easily are called electrical insulators. • Metal is a good conductor of electricity, as well as heat. • A circuit tester can help to distinguish electrical conductors from electrical insulators. • Electricity is useful to us. • However, it can cause us harm if we are not careful when using it. • Never touch switches with wet hands. • When using electrical tools, make sure they have plastic or wooden handles. • Do not put too many plugs into one socket (overloading). • Check electrical appliances regularly for exposed wires. • Never repair any electrical equipment yourself.	• Recognise that an electrical conductor is a material that allows electric current to flow through easily • Recognise that an electrical insulator is a material that does not allow electric current to flow through easily • Recognise that metal is a good conductor of electricity, as well as heat • Construct a circuit tester to distinguish between electrical conductors and insulators • Classify different materials as electrical conductors or insulators • Recognise the need to handle electricity and electrical appliances safely • Communicate the ways in which one can handle electricity and electrical appliances safely

Information Technology (IT)

Use of the Internet to gather information about electrical conductors and insulators

National Education (NE)

Ask the pupils to design a poster to encourage the safe use and handling of electricity and electrical appliances

Engage (1st E) Use of a scenario

Purpose: To stimulate the pupils to think by giving them a problem to solve
Resources: Science journal, D-sized battery in a battery holder, bulb in a bulb holder, wire

1. Prepare an electric circuit by connecting a battery and a bulb in series. Leave a gap between the ends of two wires to create two contact points.
2. Show the pupils the electric circuit and inform them that the wires used were too short and the bulb cannot light up because of the open circuit.
3. Ask the pupils to think of ways to solve the problem. Some questions to elicit their responses include:
   - What can you use to close the electric circuit? (Answer: An electrical conductor can be used to close the electric circuit.)
   - What types of materials can you use to close the electric circuit? (Answer: Metals can be used to close the electric circuit because they are electrical conductors.)

Explore (2nd E) Guided inquiry

Purpose: To find out the materials that allow electricity to pass through
Resources: Activity Book, D-sized battery in a battery holder, bulb in a bulb holder, wire, common objects in the classroom

1. Ask the pupils to turn to Activity 7.1. Guide them to:
   - Carry out the procedures in small groups.
   - Discuss and fill in their best possible answers.
2. Ask the pupils to share their answers to Activity 7.1.
3. Correct and/or refine the pupils' answers to ensure that their answers are scientifically correct.

Feature of Science inquiry

Question (Q4)
Pupils engage in the question provided by the teacher, materials or other sources.

Evidence (Evi2)
Pupils are directed to collect certain data.

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Explain (3rd E) Teacher-directed discussion

Purpose: To distinguish between electrical conductors and insulators
Resource: Textbook

1. Ask the pupils to read page 55 of the Textbook to understand what electrical conductors and insulators are.
2. Explain to the pupils that electrical conductors allow an electric current to flow through easily and can close an electric circuit. When an electrical insulator is used, an electric current does not flow through easily and the electric circuit is open.
3. Highlight to the pupils that metals are good electrical conductors, while glass, wood and plastic are electrical insulators.

Explanation (Exp3)
Pupils are given possible ways to use evidence to formulate explanation.

Elaborate (4th E) Application to the real world

Purpose: To apply the concepts learnt to the safe use of electricity
Resource: Science journal

1. Pose the following question:
   - Why is it important to distinguish between materials that are electrical conductors and materials that are electrical insulators? (Answer: It is important to distinguish between materials that are electrical conductors and materials that are electrical insulators because the information can keep us safe when using electricity.)
2. Inform the pupils that an electrical insulator, such as plastic, is often used to make safety plugs and sockets to prevent harm to anyone who touches them. An electrical conductor, such as a metal object or a wet body part, can cause a serious electric shock to a person touching a socket with it. Objects we use in our daily lives, such as hair dryers and extension cords, are often covered with plastic or rubber to insulate us against electricity and prevent an electric shock.
3. Discuss with the pupils examples of accidents that result due to the unsafe use of electricity.

Connection (Con2)
Pupils are directed towards areas and sources of scientific knowledge.

Evaluate (5th E) Assessment

Purpose: To assess the pupils' understanding of the lesson
Resources: Textbook, Activity Book, big sheet of paper, Homework Book, Tests, HOTS

1. Ask the pupils to read the Explore section on page 56 of the Textbook. Discuss with them the answers to the question posed.
2. Ask the pupils to design and present a poster to show the "do's and don'ts" when handling electricity.
3. Correct and/or refine the pupils' information on their posters to ensure that their information is scientifically correct.
4. Conclude the lesson by emphasising the eleven essential learning points.
5. Ask the pupils to complete Systems Chapter 7 of the Homework Book.
6. Ask the pupils to complete Systems Revision Exercise of the Activity Book.
7. Ask the pupils to attempt Test 3 and Thematic assessment 1 of the Tests book.
8. Ask the pupils to try Systems Chapter 7 of the HOTS book.

Communication (Com1)
Pupils form reasonable and logical arguments to communicate explanations.

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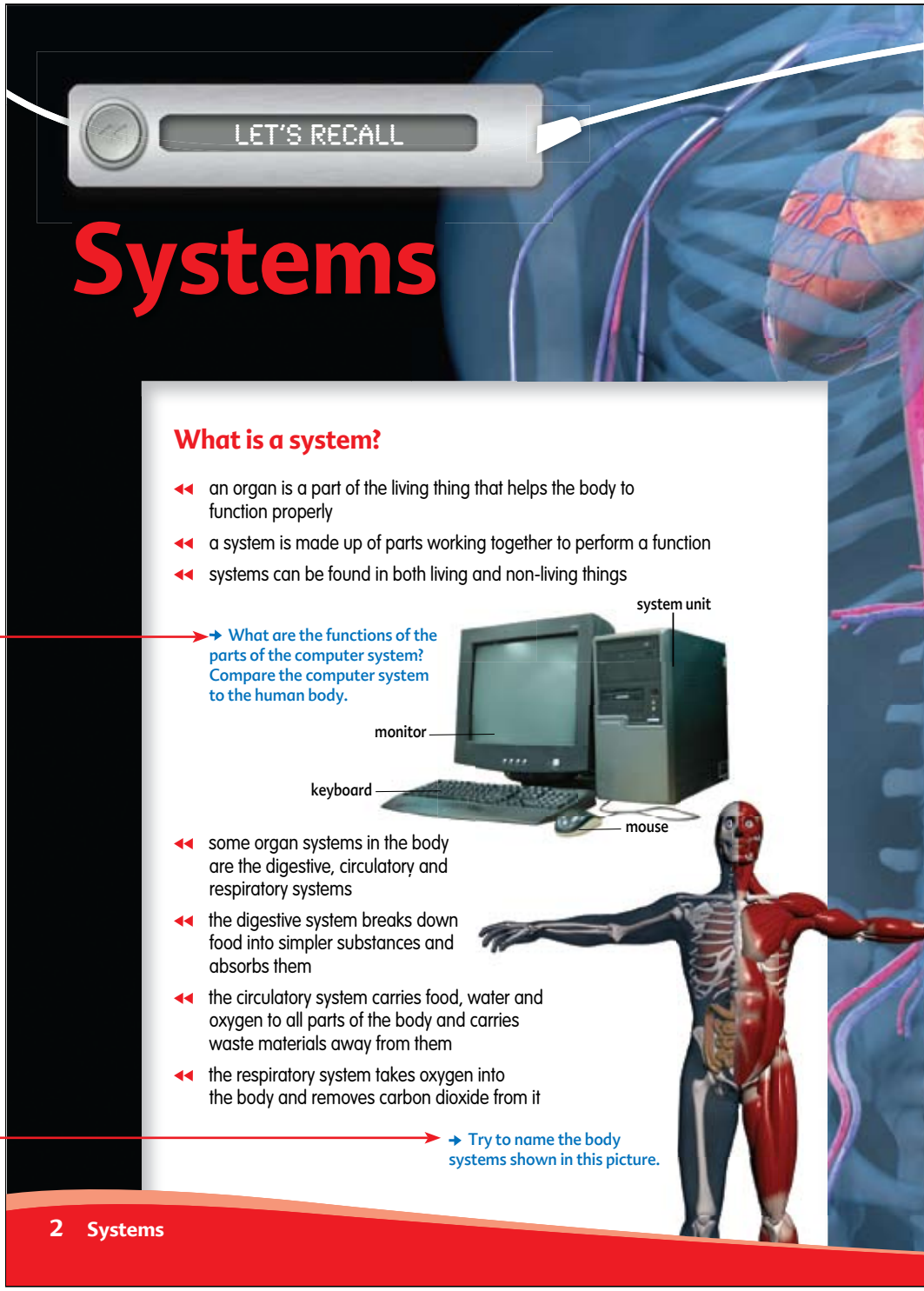

The monitor allows the user to view data that is keyed in using the keyboard and data that is stored in the system unit. The mouse allows the user to manoeuvre and select his or her choice of data. The computer system is made up of several parts, including electrical parts, which work together to perform a function. Likewise, a human body is made up of parts that work together to allow us to carry out life processes.

Digestive, respiratory, skeletal and muscular systems.

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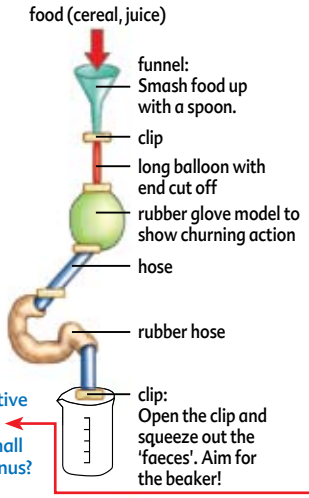
The digestive system

- the food that you eat must be digested before your body can use it
- when food is digested, it is broken down and changed into a simpler form
- digestion takes place in the organs such as mouth, stomach and small intestine
- the digested food is absorbed into the blood through the walls of the small intestine
- the large intestine absorbs water
- undigested food is passed out as waste through the anus

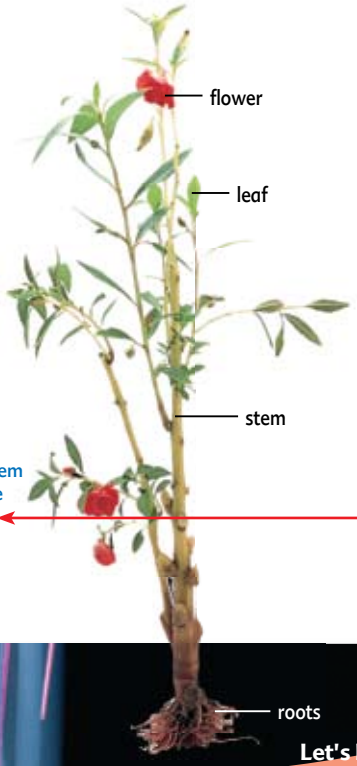


→ Here is a model of the digestive system. Which parts represent the mouth, gullet, stomach, small intestine, large intestine and anus?

Mouth — funnel
Gullet — long balloon
Stomach — rubber glove model
Small intestine — hose
Large intestine — rubber hose
Anus — clip after the rubber hose

Plants and their parts

- roots, stems and leaves are organs that make up the main parts of a plant
- leaves make food for the plant
- generally, the stem supports the plant, and carries food, water and mineral salts to all parts of the plant
- generally, roots hold the plant firmly to the ground and absorb water and mineral salts from the soil



→ The main parts of a plant system are the leaf, stem, flower and the roots. What are these parts for?

Leaf — chlorophyll in the leaf traps light energy and allows the plant to make food.
Stem — transports water and mineral salts from the roots to other parts of the plant. The stem also supports the plant and holds it upright so that the leaves can get sunlight to make food.
Flower — turns into a fruit, which contains seeds that grow into new plants to ensure the continuity of the plant.
Roots — hold a plant firmly to the ground. They also absorb water and mineral salts for the plant.

Let's Recall 3

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Introducing the theme

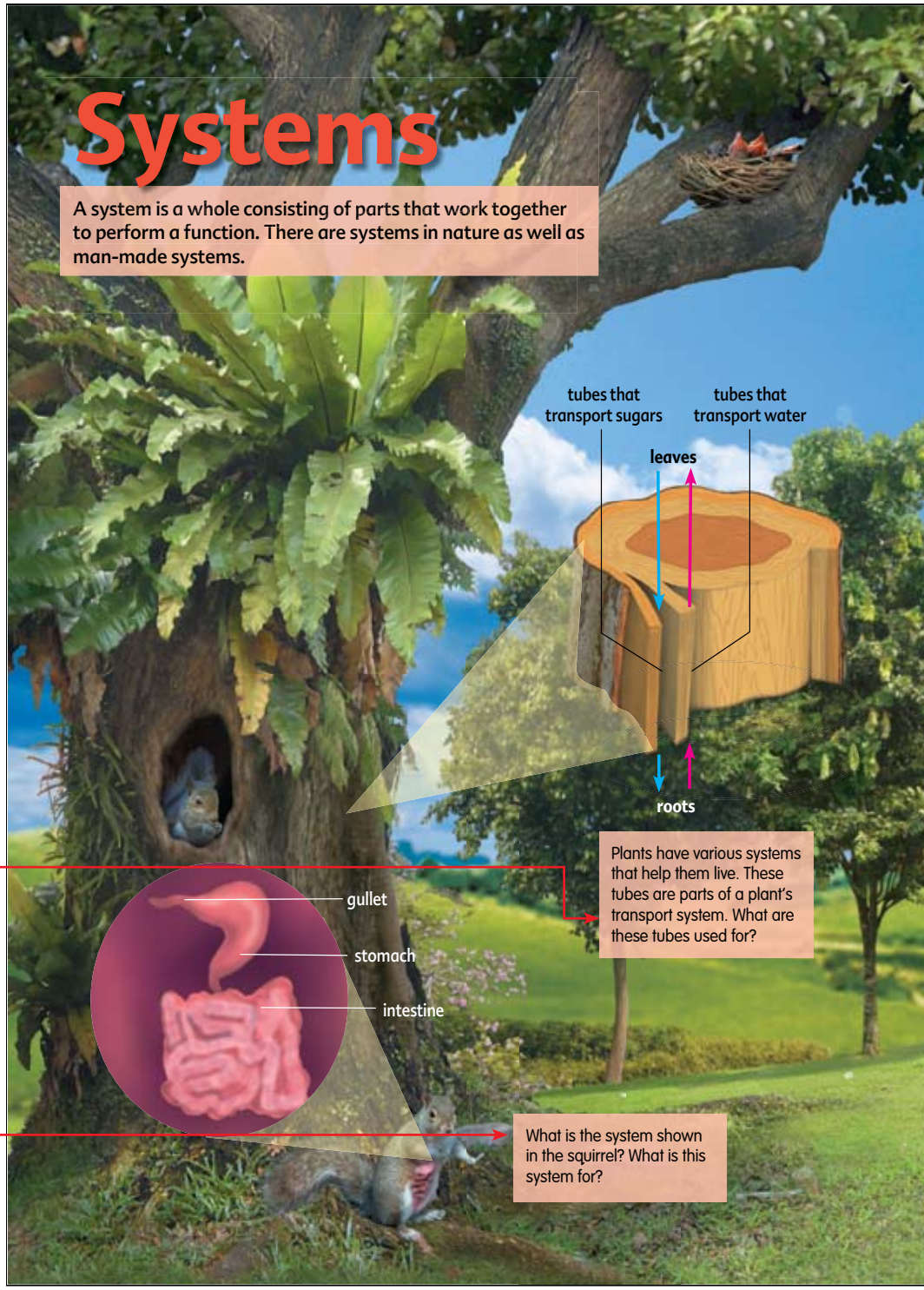
To appreciate this theme, pupils should be introduced to the concept of systems at grade-appropriate level.

Pre-lesson preparation
Prepare parts of an object, for example a mechanical pencil or a table fan, to explain how the parts work together to perform a function.

Enrichment

In this picture, the examples of systems are:

Systems in nature	Man-made systems
Transport system in the tree, digestive system in the squirrel, respiratory system in the bird	Electrical system on the bicycle, sunglasses on the cyclist, helmet on the cyclist



The food-carrying tubes transport food made in the leaves to other parts of the plant. The water-carrying tubes transport water and mineral salts from the roots to other parts of the plant.

The system shown is the digestive system. This system breaks down the food that the squirrel eats into simple substances that can be used by the body.

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Introducing the theme

To appreciate this theme, pupils should be introduced to the concept of systems at grade-appropriate level.

Pre-lesson preparation
Prepare a picture of a person riding on a bicycle (similar to the one found on the theme page).

Activity
1. Show the pupils the picture of a person riding on a bicycle (to ride a bicycle into the classroom, if you can get hold of one, would definitely be more attention-grabbing.)
2. Ask the pupils to name the systems they can see (Answers include the person, the helmet (if the cyclist is wearing one) and the bicycle).
3. Ask the pupils why they are systems. Reinforce the concept that a system is made up of parts that work together to perform a certain function.
4. Group the pupils and get them to discuss the parts that make up a bicycle and their functions. (Main parts include handlebar, frame, bell, braking system, seat, wheels, chain and lights.)
5. Ask whether any of the pupils have experienced the bicycle chain coming loose while cycling. If there are pupils who raise their hands, ask whether their bicycles can carry on moving forward. Explain to the pupils that the bicycle chain is part of the system that transfers power from the pedals to the drive-wheel of the bicycle, thus propelling it. When it comes loose, the bicycle cannot perform its function of transporting its rider.
6. Ask the pupils to read the Theme Page and point out the rest of the systems. Lead the pupils to conclude that systems can be living or non-living.

Other electrical systems include the toaster, torchlight, fan, computer and table lamp.

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Background information for teachers

Mineral salts are taken up by the roots in soluble form. When mineral salts dissolve in water, they separate into particles called ions. Some of the ions travel by diffusion into the roots; others are absorbed by active transport. The minerals required in the greatest amounts are those containing the element nitrogen, for example nitrates, which are a key component of inorganic fertilisers. A plant uses nitrates in the production of proteins such as enzymes, so they are important for plant growth. However, nitrates are often in short supply in the soil, which is why inorganic fertilisers are required. Plants also require phosphates to make ATP (the substance that stores energy in cells), potassium salts to enable the transfer of mineral salts across cell membranes and magnesium to make chlorophyll.

1 The plant transport system

Let's find out:

A. What are the parts of the plant transport system?
B. How are water, mineral salts and sugar transported in a plant?

Plants require water, oxygen and sunlight to survive. Without water, plants will become weaker and eventually die. Plants are an important form of life on Earth because all animals are directly or indirectly dependent on plants for their survival.

- Can a tree survive without a transport system?
- Why should we water a plant near its roots instead of its leaves?
- How do water and mineral salts get to the leaves and other parts of a plant?

No.

Roots absorb water from the soil and transport it to other parts of a plant.

Water and mineral salts are absorbed by the roots and transported to other parts of a plant through the stem.

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Common misconceptions

1. Misconception: Food is made and stored only in the leaves.
Actual fact: Food in the form of glucose is made in the leaves and sent to all parts of the plant. The glucose is then transported through tubes in the leaf to other parts of the plants. Some of the sugar is used immediately by the plant for energy; some is built into a more complex substance, like plant tissue or cellulose. Plants often produce more food than they need, which they store in stems, roots, seeds or fruit.

Enrichment

We need nutrients, which we obtain from the food and supplements we consume in order to stay healthy. Plants also need a number of nutrients for healthy growth. These nutrients are absorbed as mineral salts dissolved in the water, which plants take in through their roots. The most important of these mineral salts are nitrates, phosphates and potassium salts.

A. The plant transport system

Which parts of the plant help to transport substances absorbed by the roots?

The water-carrying tubes of the plant help to transport substances absorbed by the roots.

Link

Cycles
During photosynthesis, the leaves of plants make food in the presence of sunlight using water which is taken in by the roots, and carbon dioxide which is taken in from the air by the leaves.

Plants have special tubes that carry different substances to the parts that need them.

The leaves of plants make food during photosynthesis. The food is used by plant parts such as the roots, the stem, the flowers and the fruits.

Plants need water and mineral salts from the ground as well. These are taken in through the roots and are needed to help plants stay healthy.

Explore

Getting to the root!
Put a few drops of red food colouring into a beaker of water. Stir the solution well. Cut off a small section, about 3 cm away, from the end of a celery. Place the celery, with the cut end facing downwards, into the beaker of coloured solution. Leave it to stand for a few hours and observe the cut end after that. What do you see when you look at the cut end? What does this show?

The cut end will have spots of red ink. This shows that the water-carrying tubes in the celery have transported the red coloured solution from the beaker to all parts of the celery.

Building Block

Why do plants need a transport system?

Plants need water for photosynthesis, as well as mineral salts to stay healthy. These can only be transported by the water-carrying tubes, which link the roots to all parts of the plant. Food made in the leaves needs to be transported to the other plant parts to ensure the survival of the plant. This can only be transported by the food-carrying tubes.

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Background information for teachers

A vascular plant is one with a vascular system made up of vascular tissues, such as xylem and phloem. There are some non-vascular plants, such as algae, mosses and liverworts. These plants have no true roots, stems and leaves. Due to a lack of roots and stems, these plants cannot reach water under the soil and actively take it up. They absorb water directly through their cell walls and the water moves from cell to cell via osmosis. These plants are usually small in size and close to the ground because they cannot transport water and food very far against gravity.

Celery stalk A tastes sweet, while celery stalk B tastes salty.

The sugar and salt had travelled up the water-carrying tubes to reach other parts of the plant. (Pupils are asked to find out which tubes the salt and sugar had travelled in. This can be seen by repeating the activity, this time using water with some food colouring. In this way, the tubes can be seen.)

The food-carrying tubes transport sugar made in the leaves to other parts of the plant. The water-carrying tubes transport water and mineral salts from the roots to the other parts of the plant.

Tube B, because sugar is food and is carried in the food-carrying tubes, which are found on the outer side/ring.

Explore

Celery with different tastes
Dissolve some sugar in a glass of water. Put in a stalk of celery and label it as set-up A. Next, dissolve some salt in another glass of water. Put another stalk of celery in this glass and label it as set-up B. After a few hours, cut a section from each celery stalk.

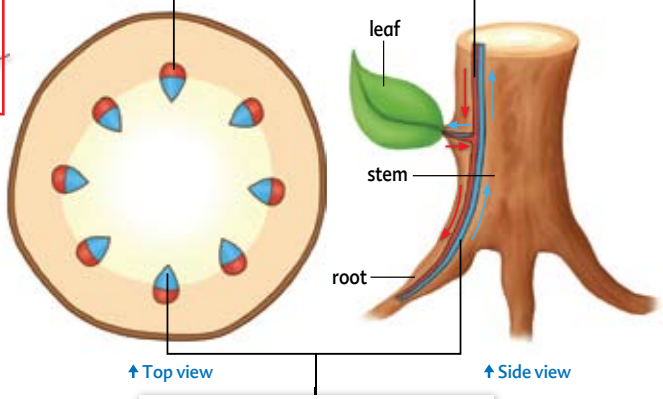
Try tasting a piece from celery stalk A and a piece from celery stalk B. How do they taste? Find out which tubes the sugar and salt had travelled in to reach other parts of the plant?

B. Tubes for transporting

Like animals, plants also have a **transport system**. A plant's transport system is made up of two separate sets of fine tubes that run through the leaves, stems and roots.

What are the functions of the different tubes in the plant transport system?

Food-carrying tubes
This set of tubes transports sugar made in the leaves to other parts of the plant.

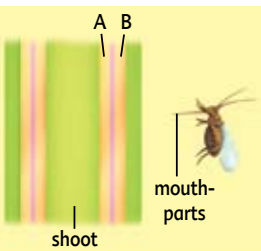


Water-carrying tubes
This set of tubes transports water and mineral salts from the roots to the other parts of the plant.

Building Block

An insect feeds from the shoot of a plant as shown.

Which set of tubes, A or B, must the insect's mouthparts enter to obtain sugar? Why?



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Enrichment

Xylem is made up of a set of thick-walled vessels (water-carrying) that are connected end to end. They also provide support for the plant. When an old tree is cut down, a set of rings is observed in the cross-section. These rings are the remains of old xylem tissues, one ring for every year the tree was alive. Phloem (food-carrying) tissue, unlike xylem tissue, is always alive.

Common misconceptions

1. **Misconception:** Xylem and phloem are found only in the stem.
   Actual fact: Xylem and phloem are found in different parts of the plant, in leaves, flowers and roots. This ensures that water and food will also reach the plant cells in these parts of the plant.

The water-carrying tubes

How do plants transport the useful materials absorbed by the roots to all parts of the plant?

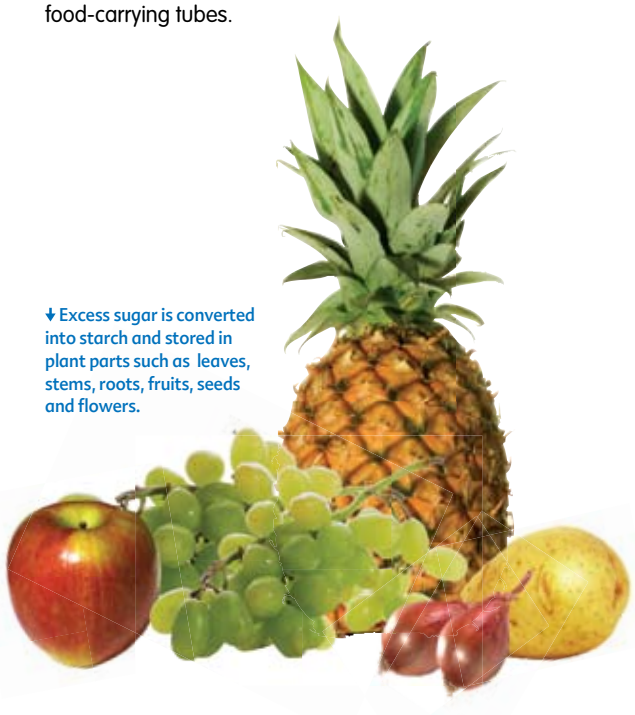
The water-carrying tubes of plants transport water and dissolved substances from the roots, up the stem, to the leaves and even the petals of flowers.

From the experiment on the right, we can see where the water-carrying tubes of a plant are.

The food-carrying tubes

Where is the food made in the leaves stored? What are some examples of leaves, stems, roots, fruits and seeds that store food?

Plants make sugar during the process of photosynthesis. Plants make use of this sugar for their life processes. Excess sugar is transported to different parts of a plant through the food-carrying tubes.



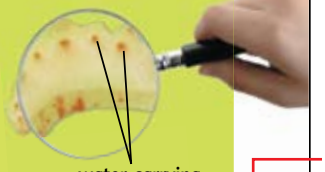
↓ Excess sugar is converted into starch and stored in plant parts such as leaves, stems, roots, fruits, seeds and flowers.

Explore

Fill a glass with water mixed with red food colouring and place a few stalks of celery in the glass. Leave the set-up aside for a few hours. What do you think will happen to the celery stalks and leaves?

After a few hours, you will find that parts of the celery stalks are stained with the food colouring. The water-carrying tubes in the stalks have transported the coloured water through the stems to the leaves.

You can see the water-carrying tubes by examining a cross-section of a stalk of celery with a magnifying glass.



water-carrying tubes stained red

You will see red spots on the cross-section of the celery.

From this activity, what can you infer about one function of stems?

Activities 1.1 and 1.2

Plants transport the useful substances through the water-carrying tubes that run from the roots through the stem to all parts of the plant.

The celery stalks and leaves will be coloured red.

Stems have water-carrying tubes that carry water and dissolved substances from the roots or base of the stem to all parts of the plant.

The food made in the leaves is stored in plant parts, such as leaves, stems, roots, fruits and seeds.

- Examples of leaves: lettuce, spinach, cabbage
- Examples of stems: sugar cane, stems of vegetables like cai xin or kang kong
- Examples of roots: radish, carrot, tapioca, sweet potato
- Examples of fruits: all types of fruits
- Examples of seeds: all types of seeds

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Concept map

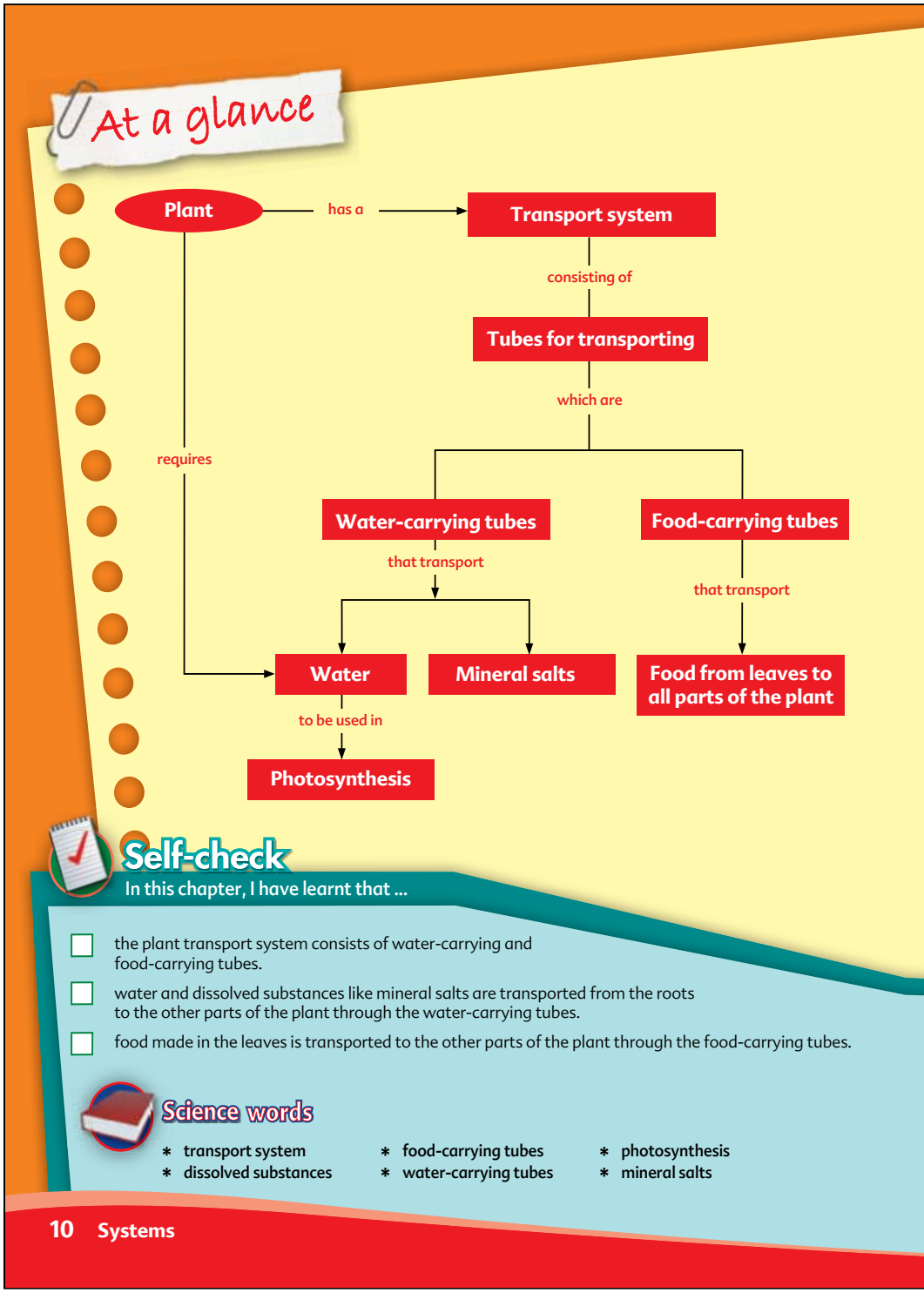
Gives an overview of the concepts learnt in this chapter. Words in the boxes can also act as keywords to help pupils understand the link between different concepts within a chapter.

Self-check

Helps pupils to reinforce what they have learnt in the chapter and address syllabus requirements.

Science words

Words introduced in this chapter. These words can also be used as spelling words.



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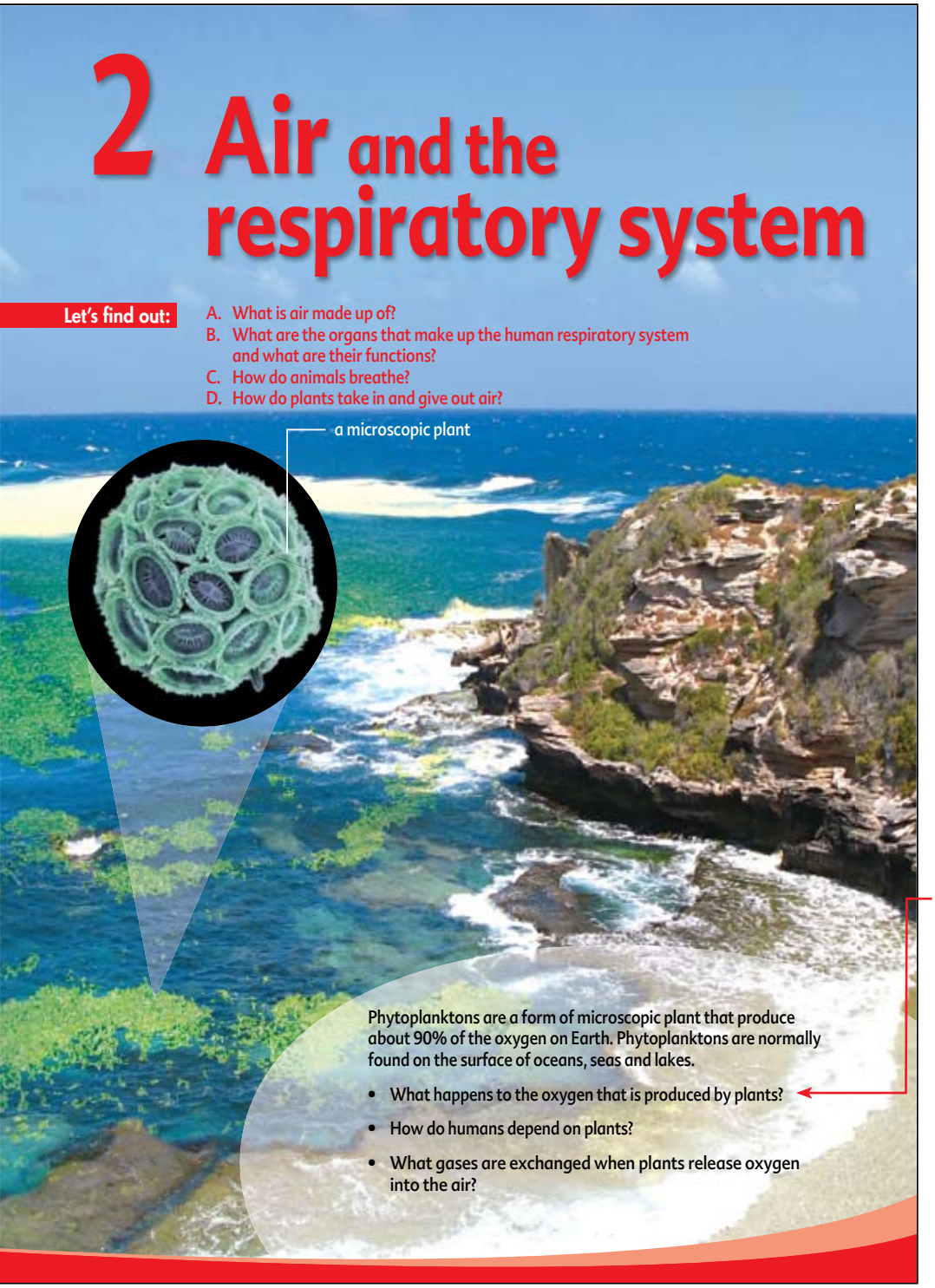
Background information for teachers

Phytoplankton are the producers in aquatic food chains and food webs. Most phytoplankton are single-celled organisms that carry out the process of photosynthesis, although some may be multi-cellular or filamentous. As phytoplankton need sunlight for the process of photosynthesis, they are often found nearer the well-lit surface of an ocean, sea or lake.

2 Air and the respiratory system

Let's find out:

A. What is air made up of?
B. What are the organs that make up the human respiratory system and what are their functions?
C. How do animals breathe?
D. How do plants take in and give out air?



Phytoplanktons are a form of microscopic plant that produce about 90% of the oxygen on Earth. Phytoplanktons are normally found on the surface of oceans, seas and lakes.

- What happens to the oxygen that is produced by plants?
- How do humans depend on plants?
- What gases are exchanged when plants release oxygen into the air?

The oxygen produced by plants is taken in by all living things on Earth.

Humans give out carbon dioxide when they breath. Plants take in this carbon dioxide during photosynthesis and produce oxygen that is essential for the survival of humans.

Plants take in carbon dioxide in exchange for the oxgen that they produce.

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Background information for teachers

Global warming, a recent warming of the Earth's lower atmosphere, is believed to be the result of increased concentrations of greenhouse gases in the atmosphere, causing a greenhouse effect (a process in which the emission of infrared radiation by the atmosphere warms a planet's surface).

Greenhouse gases are the gases present in the Earth's atmosphere which reduce the loss of heat into space. Greenhouse gases are essential to maintaining the temperature of the Earth; without them, the planet would be so cold as to be uninhabitable. However, an excess of these can raise the temperature of a planet to dangerous levels. The most important greenhouse gases are:

- Water vapour, which causes about 36–70%;
- Carbon dioxide, which causes 9–26%;
- Methane, which causes 4–9%;
- Ozone, which causes 3–7% of the greenhouse effect on Earth.

They are oxygen, nitrogen, carbon dioxide, water vapour and other gases (such as rare gases like argon, krypton, neon, helium and radon).

An astronaut gets his supply of air from the oxygen tank attached to his space suit.

↑ There is no air in outer space. How does an astronaut in space get his supply of oxygen?

A. All mixed up!

Living things are able to survive on Earth because there is air around it. Air contains different types of gases that are needed for life. Do you know what the different types of gases are?

Oxygen
Living things on land take in oxygen from the air around them. In addition, oxygen dissolves in water. Animals and plants that live in water take in this oxygen. Oxygen is also found in the soil. Animals living in the ground and roots of plants are able to use the oxygen in the soil.

Oxygen is also needed for burning. When we light a candle, burn a piece of paper or set fire to wood, oxygen is used up. A continuous supply of fresh air, rich in oxygen, is needed to keep things burning.

Water vapour in the air we breathe out creates the "mist" as it condenses in the cold air.

↑ What is present in the air which we breathe out that creates this mist?

Carbon dioxide, water vapour and other gases
When living things breathe or when things burn, oxygen is used up and carbon dioxide is produced. Carbon dioxide is important to plants. During the day, plants use carbon dioxide and water to make food during a process called **photosynthesis**. Oxygen is produced at the same time.

The gases include car exhaust (carbon monoxide) and other air pollutants like sulphur dioxide, hydrogen sulphide, nitrogen monoxide, nitrogen dioxide, ammonia and methane.

↑ What gases are being added to the air around us every day?

Xtra

The Earth's gravity keeps the layer of air that surrounds Earth from flinging off while Earth is rotating. The layer of air closest to Earth is called the troposphere which stretches to a height of about 10 to 15 km. This area supports all the life on Earth and is responsible for the weather that we experience.

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Enrichment

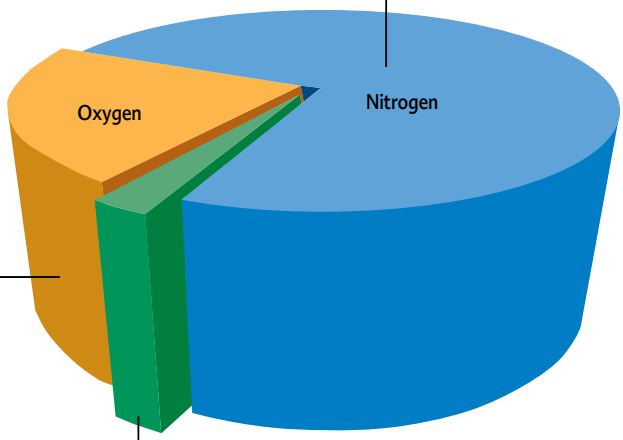
Air pollution is the human introduction into the atmosphere of chemicals. Major air pollutants produced by human activity include:

- Sulphur oxides, especially sulphur dioxide, emitted from burning of coal and oil.
- Nitrogen oxides, especially nitrogen dioxide, emitted from high temperature combustion.
- Carbon monoxide emitted mainly in vehicle exhaust.
- Particulate matter (PM), measured as smoke and dust.
- Chlorofluorocarbons (CFCs) emitted from products currently banned from use due to its harm to the ozone layer.
- Ammonia emitted from agricultural processes.
- Odours from garbage, sewage and industrial processes.
- Radioactive pollutants produced by nuclear processes.

Enrichment

The Earth's atmosphere is a layer of gases surrounding the Earth that is retained by the Earth's gravity. The atmosphere protects life on Earth by absorbing harmful ultraviolet radiation and reducing temperature extremes between day and night. Besides nitrogen, oxygen, carbon dioxide and water vapour, air also contains 0.93% argon and other rare gases (neon, helium, krypton and xenon), hydrogen, methane and nitrous oxide.

Nitrogen
Nitrogen makes up about four-fifths of the air.



Building Block

If there are several people trapped in a lift for 45 minutes, and there is no fresh air entering the lift during this period of time, predict whether the amount of the following gases in the lift will increase, decrease or remain the same.

- Oxygen
- Water vapour
- Carbon dioxide

Oxygen will decrease.
Water vapour will increase.
Carbon dioxide will increase.

Xtra

Composition of air	
Nitrogen	78%
Oxygen	21%
Carbon dioxide, water vapour and other gases	1%

- On average, we breathe 18 times a minute. We breathe more than 25 000 times a day.
- The size and shape of our lungs are not the same. The right lung is broader with three lobes. The left lung has only two lobes. The left lung is also smaller to allow space for our heart which lies more to the left side of our chest.

The mixture of **nitrogen**, **oxygen**, **carbon dioxide**, **water vapour** and **other gases** is called **air**. When air moves, it is called **wind**.

How much air can your lungs hold?

Air can be mixed with harmful gases and particles. How does a face mask help us breathe cleaner air?

A face mask blocks out harmful gases and prevents particles like soot, ash and dirt from being breathed in.

How much air your lungs can hold depends on your age, health and the activity you are doing. It can be between 1 to 1.5 litres of air.

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Enrichment

What are some common medical conditions that affect the lungs? Access the Internet to find out more about asthma, bronchitis and pneumonia: www.medicinenet.com/lungs/focus.htm.

Asthma results in breathing difficulties due to a chronic inflammation of the bronchi. The bronchi swell and narrow (constrict), reducing the diameter of the respiratory tract. They may be extremely sensitive to allergens (specific triggers) or irritants (non-specific triggers). For some sensitive individuals, their bronchi are more likely to swell and narrow, when exposed to triggers or even exercise.

Bronchitis is a respiratory disease, where the mucous membrane in the bronchioles becomes inflamed. As the mucous membrane swells and thickens, it becomes more narrow and may close off the respiratory tract leading to the air sacs in the lungs. This can result in coughs that are accompanied by breathlessness and thick phlegm.

Pneumonia is an inflammation of one or both lungs, due to various causes, such as chemical injury, physical injury and infection with bacteria, viruses, fungi or parasites. The air sacs may become filled with liquid, making breathing difficult.

Air rushes in and out of the nose.

Cool air rushes in and warm, moist air rushes out.

The average number of breaths per minute is 44 for newborn babies, 20–40 for infants, 20–30 for preschool children, 16–25 for older children and 12–20 for adults.

Background information for teachers

Air enters the body through the nose, is warmed, filtered and passed through the nasal cavity. It then passes over the pharynx (which has the epiglottis that prevents food from entering the trachea or windpipe). The upper part of the trachea contains the larynx. The vocal cords are two bands of tissue that extend across the opening of the larynx. After passing over the larynx, the air moves into the bronchi that carry air in and out of the lungs. Bronchi branch into smaller and smaller tubes known as bronchioles, which end in grape-like sac clusters known as alveoli. Alveoli are surrounded by a network of thin-walled capillaries. Only about 0.2 μm separate the alveoli from the capillaries so that substances can be easily exchanged between them.

Explore

- Place your index finger under your nose and breathe in and out. What do you feel rushing in and out of your nose? Now place your hand over your opened mouth. What do you feel this time?
- Now count the number of times you breathe in one minute. This is your breathing rate. Record it as breaths per minute.

B. Human respiratory system

Breathe in, breathe out

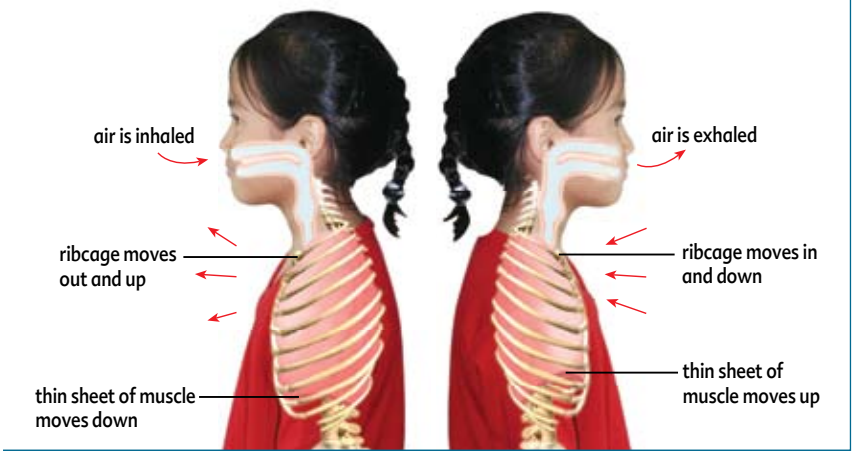
Breathing is the process of taking in air into our body and giving it out. When we breathe, we take in oxygen and give out carbon dioxide.

The parts of a living thing that help it to breathe form the respiratory system. Different animals have different parts in their respiratory systems.

Xtra

When you breathe in, your ribcage moves out and upwards. The thin sheet of muscle below your lungs moves downwards. This causes the space in your chest to become bigger.

When you breathe out, your ribcage moves in and downwards. This time, the thin sheet of muscle below your lungs move upwards. This causes the space in your chest to become smaller and the air that has carbon dioxide in it is forced out of your lungs.



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Common misconceptions

1. Misconception: The term "respiration" is used strictly to describe the breathing process during which gases are exchanged.

Actual fact: Respiration can refer to the process (physical) that brings about an exchange of gases between the organism and its environment, but it can also refer to the process (chemical) occurring in living cells that releases energy from food substances and makes it available for life processes, such as movement, growth and repair.

Every breath you take

How does air move in and out of our body? What are the organs involved in breathing? What are the functions of the organs in our respiratory system?

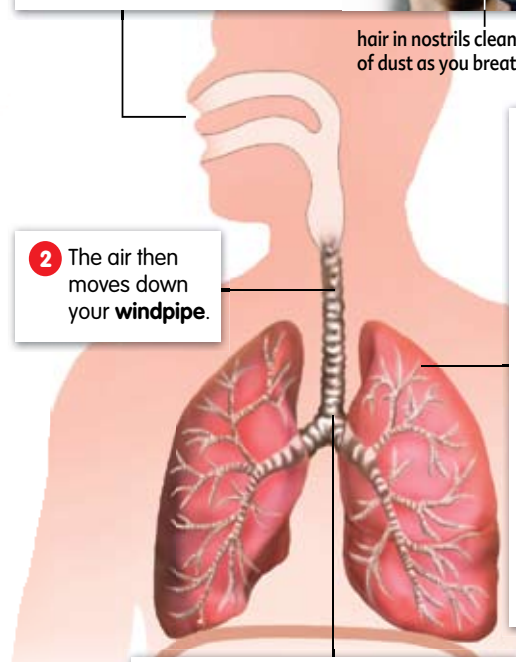
Link

Cycles and Energy

Cells in your body always need to repair and replace themselves. To do this, they need food and oxygen. The nutrients are absorbed by the blood vessels in the small intestine when food has been completely digested. Find out more about cells and how you get energy in the chapters, *The unit of life* and *Energy in food.*

1 When you breathe in, air rushes into your body through your **nose**. Air that enters your respiratory system is cleaned, warmed and moistened.

hair in nostrils cleans the air of dust as you breathe in



2 The air then moves down your **windpipe**.

3 Your windpipe branches to the left and right into two smaller tubes.

4 Each of these tubes leads to one of your two **lungs**. These tubes branch further into tiny tubes that end in tiny balloon-like air sacs.

The air sacs have a rich supply of blood vessels. When the air you breathe in reaches your air sacs, oxygen passes through the walls of the sacs into the blood vessels. Your blood then carries the oxygen to all parts of your body. At the same time, carbon dioxide carried in the blood vessels of your body passes into the air sacs.

Why do you think air sacs need to have a rich supply of blood vessels?

Building Block

Describe how oxygen in the air enters your blood.

Activities 2.1 and 2.2

Air moves in and out of our body through the movement of our rib cage and a thin sheet of muscle below it. When we breathe in, the rib cage moves up and out and the thin sheet of muscle moves down to draw air into the respiratory system through our nose or mouth. When we breathe out, the ribcage moves down and in and the thin sheet of muscle moves up to push air out through our nose or mouth.

The organs involved are the nose, windpipe and left and right lungs.

- Nose — Hair in the nose cleans the air by filtration. Air that passes through is also warmed and moistened.
- Windpipe — Transfers air from the nose or mouth to the left and right lungs.
- Lungs — Contain the air sacs where the exchange of gases between the air we breathe in and the blood takes place.
- Air sacs — Contain blood vessels to absorb oxygen and release carbon dioxide.

The air sacs in our lungs have a rich supply of blood vessels. When the air we breathe in reaches the air sacs, oxygen passes through the walls of the sacs into the blood vessels. Our blood then carries the oxygen to all parts of our body.

A rich supply of blood vessels will increase the surface area for the absorption of oxygen and the release of carbon dioxide.

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Background information for teachers

The table below summarises how living things exchange gases with the surroundings.

Living thing	Gas exchange
Single-celled organisms	Directly across cell membrane by a process called diffusion
Sponges, hydra, corals, sea anemones and jellyfish	Diffusion across outer surface
Flatworms and annelids (e.g. earthworms)	Diffusion across moist outer surface
Crustaceans (e.g. crabs)	Gills
Arachnids (e.g. spiders)	Spiracles leading to a series of tubes called tracheae
Insects	Spiracles leading to a series of tubes called tracheae
Amphibians	Lungs, skin and sometimes gills
Mammals, birds and reptiles	Lungs

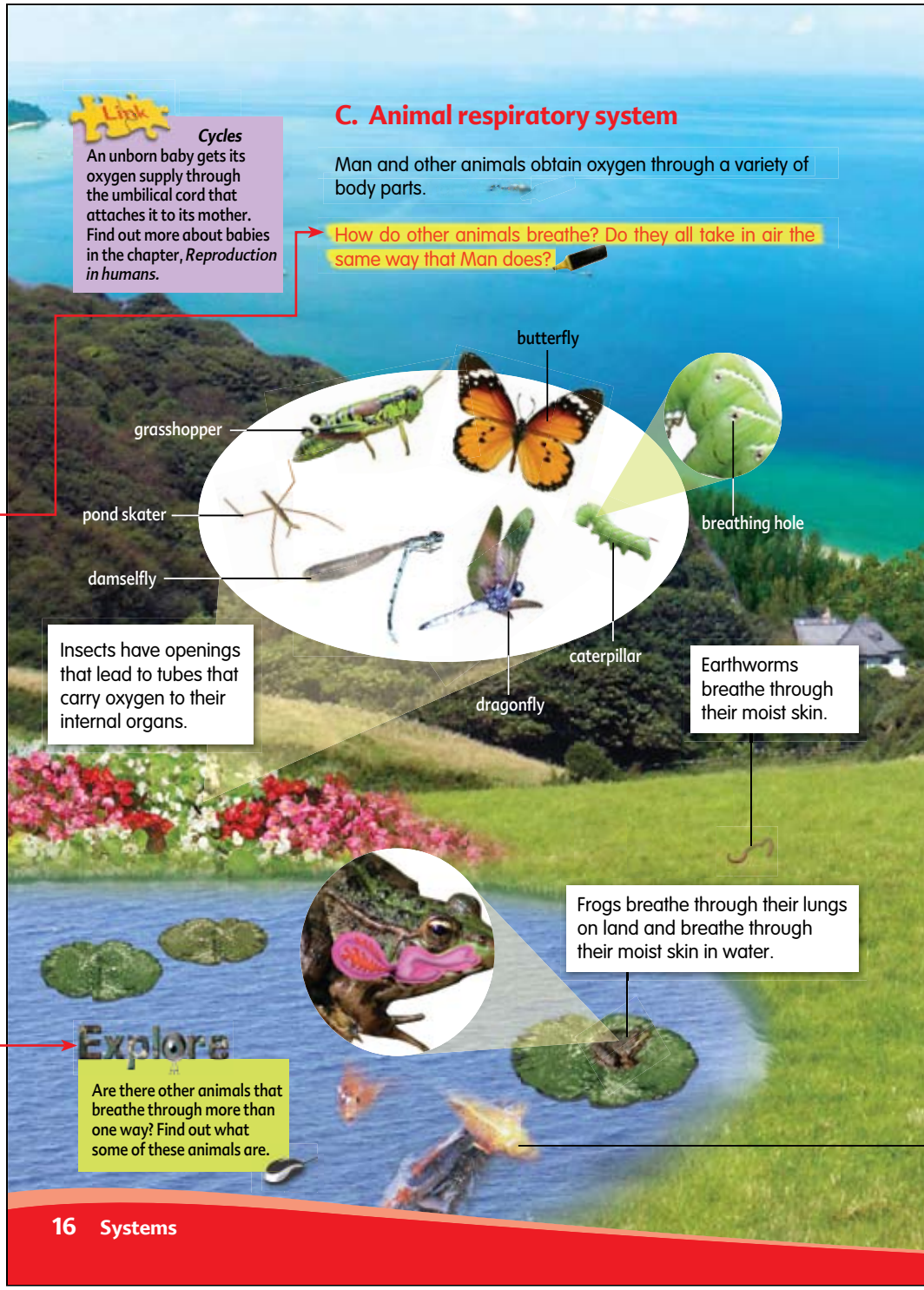
Common misconceptions

1. Misconception: Whales and dolphins are fish and breathe through gills.
Actual fact: Whales and dolphins are mammals that live in the sea. Their nostrils have been modified into blowholes on the top of the head. A series of valves and plugs closes the blowhole when the animal dives. During their short time at the surface, whales obtain all the oxygen they need for dives that can last up to two hours in some species. Although they breathe less often than land mammals, whales will compensate by taking deeper breaths and extracting more oxygen from the air they breathe. In whales, 85–90% of the air from the lungs is exchanged for fresh air, unlike humans who only renew 10–20% of the air in the lungs.

Other animals can breathe through nostrils, blowholes, breathing holes, moist skins or gills. Birds and mammals that live on land take in air through their nostrils into their lungs. Mammals that live in water, like whales and dolphins, have blowholes on the top of their heads to take in air from above the water surface. Insects breathe through breathing holes. Earthworms and frogs breathe through their moist skins. Fish breathe through their gills.

Man, like birds and mammals that live on land, take in air through his nostrils into his lungs.

Mudskippers and crabs have gills to breathe in oxygen in water. On land, they breathe in oxygen through their gill chambers, which contain oxygen that is dissolved in the water.



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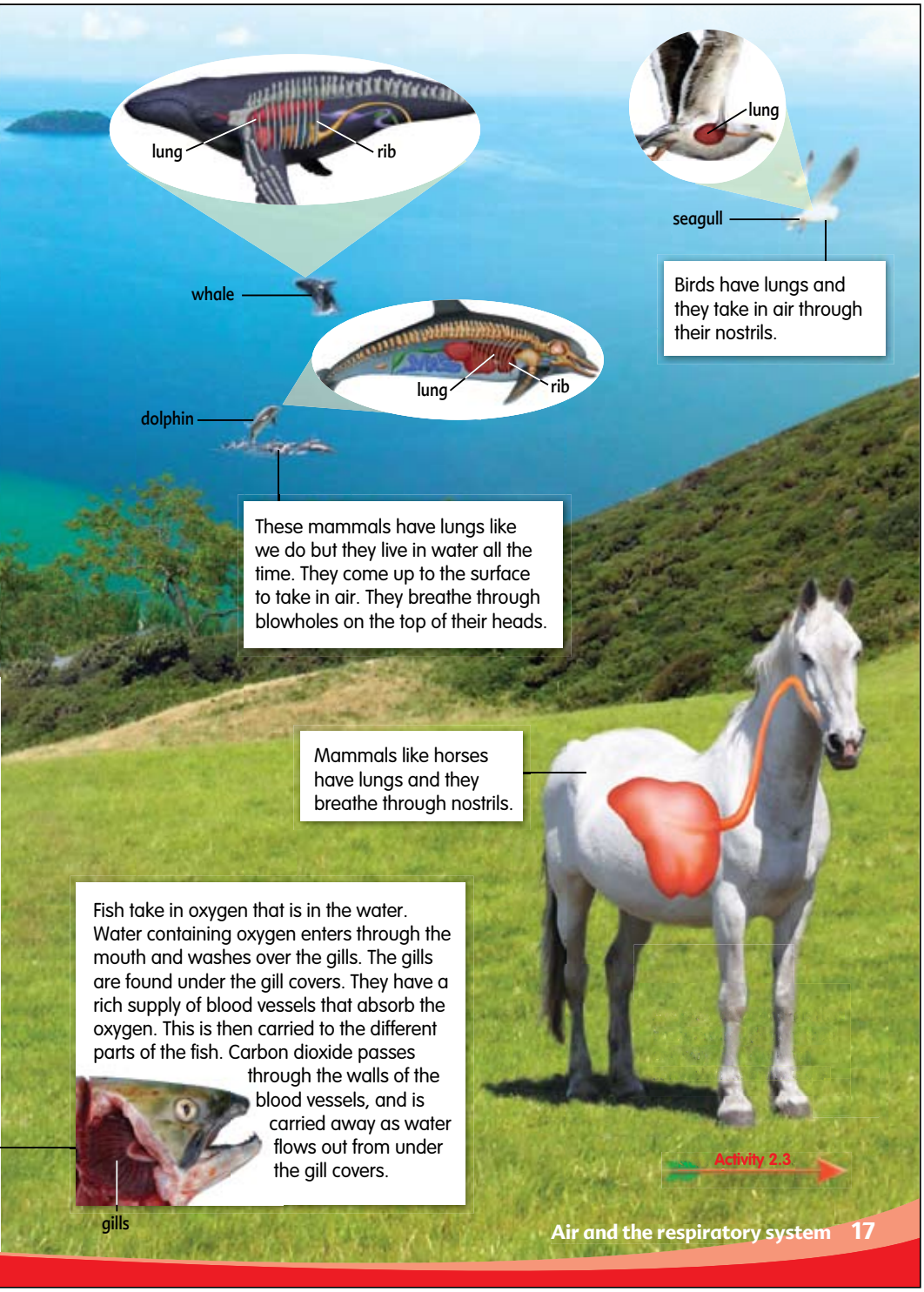
Enrichment for high ability pupils

The respiratory system of birds, adapted for flight, is very different from that of animals that are land-bound. The lungs have two openings, one for taking in oxygen-filled air; the other for getting rid of carbon dioxide-laden air. The air does not end up in the alveoli but loops through the lungs so that the oxygen flow through the lungs is continuous. This design enables birds to obtain the maximum amount of oxygen they need to power the extremely high-energy demands of flight.



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Background information for teachers

Stomata are tiny openings or pores, found mostly on the underside of a plant leaf and used for gas exchange. The pore is formed by a pair of specialised cells known as guard cells, which are responsible for regulating the size of the opening.

When the light intensity is high, the guard cells swell, causing the opening to be at its widest, and carbon dioxide diffuses into the leaf and into the cells to be used in photosynthesis. In the dark, the guard cells are not turgid, most of the stomata are closed and no photosynthesis takes place.

Opening of the stomata not only allows carbon dioxide to diffuse into the leaf, but allows water vapour to diffuse out of the leaf. When absorption of water by the roots does not keep up with the rate of transpiration (evaporation from the leaves), loss of turgor occurs, and the stomata close. The change in the size of the stomata is affected by a variety of external stimuli such as light, carbon dioxide concentration and water.

Plants take in and give out air through tiny openings found on the leaves.

They have tiny openings called stomata.

They are similar to respiratory organs that animals have in that they also allow the exchange of gases to take place. They are different because the openings are microscopic and besides allowing the exchange of gases, they also allow the plant to lose excess water.

Envir-friendly

We need to plant trees to replace those that are cut down, so as to keep a balance of oxygen and carbon dioxide in the air.

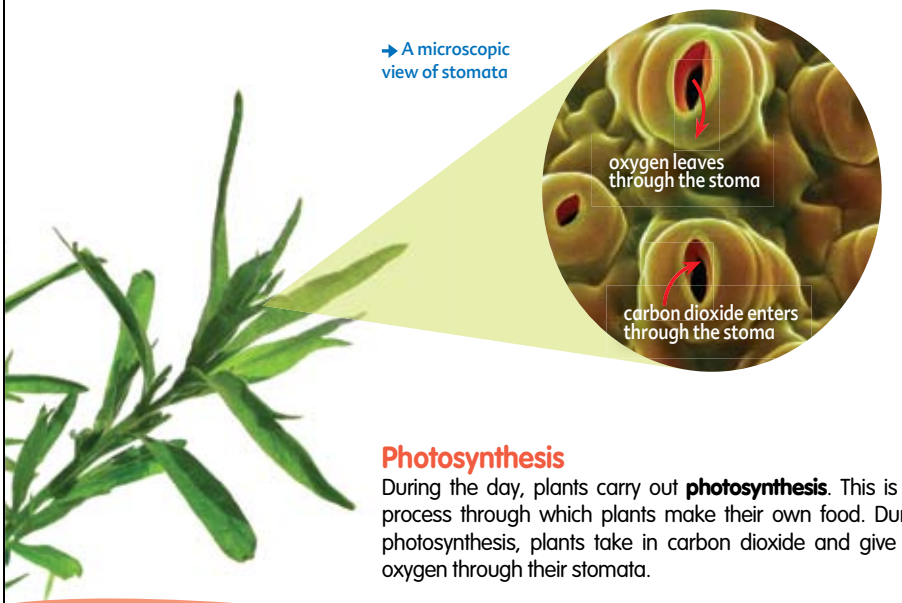
D. Plant respiratory system

Plants help to maintain the balance of oxygen and carbon dioxide in the air. Plants take in carbon dioxide from their surroundings during photosynthesis. At the same time, oxygen is produced and released into the surroundings. This exchange of gases happens continuously and helps to keep a healthy balance of oxygen and carbon dioxide in the air. However, Man's actions are now causing an imbalance in the amount of carbon dioxide in the air.

How do plants take in and give out air? What special parts do they have to do this? How are these similar to or different from the organs that animals have?

Like animals, plants also exchange gases with their surroundings. The exchange takes place through tiny openings called **stomata**. One such opening is called **stoma**.

Stomata are usually found on the underside of the leaves, away from direct sunlight. This is to prevent water inside the plant from evaporating too fast through the stomata.



A microscopic view of stomata

Photosynthesis

During the day, plants carry out **photosynthesis**. This is the process through which plants make their own food. During photosynthesis, plants take in carbon dioxide and give out oxygen through their stomata.

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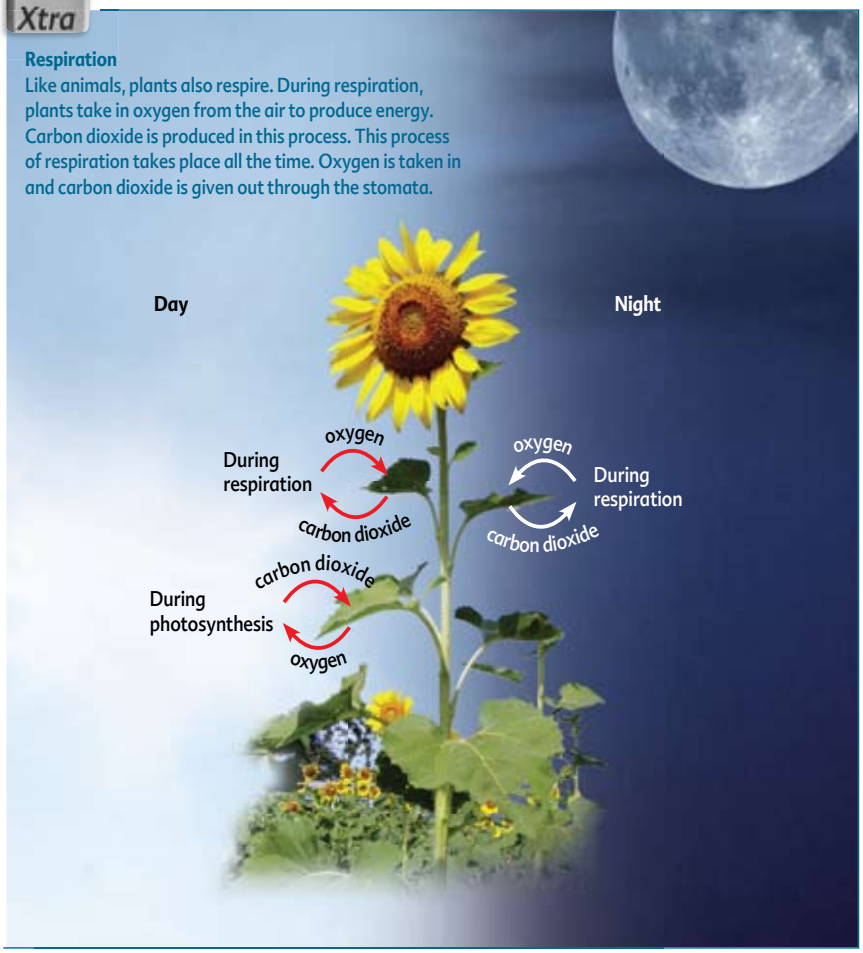
Common misconceptions

1. Misconception: Plants carry out photosynthesis in the day and respiration in the night.
Actual fact: Respiration occurs in the plant throughout the day. However, the rate of photosynthesis is much faster than the rate of respiration during the day; the carbon dioxide given out during respiration is quickly taken in for photosynthesis, and the oxygen taken in is much less than that given out. Hence, the plant appears to be only giving out oxygen and taking in carbon dioxide during the day.

Xtra

Respiration
Like animals, plants also respire. During respiration, plants take in oxygen from the air to produce energy. Carbon dioxide is produced in this process. This process of respiration takes place all the time. Oxygen is taken in and carbon dioxide is given out through the stomata.



Explore

Kelp is a large seaweed (about 30-80 m long) that lives in clear, shallow oceans. Find out why it cannot live in muddy and/or deep waters? Share your findings with your classmates.

Building Block

Explain why the following statement is wrong.

"Plants give out carbon dioxide at night and oxygen in the day."

Kelp cannot live in muddy and/or deep waters because the amount of sunlight is insufficient for it to carry out photosynthesis. Thus, it needs to live in clear, shallow oceans, where there is much sunlight available.

Respiration takes place all the time in plants. During the day, plants also carry out photosynthesis, using carbon dioxide and producing oxygen. In the night, plants respire only and do not carry out photosynthesis, so they give out carbon dioxide.

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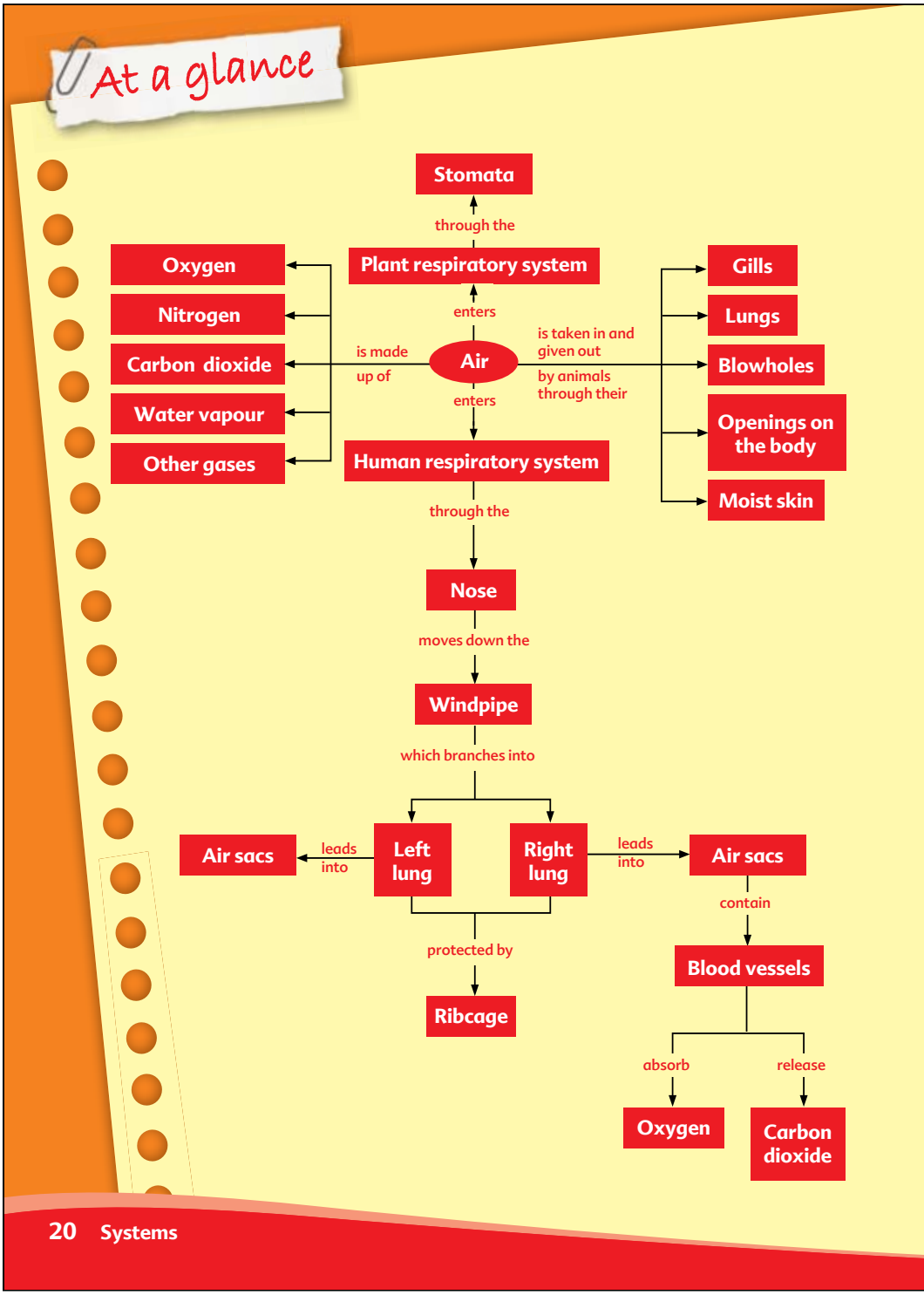
Concept map

Gives an overview of the concepts learnt in this chapter. Words in the boxes can also act as keywords to help pupils understand the link between different concepts within a chapter.



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Self-check

In this chapter, I have learnt that ...

- [ ] air is a mixture of gases.
- [ ] air is made up of oxygen, nitrogen, carbon dioxide, water vapour and other gases.
- [ ] the respiratory system of living things involves the exchange of gases.
- [ ] the main organs of the human respiratory system are the nose, windpipe, lungs and a thin sheet of muscle.
- [ ] mammals and birds have lungs and breathe through their nostrils.
- [ ] mammals like dolphins and whales have lungs and breathe through their blowholes.
- [ ] insects breathe through their air tubes or breathing tubes and some breathe in the air that is trapped in bubbles.
- [ ] frogs and worms use their moist skin to breathe.
- [ ] during the day, plants carry out photosynthesis by taking in carbon dioxide and giving out oxygen through their stomata.

Science words

* stoma
* stomata
* oxygen
* carbon dioxide
* water vapour
* breathing
* windpipe
* lungs
* air sacs
* photosynthesis

Self-check

Helps pupils to reinforce what they have learnt in the chapter and address syllabus requirements.

Science words

Words introduced in this chapter. These words can also be used as spelling words.

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Background information for teachers

The heart has four chambers and blood is pumped through the chambers aided by four heart valves. The tricuspid valve on the right and the mitral valve on the left regulate blood flow between the atrium (upper chamber) and the ventricle (lower chamber) on their respective sides of the heart. There are two other valves, the pulmonary valve on the right prevents the backflow of blood from the pulmonary artery to the right ventricle, while the aortic valve on the left prevents the backflow of blood from the aorta to the left ventricle. This is because the valves open and close to let the blood flow in only one direction.

The first heart sound (the lub) happens when the tricuspid and mitral valves close after the ventricles are filled with blood from the atria. This prevents the backflow of blood from the ventricles to the atria. The second heart sound (the dub) happens when the pulmonary and aortic valves close after the blood has been squeezed out of the ventricles.

3 The human circulatory system

Let's find out:

A. What is the function of the heart?
B. How does the blood transport food and oxygen to the body cells?
C. What are the different systems that work together with the circulatory system?

The circulatory system keeps us alive by working closely with all parts of the body, especially with the respiratory and digestive systems, to carry out life processes.

Blood transports oxygen, digested food and water to our cells and picks up carbon dioxide and waste materials produced by the cells.

The circulatory system is made up of the heart, blood and blood vessels (arteries, capillaries and veins).

Blood vessels are the roads and highways of the circulatory system. They are found everywhere in our body. Blood vessels are hollow tubes that carry blood to all parts of our body. Blood delivers food and oxygen to our body cells and collects waste materials from these cells.

- Why is the human circulatory system important?
- Why is blood called "The River of Life"?
- What are the different parts that make up the circulatory system?

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Enrichment

The first stethoscope

Prior to the invention of the stethoscope, physicians would place their ear to the patient's chest to hear sounds of the lungs and heart. The stethoscope was invented in 1816 when a young French physician named René-Théophile-Hyacinthe Laennec was examining a female patient. Laennec was embarrassed to place his ear to her chest to listen to the heart. Then inspiration struck and he rolled up sheets of paper, placed one end to his ear and the other end to the woman's chest. He was delighted to discover that the sounds were not only conveyed through the paper cone, but they were also loud and clear. He then created a listening device that consisted of a wooden tube with a funnel-shaped opening at one end to detect not only heartbeats but respiration and a host of other sounds. Thus, the first stethoscope was created.

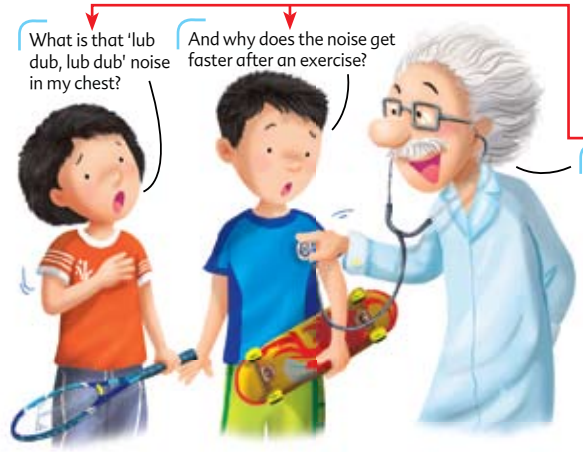
A. The heart

What is the function of the heart?

The function of the heart is to pump blood to the lungs and all parts of the body.

What is that 'lub dub, lub dub' noise in my chest?

And why does the noise get faster after an exercise?



The noise in your chest is the sound when your heart pumps blood around your body. Your heart pumps faster after an exercise because your body needs more oxygen.

The "lub dub, lub dub" noise is made by the heart that continuously pumps blood to all parts of our body.

The more vigorous our activity, the more oxygen the body will require. Therefore, the heart works faster, thus causing the heartbeat to sound faster.

Flashback

The circulatory system in our body carries digested food, water and oxygen to all parts of the body and carries waste materials away from different parts of the body.

The noise in your chest is the sound your heart makes when it pumps blood. Your heart is the vital organ that **pumps blood** all the time, to all parts of your body.

The heart receives blood rich in oxygen from the lungs, and then pumps this blood rich in oxygen to the body cells.

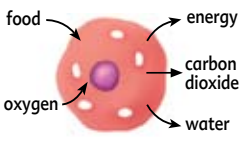
Blood also transports water and digested food to all parts of the body. Blood carries waste substances from all parts of the body to organs such as kidneys, lungs and skin.

Xtra

The rate of our heartbeat can be measured by the use of a stethoscope. The stethoscope allows us to hear the sound made by our heart and lungs.

Xtra

Oxygen is used up during respiration to produce energy. At the same time, the carbon dioxide produced during respiration is also removed from the cells and returned to the lungs where it is released.



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Enrichment

Access the Internet to find out about heart disease and stroke, which are some of the top killers in Singapore: www.medicinenet.com/heart/focus.htm.

A heart attack occurs when there is a sudden blockage of a coronary artery, leading to the death of heart muscles. Coronary arteries are the blood vessels that supply the heart muscles with blood containing oxygen and digested food. They can be blocked when plaques containing cholesterol are deposited on arterial walls, causing the hardening of the arterial walls and the narrowing of the arteries. These arteries cannot deliver sufficient blood to maintain the normal functions of the parts of the body that they reach. Sometimes, the surface of a plaque in a coronary artery may rupture, leading to the formation of a blood clot on the plaque's surface. The blood clot blocks blood flow within the artery, resulting in a heart attack.

A stroke occurs when there is a sudden blockage of the blood vessels supplying blood to the brain or the rupture of an artery in the brain, leading to the death of brain cells. This impairment in the transport of blood containing oxygen and digested food to the brain results in abnormal brain function.

Background information for teachers

Blood is a mixture of two components, namely cells and plasma. Plasma is the liquid portion of the blood, containing dissolved substances like electrolytes, nutrients and vitamins (absorbed from the intestines or produced by the body), hormones, clotting factors and proteins, such as albumin and immunoglobulins (antibodies to fight infection). Plasma distributes the substances it contains as it circulates throughout the body. Blood also contains red blood cells (RBCs) which carry oxygen from the lungs, white blood cells (WBCs) which help to fight infection and platelets which are parts of cells that the body uses for blood clotting.

A pacemaker, which is a small device that is placed under the skin of our chest or abdomen, helps to control abnormal heart rhythms. This device uses electrical pulses to prompt the heart to beat at a normal rate.

The heart lies near the middle of the chest, in between the lungs. It is made of a special muscle called the heart muscle.

Explore

- Do you know what it is like to be your heart? Make a fist and squeeze it tight for one second. Relax for one second and squeeze again. Repeat this over and over for 60 to 70 times. Your hand feels tired but your heart has to do that repeatedly for your entire lifetime!
- A heart that has been surgically removed from a person's chest cavity will continue to beat.

  How is this possible?

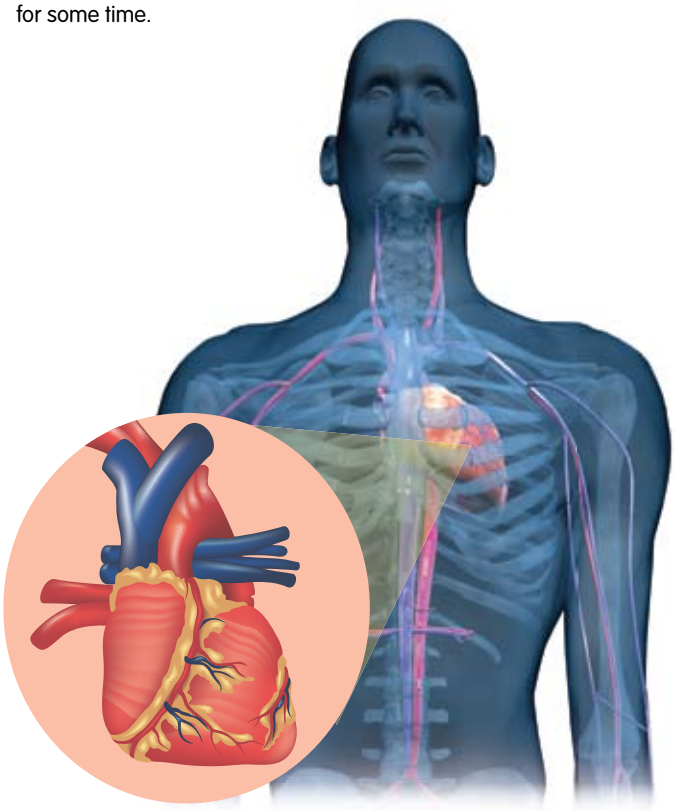
  Search the Internet to find out about our "pacemaker".

Xtra

Your heart lies near the middle of your chest. It is found between your lungs and is protected by your ribcage.

Where is your heart? What is the heart made of?

Your heart is made of a special muscle called the **heart muscle**. This amazing heart muscle contracts and relaxes continuously without ever getting tired. This allows your heart to pump blood non-stop to all parts of your body. Unlike your heart muscles, your arm and leg muscles cannot contract and relax continuously. They get tired after working for some time.



↑ This shows the muscular structure of the heart as well as the blood vessels that carry blood towards and away from the heart.

Your heart muscles are beyond your control, unlike your arm and leg muscles. You can make your arm and leg muscles move anytime you want. However, you cannot control the muscles in your heart.

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Common misconceptions

1. **Misconception:** All arteries carry oxygen-rich blood and all veins carry deoxygenated blood.
   Actual fact: Arteries carry blood away from the heart. All but the pulmonary artery carry oxygen-rich blood. The pulmonary artery carries deoxygenated blood away from the heart to the lungs for replenishing oxygen and removing excess carbon dioxide. The pulmonary veins that return the blood from the lungs to the heart thus carry oxygen-rich blood to be pumped to the rest of the body.

2. **Misconception:** Blood in the veins is blue.
   Actual fact: The blood carried by veins is dark red due to its high percentage of CO_2 as it returns to the heart (blood in the arteries is bright red due to high levels of O_2 in it). Veins appear blue through the skin tissue because the subcutaneous fat in the skin absorbs low-frequency light, permitting only the high-frequency blue light to penetrate through.

B. The blood and the blood vessels

Does blood transport digested food and oxygen to our body cells the same way that cars transport goods to different places? Does it then transport carbon dioxide and waste materials the same way that trucks remove garbage?

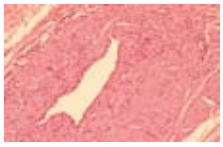
How does blood flow through your body?

Blood flows through many tubes to get to the different parts of your body. These tubes are called **blood vessels**.

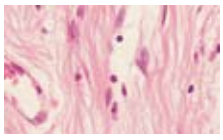
Blood flows through tubes called blood vessels (arteries, capillaries and veins) in our body.

Xtra

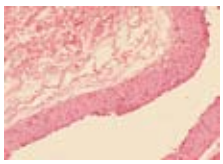
There are three types of blood vessels; the arteries, capillaries and veins. Together with the heart, they are important organs of the circulatory system.



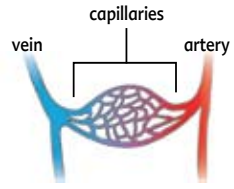
↑ Arteries are blood vessels that carry blood rich in oxygen from your heart to all parts of your body.



↑ Capillaries have very thin walls where the exchange of useful and waste products take place.



↑ The veins then carry blood rich in carbon dioxide back to the heart.

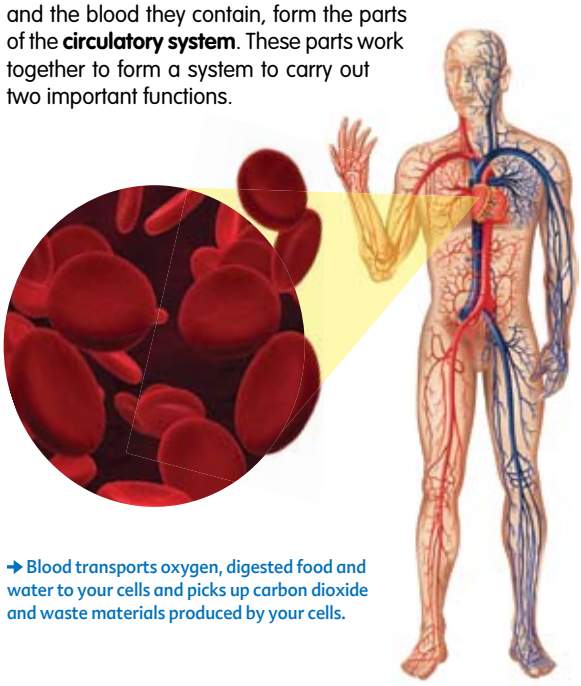


C. From parts to whole

Function of the circulatory system

How do the heart, blood and blood vessels work together?

Your heart, together with your blood vessels and the blood they contain, form the parts of the **circulatory system**. These parts work together to form a system to carry out two important functions.



→ Blood transports oxygen, digested food and water to your cells and picks up carbon dioxide and waste materials produced by your cells.

Our heart pumps the blood in our body, and the blood flows through our blood vessels to reach all parts of the body.

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Background information for teachers

Dual/Double circulation refers to the journey along two separate "loops", where the blood passes through the heart twice. The first "loop" is the pulmonary circulation, where blood is sent to the lungs in order to oxygenate blood. The second "loop" is the systemic circulation, where oxygen-rich blood is sent to the rest of the body to ensure that the body cells receive sufficient oxygen. Pulmonary circulation is the portion of the circulatory system that carries oxygen-poor blood from the heart to the lungs, and returns oxygen-rich blood back to the heart. Systemic circulation is the portion of the circulatory system that carries oxygen-rich blood from the heart to the rest of the body, and returns oxygen-poor blood back to the heart.

During blood circulation, blood carries waste materials away from the body cells. The waste materials that are passed into the bloodstream include water, carbon dioxide, salts and urea. These waste materials are then sent to excretory organs, such as lungs, skin, liver and kidneys, for removal.

Common misconceptions

1. **Misconception:** We pant during a vigorous exercise because we are tired.
   Actual fact: Our body needs oxygen in order to efficiently break down glucose and release energy. As we do more vigorous exercises, we need more oxygen to release more energy. Hence, we breathe faster and harder to keep up with the oxygen demand. Our heart also needs to pump faster to send more oxygen-rich blood from the lungs to the muscles. As a result, our heart rate also increases. However, there is some truth in the statement as lactic acid may build up in the muscles when there is insufficient oxygen, so by breathing harder, we obtain more oxygen to remove the lactic acid that is causing fatigue.

Xtra

There are about 96 000 km of blood vessels in the body. If all the blood vessels in your body are laid from end to end, they can encircle the Earth more than twice!

First, they transport **oxygen**, **digested food** and **water** to all parts of your body. Second, they carry **carbon dioxide** and **waste materials** away from different parts of your body. The waste is then released from the body.

This system is called the circulatory system because it circulates or moves blood from your heart to all parts of your body and back to your heart again.

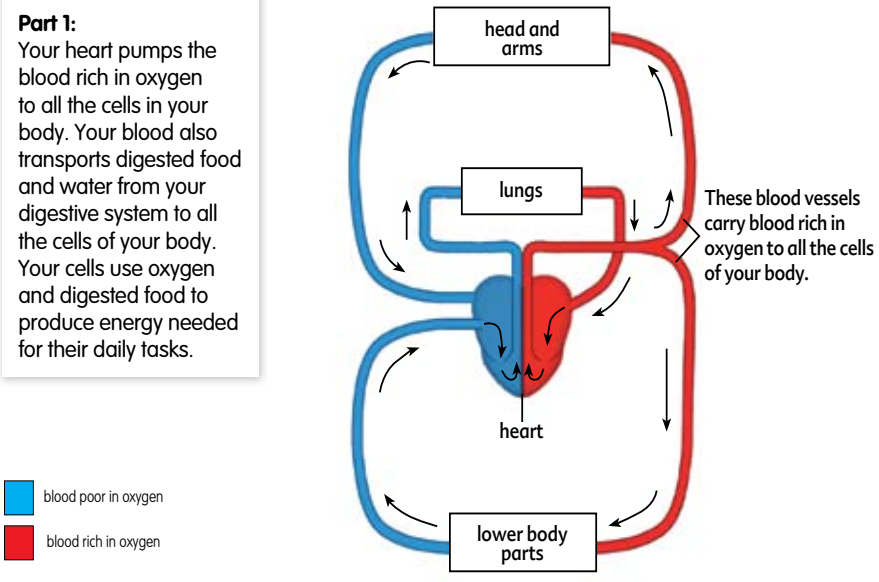
Activity 3.1

Flow of blood in the circulatory system

How does the circulatory system circulate blood?

Your circulatory system circulates blood in two parts:

Part 1:
Your heart pumps the blood rich in oxygen to all the cells in your body. Your blood also transports digested food and water from your digestive system to all the cells of your body. Your cells use oxygen and digested food to produce energy needed for their daily tasks.



The heart pumps blood containing oxygen, digested food and water, to all the body cells in our body through the blood vessels. The cells use the oxygen and digested food to produce energy and carbon dioxide. As blood goes around, it picks up the carbon dioxide and waste materials and returns to the heart.

Part 2:
As blood goes around your body, it picks up carbon dioxide and waste materials produced by your cells.

On its way back to your heart, blood passes on waste materials to some organs. These waste materials are eventually passed out from your body. When blood reaches your heart again, it is sent to the lungs where carbon dioxide is removed and oxygen is taken in.

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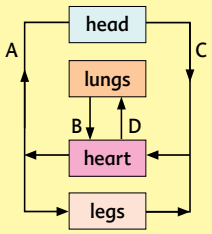
Enrichment for high ability pupils

Bruises form when capillaries near your skin's surface are broken by the impact of a blow or injury. When this happens, blood leaks out of the vessels into the surrounding tissue and initially appears as a blue-black mark. Eventually your body reabsorbs the blood, and the mark usually disappears. As we age, we may experience increased bruising because over time, our capillary walls become more fragile and prone to rupture and our skin becomes thinner and loses some of the protective fatty layer that helps cushion the blood vessels against injury.

Building Block

The following is a simplified diagram showing blood flow to different parts of the body.



(a) Which blood vessel, B or D, carries blood rich in oxygen?
(b) Give a reason for your answer in (a).
(c) C carries a greater amount of substance 'X' than A. What is substance 'X'?

(a) Blood vessel B

(b) When we breathe in, oxygen enters our nose, moves down our windpipe and enters our lungs. Oxygen in the lungs then enters the bloodstream and flows to the heart, which pumps blood rich in oxygen to all the cells of our body.

(c) Substance X is carbon dioxide.

Explore

- Gently pull your lower eyelids down. Do you see red lines running everywhere? What are they?
- Have you ever seen a bruise? What does it look like? What do you think happened underneath the skin?
- What does a nurse do when she collects blood for a blood test?

Yes. The red lines are our blood vessels (capillaries).

Yes. A bruise normally looks blue-black because the blood vessels beneath the skin are broken and blood has leaked out.

A nurse looks for our blood vessels and pierces the needle through a blood vessel to draw out blood.

How fast does your heart beat?

Each heartbeat is a cycle of contraction and relaxation of your heart muscles. With every beat of your heart, blood is pumped through your blood vessels, causing them to expand and relax. After every heartbeat, a pressure wave passes along your blood vessels. It is similar to a ripple that spreads outwards from your heart and pushes the blood through the blood vessels.

The heart of an average healthy adult beats about sixty to seventy times in a minute. The rate of your heartbeat changes with age and health as well as the type of activity you are doing.

For example, when you exercise, your heart rate increases. This happens because the heart needs to supply more digested food and oxygen carried in the blood to the various parts of the body to produce more energy.

Our heart beats an average of 60 to 70 times per minute.

Xtra

There is a type of nerve called the accelerans nerve that increases the pulse rate. Factors that activate this nerve include fear and violent exertion. The heart may increase from 70 beats per minute in an average adult to 180 beats per minute.

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Background information for teachers

Pacemaker: A pacemaker is a small device that is placed under the skin of the chest or abdomen to help control abnormal heart rhythms. This device uses electrical pulses to prompt the heart to beat at a normal rate. A pacemaker is used to treat heart rhythms that are too slow, fast or irregular. It can help a person who has an abnormal heart rhythm resume a more active lifestyle.

Sphygmomanometer: Blood pressure is the force of the blood pushing against the artery walls. Each time the heart contracts, it pumps blood into the arteries, resulting in the highest blood pressure. One can measure blood pressure using an electronic blood pressure monitoring device known as a sphygmomanometer. Two numbers are recorded when measuring blood pressure. The higher number, or systolic pressure, refers to the pressure inside the artery when the heart contracts and pumps blood through the body. The lower number, or diastolic pressure, refers to the pressure inside the artery when the heart is at rest and is filling with blood. Both the systolic and diastolic pressures are recorded as "mm Hg" (millimeters of mercury). This recording represents how high the mercury column is raised by the pressure of the blood.

Electrocardiograph: An electrocardiograph is a device that measures and records electrical activity in the heart by the use of ECG pads placed on the chest and connected to wires, called leads. The leads are connected to a bedside monitor where the information is displayed. By continuously monitoring the electrical activity in the heart, we can tell if the heart is beating too fast or slow and if the heart is following a normal or abnormal rhythm.

Activities 3.2 and 3.3

This instrument is used to measure the pressure wave that passes along your blood vessels when your heart beats .

Xtra

Did you know that you can restart your heart if it stops beating? Doctors and emergency rescue workers can do this using a machine called a defibrillator. An electric shock is passed from the handles of the defibrillator to the heart so as to cause it to start beating again.

This graph is taken by a machine called the electrocardiograph that measures the activity of the heart over time.

Explore

- **Feel the beat**
  With every beat of your heart, blood is pushed along blood vessels, forming waves. Each push or pulse can be felt where blood vessels run over a bone or hard surface.

  The most convenient place to feel your pulse is at the wrist. Gently press two fingers down at your wrist. Do you feel your pulse? Where else in your body can you feel your pulse?

- **Your pulse rate**
  The number of times your heart beats in a minute is also your pulse rate. Count the number of pulses for fifteen seconds. Multiply this by four to obtain your pulse rate. Try different activities before taking your pulse rate again. What has happened to your pulse rate?

Pulse can be felt at the neck, temples, on either side of your head or any other place that allows an artery to be compressed against our bone. As the activity gets more intense/vigorous, the pulse rate increases.

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Common misconceptions

1. Misconception: Only the skeletal and muscular systems are involved in enabling one to move.

Actual fact: Besides the skeletal and muscular systems working together, the digestive system, the respiratory system and the circulatory system are just as important in providing muscle cells with the raw materials (food and oxygen) for the energy release that powers the muscles.

Enrichment

Ask the pupils to conduct a research to find out how different body systems work together to provide energy as well as cool the body down when we exercise. Their research should include:

- How body systems such as the digestive, respiratory, circulatory, skeletal, muscular and excretory systems work together.
- Observed changes in the body such as increased heart rate and respiration rate, perspiration, flushed face and others.

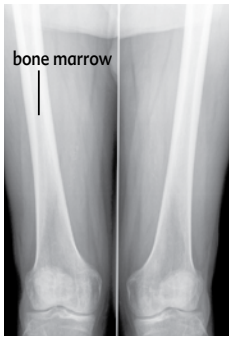
Working together

Every system in your body has its own special tasks. As you have seen, your circulatory system works very closely with all parts of your body, especially your respiratory and digestive systems.

Without your respiratory system, the supply of oxygen in your blood will run out very quickly. In turn, your cells will not be able to produce energy from digested food transported by your blood. As a result, all other systems like your skeletal and muscular systems will not be able to perform their tasks.

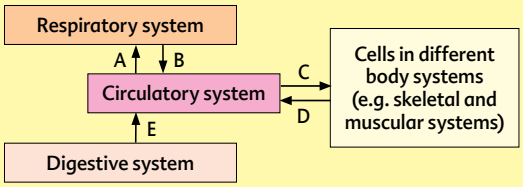
Xtra

Bone marrow is a soft tissue found in the hollow areas of bones. In adults, marrow in large bones produce new red blood cells and white blood cells.



Building Block

The following is a simplified diagram showing the flow of substances, oxygen, carbon dioxide and food, between different body systems.



Name the substance(s) represented by A, B, C, D and E.

A — Carbon dioxide
B — Oxygen
C — Digested food and oxygen (and water)
D — Carbon dioxide (and waste materials)
E — Digested food (and water)

Super Scientist

Karl Landsteiner was born on June 14, 1868. He was an Austrian biologist and physician. He is noted for discovering the different types of blood groups in humans. His discovery was based on his observation that blood transfusion between humans and animals is always unsuccessful.

His observations received little attention until he classified the blood of human beings into A, B, AB, and O groups and showed that blood transfusions between individuals of the same blood groups will be successful. In 1930, he received the Nobel Prize in Physiology or Medicine. He continued to work energetically until his death from a heart attack in June 26, 1943.

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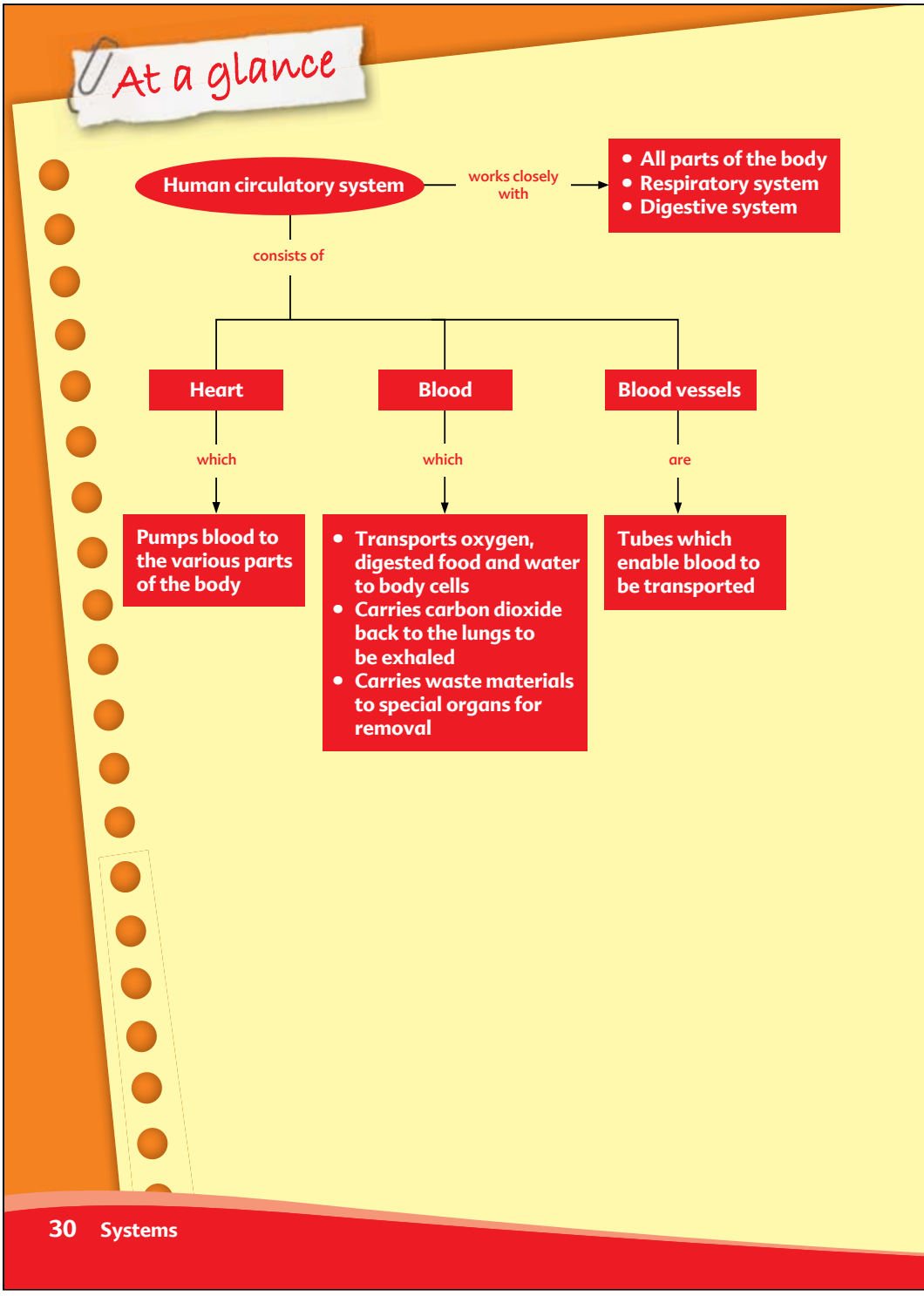
Concept map

Gives an overview of the concepts learnt in this chapter. Words in the boxes can also act as keywords to help pupils understand the link between different concepts within a chapter.



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Self-check

In this chapter, I have learnt that ...

- [ ] the heart is the vital organ that pumps blood to all parts of the body.
- [ ] blood transports oxygen, water and digested food to the cells that require them.
- [ ] blood removes carbon dioxide and waste substances from the cells.
- [ ] the heart is made up of heart muscles which allow the heart to pump blood non-stop to all parts of the body.
- [ ] the heart, together with the blood vessels and the blood they contain, form the circulatory system.
- [ ] your heart pumps the blood rich in oxygen to all the cells in your body. Your blood also transports digested food and water from your digestive system to all the cells of your body.
- [ ] on its way back to your heart, blood passes on waste materials to some organs. These waste materials are eventually passed out from your body. When blood reaches your heart again, it is sent to the lungs where carbon dioxide is removed and oxygen is taken in.
- [ ] the circulatory system works very closely with all parts of the body, especially the respiratory and digestive systems.

Science words

* circulatory system
* heart
* blood vessels
* waste materials
* digestive system

Self-check

Helps pupils to reinforce what they have learnt in the chapter and address syllabus requirements.

Science words

Words introduced in this chapter. These words can also be used as spelling words.

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Background information for teachers

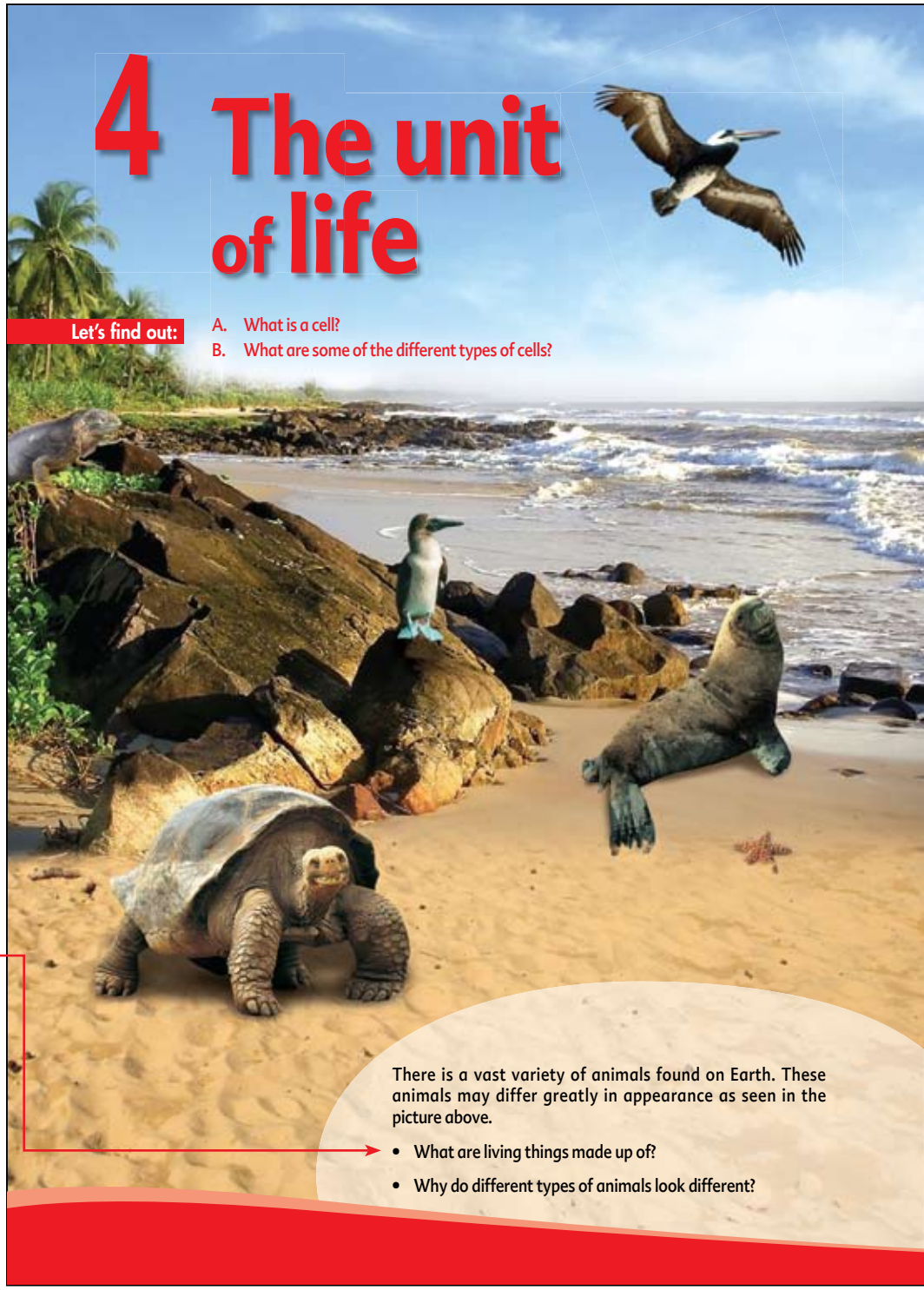
More about micro-organisms:

Euglena — A euglena is a protist that can surround a particle of food and eat it like animals do, as well as make food like plants do as it contains chloroplasts and chlorophyll. Euglena live in freshwater, salt water and in the soil. Many euglena are able to move by using a flagellum, which is a long whip-like structure.

Paramecium — A paramecium is covered by cilia, tail-like projections, which allow the cell to move and help to sweep food along with some water into the cell. Paramecia are widespread in freshwater environments, and are especially common in scums. They feed on micro-organisms like bacteria, algae and yeasts.

Plankton — Plankton are drifting organisms (animals, plants or bacteria) that are found in oceans, seas or bodies of freshwater. They provide a crucial source of food for aquatic life. Planktons are divided into three broad groups: phytoplankton (make their own food), zooplankton (feed on other plankton, egg and larvae of fish and crustaceans), bacterioplankton (feed on organic material).

Seed shrimp — A tiny marine and freshwater crustacean having a shrimp-like body enclosed in a hinged bivalve shell.



4 The unit of life

Let's find out:

A. What is a cell?
B. What are some of the different types of cells?

There is a vast variety of animals found on Earth. These animals may differ greatly in appearance as seen in the picture above.

- What are living things made up of?
- Why do different types of animals look different?

Living things are made up of cells.

Different types of animals look different due to the characteristics that they have inherited from their parents. Animals are different in size due to the different number of cells they are made up of.

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Enrichment for high ability pupils

The amoeba is a tiny single-celled organism — the largest is only about 1 mm across. Amoebae live in freshwater, salt water, wet soil and in animals. An amoeba consists of a single cell surrounded by a porous cell membrane. Oxygen from the water passes into the amoeba through the cell membrane and carbon dioxide leaves through it. The amoeba eats algae, bacteria, plant cells and other micro-organisms. They eat by surrounding tiny particles of food with pseudopods (foot-like structures), forming a bubble-like food vacuole. The food vacuole digests the food. Wastes and excess water are removed from the cell by contractile vacuoles that move to the amoeba's surface when full.

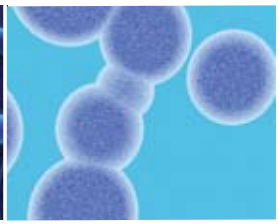
A. Cells

What are living things made up of?

All living things are made up of cells. A **cell** is the smallest unit of life in the body.

Some living things like bacteria and yeast are made up of only one cell. They can only be seen under a microscope.

↑ The presence of tail-like structures called the flagella on the *E. coli* bacteria allows it to move.



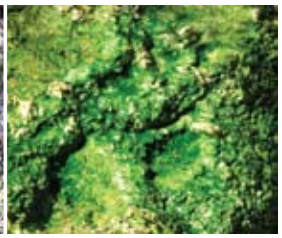
↑ A clump of yeast cells. Yeast cells are useful in making bread.

Xtra

- Yeasts are fungi and they are made up of only one cell each. They can be found in soil and on plants. Yeasts are commonly used in bread-making to make the dough rise. They are also used in the production of alcoholic drinks, antibiotics, animal feed and some types of food.
- Microbes are very small living organisms that can only be seen with the help of a microscope.

Can you think of other organisms that are made up of only one cell?

↑ Micro-organisms made up of one cell such as paramecium are commonly found in ponds.



↑ Some algae and mosses are made up of a few cells. Most animals and plants, including human beings, are made up of millions of cells.

Explore

Look at your little finger. Estimate how many cells it might represent. Imagine a whole house filled with green beans. If the house is your little finger, the beans are the cells. That's a lot of cells!

Activity 4.1

All living things are made up of cells.

Amoeba, paramecium, euglena

It is estimated that an average adult human body is made up of 50 trillion cells, while others estimate it to be closer to 10 trillion or even 100 trillion cells. However, the number of cells in a person's body will depend on the size of his or her body.

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Background information for teachers

We are made up of about 200 different types of cells, e.g. nerve cells, muscle cells, skin cells, bone cells. Cells of the same type group together to form a tissue.

Some tissues in the body include nervous tissue (in brain, spinal cord), muscle tissue, epithelial tissue (covers body surfaces or lines internal organs such as skin or mucosa), connective tissue such as bone, cartilage and blood. Tissues that group together to perform a function form an organ.

The organs in the body include brain, voice box, lungs, heart, spleen, liver, stomach, gall bladder, pancreas, small intestine, large intestine, appendix, kidneys, bladder, female genitals, male genitals and sense organs — eyes, ears, nose, tongue, skin.

The bigger the animal, the greater the number of cells it has.

Explore

Compare the size of an ant and an elephant. Does the size of the animals tell us anything about the size of their cells? Read up to find out.

The cells in our body are different from one another based on their shapes, sizes and functions.

B. Different types of cells

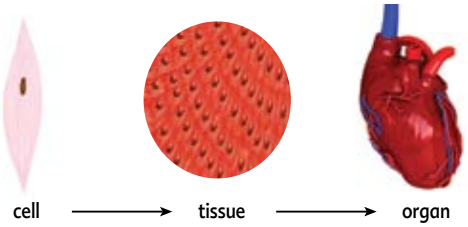
How are the cells in our bodies different from one another?

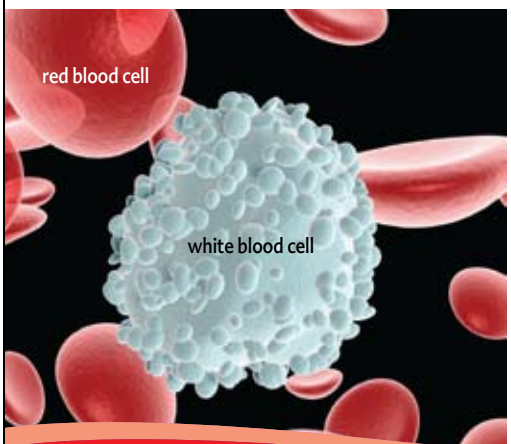
Cells in an organism differ in **shape**, **size** and **function**.

The human body, for example, is made up of hundreds of different kinds of cells. Our blood cells are different from our bone cells and our muscle cells are different from our nerve cells. Each of these cells has a different function.

Cells in our body are usually packed tightly together. Cells which are of the same type are grouped together to form tissue. Groups of our muscle cells form our muscle tissue.

An organ is formed when several tissues work together to form a special function. The heart, stomach and brain are some organs in our body.





Other cells such as the red and white blood cells travel within the body to do their jobs.

← The circulatory system carries red and white blood cells.

The egg cell produced by the ovary of a female is the largest cell in the human body. It is about the diameter of a human hair. Most human cells are smaller, about one-tenth of the diameter of a human hair.

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Enrichment for high ability pupils

Red blood cells (RBCs) are shaped like slightly indented, flattened discs. They contain the iron-rich protein, haemoglobin. The blood turns bright red when haemoglobin picks up oxygen in the lungs. As the blood travels through the body and oxygen is released to the tissues, the haemoglobin in the blood turns a darker red. The body contains more RBCs than any other type of cell.

White blood cells (WBCs) are a key part of the body's system for defending itself against infection. They can move in and out of the bloodstream to reach affected tissues. Some types of WBCs fight and devour germs such as bacteria and viruses that invade the body. Some types of WBCs produce antibodies to help the body destroy or neutralise foreign materials. The white cell count (the number of cells in a given amount of blood) in someone with an infection is often higher than usual because more WBCs are being produced to battle the infection.

Sperm cells produced by the male reproductive system approach an egg cell produced by the female reproductive system to fertilise it.

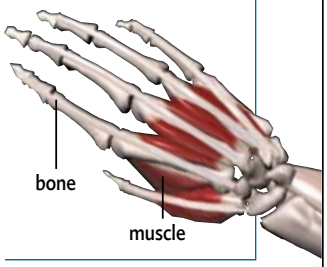
Stomach, liver, kidney, lungs

Building Block

Besides the heart and the brain, can you name other organs in your body?

Xtra

Cells need one another to function. Our fingers function only when all the different types of cells in the fingers work together. The different cells of each finger also exchange messages with other cells within the body at certain times. We do not notice much of this because most of this work is done automatically.



What about plants? What are their cells like?

All parts of a plant are made up of cells. These cells differ in shape, size and function too.

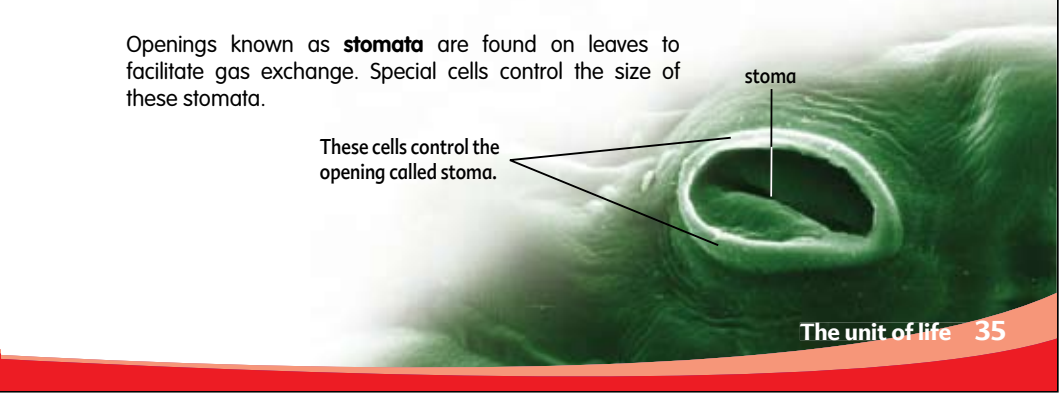
The outer surface of plants is covered with cells that prevent loss of water and act as a barrier to bacteria and other organisms.

Some cells in the stem transport food and water within the plant. The water-carrying tubes and the food-carrying tubes are made up of such cells.

The cells in the leaves contain the green pigment chlorophyll which traps light energy from the Sun, enabling the plant to make food.

Openings known as **stomata** are found on leaves to facilitate gas exchange. Special cells control the size of these stomata.

Plant cells consist of cell walls and chloroplasts, which are not present in animal cells.



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Background information for teachers

Common parts of an animal cell and a plant cell include:
Plasma membrane — controls the flow of substances into and out of a cell.

Cytoplasm — jelly-like substance within a cell; location of many chemical reactions.

Mitochondrion — powerhouse of a cell; packages the energy of food into ATP molecules.

Vacuole — contains water, dissolved minerals and wastes.

Ribosome — structure that makes proteins.

Nuclear membrane — surrounds the nucleus.

Nucleus — control centre of the cell; contains nucleolus (that is responsible for making ribosomes), chromosomes (that are long, thread-like molecules called DNA (Deoxyribonucleic acid), containing all the information for cells to live, perform their functions and reproduce) and other proteins.

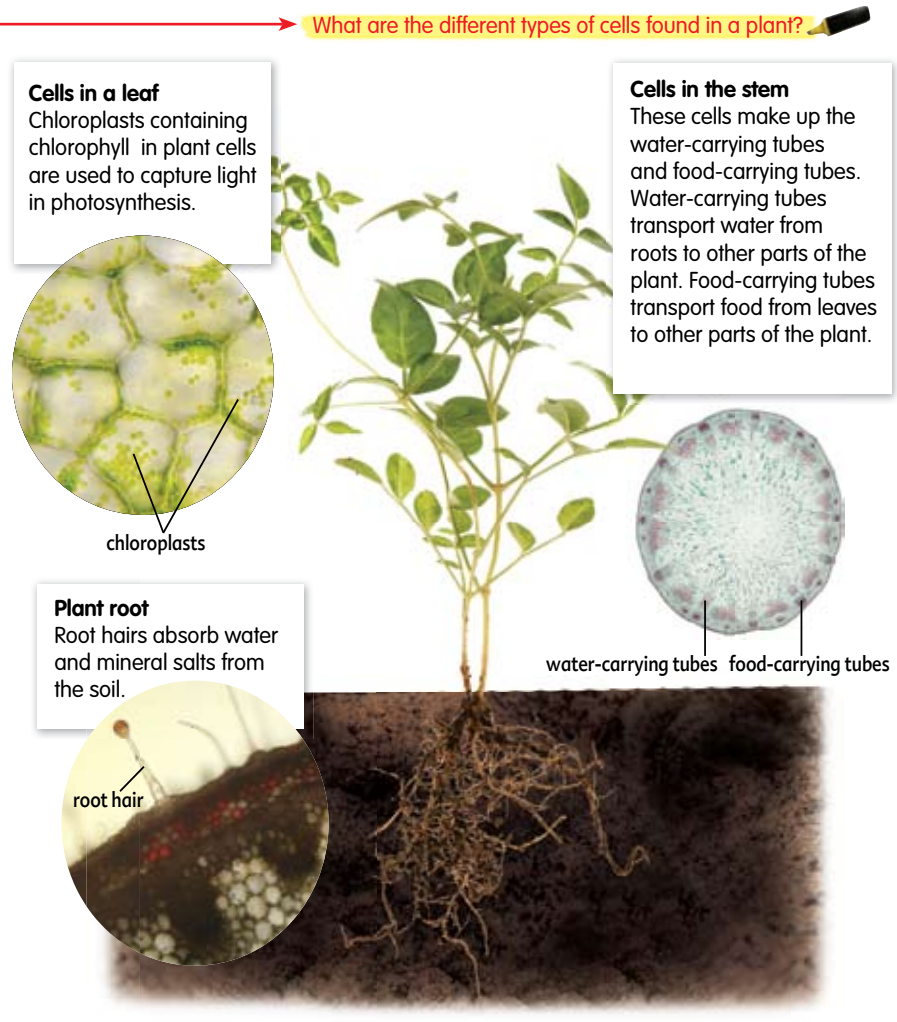
In addition to cell membranes, plant cells have cell walls that provide protection and support. Plant cells also have chloroplasts that contain chlorophyll, which traps light energy to make food through photosynthesis.

Common misconceptions

1. Misconception: All cells contain a nucleus.
Actual fact: The mammalian red blood cell has no nucleus and also lacks other organelles such as mitochondria. This is because the red blood cell serves as a transport vessel to ferry oxygen. Without large structures in the cell, it can carry more oxygen. However, without the nucleus, it cannot reproduce and will die eventually. A red blood cell's life span is about 3–4 months. After that, it will be sent to the liver to be destroyed.

What are the different types of cells found in a plant?

Leaf cells, water-carrying tubes, food-carrying tubes and root hairs.



No. Non-living things are not made up of cells.

What about non-living things? Are these objects made up of cells like living things?

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Enrichment for high ability pupils

Chloroplasts containing chlorophyll are found in the cells of leaves. However, chloroplasts are also found in other green structures in plants, including stems and un-ripened fruit. The majority of photosynthetic activity in most plants occurs in the leaves where the chloroplast density is the greatest. Besides the green pigment chlorophyll, other coloured pigments are also present in the leaves of deciduous trees and shrubs. A green leaf is green because there is an abundance of chlorophyll in the leaf's cells. The chlorophyll's green colour dominates and masks out the colours of any other pigments that may be present in the leaf. Thus, the leaves are characteristically green in summer. The green chlorophyll pigment often degenerates as autumn approaches, yielding leaves with vibrant red, yellow, brown and orange pigments that were hidden during much of the growing season.

Parts of a cell

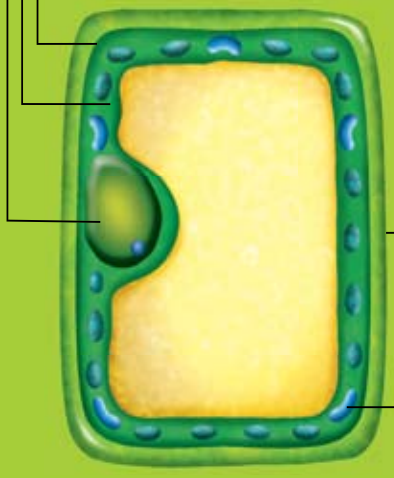
What are the parts of a cell? Do animal cells and plant cells have the same parts?

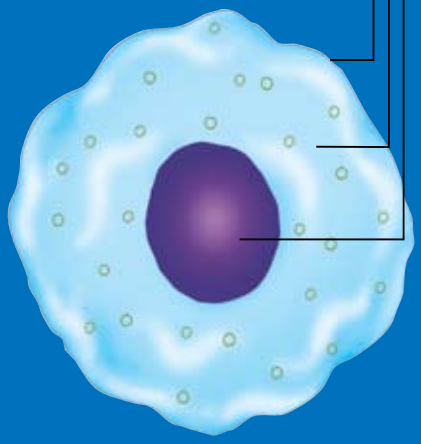
Activities 4.2, 4.3 and 4.4

The **nucleus** controls all the activities in the cell. It contains genetic information that is passed from one generation to the next.

Cytoplasm is a jelly-like substance containing many cell parts. These parts in the cytoplasm perform other functions.

The **cell membrane** is a soft, thin membrane that surrounds the cytoplasm. It controls the movement of substances in and out of the cell.





Chloroplasts are green structures that contain chlorophyll, the pigment that captures sunlight to make food for the plant.

The **cell wall** is found outside the cell membrane. It supports and gives the plant cell its shape.

Chloroplasts are absent in animal cells.

Animal cells do not have **cell wall**.

Nucleus, cytoplasm, cell membrane

No. Chloroplasts and cell walls are absent in animal cells but present in plant cells.

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Background information for teachers

Mitosis is a method of cell division that enables growth and repair to take place. It occurs wherever an increase in number of cells is needed. In mitosis, a "mother" cell divides into two "daughter cells" that are exactly like the mother cell. Most human cells have two complete sets of 23 chromosomes. Before it divides, the mother cell makes a copy of each chromosome, meaning that the mother cell now has four complete sets of 23 chromosomes. After dividing, each daughter cell then receives two complete sets of chromosomes identical to the original mother cell.

Meiosis is another method of cell division for the production of sex cells. In meiosis, the mother cell first copies its chromosomes and divides to form two daughter cells. Next, the two daughter cells divide without first copying their chromosomes, forming four haploid cells, each with only one complete set of chromosomes. Sperm and egg cells are haploid cells with only one complete set of chromosomes. Only when they meet and fuse will they result in a "zygote" with two complete sets of chromosomes. When the zygote begins to divide (through mitosis) into billions of cells, a baby forms.

The cell membrane is the outermost layer of the *E. coli* bacterium. The *E. coli* bacterium does not have a "true" nucleus, which means that its genetic material is not bound by a membrane. Instead, it has a nucleoid region where the DNA is commonly found. The cytoplasm fills the interior of the *E. coli* bacterium.

Besides the nucleus, the cytoplasm of a cell contains other cell parts, such as mitochondrion, vacuole and ribosome. The mitochondrion is the powerhouse of a cell and can package the energy of food into ATP molecules. The vacuole contains water, dissolved minerals and wastes. The ribosome is a structure that makes proteins.

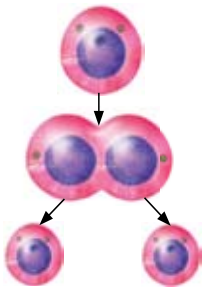
No, not all animal cells have a nucleus. For example, the red blood cell does not have a nucleus.

When cells grow old, they die.

Cancer occurs when cells in our body become abnormal. These abnormal cells destroy other normal cells that surround them. Cell growth in both children and adults can cause cancer to spread to other parts of the body. This is especially fast in children who are still in the process of growing into adults. To find out more about cancer, visit the Singapore Cancer Society's website at www.singaporecancersociety.org.sg.

Xtra

New cells are produced by **cell division**. Cell division allows cells to multiply.

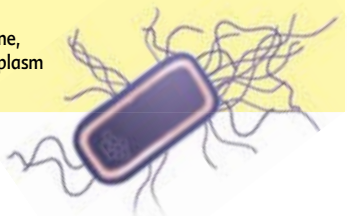


When we grow, we increase in size due to an increase in the number of cells in our body through cell division.

Organisms made of only one cell such as bacteria and some algae also multiply by cell division. The new cells produced are identical to the original cell.

Building Block

Identify the cell membrane, the nucleus and the cytoplasm of the *E. coli* bacterium.



Explore

- Other than the nucleus, the cytoplasm of a cell contains many other cell parts. Work in groups to find out more about these cell parts and their functions.
- Do all animal cells have a nucleus? Find out from the Internet.

Producing new cells

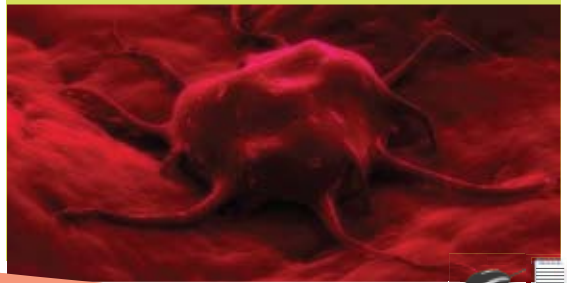
What happens when cells grow old?

Cells do not live forever. When cells are old, they die. Some cells get damaged too. New cells are produced to replace the dead or damaged cells. This takes place in our body all the time. Our skin cells can live for approximately three weeks while cells lining our intestines are replaced after every three days.

Some organisms, such as yeast, multiply by a special method called **budding**. In this process, a small bud grows from the original yeast cell. The bud gradually increases in size and then breaks away.

Explore

Do you know that cancer is a disease caused by a group of cells that grow and divide abnormally? Find out more about cancer from the Internet and write a one page report on this.



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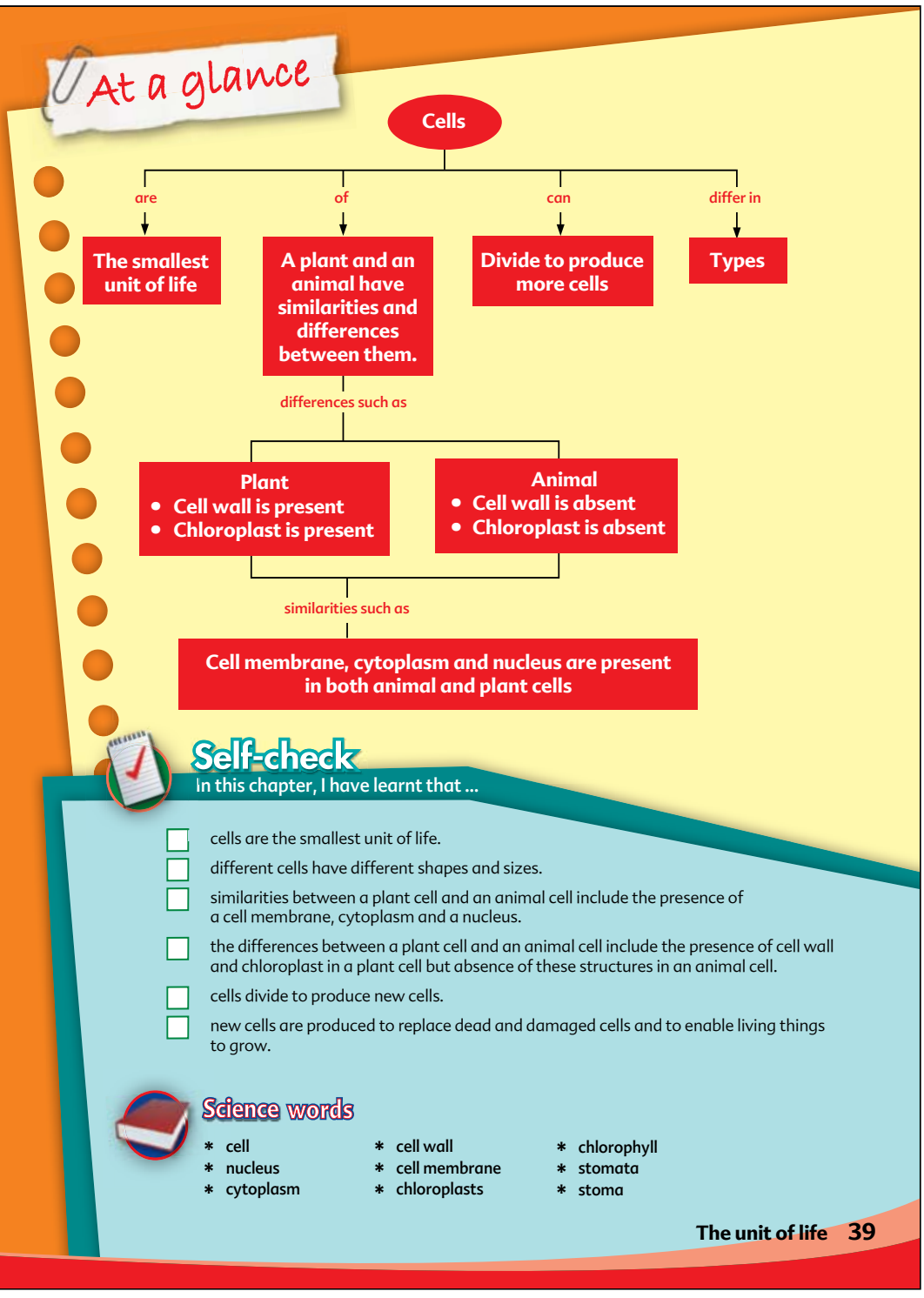
Common misconceptions

1. Misconception: As we grow, we increase in size because our cells become larger.
Actual fact: When we grow, our cells multiply and increase in number rather than in size. Larger mammals too, do not typically have bigger cells, they just have more of them.

Enrichment

As soon as cells wear out, they are replaced by new ones. Humans shed their outer skin and it re-grows about every 27 days. However, not all types of cells can be replaced. Unlike many types of cells, neurons or nerve cells cannot divide. Thus, when nerve cells die as a result of old age or injury, they cannot be replaced by cell division.



Concept map

Gives an overview of the concepts learnt in this chapter. Words in the boxes can also act as keywords to help pupils understand the link between different concepts within a chapter.

Self-check

Helps pupils to reinforce what they have learnt in the chapter and address syllabus requirements.

Science words

Words introduced in this chapter. These words can also be used as spelling words.

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Background information for teachers

Concepts commonly encountered in electrical circuits:
The electromotive force (emf) of a cell (battery) is the work done on a unit of charge to drive it through the cell. The higher the emf, the greater the energy gained by the charge, resulting in a greater current in the circuit. The potential difference (commonly known as voltage) between two points is the work done to move a unit of charge between two points in an electric field. Both emf and voltage are measured in volts (V).

The resistance of a material is the property that restricts the movement of charges in the material and is measured in ohms (Ω). The greater the resistance of a material, the smaller the current that passes through it.

The current in a circuit is the rate of flow of charges in the circuit and is measured in amperes (A). The amount of current in a circuit is affected by the cell's emf and the resistance of the circuit.

Access the following website to understand what happens when a battery is connected to a circuit: www.southerncompany.com/learningpower/activities.asp (Click Watered Down Electricity).

Common misconceptions

1. **Misconception:** A battery stores electricity.
   Actual fact: A battery stores chemicals, not electricity. The chemicals interact to produce electrons and the movement of these electrons results in an electric current or electricity.

2. **Misconception:** The bigger the battery size (D-sized compared to AAA-sized), the greater the current driven in the circuit.
   Actual fact: A D-sized battery can be of the same emf as an AAA-sized battery. The amount of current driven by the battery is determined by the resistance of the circuit, not by the size of the battery. The advantage of a larger battery is simply that it lasts longer before becoming "dead".

5 Electric circuits

Let's find out:

A. What is an electrical system made up of?
B. How can we construct a simple electric circuit?
C. When does an electric current flow in a circuit?

We use light very often, at home, in school, as well as in places such as the shopping mall. When we want to turn on a light, we usually press a switch and light will shine forth from a bulb.

- Can the bulb produce light on its own?
- What causes the bulb to shine?
- How does a switch cause a bulb to light up or go off?

No, the bulb needs to be connected to an energy source for it to produce light.

The bulb shines when its filament becomes very hot and begins to give off light.

When a switch is switched on, the circuit is closed and the bulb lights up. When the switch is switched off, the circuit is open and the bulb goes off.

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Enrichment

The voltage of batteries of different sizes, such as a D-sized battery, AA-sized battery and AAA-sized battery, can be the same and is usually at 1.5V. However, a D-sized battery provides electricity for a longer period than an AAA-sized battery as its larger size allows it to store more chemicals, which are "used up" as they interact.

Batteries contain chemicals that interact to produce electrons (electric current), which move from the negative terminal to the positive terminal of a battery. The chemicals differ depending on the type of battery. When the chemicals have completed their interactions or are "used up", they no longer supply electrons and there would not be an electric current. We say the battery is "dead". Some batteries, such as handphone or car batteries, can be recharged. Recharging involves the supply of an electric current to the battery from an external source to regenerate the original chemicals in the battery.

A. Electrical systems

An electrical appliance is made up of different parts connected together to form a system. Some of the parts are connected together to form an **electric circuit**. An electric circuit is a system because it is made up of **components** that work together. In every electrical appliance, there is an electric circuit. When electricity passes through its electric circuit, the electrical appliance will work.

Is an electric torch a system?

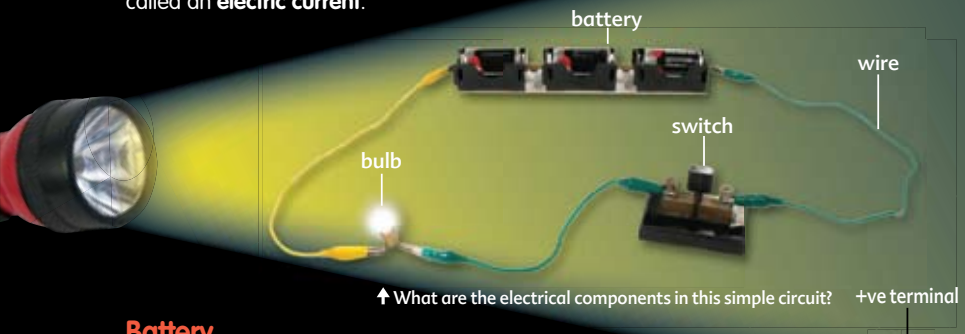
The torch is made up of a simple electric circuit similar to the one shown below. Hence, an electric torch is a system too. Each electrical component has its own function. When the components are connected together, electricity flows along the circuit and the bulb lights up. This flow of electricity is called an **electric current**.

Explore

Imagine you are going for an overnight camp at Pulau Ubin. What objects would you bring along that need batteries to work, like the MP3 player? Why?

Possible answers:
MP3 player — The MP3 player plays music to entertain us.
Torch — To light up the campsite.

Yes, an electric torch is a system because it is made up of several electrical parts such as batteries, wires, bulbs and switch that work together to allow the electric torch to function.



What are the electrical components in this simple circuit?

Battery

A **battery** has a **positive(+ve)** terminal and a **negative(-ve)** terminal. There are chemicals inside a battery. When the positive and the negative terminals are connected together, the chemicals react to produce energy. Hence, the battery is the **energy source** and it drives an electric current through an electric circuit.

Here are a few other types of batteries that we can find around us:


Used in handphones


Used in toys


Used in laptop computers


Used in cars

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Background information for teachers

The filament in a light bulb is housed in a sealed chamber filled with an inert gas, argon. Argon is chosen as it does not normally react with other elements, even at high temperatures. The filament is made of tungsten, a material with a high melting point. The filament is thin and coiled to increase its resistance so that more heat will be produced for light to be emitted.

Common misconceptions

1. **Misconception:** The gas found inside a bulb is air.
   Actual fact: A bulb is filled with an inert gas called argon, as it will not react with the filament at high temperatures, unlike air which supports combustion and causes oxidation of the filament.

2. **Misconception:** A bulb produces more light than heat.
   Actual fact: A bulb produces more heat than light. In an incandescent bulb, about 90–95% of the energy consumed is converted into heat energy, only 5–10% is converted into useful light energy. This wastes a lot of electricity. A fluorescent lamp is more energy-efficient than an incandescent bulb, but even then, it converts about 25–40% of consumed energy into light.

↑ These copper wires have a rubber covering. Why?

The rubber covering prevents electric current from flowing out of the wires and causing electric shocks to anyone touching the wires.

Xtra

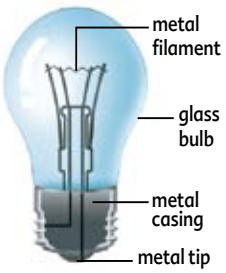
- Metal filament

  The metal filament is usually made of a metal called tungsten. When current flows through the metal filament, the metal filament glows and gives off light and heat.

- Glass bulb

  The metal filament is enclosed in a glass bulb. There is very little air inside the bulb, so that the metal filament does not burn up. The glass bulb also prevents the metal filament from being damaged.

- The metal casing and metal tip are the parts of the bulb which are connected to an electrical circuit.



Wire

Electrical wires are made of thin strands of metal. Most wires are made of copper. Wires are used to connect one electrical component to another. They allow electric currents to flow in a circuit. Most of the wires we see around us are insulated with a rubber covering.

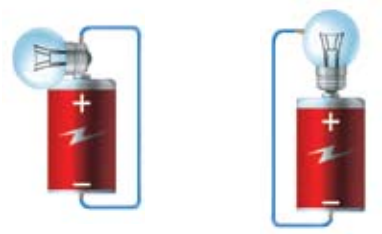
↑ Cables behind a computer. A cable consists of some wires wrapped together.

↑ Bare copper wire

Bulb

A bulb produces light and heat. In order for a bulb to light up, it has to be properly connected in a circuit.

↑ This bulb is lighted up because it is properly connected.



↑ These two bulbs cannot light up because they are not properly connected.

Activitiy 5.1

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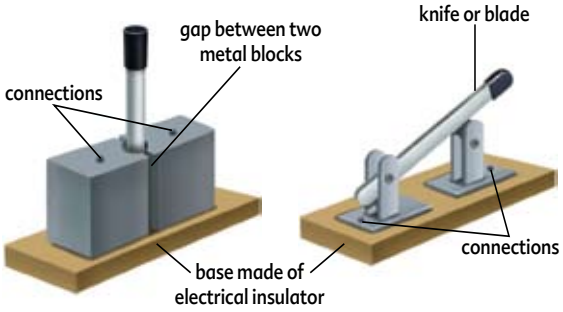
Enrichment

When does a bulb blow?
When a bulb is rated at 6V, it means that it will be lit to its maximum brightness when a potential difference of 6V is applied across it. If the potential difference across the bulb is too high, the filament will get too hot and melt. The bulb is said to have blown.

Switch

A **switch** controls electric current flow in a circuit. Electric current flows if the switch is on and the bulb will light up. Electric current stops flowing if the switch is off and the bulb will not light up.



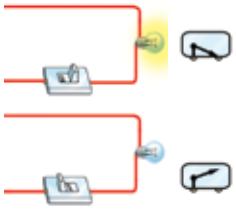
These are some examples of switches used in a school laboratory.

These are some examples of other switches found in our homes. Do you know where they are found at home?

Switches can mostly be found on the walls at home.

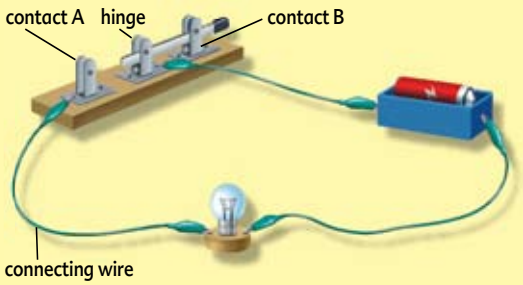
Xtra

The diagrams below show how a typical household wall switch works.



Building Block

What would you do to the switch to make the bulb light up?



Swing the metal blade in-between the hinge to the other side such that the blade is in contact with contact A.

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Background information for teachers

When a circuit is connected across the two terminals of a battery, the battery places an electric field across the components of the circuit. The free electrons start to drift towards the positive terminal of the battery under the influence of this field. These electrons constitute the current flow from the negative to positive terminal of the battery. However, the conventional current assumes that current flows from the positive terminal through the circuit to the negative terminal of the battery. This was the convention chosen during the discovery of electricity, which later, although proven wrong, is still the standard that most of the world follows.

Common misconceptions

1. Misconception: In an open circuit, the current will flow up to the point where the break in the circuit is, i.e. if a bulb is placed between the positive terminal of the battery and the gap, it will light up.

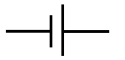
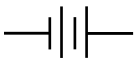
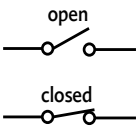
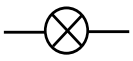
Actual fact: If there is a break in the circuit and there is no complete path for the electrons to flow, there will be no current at all in any part of the circuit.

2. Misconception: Electricity flows from positive to negative terminal of a battery.

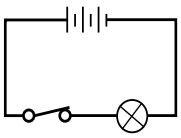
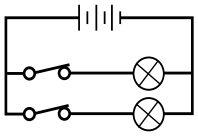
Actual fact: Electricity is a flow of electrons from the negative to the positive terminal of the battery. When electricity was first discovered, scientists believed that it was a flow of charges from the positive to the negative terminal of the battery. This conventional current flow has been used by many till now despite later discovery of the mistake.

B. Symbols in an electric circuit

The different parts of a circuit are represented by different **symbols**.

The actual component	Symbol of the components
	
	
	
	
	

To communicate what an electric circuit looks like, we use a circuit diagram to represent an actual electric circuit.

The actual component	Circuit diagram
	
	

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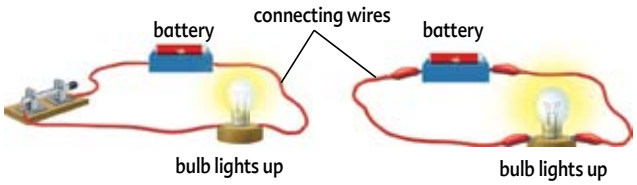
Enrichment

A short circuit allows a current to flow along a different path from the one intended as that chosen path offers little or no resistance. An example of a short circuit happening is when the positive and negative terminals of a battery are connected together with a low-resistance conductor, like a wire. With low resistance in the connection, a high current flows, causing the battery to deliver a large amount of energy in a short time. A short circuit produces a huge amount of heat and can potentially cause a fire.

C. Closed and open circuits

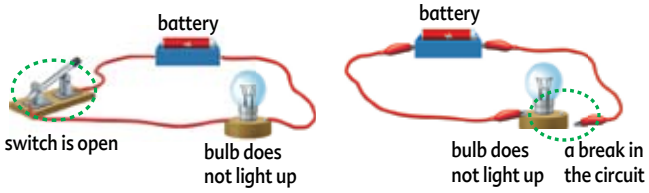
An electric current will only flow if the components in an electric circuit form a complete path without any gaps. A circuit through which electric current can flow is called a **closed circuit**. Circuits A and B below are closed circuits. The bulbs light up because electric current flows in the circuits.



Circuit A: All the components are properly connected. The switch of this circuit is closed. The bulb lights up because electric current can flow in the closed circuit.

Circuit B: There is no switch in this circuit but the components are properly connected. Electric current can flow and so the bulb lights up.

Electric current will not flow through a circuit if there are gaps between the electrical components. A circuit through which electric current cannot flow is called an **open circuit**. Circuits C and D below are open circuits. The bulbs do not light up because electric current is not flowing in the circuits.



Circuit C: The switch of this circuit is off. The circuit is open. No electric current flows in this circuit and so the bulb does not light up.

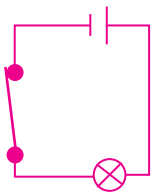
Circuit D: The wire is not connected to the bulb. The circuit is open. No electric current flows in this circuit and so the bulb does not light up.

Explore

Now that you have learnt about constructing simple circuits, try to make your own flashlight with some simple materials.

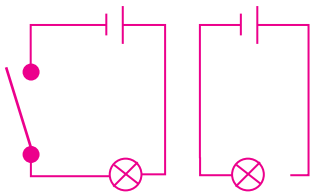
Can you draw circuit diagrams for circuits A to D?.

Circuit A



Circuit B

Circuit C



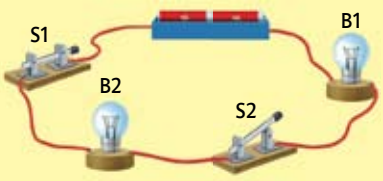
Circuit D

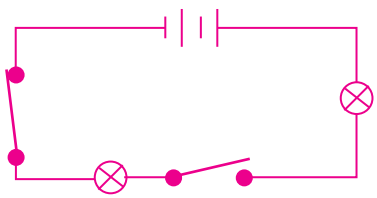
Activitiy 5.2

Building Block

Draw the circuit diagram for the circuit on the right.

The bulbs B1 and B2 in this diagram do not light up. Why? How would you make both bulbs B1 and B2 light up?





S2 is not closed properly.

B1 and B2 can be lighted up by closing S2 properly.

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Concept map

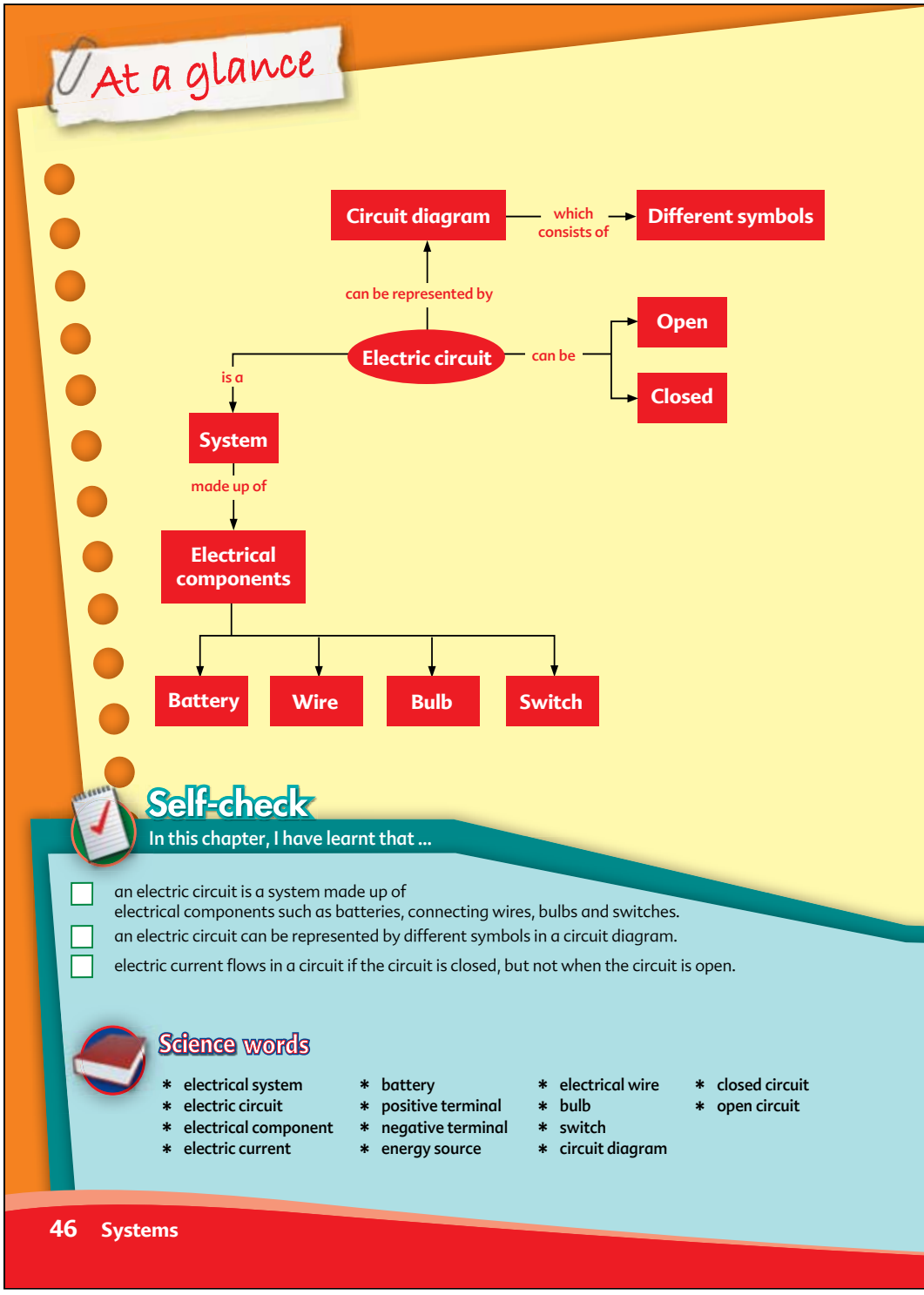
Gives an overview of the concepts learnt in this chapter. Words in the boxes can also act as keywords to help pupils understand the link between different concepts within a chapter.

Self-check

Helps pupils to reinforce what they have learnt in the chapter and address syllabus requirements.

Science words

Words introduced in this chapter. These words can also be used as spelling words.



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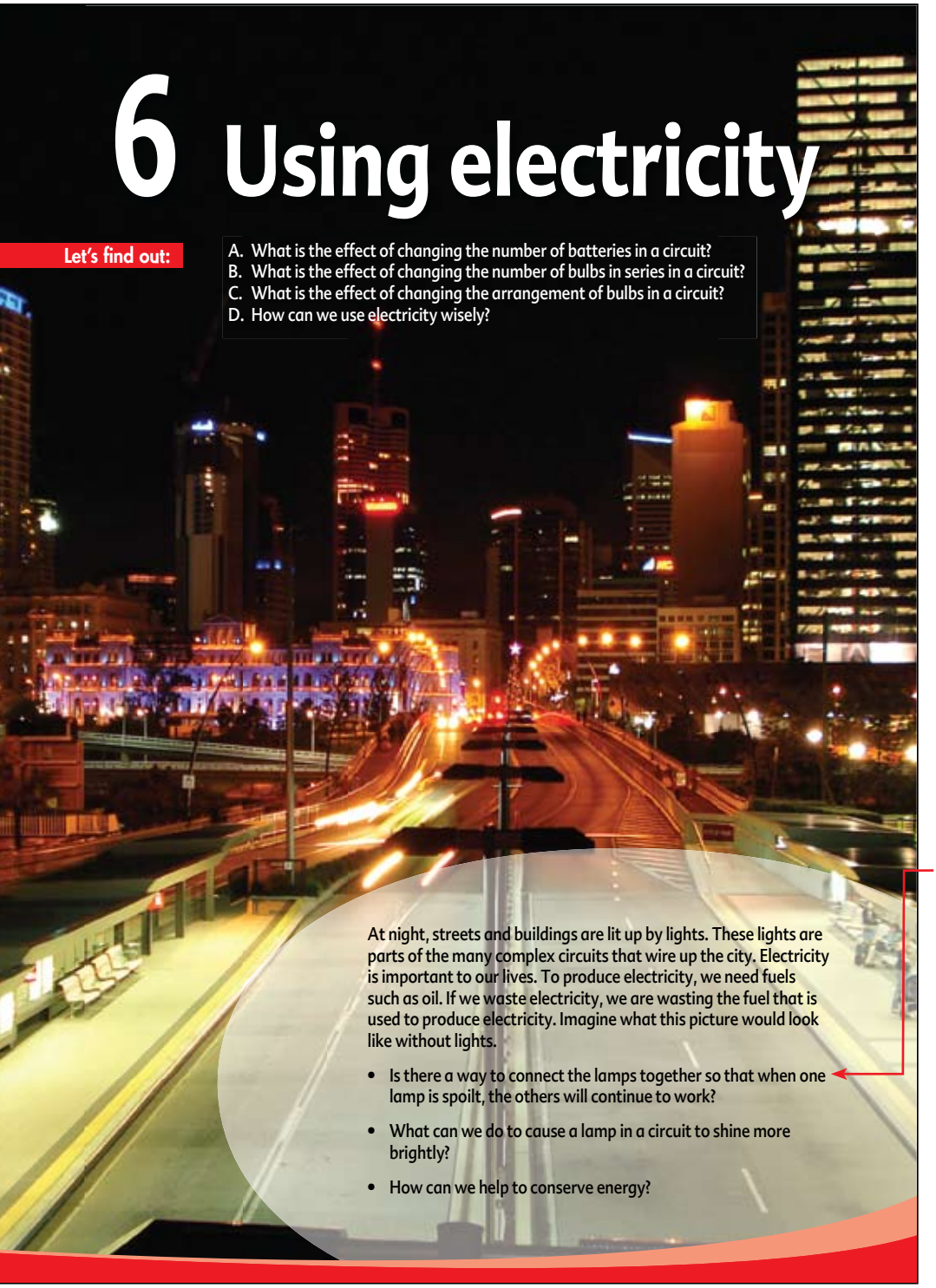
6 Using electricity

Let's find out:

A. What is the effect of changing the number of batteries in a circuit?
B. What is the effect of changing the number of bulbs in series in a circuit?
C. What is the effect of changing the arrangement of bulbs in a circuit?
D. How can we use electricity wisely?



At night, streets and buildings are lit up by lights. These lights are parts of the many complex circuits that wire up the city. Electricity is important to our lives. To produce electricity, we need fuels such as oil. If we waste electricity, we are wasting the fuel that is used to produce electricity. Imagine what this picture would look like without lights.

- Is there a way to connect the lamps together so that when one lamp is spoilt, the others will continue to work?
- What can we do to cause a lamp in a circuit to shine more brightly?
- How can we help to conserve energy?

Connect the lamps in parallel arrangement to allow other lamps to continue to work.

Increase the number of batteries (in a series arrangement) to cause a lamp in a circuit to shine more brightly.

Do not waste electricity — We should switch off the electrical appliances when we do not use them. We should use more efficient electrical appliances, for example, energy saving bulbs.

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Background information for teachers

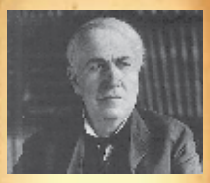
When a number of batteries are connected in series, the total emf is the sum of the emfs of the individual batteries. To light up a bulb rated at 6V to its maximum brightness, for example, four batteries of 1.5V each, connected in series, are needed. On the other hand, when two or more batteries of 1.5V each are connected in parallel, the total emf is still 1.5V.

Common misconceptions

1. Misconception: The batteries in a battery holder for four batteries are aranged in parallel as there are two side-by-side compartments.

Actual fact: The four batteries are in fact arranged in series. To check, trace the path of electricity. The design of the battery holder is so that the batteries can be arranged in a more compact manner.

Super Scientist

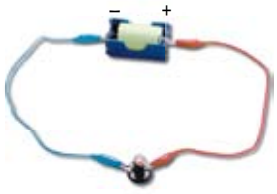


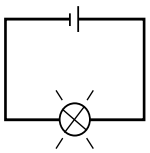
Thomas Edison (1847-1931) invented more than 1,000 things, but he is probably most famous for inventing the light bulb. This invention did not come easily. Edison actually tested more than 3,000 metal filaments before deciding on his version of the practical light bulb. Edison's hard work and persistence finally paid off.

A. Number of batteries in series

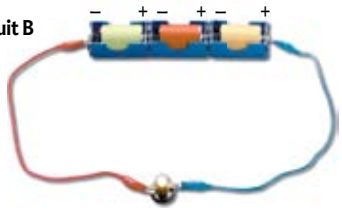
Study circuits A and B. Compare the brightness of the bulbs in the circuits. Which bulb lights up brighter? What do you think is the cause?

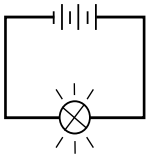
Circuit A





Circuit B

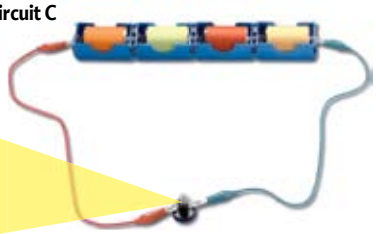




If more batteries are connected to the circuit, the brightness of the bulb increases. Look at circuit B. Observe how three batteries are connected together. The positive terminal of one battery is in contact with the negative terminal of another battery. These batteries are arranged in a **series** connection.

When a bulb is blown, its metal filament melts and it will not light up.

Circuit C



As the number of batteries increases, more electric current flows through the bulb and causes the bulb to light up more brightly. However, if too many batteries are used, too much electric current flows and the bulb might blow, or we can say the bulb is **fused**. This happens in circuit C.

Activity 6.1

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Common misconceptions

1. Misconception: When bulbs are connected in series, the bulb nearest to the positive terminal of the battery will be lit brighter than the one furthest away. This is because current is "used up" along the way.

Actual fact: When a few bulbs are connected in series, the current in the circuit will be lower than the current in a circuit with one bulb. However, the same current will pass through each of the three bulbs to light them up to the same brightness as current does not get used up.

Enrichment for high ability pupils

A bulb offers resistance to the current flow in a circuit. When more bulbs are connected in series, they offer a greater resistance (total resistance is equal to the sum of the individual resistances), thus the current flow which is inversely proportional to resistance, will decrease accordingly.

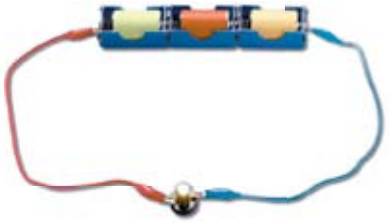
B. Number of bulbs in series

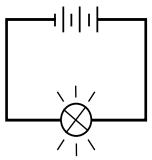
How does the number of bulbs in a circuit affect the brightness of the bulbs?

The bulbs will light up less brightly if the number of bulbs (in series) in a circuit is increased. If too many bulbs are connected to the circuit, they may not light up.

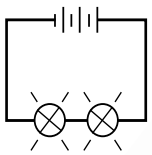
Study circuits D and E. How are they different? Compare the brightness of the bulbs in each circuit.

Circuit D





Circuit E



The bulbs in circuit E are less bright than the one in circuit D.

Note that the bulbs in circuit E are connected one after another in the circuit. These bulbs are arranged in a **series** connection. If more bulbs are connected in series without increasing the number of batteries, the brightness of the bulbs will decrease. This is because of the decrease in the current flowing through the bulbs. A decrease in current flow causes the brightness of the bulbs to decrease.

Activity 6.2

Xtra

Fluorescent lights are quite common these days. They seem to be able to produce a special, bright light and yet not become extremely hot. This is mainly due to the presence of a substance known as phosphor, which gives off light when it is exposed to light. Fluorescent light tubes usually have a layer of phosphor powder coating.

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Background information for teachers

High-energy usage household appliances include oven, microwave, clothes dryer, water heater, automatic dishwasher and refrigerator (because it is switched on all the time). Generally, the home appliances that are used to create heat use the most energy. We can reduce the energy usage of home appliances by using them wisely and by replacing older, out-of-date models with newer, energy-efficient ones. For example, replacing an inefficient air-conditioning unit will help save a lot of energy and money. When purchasing new home appliances, we can compare their power ratings (in watts or kilowatts). The higher the power rating, the greater the power or energy consumed.

Common misconceptions

1. Misconception: Two bulbs connected in series in a circuit will be brighter than two bulbs connected in parallel because the bulbs in series have to share the current in the circuit, whereas the bulbs in parallel do not.

Actual fact: The two bulbs in parallel will be brighter than the two bulbs in series if the same battery is used, as the total resistance of the first arrangement is much lower than that in the second arrangement, resulting in a greater current flow in the circuit.

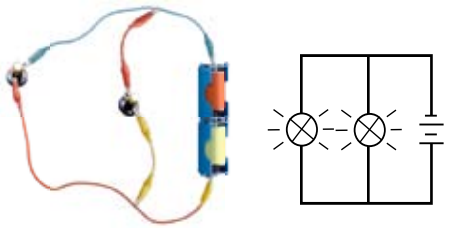
C. Arrangement of bulbs in series and in parallel

If we change the arrangement of the bulbs in a circuit, will their brightness be affected?

Study circuits F and G. Note the difference in the arrangement of the bulbs. Compare the brightness of the bulbs in each circuit.

Circuit F

Circuit G



↑ The bulbs in circuit G are brighter than the bulbs in circuit F.

Circuits F and G have the same number of batteries and bulbs. The bulbs in circuit F are connected in series. The bulbs in circuit G are connected in **parallel**. The bulbs arranged in parallel light up more brightly than the bulbs arranged in series.

What can affect the brightness of a bulb in a circuit?

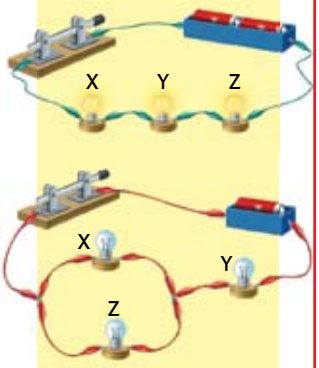
The brightness of a bulb in a circuit depends on the amount of electric current flowing through it. The amount of electric current flowing through the bulbs in a circuit is affected by the:

- number of batteries
- number of bulbs
- arrangement of bulbs

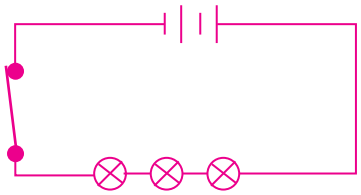
Activity 6.3

Building Block

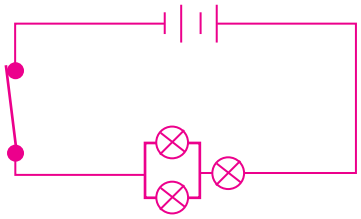
Draw the circuit diagrams of the circuits shown below. What will happen to the other bulbs if bulb X in each circuit blows suddenly?



First circuit



Second circuit



The bulbs in the first circuit will not light up. Bulbs Y and Z in the second circuit with continue to light up.

Yes, bulbs arranged in parallel will light up more brightly than bulbs arranged in series.

↑ If one of the fluorescent lights in your classroom blows out, the others would continue to be lit. Are these lights connected in series or in parallel?

The number of batteries, the number of bulbs and the arrangement of the bulbs can affect the brightness of a bulb in a circuit.

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Enrichment for high ability pupils

To move electricity to homes, we channel the electricity from the power station over transmission wires. Transmission wires operate at high voltages — up to 500,000V — to travel long distances with minimum loss of energy. Since the mains voltage in your home is at 240V, the electricity must be "stepped down" before it comes into your home. The process of stepping up electricity for travel, or down for use, is carried out by devices called transformers.

D. Saving energy

Electricity is useful because it makes electrical appliances work. With electrical appliances, our lives become more comfortable and convenient.

Our daily activities are greatly dependent on electricity.

Explore

Do you know how much we depend on electricity? Look around your classroom and imagine what it would be like if there is no electricity.

Where do we get electricity from?

You have learnt that batteries provide us with electricity. In our homes, there are also power points into which we push in a plug to get electricity.

Electricity is produced in a power station and reaches our homes through underground cables.

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Background information for teachers

Power stations may depend on a variety of fuels, such as coal, natural gas, oil, biomass, nuclear materials, to generate electricity, coal being the most abundantly used. Power stations may also make use of hydropower, wind, solar and geothermal sources. In power generation that involves combustion, fuels such as coal are burnt in a large furnace that heats water into steam. The steam is then used to turn turbine blades that spin electric generators. Through electromagnetic induction, electricity is produced.

Enrichment for high ability pupils

1. Assign pupils the task of comparing the energy consumption and cost of using the air-conditioning system versus the electric fan at home.
2. Pupils are to find out the power ratings of the two appliances in kilowatts (To convert watts to kilowatts, divide by 1,000).
3. Next, get pupils to find out from their parents the rate of electricity usage per kilowatt hour from their electricity bills (about $0.24 per kWh).
4. Pupils then calculate the energy consumption in kWh by taking the product of the power of the appliance (in kW) and the number of hours it is used (e.g. 8 h when we sleep).
5. The energy consumption multiplied by the rate will give the cost of using the appliance.
6. Get the pupils to compare the cost difference between using the electric fan and the air-conditioning unit.

We need to conserve energy to ensure that fuels such as coal and gas can last for a long time. Energy conservation also helps to reduce pollution and global warming.

Switch off electrical appliances when not in use. Use a fan instead of an air-conditioner. More ways can be found on the following website: www.e2singapore.gov.sg/esf-computer.html

National Education

Electricity is the most common form of energy we use. Electricity is not free and it costs money to produce. The power stations in Singapore use coal to produce electricity and coal is imported from other countries. Wasting electricity is wasting money.

Some appliances such as computers and televisions have a 'standby' mode. When we leave appliances in this mode, a small amount of electricity is still being used. If every household and office makes an effort to switch off these appliances, we can make a significant effort in conserving electricity.

Explore

Think of other possible ways to save electricity at home and in school. Share them with your class.

Using electricity wisely

We are often reminded not to waste electricity. Why is there a need to conserve electricity?

The electricity we use at home comes from power stations. In Singapore, fuels such as coal and oil are burnt in power stations to produce electricity. The coal and oil on Earth will not last forever. Burning fuels also causes harm to the environment because they produce air pollutants and greenhouse gases. The more electricity we use, the more coal and oil we have to burn. So by using less electricity, fuel will be burnt at a slower rate.

There are many things we can do to conserve electricity. Let us see how Sue's family does it.

We use energy saving bulbs instead of filament bulbs. They use less electricity and keep our electricity bill low.

I remind the children not to open the door of the refrigerator unnecessarily. Each time the door is opened, more electricity is needed to cool the refrigerator.

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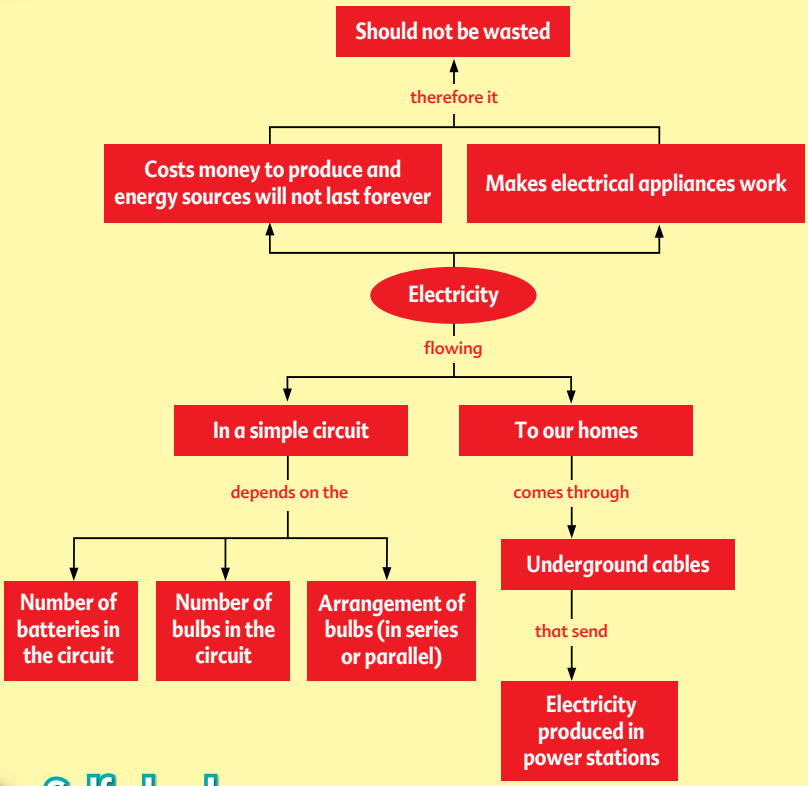
At a glance



Self-check

In this chapter, I have learnt that ...

- [ ] changing the number of batteries in a circuit affects the brightness of the bulbs.
- [ ] a simple circuit with two bulbs and an electric source can be arranged in series or in parallel.
- [ ] changing the number and arrangement of bulbs in a circuit affects the brightness of the bulbs.
- [ ] electricity is useful and energy needs to be conserved.

Science words

* series
* parallel
* fluorescent light
* power station
* underground cables
* conserve electricity
* fuse

Concept map

Gives an overview of the concepts learnt in this chapter. Words in the boxes can also act as keywords to help pupils understand the link between different concepts within a chapter.

Self-check

Helps pupils to reinforce what they have learnt in the chapter and address syllabus requirements.

Science words

Words introduced in this chapter. These words can also be used as spelling words.

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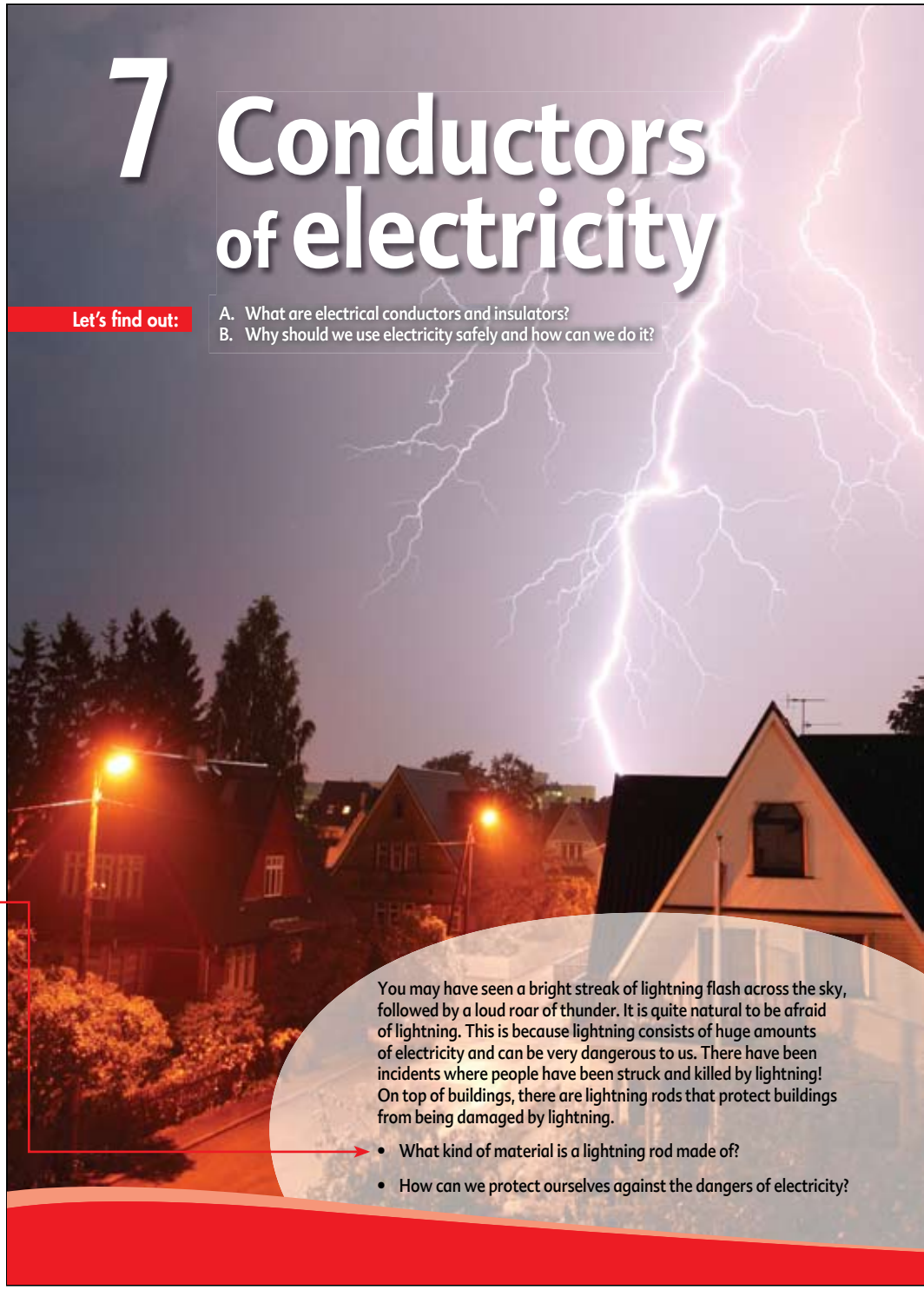
Background information for teachers

Most atoms hold on to their electrons tightly so that the electrons cannot move easily between atoms within the material. These materials have high resistance and are insulators. In metals, the outermost electrons of the atoms are loosely bound and free to move through the material. They have low resistance and make good conductors of electricity. Silver is the best conductor. Copper is almost as good at conducting as silver, and it costs a lot less, so copper is the most popular material used in electrical wires. A third category of materials allows some but not many electrons to pass through. These semi-conductors, with neither high nor low resistance, are often used in computer and photovoltaic technologies.

7 Conductors of electricity

Let's find out:

A. What are electrical conductors and insulators?
B. Why should we use electricity safely and how can we do it?



You may have seen a bright streak of lightning flash across the sky, followed by a loud roar of thunder. It is quite natural to be afraid of lightning. This is because lightning consists of huge amounts of electricity and can be very dangerous to us. There have been incidents where people have been struck and killed by lightning! On top of buildings, there are lightning rods that protect buildings from being damaged by lightning.

- What kind of material is a lightning rod made of?
- How can we protect ourselves against the dangers of electricity?

A lightning rod is made of a material that is a conductor of electricity.

Answer varies. Do not stand in an open field during a thunderstorm, do not play with electrical sockets at home, do not operate switches with wet hands.

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Common misconceptions

1. Misconception: Only solids like metals are conductors of electricity.
Actual fact: Although most familiar conductors are metals, certain liquids such as solutions of salts (e.g. salt water) and acids, also allow electrons to pass through easily. Pure water does not conduct electricity, but impure water does.

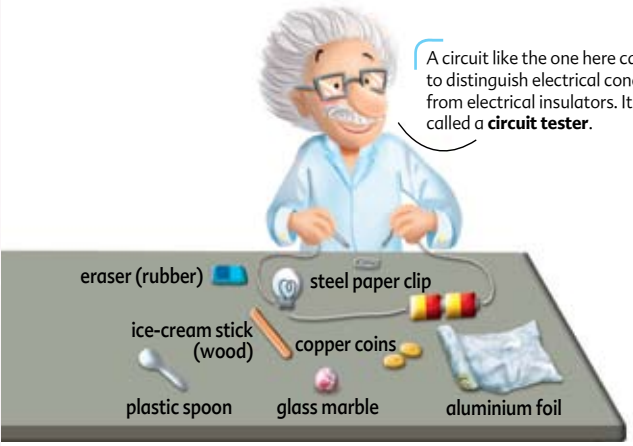
Enrichment

Lightning occurs as a result of a static charge build-up in a storm cloud. When the electric field surrounding a cloud becomes very strong, the air surrounding the cloud becomes conducting. This makes charge transfer (in the form of a lightning bolt) from the cloud to the ground possible. A grounded lightning rod is attached to a building to protect the building in the event of a lightning strike. It gathers charges and leads them safely through an alternative path of little resistance to the ground.

A. Conductors and insulators

What are electrical conductors and insulators?

Electrical conductors are materials that allow electricity to flow through them easily. Electrical insulators are materials that do not allow electricity to flow through them.



A circuit like the one here can help to distinguish electrical conductors from electrical insulators. It is called a **circuit tester**.

When the steel paper clip is connected to the wires, the bulb lights up. This is because steel can conduct electricity. This means it allows an electric current to flow through it easily.

However, when Dr Atom connects the eraser to the circuit, the bulb does not light up. This is because rubber does not conduct electricity. This means it does not allow an electric current to flow through it easily.

Materials that allow electric current to flow through easily are called **electrical conductors**. Materials that do not allow electric current to flow through them are called **electrical insulators**. Examples are glass, wood and plastic.

Electrical conductors: steel paper clip, copper coins, aluminium foil
Electrical insulators: eraser (rubber), ice-cream stick (wood), plastic spoon, glass marble

Explore

Construct a circuit like the one Dr Atom has. Use it to classify the materials into electrical conductors and insulators.

Metal is a good conductor of electricity as well as heat. This metal paper clip feels hot when it is placed in a cup of hot water. This is because metal conducts heat.

Activity 7.1

Flashback

Non-living things can be classified according to their properties. One of these properties is whether the material allows electricity to pass through it easily.

Super Scientist

Italian Luigi Galvani made an interesting discovery while performing an experiment on a frog. He noticed that when the dead frog was touched by electricity, it kicked like a living frog. The experiment has made observant Galvani the first to discover that movement in living things is related to electricity.

Building Block

Why are metal wires covered with rubber or plastic?

This is to prevent electricity from flowing to the hand and causing an electric shock.

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Background information for teachers

Some dangers of electricity:

- Damaged insulation whereby the live wire (carrying a high voltage of 240V) is exposed because the electrical insulation has worn out.
- Overheating of cables due to short circuit or overloading (which happens when too many appliances are simultaneously drawing current from the mains).
- Damp conditions whereby electrical appliances are in contact with water.

Enrichment

Most home appliances operate using the mains voltage which is as high as 240V. Be very careful when handling appliances that need mains electricity because as small as a current of 0.2A through our body may kill. Some safety devices to protect us against the dangers of electricity include:

Fuse — When a fault or overloaded current flows through it, it gets hot and melts when the current exceeds an acceptable level. This breaks the circuit, disconnecting the faulty circuit. A fuse must be replaced each time it burns out.

Circuit breaker — This automatically switches off a circuit if there is a fault. When it trips, we can simply reset the switch.

Use electrical appliances with timers so that they can switch off on their own. Before we pull a plug out of a socket, the switch must be switched off.

We should not:

- touch switches with wet hands;
- overload a socket with too many plugs;
- use electrical appliances with exposed wires to prevent electric shocks;
- use electrical tools without a handle that is made of an electrical insulator.

Explore

What other ideas do you have about using electricity safely? Share your ideas with your friends.

B. Using electricity safely

Electricity is useful to us. However, it can cause us harm if we are not careful when using it.

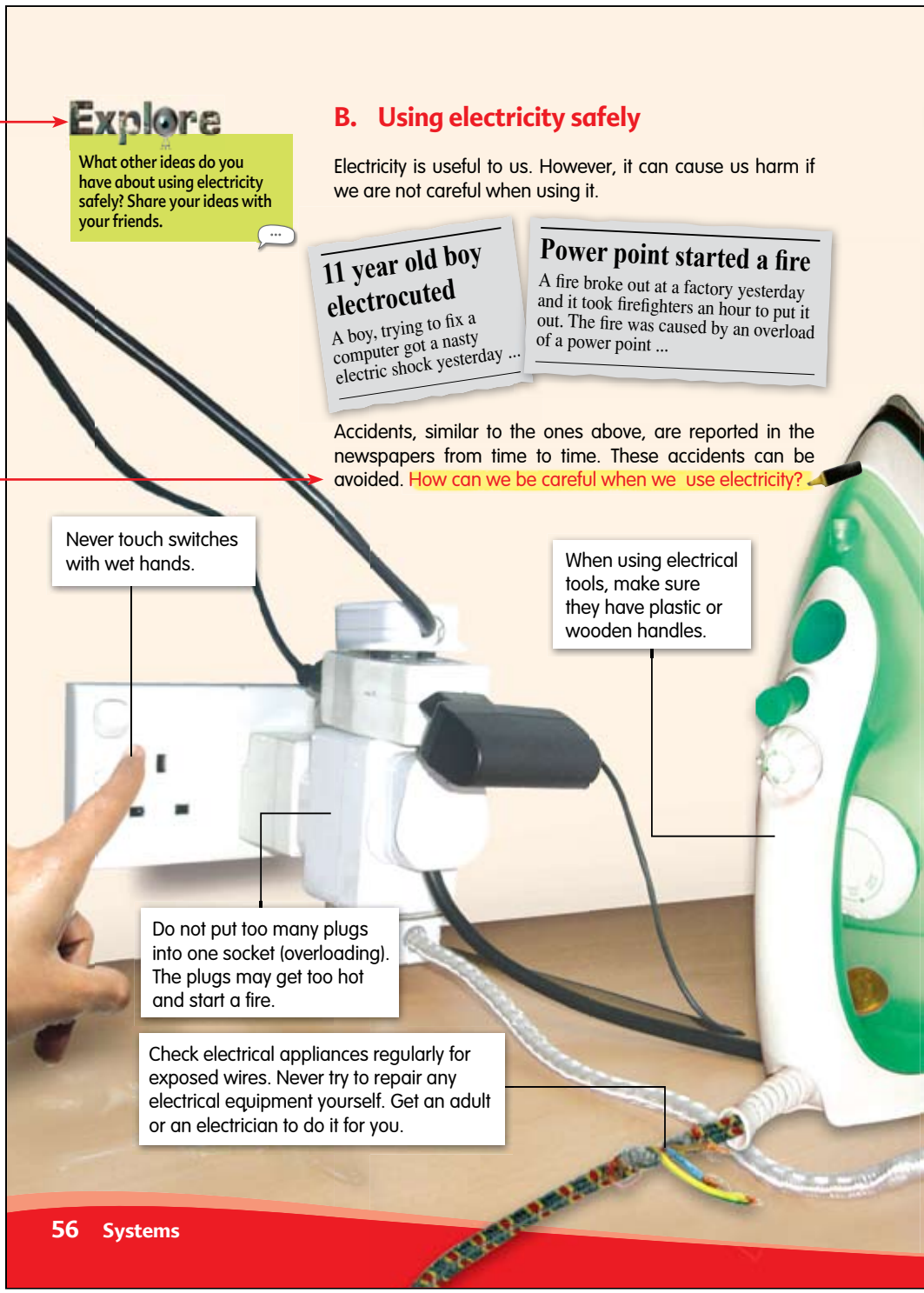
11 year old boy electrocuted

A boy, trying to fix a computer got a nasty electric shock yesterday ...

Power point started a fire

A fire broke out at a factory yesterday and it took firefighters an hour to put it out. The fire was caused by an overload of a power point ...

Accidents, similar to the ones above, are reported in the newspapers from time to time. These accidents can be avoided. How can we be careful when we use electricity?



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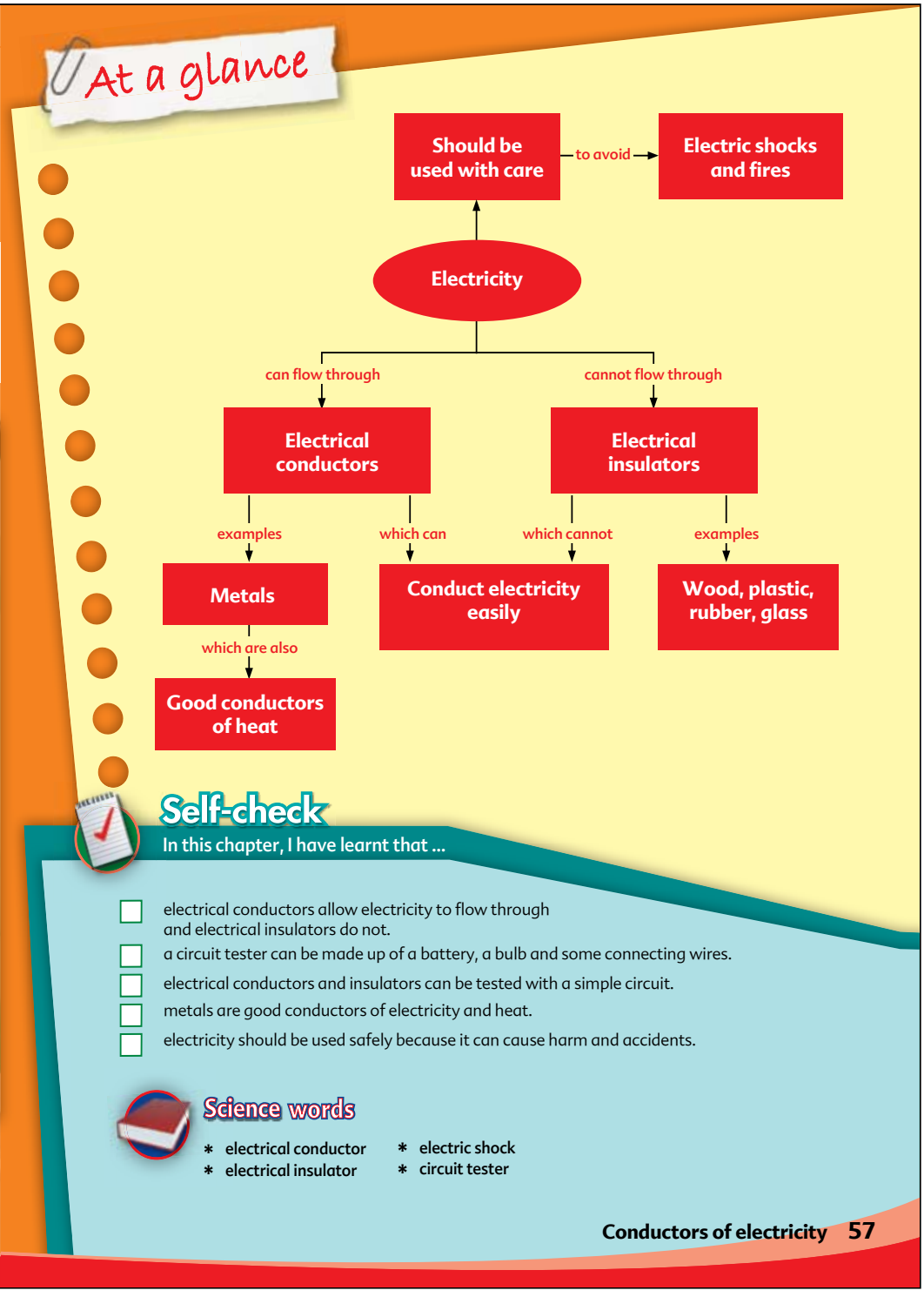
Common misconceptions

1. Misconception: It is safe to touch electrical components inside appliances that are switched off.
Actual fact: There are electrical components called capacitors (in television sets or video monitors) that will retain dangerous amounts of charges even when the appliance has been switched off. When touched, the charges flow through your body to the ground, giving you an electric shock.



Concept map

Gives an overview of the concepts learnt in this chapter. Words in the boxes can also act as keywords to help pupils understand the link between different concepts within a chapter.

Self-check

Helps pupils to reinforce what they have learnt in the chapter and address syllabus requirements.

Science words

Words introduced in this chapter. These words can also be used as spelling words.

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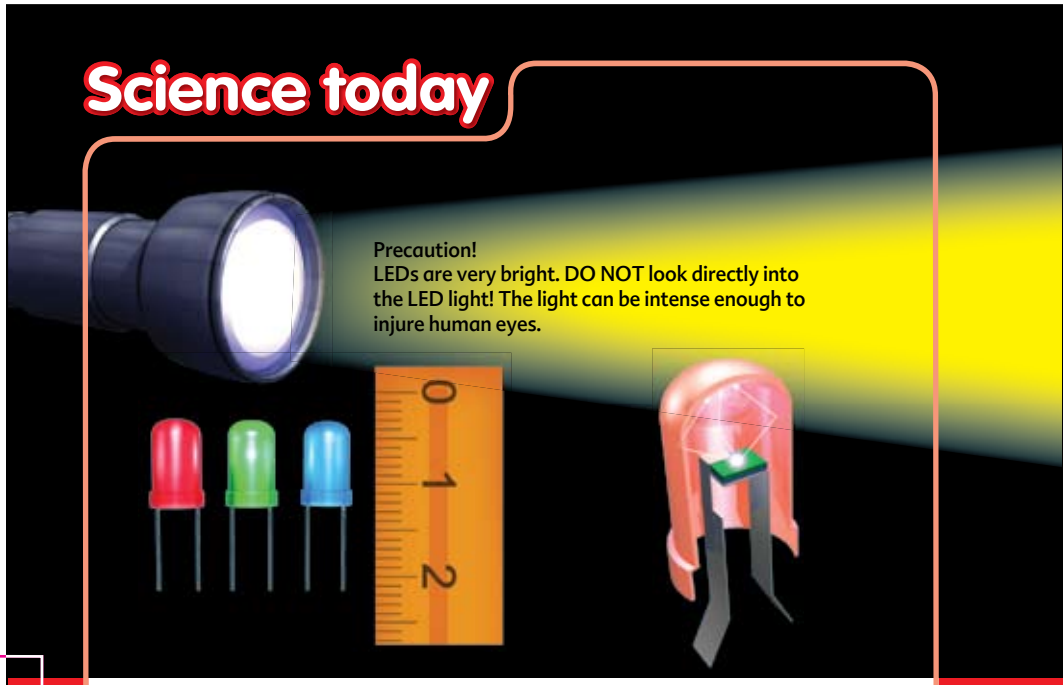
Science today



LED — A brighter future

This is an LED flashlight. It is different from the conventional flashlights that make use of filament light bulbs. "LED" stands for "light emitting diode". Besides being used in flashlights, LEDs are also used in remote controls, traffic lights, brake-lights and many electronic devices.

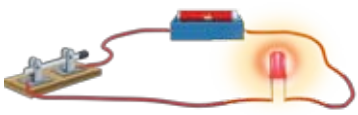
An LED consists of a plastic casing with a small piece of material which may produce light when electricity passes through it.

LEDs have several advantages over ordinary light bulbs. Firstly, they last much longer because they do not have metal filaments that burn out. Secondly, because they are small, cooling fans can fit inside small modern electrical appliances. Thirdly, LEDs use electricity more efficiently. They require less energy than light bulbs. Most of the electricity is converted to light in LEDs. LEDs are thus more cost effective. In the future, they will play a bigger role in our lives.

Discussion Zone

1. What can LEDs be used for?
2. Draw a three-dimensional diagram of a closed circuit that consists of an LED, a switch, and a battery.
3. (a) State the energy conversion that takes place when electricity passes through a filament bulb.
   (b) State the energy conversion that takes place when electricity passes through an LED.
4. What are the advantages of using LED lamps over the normal light bulbs?
5. Are LED lamps friendly to the environment? Why?

1. LEDs can be used in flashlights, remote controls, traffic lights, brake-lights and other electronic devices.

2. 

3. (a) Electrical energy changes to heat and light energy
   (b) Electrical energy changes to heat and light energy

4. LED lamps are more efficient compared to normal light bulbs because most of the electricity is converted to light and less is wasted as heat.

5. Yes. They use less energy than light bulbs (to produce the same brightness of light). By using less energy, they are more environment-friendly.

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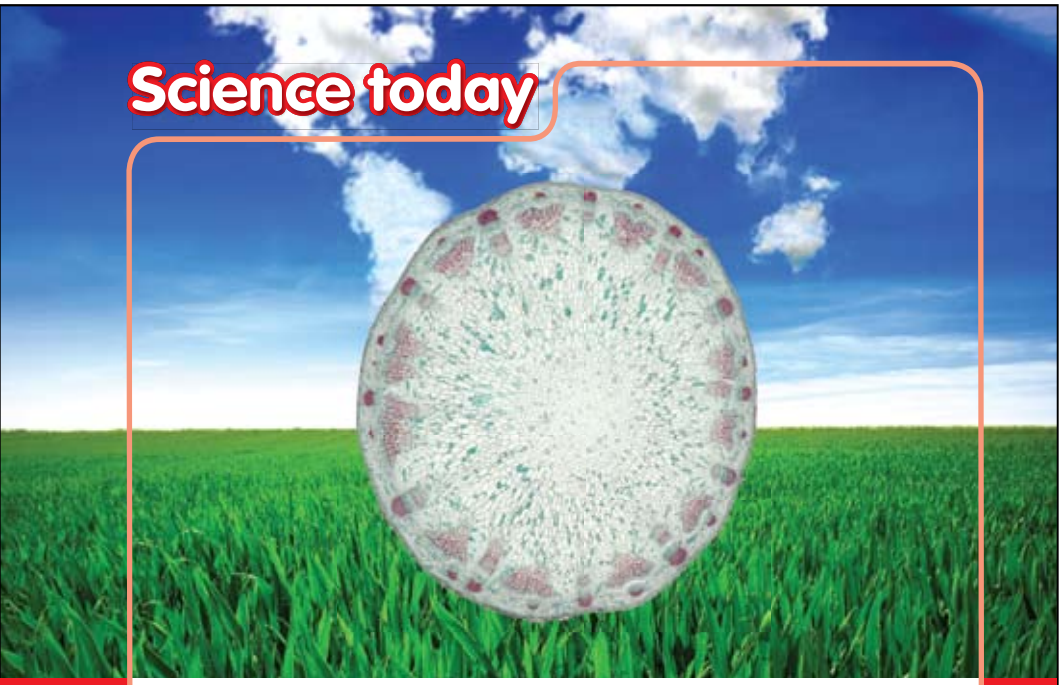

Science today

How do plants move sugars?

In 1991, Robert Turgeon, a professor of plant biology, proposed a theory to explain how plants transport sugars from their leaves to other parts of the plant. The theory first describes the movement of simple sugars from the leaves into the food-carrying tubes. Next, simple sugars in the food-carrying tubes combine to form larger sugars. These larger sugars are too big to flow back into the leaves. Hence, they are transported to other parts of the plant where they may be used or stored. Turgeon finally proved this theory with the use of genetic engineering techniques.

In addition, photosynthesis slows down as more simple sugars form and collect in the leaves. As a result, the plant takes in less carbon dioxide from the air. However, when simple sugars are moved out of the leaves, photosynthesis speeds up and the plant takes in more carbon dioxide from the air.

In fact, it was suggested that photosynthesis may speed up if the food-carrying tubes could be made to move simple sugars out of the leaves at a faster rate. This might be important in an era of global warming.

Discussion Zone

1. "... they are then moved to other parts where they may be used or stored..." Give examples of the "other parts".
2. "This might be important in an era of global warming." Explain how the findings are important to the environment.

1. Stems, roots, fruits, seeds and flowers.

2. If the rate of photosynthesis is increased, more carbon dioxide will be taken in and more oxgen given out by plants. This will reduce the level of greenhouse gases that contribute to global warming.

Note: This article shows that a theory can only be proven true after many years of research and extensive experimentation.

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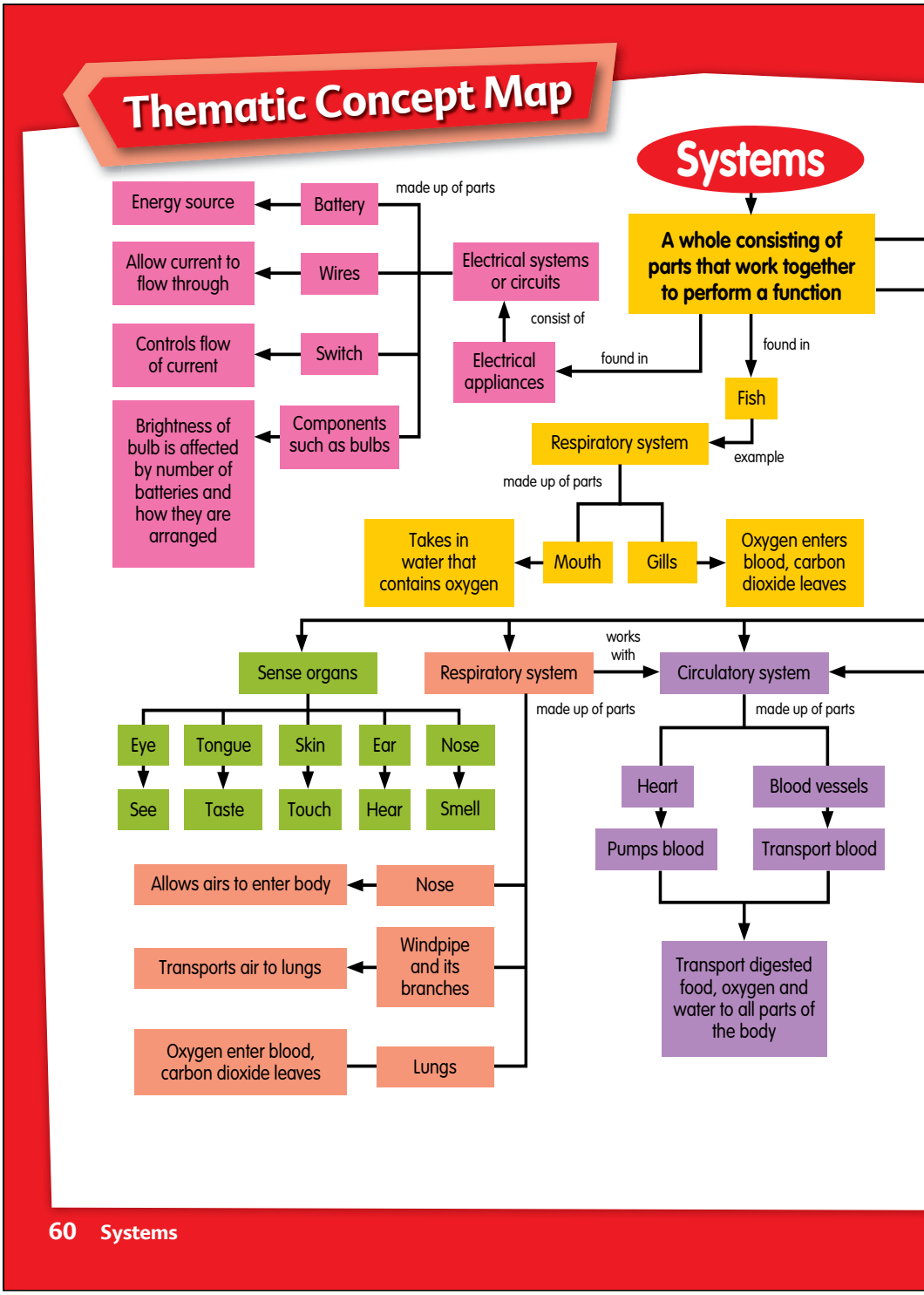
Thematic concept map

Gives an overview of the concepts learnt in this theme. Words in the boxes also act as keywords to help pupils understand the link between different concepts across all chapters in the systems theme.



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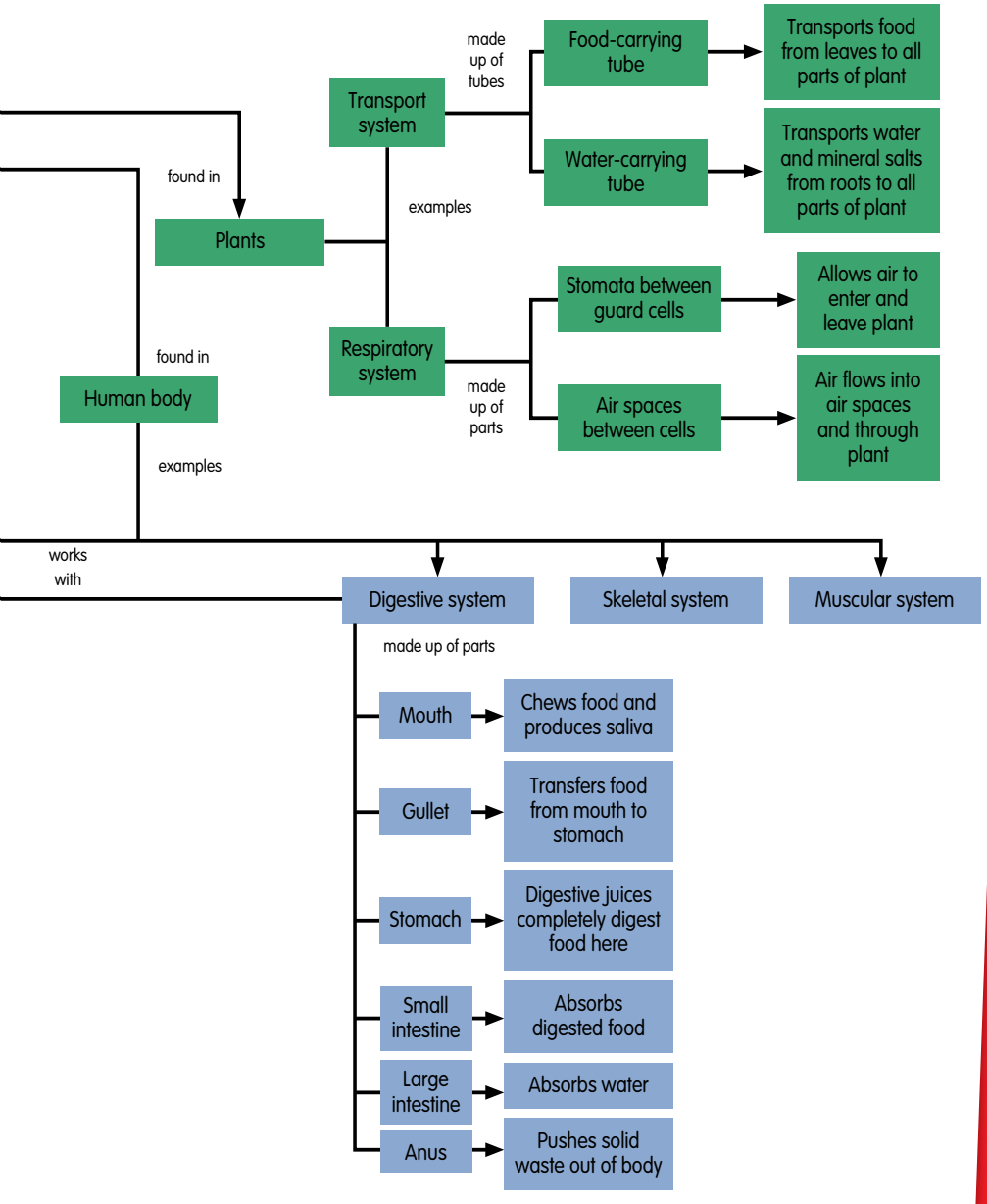

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Systems Glossary

Battery:
The energy source in an electrical system that has a positive (+ve) and negative (-ve) terminal.

Blood:
The liquid found in blood vessels that transports substances around the body.

Blood vessels:
A network of tubes that carries blood throughout the body.

Breathing:
The process of taking air into our bodies and giving it out.

Bulb:
The component in an electrical system that produces light and heat.

Circuit diagram:
A simple drawing using symbols to represent the actual circuit.

Circulatory system:
A body system that is made up of the heart, blood vessels and blood.

Cytoplasm:
A jelly-like substance surrounded by the cell membrane that contains many cell parts.

Electric current:
The flow of electricity in a circuit, when all the components are connected together properly.

Electrical conductor:
A material that allows electric currents to flow through easily.

Electrical insulator:
A material that does not allow electric currents to flow through easily.

Electrical system:
A system consisting of different components connected together properly before electric currents can flow.

Electrical wire:
The component in an electrical system that allows electric currents to flow.

Food-carrying tubes:
The set of tubes found in a plant that transports sugar made in the leaves to other parts of the plants.

Heart:
The organ that pumps blood to all parts of the body.

Nucleus:
The part of a cell that controls all the activities that take place within the cell.

Photosynthesis:
The process by which plants make their own food.

Plant transport system:
The system in plants comprising of water-carrying tubes and food-carrying tubes.

Series arrangement:
The set-up of an electrical circuit such that the batteries or bulbs come one after another on the same wire.

Switch:
The component that controls the flow of electric current in an electrical circuit.

Symbol:
A simple drawing used to represent the actual electrical component.

Water-carrying tubes:
The set of tubes found in a plant that transports water and mineral salts from the roots to other parts of the plants.

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Before you carry out the activity

Pupils should have been taught

- All parts of a plant need water and food to stay alive.
- The stem carries food, water and mineral salts to all parts of the plant.

Where to obtain or buy

- The celery stalks and food colouring can be bought from supermarkets.

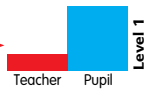
Tips and time-savers

- Prepare all the individual stalks of celery and other items before the start of the lesson.
- Instruct the pupils to cut part of the celery stalk lengthwise into halves, immerse them in coloured water, then very carefully cut about 2.5 cm off the bottom of each half of the stalk while it is immersed in water. This is to ensure that the vascular tissue is open as this will speed up the rate of water intake.

The suggested inquiry level is at Level 1, where this activity can be more pupil directed.

Name: _____ Class: _____ Date: _____

Activity 1.1 In the flow



Process skills

Identifying : the distribution of water throughout the plant
Comparing : the movement of water in two halves of a celery stalk

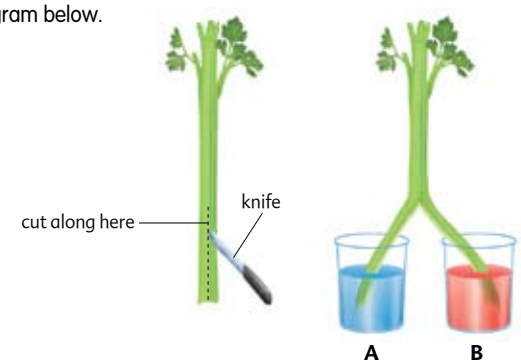
Aim: To show the movement of water in a plant through the water-carrying tubes

Materials: A stalk of celery, blue and red food colouring, two 1000 mℓ beakers, knife

Procedures

1. Cut part of a stalk of celery into two halves, as shown in the diagram below.
2. Fill two beakers with 500 mℓ of water each.
3. Mix two tablespoons of red food colouring in one beaker and two tablespoons of blue food colouring into the other beaker of water.
4. Place one half of the stalk of celery in the blue-coloured water and the other half in the red-coloured water as shown in the diagram below.

Handle the food colouring with care. Do not stain your uniform.



5. Leave the set-up aside overnight.
6. Observe the stem and leaves of the stalk of celery the next day.

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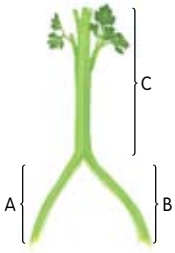
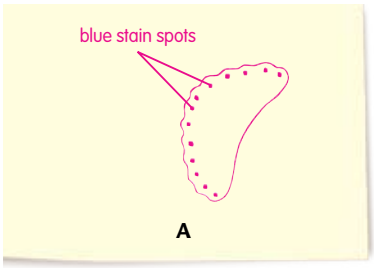
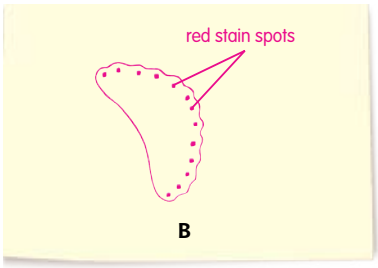
Observations

1. Cut a cross-section of the stalk of celery from parts A and B. Draw the cross-section in the space below and colour the stained spots.







2. Take sections from part C and observe the stains. Is there any mixing of the blue and red colours in any part of this upper portion of the stalk? Explain your answer.

No. The coloured water was transported in separate tubes.

Conclusion

In the diagram below, draw the tubes that run up the stem transporting water to the whole plant.

How it can be done

- Ask the pupils to carry out the activity, and while leaving the stalks to stand, carry on with the teaching of the concepts, as well as the discussion of the questions posed in Activity 1.2.
- If time does not allow the observation and discussion of the results, the stalks can be left to stand until the next lesson.
- Point out to the pupils that besides the stalk, the leaves of the celery will also change colour. Lead them to conclude that the water-carrying tubes extend to other parts of the plant to transport water there as well.

Safety precautions

- Pupils are to be careful when handling the knife used to cut the stalk.

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Notes on observations and results

- If pupils observed that there was no mixing of the blue and red colours, it was because the coloured water was transported in separate tubes. However, it is also possible that while cutting the stalk into halves, pupils have split the xylem tubes and the colour of one or two tubes in the cross-section appears purplish.

Question

Compare the stem-sections from the base with one near the top. What difference do you notice about the way they are coloured? Why is this so?

The stem cross-sections from the base have tubes that are all coloured either red or blue. Those near the top are coloured half red and half blue. The water-carrying tubes in the stalk are separate tubes so there is no mixing of the coloured water.

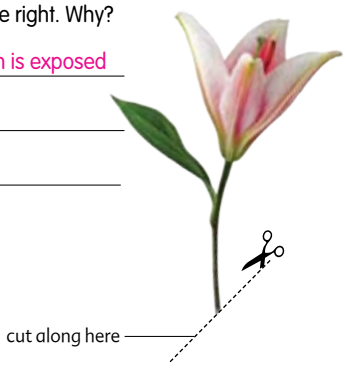
Extension

1. How do you think you can obtain a carnation that is half red and half blue?

   Cut the stem of the carnation into half lengthwise or split the stem of the carnation down the middle and put half of it in red-coloured water and half in blue-coloured water.

2. Florists usually cut stems at an angle as shown on the right. Why?

   By cutting at an angle, more surface area of the stem is exposed to water. This makes the intake of water easier.



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Before you carry out the activity

Pupils should have been taught

- All parts of a plant need water and food to stay alive.
- The stem carries food, water and mineral salts to all parts of the plant.

Tips and time-savers

- The pupils can carry out this activity while waiting for the results of Activity 1.1.

How it can be done

- Give the pupils the scenario stated in the activity. Ask them to compare the diagrams and point out the difference.
- Brainstorm with them the possible explanations.

The suggested inquiry level is at Level 2, where this activity can be more pupil directed with some teacher guidance.

Name: _____ Class: _____ Date: _____

Activity 1.2 Sugar in the flow

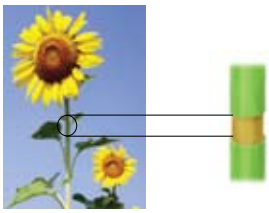
Teacher Pupil Level 2

Process skill

Inferring : the substances carried in the tubes

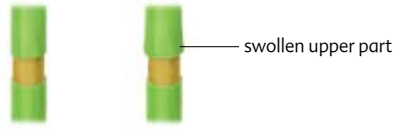
Aim: To show the movement of food in the plants

Joe is investigating what happens when a ring of food-carrying tubes is removed from a sunflower plant. He cuts off a portion of the stem of a sunflower plant as shown below.



a stem with a ring of food-carrying tubes cut off

He leaves the plant aside for a week. This is what he observes at the end of the week.



Questions

1. Is it still possible for water to be transported from the roots to the other parts of the plant? Explain your answer.

   Yes, it is still possible for water to be transported. This is because the water-carrying tubes are still present in the plant.

2. Why does the upper part of the cut region swell?

   Food made in the leaves travels down the food-carrying tubes and gathers at the upper part of the cut region.

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Before you carry out the activity

Pupils should have been taught

- The lung is part of the human respiratory system.

Where to obtain or buy

- Clear plastic cups, straws and balloons can be obtained from supermarkets or party shops.

Tips and time-savers

- Before the lesson, melt a hole in the bottom of the plastic cup by using a hot metal rod.
- For better results, use balloons of thinner rubber (more elastic) or stretch the balloons well before using them for the model. Use a small one for the lung and a bigger one for the diaphragm.
- Practise assembling the lung model at home before doing it in front of the class to make sure that it works properly.

The suggested inquiry level is at Level 2, where this activity can be more pupil directed with some teacher guidance.

Name: _____ Class: _____ Date: _____

Activity 2.1 The lung machine

Teacher Demonstration

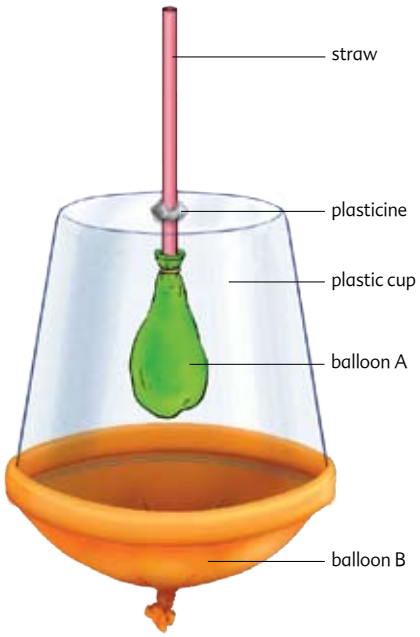
Process skills

Observing : the model set-up
Inferring : how your respiratory system works

Aim: To set up a lung model and understand how our lungs work when we breathe

Materials: A transparent plastic cup, a straw, two balloons, plasticine, measuring tape

Your teacher will show you how to make a lung model like the one shown below.



Lung model

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Procedures

1. Place a hand between your abdomen and chest.
2. Breathe in and out. Observe what happens to your abdomen and chest.
3. Get your friend to measure your chest size using a measuring tape when you:

   (a) breathe in : 80 cm

   (b) breathe out : 76 cm

   Note for teachers :
   Advise the pupils to place the measuring tape around their chest area.

4. Now, gently pull down balloon B. Observe and state what happens to balloon A.

   Balloon A expands.

5. Next, slowly release balloon B. Observe and state what happens to balloon A again.

   Balloon A becomes smaller.

Questions

1. Which parts of your body are like the following parts of the lung model?

Lung model	Your body
Straw	Windpipe
Balloon A	Lungs

How it can be done

- During the lesson, tell the pupils that you are going to make a lung machine and display all the items needed.
- Fasten the small balloon to the straw with a tape. Insert the straw through the hole in the cup and seal the hole with plasticine.
- Tie a knot at the mouth of the bigger balloon and cut a large part of the balloon in half horizontally.
- Stretch the balloon over the bottom of the cup using the half with the knot.

Safety precautions

- Be careful when handling the hot metal rod used to make a hole in the cup. Do not allow the pupils to try this and caution them to engage their parents' help if they were to try making their own lung model at home.

Notes on observations and results

- When pulling down and releasing the balloon diaphragm, get the pupils to place their hands near the opening of the straw to feel the rush of air into and out of the cup.

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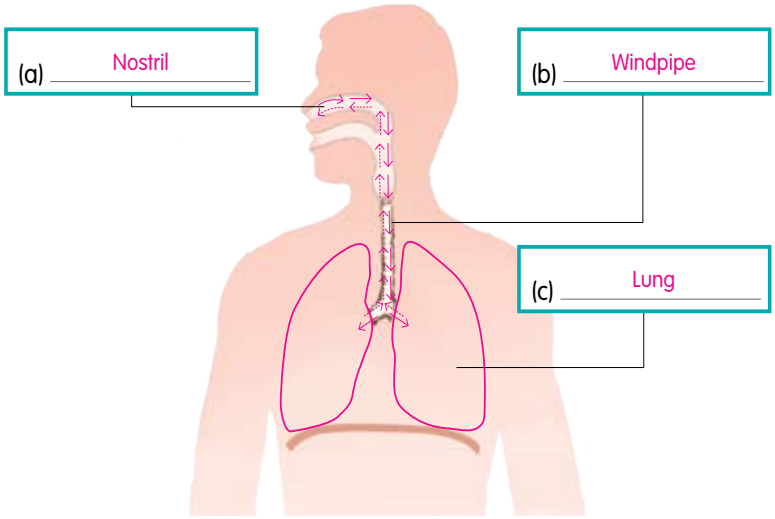
2. (a) Using a pencil, draw the missing parts of the human respiratory system. Label all the parts of the respiratory system (including those that you have drawn).



(b) In the diagram above, use arrows (⟶) to show how air enters your respiratory system.

(c) Then use broken arrows (⇢) to show how air leaves your respiratory system.

Reinforcement

Compare the lung model and the human respiratory system.

	Lung model	Human respiratory system
Similarity	Balloon A expands when air enters the cup.	Our lungs expand when we breathe in.
Difference	The plastic cup cannot expand or contract when air enters or leaves it.	Our chest can expand and contract when we breathe in and out.

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Tips and time-savers

- Start collecting 1.5 ℓ plastic bottles a month before the activity is carried out. You may want to engage the help of pupils in collecting the bottles. Make markings on all the bottles before the lesson.
- Get ready wipes to clean the tubes between blows and also rags to wipe off any spilt water.

Before you carry out the activity

Pupils should have been taught

- Exchange of gases takes place in the lungs.
- Air occupies space and displaces water in a bottle.

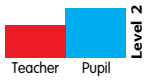
Where to obtain or buy

- Rubber tubes can be obtained from hardware store and 1.5 ℓ bottled drinks can be bought from most provision shops and supermarkets.

The suggested inquiry level is at Level 2, where this activity can be more pupil directed with some teacher guidance.

Name: _____ Class: _____ Date: _____

Activity 2.2 I'll huff and I'll puff



Teacher Demonstration

Process skill

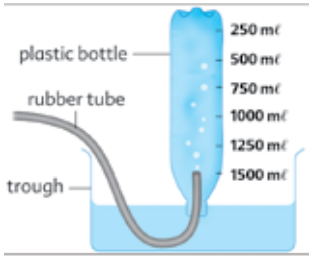
Observing : how the amount of air we breathe can be measured

Aim: To find out the volume of air that can be taken in and out during normal breathing

Materials: A 100 mℓ beaker, a 1.5 ℓ (1500 mℓ) plastic bottle with a cap, a permanent marker, a trough, 50 cm long rubber tube

Procedures and result

1. Measure 50 mℓ of water in a beaker. Pour the water into a 1.5 ℓ plastic bottle. Mark the level of water with a permanent marker.
2. Repeat step 1 until you have filled the bottle with 1.5 ℓ of water. Make sure that the bottle is filled to its brim with water. Screw on the bottle cap.
3. Fill the trough with water until it is half-full.
4. Invert the bottle and submerge the mouth of the bottle in the trough of water. Then, unscrew the bottle cap slowly. Keep the mouth of the bottle submerged in the water at all times.
5. Thread a 50 cm long rubber tube into the bottle as shown on the right.
6. Take a deep breath and blow out as much air as you can into the rubber tube.
7. Look at the markings on the bottle and find out the volume of air you have exhaled into the bottle. The volume of air in the bottle represents the volume of air that can be breathed in or out during normal breathing.



$1\ \ell = 1000\ cm^3$

The volume of air in the bottle is 500 cm^3.

Final answer varies according to the pupil.

Do not place the tube into your mouth immediately after your classmate has finished blowing into it. Wipe the free end of the tube with alcohol or water before you blow into it.

How it can be done

- You may want to set up five to eight stations in the laboratory where pupils can measure their lung capacities.
- Allow the pupils to take turns to measure and record their lung capacities. Instruct them to take a deep breath before blowing into the tube.
- Challenge the pupils to find a winner who has the greatest lung capacity.

Safety precautions

- Make sure that the pupils wipe the tube each time they have finished blowing into it.

Notes on observations and results

- The lung capacities of different pupils differ (average lung capacity will fall between 2.8–3.2 ℓ). Ask the pupils to suggest ways they can increase their lung capacities (e.g. practise deep breathing, exercise, learn to play a wind instrument, stay away from smoking or second hand smoke.

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Before you carry out the activity

Pupils should have been taught
- Fish breathe through gills.

Where to obtain or buy
- Small fish such as ikan kuning can be obtained from the wet market or supermarket.

Tips and time-savers

- Place the fish in crushed ice in a styrofoam box to bring to school. Do not remove the fish from the ice until you are ready to show the pupils. This will slow down the decomposition and help to maintain the colour of the fish gills. In addition, it will prevent blood from dripping, splashing onto the pupils and staining their clothes during handling.
- You may want to prepare a few more fish so that pupils can gather in groups to observe the gills more closely. To have the entire class crowd round the teacher's bench to observe a small fish may prove ineffective in meeting the desired objective.

How it can be done

- Demonstrate where the gills of the fish are found and discuss the appearance. Draw attention to the large surface area of the gills.
- Break the pupils into groups and distribute fish on paper plates for them to observe in smaller groups.
- You may want to distribute forceps so that the gills can be studied more closely.

The suggested inquiry level is at Level 2, where this activity can be more pupil directed with some teacher guidance.

Name: _____ Class: _____ Date: _____

Activity 2.3 Fishy business

Level 2 — Teacher / Pupil

Teacher Demonstration

Process skill

Observing : the gills of a fish

Aim: To study the respiratory system of a fish

Materials: A small fish (for example, an ikan kuning), a hand lens, a big bowl of crushed ice

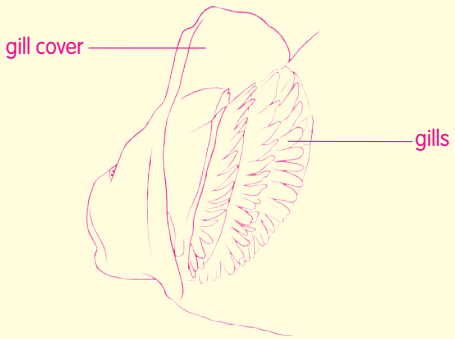
Procedures

1. Place a fish on a bowl of crushed ice for five minutes.
2. Pull back the gill cover.

Pull back the gill cover gently to prevent water from splashing onto you. If your clothes get stained, wash them immediately.

Observations

3. Use a hand lens to observe what is below the gill cover.
4. Draw what you see in the box below. Label your drawing.



(Note for teachers : Fish often open and close their mouth to allow water to enter their mouth and exit through the gills. This allows the fish to take in oxygen and breathe.)

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Notes on observations and results

- If the fish is not fresh, the gills may appear brownish rather than reddish.

Questions

1. (a) What is the colour of the gills?

Red.

(b) Why do you think the gills are this colour?

They are filled with blood. (Note for teachers : This is important to allow the optimum amount of oxygen to be absorbed by the gills.)

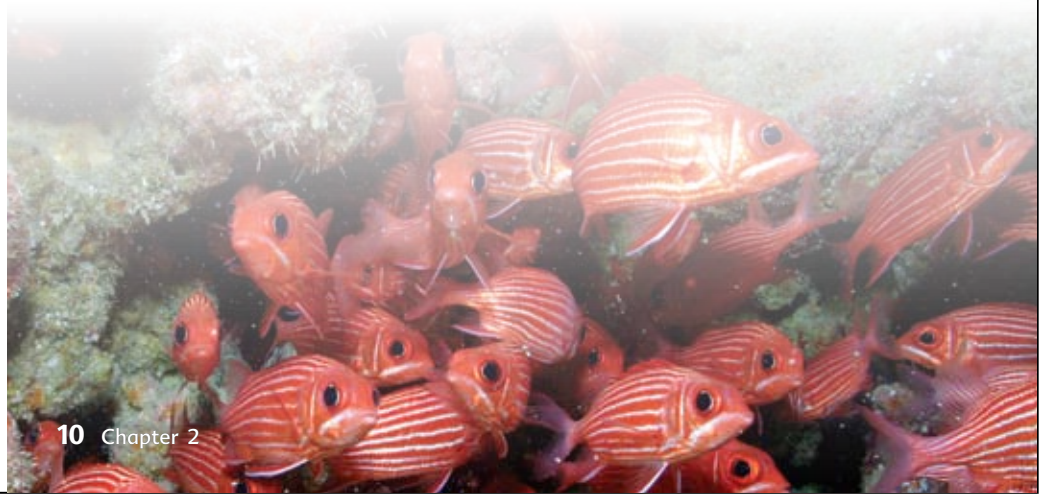
2. How are the gills you have drawn useful to the fish?

They enable the fish to take in oxygen from the water and get rid of carbon dioxide. (Note for teachers : Draw pupils' attention to the large surface area of the gills which is important for optimum contact with water.)

Conclusion

Fish do not have lungs like mammals. They breathe through their gills. These are found on the sides of their head.

Oxygen from the water that passes through the gills, is taken in by the blood.



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Before you carry out the activity

Pupils should have been taught

- The different parts of the circulatory system.
- The different substances transported by blood to different parts of the body.

How it can be done

- Pupils should be asked to work on Activity 3.1 individually to test their understanding of the lesson.

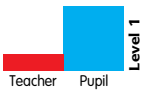
Notes on observations and results

- Pupils should be informed that the lungs are not a part of the circulatory system. Instead, they work together with the circulatory system to provide oxygen for all parts of the body and to remove carbon dioxide from the body.

The suggested inquiry level is at Level 1, where this activity can be more pupil directed.

Name: _____ Class: _____ Date: _____

Activity 3.1 Go with the flow

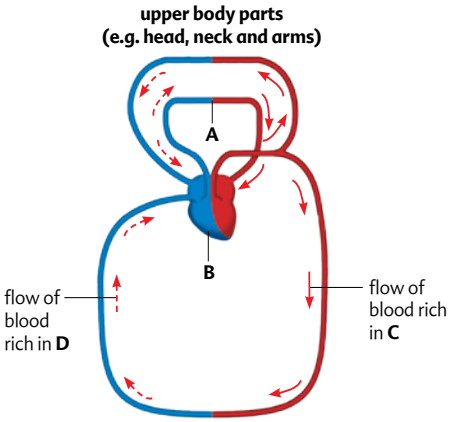


Process skill

Elaborating : our circulatory system

Aim: To describe the movement of blood in the human circulatory system

Study the simplified circulatory system shown below and identify **A** to **D**.



A: L U N G S

B: H E A R T

C: O X Y G E N

D: C A R B O N D I O X I D E

Complete the following sentences.

The body has about 5 litres of blood travelling through its circulatory system. The heart, the lungs, and the blood vessels work together in the system. The pumping of the heart forces the blood through the system.

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The suggested inquiry level is at Level 2, where this activity can be more pupil directed with some teacher guidance.

Name: _____ Class: _____ Date: _____

Activity 3.2 Run for your life!

Process skill

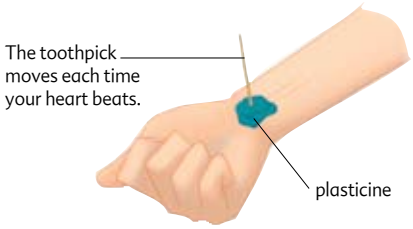
Observing : the pulse rate of an individual

Aim: To learn how to make and use a pulse detector

Materials: Plasticine, toothpick

Procedures

1. Flatten a small piece of plasticine and stick a toothpick in the middle. You have just made a pulse detector.
2. Balance the plasticine on your wrist, where you can feel your pulse. Can you see the toothpick move?



3. Count the number of times the toothpick moves in one minute. Record your pulse rate. Your pulse rate is the number of times your heart beats in a minute. This is the resting heart rate. The resting heart rate is the minimum number of beats required by the heart to maintain body functions at rest.
4. Walk quickly for five minutes. Stop and balance the pulse detector on your wrist again. Record your pulse rate.
5. Run on the spot for five minutes. Stop, measure and record your pulse rate again.

Observations

Action	Pulse rate (beats per minute)
Resting rate	100
After walking quickly for five minutes	115
After running for five minutes	130

(Suggested answers. Answers will vary for each pupil.)

Before you carry out the activity

Pupils should have been taught

- Each heartbeat is a cycle of contraction and relaxation of the heart muscles.
- Each heartbeat is followed by a pulse as a pressure wave passes along the blood vessels.

Where to obtain or buy

- Plasticine can be obtained from most bookshops.

Tips and time-savers

- This activity should be carried out in the field or hall to facilitate movement, as there will be too much noise within the constraints of the classroom setup.

How it can be done

- Give each pupil a pea-sized plasticine and a toothpick. Get them to flatten the plasticine before sticking the toothpick in upright and balancing it on the inside of the right wrist.
- Make sure all the pupils have located the spot on their right wrists where the movement of the toothpick is the most obvious (i.e. where pulse is the strongest). If the pupils cannot locate the spot using the toothpick and plasticine, get them to try using their fingers to feel the pulse instead.
- When the pupils are ready, give them the cue to start and stop counting the number of times the toothpick moves (or the number of pulses they feel) in one minute by using a stopwatch or the timer on the watch.
- Tell the pupils that you will repeat the process two to three times to make sure that the pupils who have lost count during the first time can try again later.

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Safety precautions

- Choose toothpicks with blunt ends.
- Get the pupils to stick the toothpick in the plasticine before placing it on the wrist to avoid the toothpick pricking the wrist.

Notes on observations and results

- Children should have a resting pulse rate higher than adults. The pulse rate of a child from age 1 to 10 can fall in the range 60 to 140, whereas that of a child from age 11 to 17 is found to be between 60 to 100.
- The pulse rates of the children should increase by walking quickly and even more after running.
- Lead the pupils to infer that the heart beats faster with exercise as the muscles involved need more oxygen and nutrients to be sent there to release the energy that they need for the activity.

Conclusion

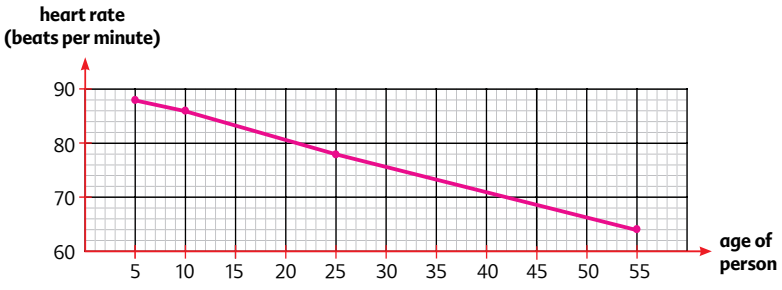
The pulse rate is the number of beats (number of beats/volume of blood) your heart beats in a minute. Your pulse rate varies with (is independent on/varies with) the type of activity you do.

Extension

The resting heart rate of four individuals are presented in the table below.

	Heart rate (beats per minute)
5 year-old child	88
10 year-old child	86
25 year-old adult	78
55 year-old adult	64

(a) Plot a line graph to present the data presented in the table.



(b) Estimate the heart rate of a 50 year old person. 66 beats per minute

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Before you carry out the activity

Pupils should have been taught

- The heart rate of an average healthy person is about 60 to 70 beats per minute.
- The rate of heartbeat changes with age, health and the type of activity.
- How to read graphs.

How it can be done

- This activity can be done as a follow-up activity to Activity 3.2 to assess the pupils' understanding of the lesson.

The suggested inquiry level is at Level 2, where this activity can be more pupil directed with some teacher guidance.

Name: _____ Class: _____ Date: _____

Activity 3.3 The ups and downs of life

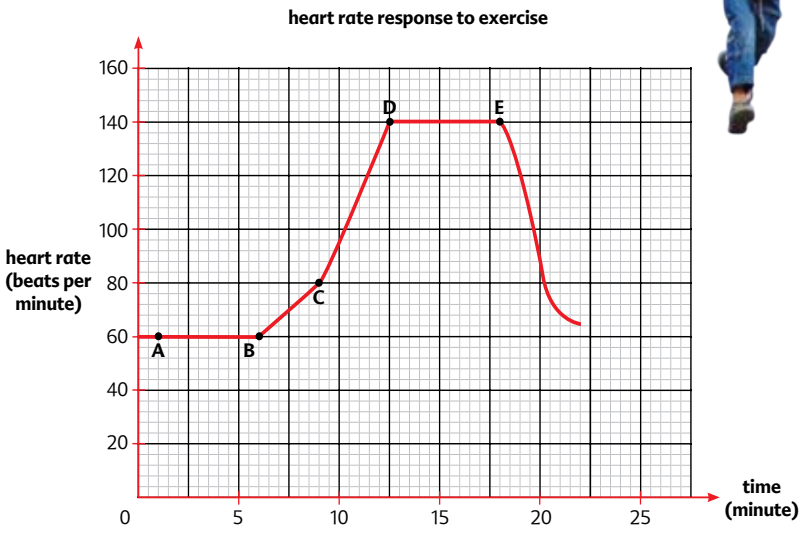
Teacher Pupil Level 2

Process skills

Observing : the effect of exercise on the heart rate
Inferring : the relationship between exercise and heart rate

Aim: To observe how exercise affects the heart rate of a person

The graph below shows the changes in the heart rate of a boy. He ran on the spot and stopped after some time. Use the readings on the graph below to answer the following questions.



Questions

1. What is the approximate heart rate when the boy is resting?

   60 beats per minute

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Notes on observations and results

- Ask the pupils to relate the heart rate to the type of activity the person is engaged in.
- Assess the pupils' understanding of the previous lesson by eliciting their reasons for the increase in heart rate. Pupils should be able to explain that the heart beats faster with exercise as the muscles involved need more oxygen and nutrients to be sent there to release the energy that they need for the exercise.

2. At which point (A, B, C, D or E) did he start running?

   He started running at point B.

3. At which point (A, B, C, D or E) did he stop running?

   He stopped running at point E.

4. How long did he run?

   Time taken to run = 12 minutes

5. What is the difference between his heart rate when he is running and when he is resting?

   Difference = 140 – 60 = 80 beats per minute

6. (a) What happens to the boy's heart rate when he exercises?

   His heart rate increases.

   (b) Why do you think this happens?

   When he exercises, the cells in his body require more oxygen to release energy faster. So, his heart pumps blood at a faster rate to supply the cells in the various parts of the body with more oxygen.

Conclusion

Complete the following sentences by choosing the correct words.

Exercise ___increases___ (increases/decreases) the heart rate. The heart needs to ___pump___ (produce/pump) more blood and ___oxygen___ (carbon dioxide/oxygen) to various parts of the body to produce more ___energy___ (energy/sugar).

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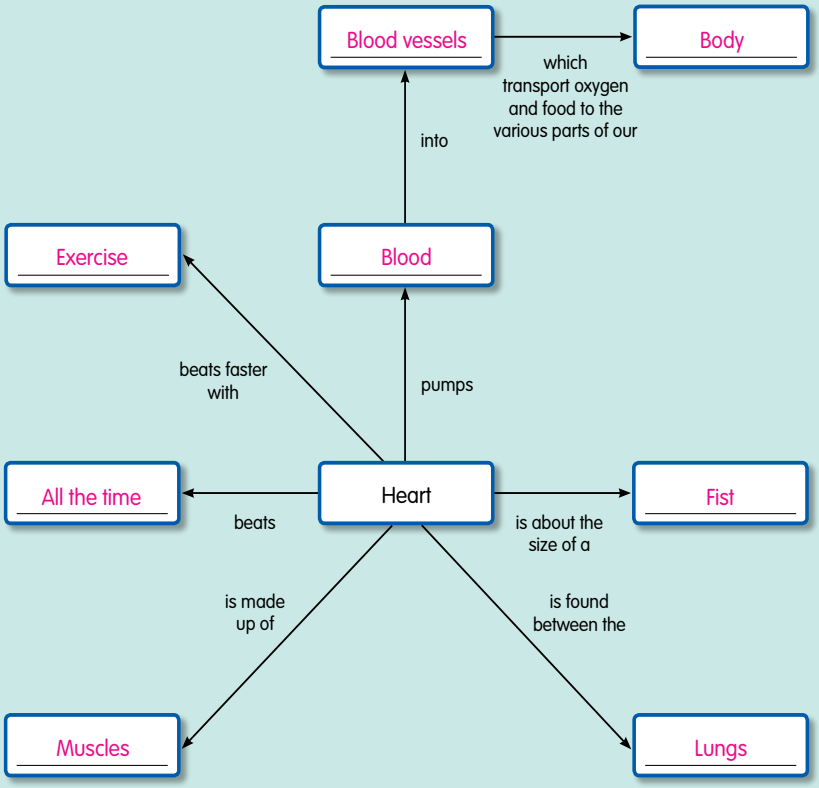
Reinforcement

Use the given words to complete the concept map.

Blood vessels	Exercise	Fist	Lungs
All the time	Blood	Body	Muscles



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Before you carry out the activity

Pupils should have been taught

- Micro-organisms are living things our naked eye cannot see.
- A cell is the smallest unit of life.

Where to obtain or buy

- Pond water can be obtained from the school pond or ponds in Botanic Gardens or other parks.

Tips and time-savers

- Prepare the slides before the lesson.
- Identify the type of pond organisms found on the slide before the lesson.

How it can be done

- Set up stations with microscopes and prepared slides.
- Brief the pupils on the parts of a microscope and how to use it.
- Ask the pupils if there are any living things in pond water and tell them they are about to find out before dispersing them into groups to observe the slides.

The suggested inquiry level is at Level 2, where this activity can be more pupil directed with some teacher guidance.

Name: _____ Class: _____ Date: _____

Teacher Pupil Level 2

Activity 4.1 Micro-organisms in pond water

Process skill

Inferring : how different pond organisms obtain nutrients

Aim: To observe pond micro-organisms using a microscope

Materials: Prepared slides, microscope

Procedures

1. Place a prepared slide on the stage of the microscope.
2. Using the microscope, examine the organisms in the pond water.
3. Repeat steps 1 to 3 if necessary.

Observations

The pictures below show some micro-organisms that may be found in pond water. Put a tick in the box next to the micro-organism if you spot it on your slide.

Vorticella	Blue-green algae	Copepod	Cyclops
A ☐	B ✔	C ☐	D ☐
Euglena	**Diatom**	**Volvox**	**Amoeba**
E ✔	F ✔	G ✔	H ☐

(Suggested answers. Answers depend on the micro-organisms found in the pond water.)

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Safety precautions

- To wash hands after handling the slides with pond water samples.

Notes on observations and results

- Pupils' answers may vary according to the pond water sample that they have obtained.
- Ask the pupils why plants can carry out photosynthesis. Lead the pupils to infer that micro-organisms that are green in colour contain chlorophyll and are able to photosynthesise as well.

Questions

1. Which of the micro-organisms, A to H, carry out photosynthesis? State the reason for your answer.

   Micro-organisms B, E, F and G, which are green in colour, carry out photosynthesis. Green indicates the presence of chlorophyll which is important in carrying out photosynthesis.

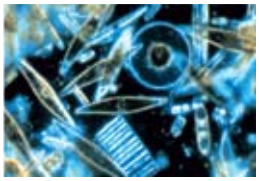
2. The micro-organisms in a pond need air, water and food to survive.

3. What are some of the other ways that pond micro-organisms obtain their nutrients besides photosynthesis?

   Pond micro-organisms obtain their nutrients by feeding on other micro-organisms or by absorbing the nutrients through their body's outer layer.

Extension

Planktons are micro-organisms that drift in oceans, seas, lakes or rivers. They are an important source of food to aquatic life. Three groups of planktons are plant planktons, animal planktons and bacteria planktons. Only plant and animal planktons are shown below.



plant planktons

animal plankton

(a) What instrument is needed to observe planktons? Microscope

(b) (i) Which group of planktons should contain chloroplast in their cells? Plant planktons

(ii) This group of planktons lives near the water surface. Why are they not found in deep oceans?

There is no light under deep oceans for plant planktons to make food.

(c) The oxygen that we breathe not only comes from land plants. It also comes from plant planktons.

Through what process do plant planktons produce oxygen? Photosynthesis

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Before you carry out the activity

Pupils should have been taught
- The different parts of a cell.

Where to obtain or buy
- Iodine solution should be available in the lab; if not, buy from pharmacies.
- Elodea leaf can be obtained from any plant nursery that sells water plants.

Tips and time-savers

- Lay the Elodea leaf flat on the clean glass slide so that light can penetrate the leaf for better view of plant cells.

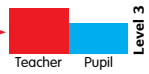
How it can be done

- Demonstrate once to the pupils how the experiment should be carried out before asking them to attempt the activity.
- If time allows, show the pupils how onion cells are similar to or differ from the Elodea leaf cells.

The suggested inquiry level is at Level 3, where this activity can be more teacher guided with some pupil direction.

Name: _____ Class: _____ Date: _____

Activity 4.2 Plant and animal cells



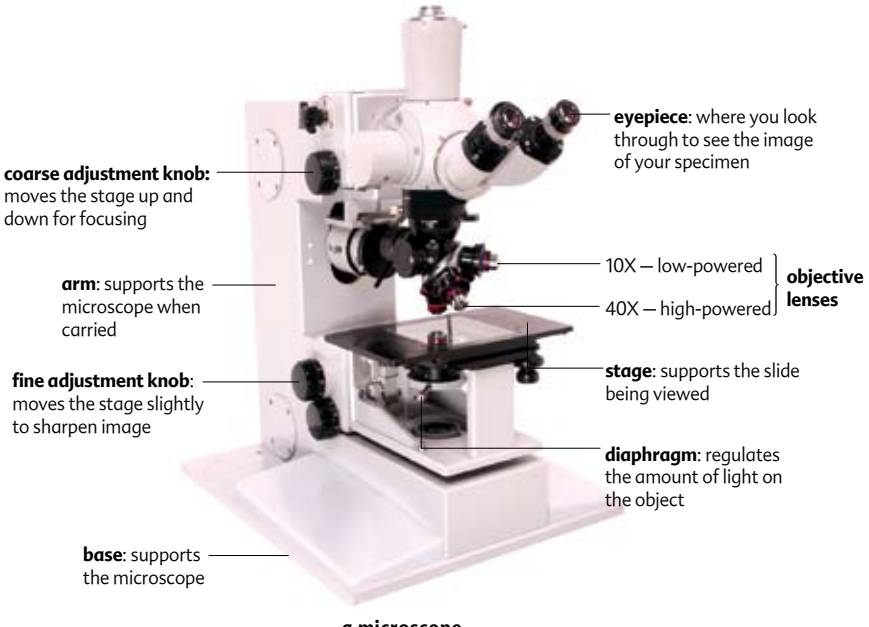
Process skills

Observing : the structures of plant and animal cells
Comparing : the similarities and differences between a plant and animal cell

Aim: To observe plant and animal cells using a microscope

Materials: Toothpick, glass slides, iodine solution, cover slip, a pair of forceps, onions, microscope, glass dropper

When using the microscope to observe things, always use the low power objective first. Change to the high power objective if you need to see more details.



a microscope

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Safety precautions

- Choose toothpicks that have blunt or rounded ends in case pupils injure themselves while scraping the insides of their cheeks.
- Use iodine solution with a dropper to prevent staining.

Notes on observations and results

- Check that the pupils have in their cell diagrams the following parts: nucleus, cytoplasm and cell membrane. For the plant cell, chloroplasts and cell wall should be present.

Procedures

1. Use the lens with magnification '10X' written on it. Ensure that the lens has clicked into position.
2. Turn on the light and look down the tube.
3. Place the glass slide on the stage and make sure that the slide is held firmly by the stage clips.
4. Using the coarse adjustment, focus the lens until the image is clear.
5. Rotate the objective lenses of the microscope until the lens with magnification '40X' clicks into position.

6. Using the fine adjustment knob, slowly turn the knob until the image is in focus.

Animal cell

7. Gently scrape the inside of your cheek using the rounded end of a toothpick.

8. Spread the scrapings onto the centre of a clean glass slide and add a small drop of iodine solution to the scrapings.

9. Place the cover slip on the glass slide.

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10. Examine the cheek cells under a microscope. Use the low-power objective lens first and then the high-power objective lens.

11. Make drawings of your observations below. Label the parts of the cell.

Plant cell

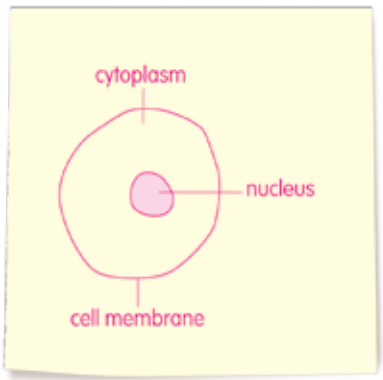
12. Using a pair of forceps, place an Elodea leaf onto the centre of a clean glass slide.

Elodea plant

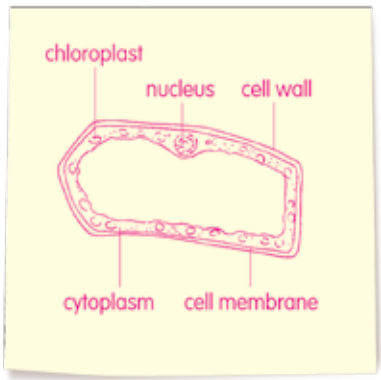
13. Add a drop of water to the leaf.

14. Repeat steps 3 to 5 as you did for your cheek cells.

Observations



animal cell



plant cell

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Questions

1. What are the similarities between a plant and an animal cell?

   Both plant and animal cells contain cytoplasm, cell membrane and nucleus.

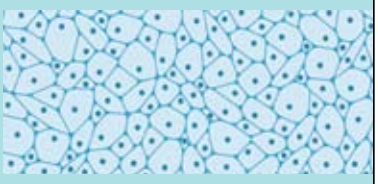
2. What are the differences between a plant and an animal cell?

   The cell wall and chloroplast are present in plant cells but they are absent in animal cells.

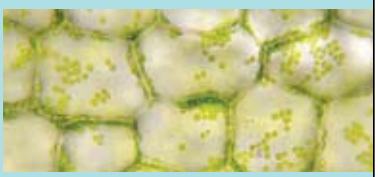
Reinforcement

Compare plant and animal cells.

Part of a cell	Animal cell	Plant cell
Cytoplasm	Present	Present
Cell Membrane	Present	Present
Nucleus	Present	Present
Cell wall	Not Present	Present
Chloroplast	Not Present	Present



animal cells



plant cells

Extension

In this activity, you have observed a typical animal cell and a typical plant cell.

In comparison to the plant cell, would you expect to see the same structures if you were to observe the cells of an onion leaf? How will they differ? (Hint: The Elodea leaf makes food for the Elodea plant but the onion bulb does not make food for the onion plant.)

The cell wall, cytoplasm and nucleus will be present in the cells of an Elodea leaf and an onion leaf. However, chloroplast is present in the cells of an Elodea leaf and absent in the cells of an onion leaf.

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Before you carry out the activity

Pupils should have been taught

- The parts of a plant cell.
- The function of stomata on plants' leaves.

Where to obtain or buy

- Nail polish can be obtained from beauty care shops.

Tips and time-savers

- Generally, a colourless nail polish would be better as the guard cells imprint will be clearer. If not, lighter colours can also be used.
- If the pupils have difficulty peeling the layer of dried nail polish off the leaf using a pair of forceps, try pressing a sticky tape to it. If done carefully, the polish should stay attached to the tape as it is peeled away from the leaf.
- Prepare a few slides beforehand in case the pupils cannot obtain a nice 'peel' with visible stomata and guard cells.

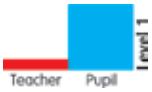
How it can be done

- Demonstrate to the pupils how the nail polish peel can be removed from the leaf. Practise this before the lesson.
- Set up stations with microscopes where the pupils can work in groups to observe the 'peel'.

The suggested inquiry level is at Level 1, where this activity can be more pupil directed.

Name: _____ Class: _____ Date: _____

Activity 4.3 Leaf prints



Process skill

Communicating : observations and conclusions

Aim: To relate the structure of a cell to its function

Materials: Microscope, glass slide, cover slip, nail polish, leaf, a pair of forceps

Procedures

1. Apply nail polish over one part of the underside of the leaf. Allow the nail polish to dry.

Do not breathe in the nail polish vapour.

2. Using a pair of forceps, carefully peel the layer of dried nail polish off the leaf (the 'peel').

3. Place the 'peel' on a clean glass slide and place a cover slip over the 'peel'.

4. Observe the 'peel' under a microscope. Use the low-power objective lens first and then the high-power objective lens.

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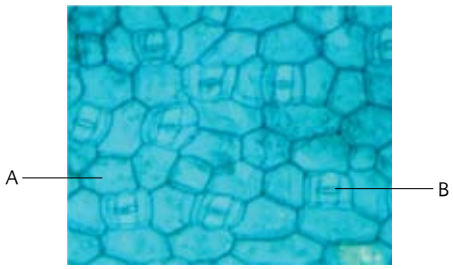
Safety precautions

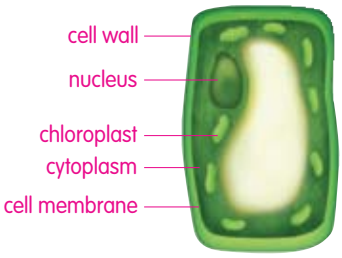
- Do not breathe in the nail polish vapour.

Notes on observations and results

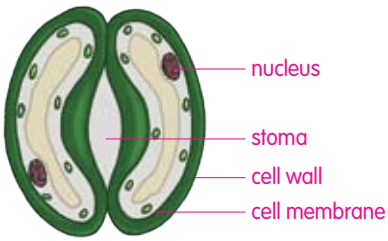
- Lead the pupils to infer the reason for the increased concentration of stomata on the underside and not the upper surface of the leaf.
- If time allows, the pupils may want to repeat the procedure with a 'peel' made from the upper surface of the leaf to confirm their prediction.

The diagram below is a picture of the 'peel' you may have observed under the microscope.





A: epidermal cell



B: guard cell

(Note for teachers : You may get pupils to label the cell parts.)

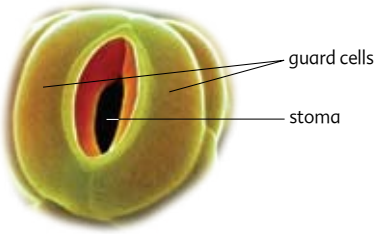
Conclusion

What can you conclude about the 'peel' you made?

It is a copy of the lower surface of the leaf showing the leaf cells.

Extension

Observe the following diagram of guard cells found in plants and answer the questions on the following page.



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1. Why do you think guard cells are called as such?

They control the opening and closing of the stoma.

2. Predict whether you will observe the same picture when the upper surface of the leaf is used to make the 'peel'. Explain your answer. (Hint: Having too many stomata can increase water loss.)

There will also be many epidermal cells. However, the guard cells may not be observed. This is because the upper surface of the leaf is exposed to sunlight. Having too many guard cells will cause the plant to lose too much water. This may kill the plant.

3. What would you do to confirm your prediction?

Repeat the procedure but make a 'peel' of the upper surface of the leaf instead of the underneath surface.

Reinforcement

A cell is made up of different parts which have different functions. Some parts are found in both the animal and plant cells. Some can only be found in plant cells. Complete the table below.

	Part of cell	Function of cell	Is this part found in both animal and plant cell?
(a)	Cell wall	Gives shape to the cell	No. It is not found in an animal cell. It is only found in a plant cell.
(b)	Cell membrane	Controls movement of substances in and out of the cell	Yes, it is found in both animal and plant cells.
(c)	Nucleus	Carries hereditary information	Yes, it is found in both animal and plant cells.
(d)	Cytoplasm	Allows substances to move around within the cell	Yes, it is found in both animal and plant cells.
(e)	Chloroplast	Traps light energy for photosynthesis	No. It is not found in an animal cell. It is only found in a plant cell.

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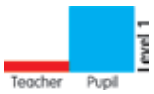
The suggested inquiry level is at Level 1, where this activity can be more pupil directed.

Name: _____ Class: _____ Date: _____

Activity 4.4 My cell model



Process skills

Applying : knowledge of cells to build a cell model
Communicating : ideas on the structure of a cell using a model

Aim: To make a 3D model of a cell

Materials: Resealable plastic bags, honey or syrup, assortment of edible objects to represent the parts of the cell, (e.g., chocolate balls and jelly beans)

Procedures

1. Work in groups of three. Discuss and decide whether to make a plant or animal cell.
2. Create a cell model using the materials mentioned above.
3. Draw and colour a picture of the model you created and paste it in the space provided below. Alternatively, you may take a picture of your model using a digital camera and print it out. Name the parts of the cell in the picture.

(Note for teachers : Students are to draw a resealable plastic bag filled with edible materials. The materials can be labelled as follows.)

resealable plastic bag — cell membrane/cell wall
honey/syrup — cytoplasm
air space — vacuole
chocolate ball/jelly bean — nucleus/chloroplast

(Answers depend on the observations made by the pupil.)

Before you carry out the activity

Pupils should have been taught

- The parts of a cell include the nucleus, cytoplasm and the cell membrane.
- An animal cell, unlike a plant cell, does not have chloroplasts and a cell wall.

Where to obtain or buy

- Ziploc bags, honey, assortment of confectionery (chocolate ball for nucleus, jellybeans (of various shapes and colours) for parts like mitochondria, chloroplasts etc) can be obtained from supermarkets.

Tips and time-savers

- Prepare all the necessary items and place an assortment of confectionery on paper plates for the intended number of groups.
- Get honey in bottles with a small opening in the cap so that honey can ooze out slowly into Ziploc bags without spilling or messing up the place.

How it can be done

- Distribute the Ziploc bags and a variety of confectionery on paper plates to the pupils.
- Get the pupils to create their cell models.
- Conduct a show and tell whereby pupils talk about the parts and functions of the cell.

Notes on observations and results

- Pupils' diagrams may differ but check that the essential parts are labelled correctly.

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Before you carry out the activity

Pupils should have been taught

- The different electrical components.
- An electric current will only flow if the components in an electric circuit form a complete path without any gaps.

Where to obtain or buy

- All the electrical components should be available from the laboratory. If not, obtain from hardware or DIY stores.

Tips and time-savers

- Check that the batteries are not dead and can light up a bulb.
- To try different ways of connecting a bulb to a battery, pupils may tape one end of the wire to the negative terminal of the battery to secure the connection and enable easier handling.

How it can be done

- Introduce the electrical components to the pupils one by one.
- Divide the pupils into groups of four and distribute the electrical components to them so that they can observe them in detail, draw diagrams and connect them together.

Safety precautions

- Caution the pupils against breaking the light bulb through rough handling.
- Caution the pupils against connecting the two ends of the wire to the two terminals of the battery directly as it causes a short circuit and produces a large amount of heat. **[NOTE: In the activity, 4(a) requires pupils to connect up a short circuit which can be dangerous.]**

The suggested inquiry level is at Level 2, where this activity can be more pupil directed with some teacher guidance.

Name: _____ Class: _____ Date: _____

Activity 5.1 Electrical components

Level 2 (Teacher / Pupil)

Process skills

Identifying : parts of electrical components
Constructing : simple circuits

Aim: To identify different electrical components and to connect the electrical components together to light up a bulb

Materials: A battery (D-sized), a piece of wire, a bulb, a magnifying glass

Procedures

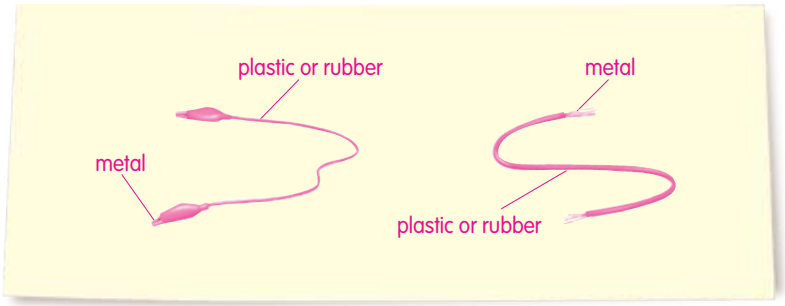
1. Look at the battery provided.

side view | back view | front view

(a) On the side-view diagram above, write a '+' and '–' to show the different terminals of a battery.

(b) Look for the parts of the battery made of metal. Shade them with your pencil in the back-view and front-view diagrams.

2. Look at some pieces of wire. Draw the wires and label the parts made of metal and the parts made of plastic or rubber.



(Suggested answers. Accept other possible answers.)

Electric circuits 27

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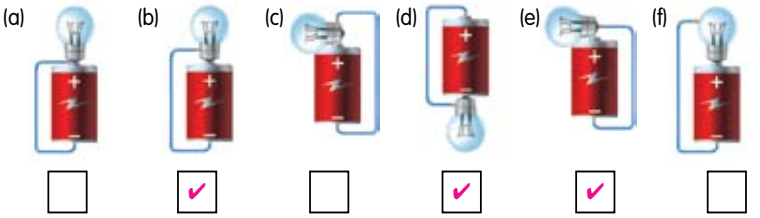
Notes on observations and results

- The light bulb would light up very dimly when the connection is correct as the battery is 1.5V and light bulbs are usually rated 6V (i.e. it will be lit to its maximum brightness when 6V is applied across it).

3. Look at the bulb using a magnifying glass. Refer to your textbook and identify the various parts of the bulb. Label them in the diagram below.

4. Try the different ways of connecting the components to light up the bulb. Put a tick in the box if it lights up.



Questions

1. Why must a battery always be present in a circuit, for the bulb to light up?

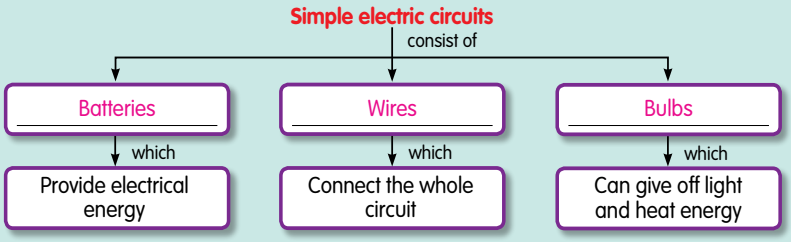
   A battery provides the energy to light up the bulb. / A battery is the energy source to light up the bulb.

2. How must a bulb be connected in a circuit?

   The metal casing and and the metal tip of a bulb must be connected to a battery.

Reinforcement

Fill in the boxes with the correct component.



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Before you carry out the activity

Pupils should have been taught

- The different electrical components.
- An electric current will only flow if the components in an electric circuit form a complete path without any gaps.

Where to obtain or buy

- All the electrical components should be available from the laboratory. If not, obtain from hardware or DIY stores.

Tips and time-savers

- Prepare all the apparatus before the class.
- Check that the batteries are not dead or running low and can light up a bulb.

How it can be done

- Group the pupils into pairs. One will work on the cardboard with the clips, the other will connect up the circuit tester using the battery, bulb and wires.
- It is important to tell the pupils that the wires on the cardboard have to form a closed loop except for one gap between two paper clips, not more.
- After the pupil with the circuit tester has successfully identified how the connections are made below the cardboard, switch the roles of the two pupils and repeat the procedure.

The suggested inquiry level is at Level 2, where this activity can be more pupil directed with some teacher guidance.

Name: _____ Class: _____ Date: _____

Activity 5.2 Closed circuits

Teacher Pupil Level 2

Process skills

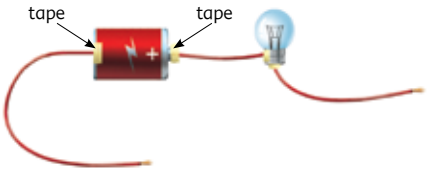
Analysing : a closed circuit
Predicting : if a bulb will light up

Aim: To find out if a bulb in a circuit will light up

Materials: A battery (D-sized), two pieces of wire, three pieces of wires with clips at the ends, a bulb in a bulb holder, a piece of stiff cardboard, six steel paper clips, masking tape

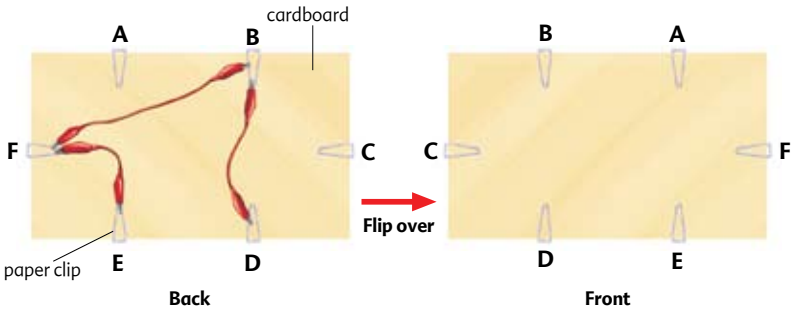
Procedures

1. Construct a simple circuit as shown below. Tape the wires to the battery and the bulb.



2. (a) Clip the six steel paper clips onto the cardboard as shown below. Label the paper clips A to F.

   (b) Join some of the paper clips with pieces of wire with clips at the end. An example is shown below.



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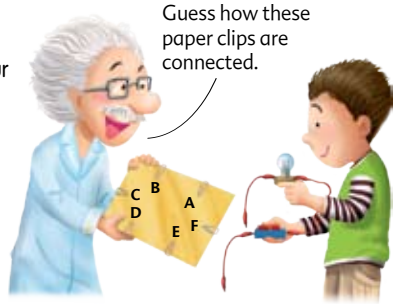
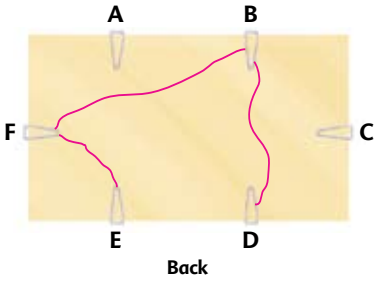
3. Flip the cardboard over so that your friend cannot see the connections you have made. Then get your friend to use the simple circuit to guess how the connections are made below the cardboard.

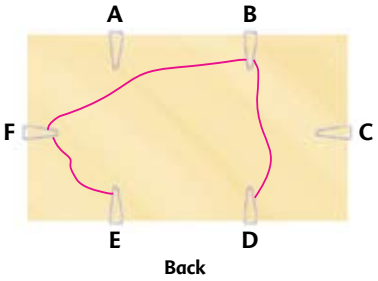


Question

Get your friend to draw what he or she thinks is the connection you have made below your cardboard.



Your friend's guess

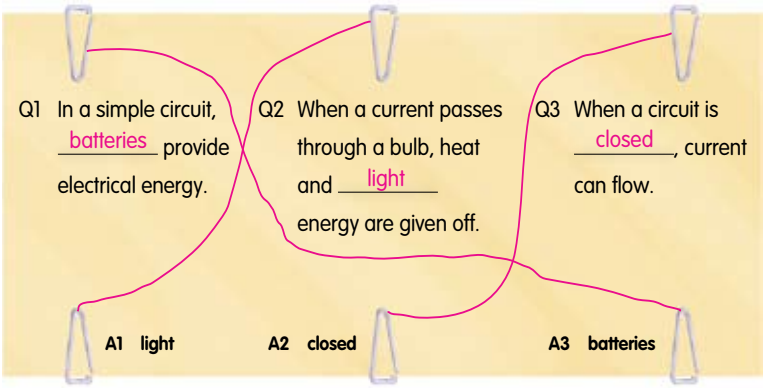


Your answer

Is your friend correct? Yes / No

Extension

Here is a card with some questions. Draw lines to show how the paper clips should be connected.



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Before you carry out the activity

Pupils should have been taught

- The battery is an energy source to drive a current around a circuit.
- When the positive terminal of one battery is in contact with the negative terminal of another, these batteries are connected in series.
- How to draw circuit symbols.

Where to obtain or buy

- All the electrical components should be available from the laboratory. If not, obtain from hardware or DIY stores.

Tips and time-savers

- Before the lesson, check that the batteries are not running low.
- For this experiment, connecting wires with crocodile clips should be used for easier connection to the bulb and battery holder.

How it can be done

- Ask the pupils to write down their predictions before connecting up the three circuits.
- After the pupils have finished with the three circuit connections and recorded their results, gather them around the teacher's bench in two batches to demonstrate to them what happens when more than three batteries are added in series until the bulb blows. This will reduce the number of bulbs that have to be discarded because they are blown.
- For battery holders that hold four batteries or more, trace the wire connection to show pupils how the batteries are arranged in series (As the holders have side-by-side compartments, pupils may think that the batteries are connected in parallel.

The suggested inquiry level is at Level 3, where this activity can be more teacher guided with some pupil direction.

Name: _____ Class: _____ Date: _____

Activity 6.1 More batteries in series

Teacher Pupil Level 3

Process skills

Constructing : simple circuits from diagrams of circuits
Investigating : the effect of the number of batteries (arranged in series) on the current in a circuit
Communicating : circuit diagrams from diagrams of circuits

Aim: To find out the effect of connecting more batteries in series to a bulb

Materials: Four batteries (D-sized, each in a battery holder), a bulb in a bulb holder, some connecting wires, magnifying glass

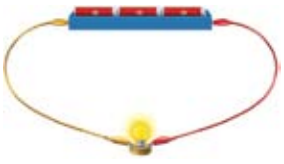
Procedures

1. Will connecting more batteries in series to a bulb make the bulb brighter? Write down your prediction.

   I predict that connecting more batteries in series will make the bulb brighter. When there are too many batteries, the bulb will blow.

   (Accept other possible answers.)

   Refer to the circuits below as you follow the steps.

Circuit 1	Circuit 2	Circuit 3
		

2. Construct circuit 1 and observe the brightness of the bulb.

3. Connect one more battery in series to circuit 1. The circuit now looks like circuit 2. Observe the brightness of the bulb.

Do not touch the bulb as it may be very hot during the experiment.

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Safety precautions

- Caution the pupils against breaking the light bulb through rough handling.
- Caution the pupils against connecting the two ends of the wire to the two terminals of the battery directly as it causes a short circuit and produces a large amount of heat.

Notes on observations and results

- Pass around the bulb that has blown so that the pupils can look at the melted filament with a magnifying glass.
- For higher ability pupils, show the pupils the rating that is marked on the light bulb (6V) and explain to the pupils that the bulb is designed to have 6V applied across it. If one battery is used, 1.5V is applied across it, and it will be lit dimly. Ask the pupils to recommend the number of batteries that should be connected in series to light the bulb brightly. If more than 6V is applied across the bulb, the filament gets overheated and may even blow because of too high a current passing through.

4. Connect one more battery in series to circuit 2. The circuit now looks like circuit 3. Observe the brightness of the bulb.

5. **(Optional)** Connect one more battery in series to circuit 3 until the bulb blows. Use a magnifying glass to observe the filament of the blown bulb.

Observations

1. Fill in the table with the number that represents the circuits on the previous page.

Brightness of bulb	Circuit
Bright	1
Brighter	2
Brightest	3

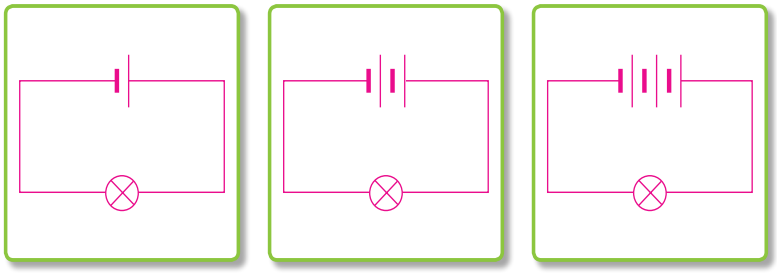
2. **(Optional)** What happened to the metal filament when the bulb blew?

   The metal filament broke/melted.

Questions

1. The number of batteries in circuit 2 is reduced by one. When the circuit is reconnected to form circuit 1, the electric | c | u | r | r | e | n | t | flowing in the circuit decreases. The bulb becomes dimmer.

2. Draw the circuit diagrams for circuits 1, 2 and 3.



circuit 1 circuit 2 circuit 3

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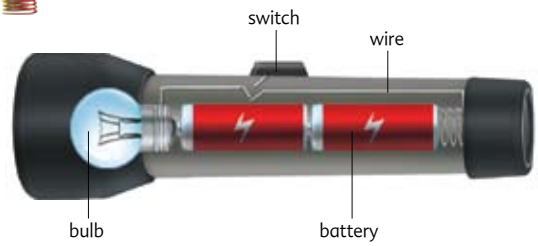
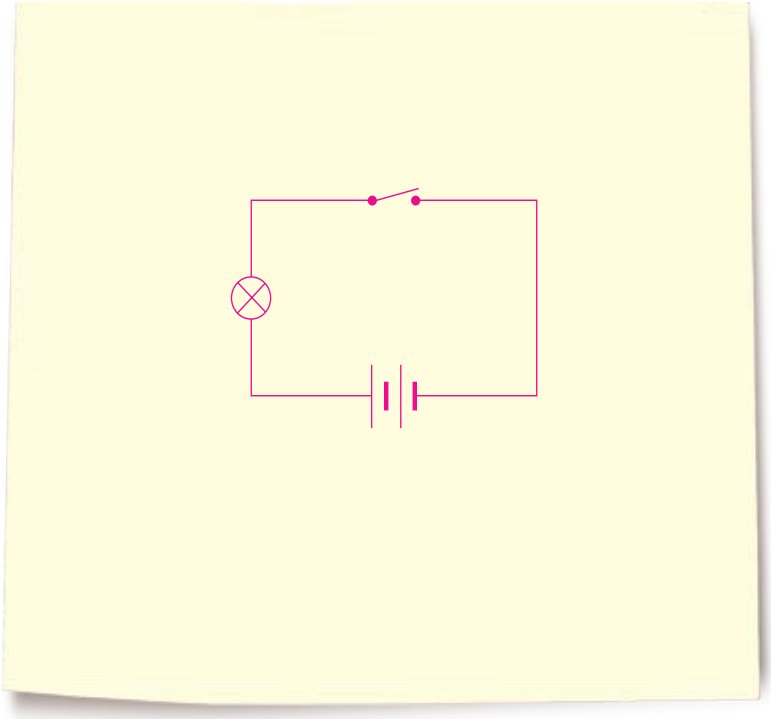
Extension



1. Are the batteries in a torch connected in series or in parallel to the bulb? How can you tell?

   In series. The batteries are arranged in one line where the positive end of one battery touches the negative end of the next battery.

2. Draw a circuit diagram to represent the circuit of the torch.



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The suggested inquiry level is at Level 3, where this activity can be more teacher guided with some pupil direction.

Name: _____ Class: _____ Date: _____

Activity 6.2 More bulbs in series

Teacher Pupil Level 3

Process skills

Constructing : simple circuits from diagrams of circuits
Investigating : the effect of number of bulbs (arranged in series) on the current in a circuit
Communicating : using circuit diagrams

Aim: To find out the effect of connecting more bulbs to a circuit

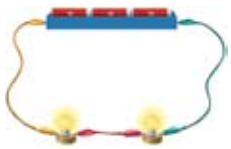
Materials: One battery (D-sized) in a battery holder, three bulbs (each in a bulb holder), some wires

Procedures

1. Will connecting more bulbs in series make the bulbs dimmer? Write down yor prediction.

   I predict that connecting more bulbs in series will make the bulbs dimmer.

   Refer to the circuits below as you follow the steps.

Circuit 1	Circuit 2	Circuit 3
		

2. Construct circuit 1 and observe the brightness of the bulb.

3. Connect one more bulb in series to circuit 1. The circuit now looks like circuit 2. Observe the brightness of the bulb.

4. Connect one more bulb in series to circuit 2. The circuit now looks like circuit 3. Observe the brightness of the bulb.

Before you carry out the activity

Pupils should have been taught
- The connection of bulbs in series.
- How to draw circuit symbols.

Where to obtain or buy
- All the electrical components should be available from the laboratory. If not, obtain from hardware or DIY stores.

Tips and time-savers

- For better comparison of results, three or four batteries should be used in this experiment with up to three bulbs in series.
- Before the lesson, check that the batteries are not running low.
- For this experiment, connecting wires with crocodile clips should be used for easier connection to the bulb and battery holder.

How it can be done

- Ask the pupils to predict the effect of connecting more bulbs in series in the circuit.
- Ask the pupils to test if their predictions are correct by setting up the circuit according to the diagrams and procedures given.

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Safety precautions

- Caution the pupils against breaking the light bulbs through rough handling.
- Caution the pupils against connecting the two ends of the wire to the two terminals of the battery directly as it causes a short circuit and produces a large amount of heat.

Notes on observations and results

- Ask the pupils to observe and compare the bulb brightness each time the number of bulbs is increased.
- For each connection, ask the pupils to also take note and compare the brightness of the bulbs within the circuit to see if there is a difference. This is to clarify the common misconception that current decreases as it travels around the circuit, so the bulb nearer the positive terminal of the battery is brighter than the one that is further.

Observations

Fill in the blank spaces in the table with the number that represents the circuit.

Brightness of bulb	Circuit
Bright	3
Brighter	2
Brightest	1

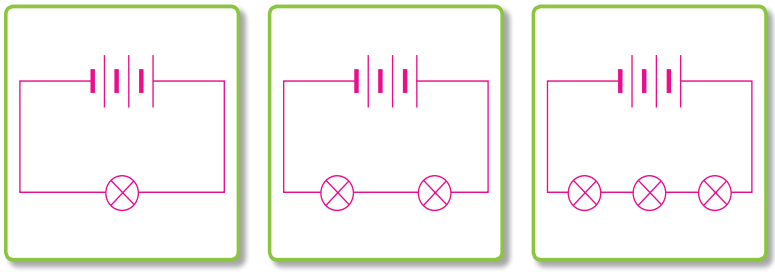
Questions

1. The number of bulbs in circuit 3 is reduced by one. When the circuit is reconnected to form circuit 2, the electric | c | u | r | r | e | n | t | flowing in the circuit increases (increases/decreases) as it is easier for it to flow. The bulb will become brighter (dimmer/brighter).

2. Do you think the bulbs will continue to light up if more and more bulbs are connected in series to the circuit? What makes you think so?

   No. I observe that as more bulbs are connected to the circuit, the bulbs will become dimmer. The time will come when too many bulbs are used and they can no longer light up.

3. Draw the circuit diagrams for circuits 1, 2 and 3.



circuit 1 circuit 2 circuit 3

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Before you carry out the activity

Pupils should have been taught

- The connection of bulbs in series and parallel.
- How to draw circuit symbols.

Where to obtain or buy

- All the electrical components should be available from the laboratory. If not, obtain from hardware or DIY stores.

Tips and time-savers

- Before the lesson, check that the batteries are not running low and have sufficient energy to light up a bulb.
- Twist the ends of the wires of the two bulb holders together in parallel before using connecting wires with crocodile clips to connect the arrangement to the battery.
- A common mistake pupils make in parallel arrangement is to connect the ends of one bulb holder to the insulating rubber of the connecting wires. There is no electrical contact and hence no current flow.

The suggested inquiry level is at Level 2, where this activity can be more pupil directed with some teacher guidance.

Name: _____ Class: _____ Date: _____

Activity 6.3 Bulbs, re-arrange!

Process skills

Constructing : simple circuits from diagrams of circuits
Investigating : the effect of the arrangement of bulbs on the current in a circuit

Aim: To find out how brightly bulbs will shine, when bulbs are arranged in series and in parallel

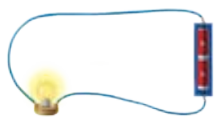
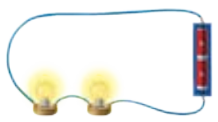
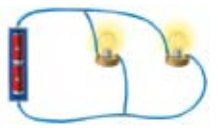
Materials: One battery (D-sized) in a cell holder, four bulbs (each in a bulb holder), some connecting wires

Procedures

1. Will connecting bulbs in parallel make the bulbs dimmer or brighter? Write done your prediction.

   I predict that connecting bulbs in parallel will make the bulbs dimmer.

   Refer to the circuits below as you follow the steps.

Circuit 1 (bulb for comparison)	Circuit 2 (bulbs in series)	Circuit 3 (bulbs in parallel)
		

2. Construct circuit 1 and observe the brightness of the bulb.
3. Connect one more bulb in series to circuit 1. The circuit now looks like circuit 2. Observe the brightness of the bulbs.
4. Remove one of the bulbs from circuit 2 and connect it in parallel as shown in circuit 3. Observe the brightness of the bulbs.

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How it can be done

- Demonstrate to the pupils how a parallel arrangement of bulbs can be connected before asking the pupils to attempt the activity.
- Ask the pupils to compare the relative brightness of the bulbs in the three circuits that they have connected.

Safety precautions

- Caution the pupils against breaking the light bulbs through rough handling.
- Caution the pupils against connecting the two ends of the wire to the two terminals of the battery directly as it causes a short circuit and produces a large amount of heat.

Notes on observations and results

- Tell the pupils that when a bulb blows, it creates a gap in the circuit.
- Ask the pupils to look at the circuit diagrams in the Extension section and check if there is an alternative complete path for the current to flow when one of the bulbs is blown.
- Lead the pupils to infer that when the bulbs are arranged in series, there is no alternative complete path for the current to flow and the circuit is open when one of the bulbs blows. On the other hand, in a parallel circuit, when one bulb blows, the current can still flow through the other bulb as the alternative path is complete.

Observations

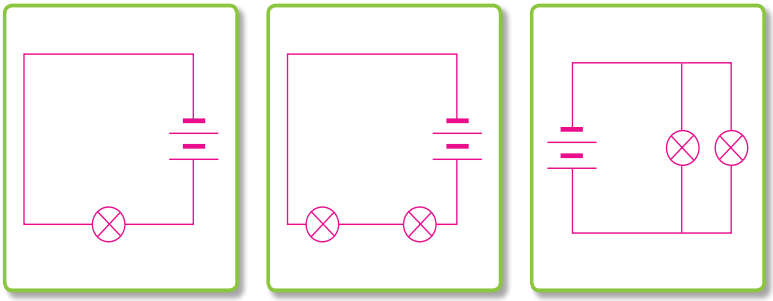
1. The bulbs in circuits 1 and 3 light up as brightly as each other.
2. The bulbs in circuit 2 light up less brightly than the bulbs in circuit 1 and 3.

Questions

1. How should two bulbs in a circuit be arranged to produce the brightest light?

   They should be arranged in parallel.

2. Draw the circuit diagrams of circuits 1, 2 and 3 in the space below.



circuit 1 (bulb for comparison) | **circuit 2 (bulbs in series)** | **circuit 3 (bulbs in parallel)**

Conclusion

What is the effect of changing the arrangement of bulbs in a circuit?

Changing the arrangement of bulbs in a circuit can affect the brightness of the bulbs in the circuit.

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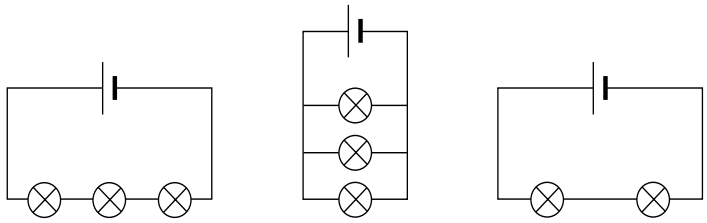
Extension

1. (a) Predict the degree of brightness of the bulbs in the following circuits. Rank them in order, from brightest to least bright. B , C , A



circuit A circuit B circuit C

(b) Complete the following table by stating whether the remaining bulbs in each circuit will continue to light up if one of the bulbs is blown.

Circuit A	Circuit B	Circuit C
No	Yes	No

2. (a) Do you think the lamps in a house are arranged in series or parallel?

The lamps in a house are arranged in parallel.

(b) What is the advantage of using this arrangement for the lamps in the house?

If one lamp is spoilt, the other lamps will still light up.

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Before you carry out the activity

Pupils should have been taught

- Electrical conductors are materials that allow electric current to flow through easily.
- Electrical insulators are materials that do not allow electric current to flow through them.

Where to obtain or buy

- Objects to be tested can be obtained from the classroom.

Tips and time-savers

- Before the lesson, check that the batteries are not running low and have sufficient energy to light up a bulb.

How it can be done

- Start the lesson with a scavenger hunt whereby the class is divided into groups and each group is asked to contribute the following objects: pen, metal ruler, steel clip, eraser, pencil lead, stapler, a stack of staples, thumbtack, A5 size notebook etc.
- Ask the pupils to set up the circuit tester and test which of the objects they have collected will make the bulb light up.
- Ask the pupils to decide what materials their objects are made of and record their answers.

The suggested inquiry level is at Level 1, where this activity can be more pupil directed.

Name: _____ Class: _____ Date: _____

Activity 7.1 Conductors and insulators

Teacher Pupil Level 1

Process skills

Constructing : simple circuits from circuit diagrams
Classifying : electrical conductors and insulators

Aim: To find out what materials allow electricity to pass through

Materials: A battery (D-sized) in a battery holder, a bulb in a bulb holder, some wires, common objects in the classroom

Background information

If the bulb lights up, the object allows electricity to pass through. Objects that allow electricity to pass through are called conductors of electricity. If the bulb does not light up, the object does not allow electricity to pass through. Objects that do not allow electricity to pass through are called insulators of electricity.

Procedures

1. Construct a circuit tester as shown below.

Do not touch the contact points with your bare hands.

2. Use the contact points to touch some objects in the classroom and observe if the bulb lights up. Choose some objects that will make the bulb light up and some that will not make the bulb light up.

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Safety precautions

- Caution the pupils against breaking the light bulb through rough handling.
- Caution the pupils against touching the contact points with their bare hands.

Notes on observations and results

- Some objects are made of more than one material, e.g. pencil box (fabric and metal zip), whether the bulb lights up depends on which two parts of the object are touched.
- It may surprise the pupils that pencil lead, which is a non-metal, is a conductor of electricity. Tell the pupils that lead is made of graphite and is one of the few non-metallic solids that conduct electricity.

Observations

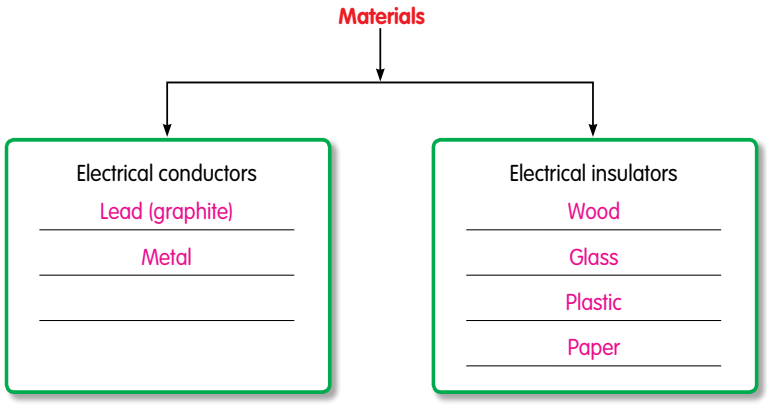
Complete the table below.

Object	Material tested	Did the bulb light up?
Pencil	Wood	No
Pencil	Pencil lead (graphite)	Yes
Window pane	Glass	No
Pen	Plastic	No
Book	Paper	No
Zip	Metal	Yes
Ruler	Metal	Yes

(Accept other possible answers.)

Question

Classify the materials tested using the following graphic organiser.



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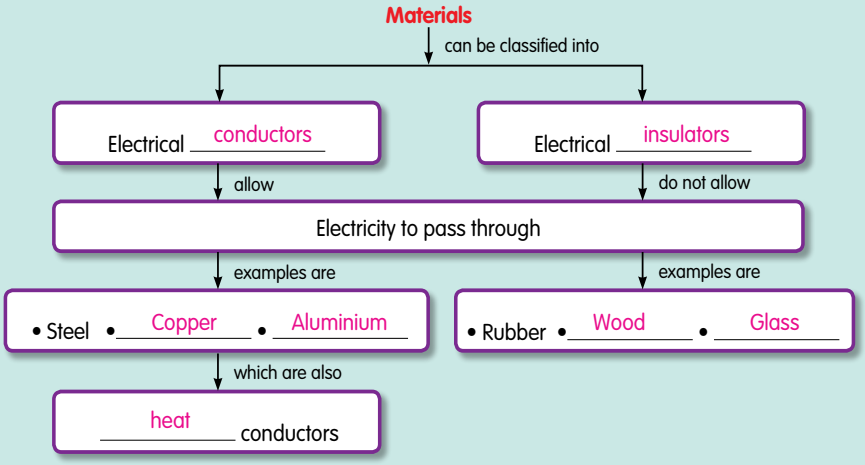
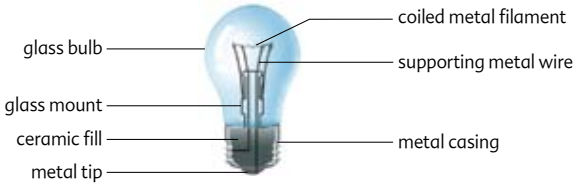
Reinforcement

Fill in the blanks with the correct answers.



Extension

Classify the labelled parts into good conductors and insulators of electricity.



Labelled parts

Electrical conductors	Electrical insulators
Coiled metal filament	Glass bulb
Supporting metal wire	Glass mount
Metal casing	Ceramic fill
Metal tip	

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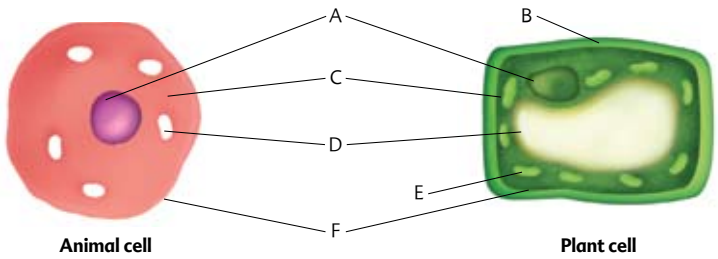
Name: _____ Class: _____ Date: _____

Revision Exercise Systems

Total marks: 16

Section A : Multiple-choice Questions [5 marks]

Questions 1 and 2 refer to the following diagram of an animal cell and a plant cell.



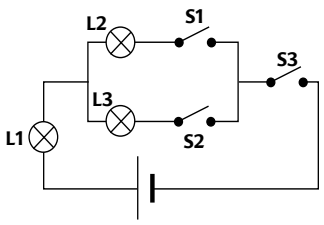
1. Which part of an animal cell protects the contents of the cell?

(1) A (2) B
(3) C (4) F (4)

2. Which of the following controls all the activities in the cell?

(1) A (2) B
(3) C (4) D (1)

3. Study the following circuit.



Which switches should be closed to light up only lamps L1 and L3?

(1) S1 and S2 only
(2) S1 and S3 only
(3) S2 and S3 only
(4) S1, S2 and S3 (3)

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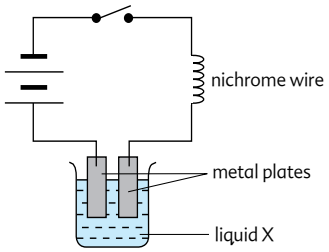
4. Rubber is an electrical insulator because _____.

(1) it is not a source of light
(2) it is not a source of heat
(3) it does not allow heat to pass through
(4) it does not allow electricity to pass through (4)

5. In the circuit shown below, the nichrome wire becomes hot when the switch is on.



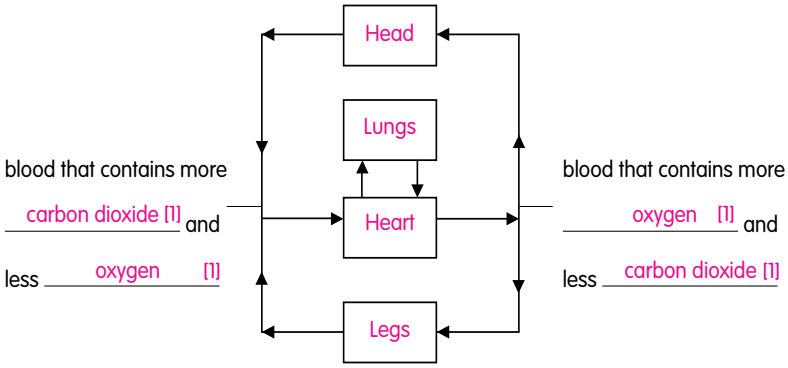
What conclusion can you draw from the experiment?

(1) Liquid X is an electrical conductor.
(2) Liquid X is an electrical insulator.
(3) Liquid X is a heat conductor.
(4) Liquid X is a heat insulator. (1)

Section B : Structured Questions [11 marks]

6. Use the given words to complete the diagram that shows how blood flows in certain parts of the body. Some words can be used more than once.

Legs Lungs Oxygen Heart Head Carbon dioxide



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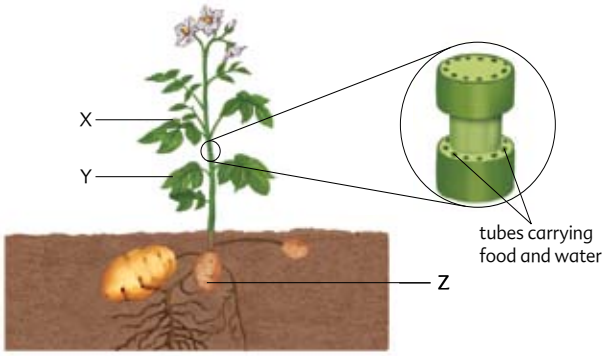
7. An outer ring of a stem was removed from a plant as shown below.

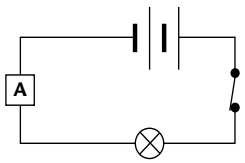


(a) What would happen to X? X would wither and die. [1]
(This is because no water reaches it for it to make food.)

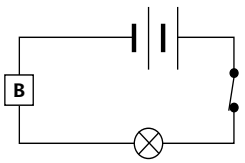
(b) What would happen to Y? Y would remain unchanged. [1]
(This is because water would be avaliable for it to continue making food.)

(c) What would happen to Z? Z would grow in size. [1]
(This is because food from Y will be transported to Z.)

8. Study the circuits below. A and B represent different materials.

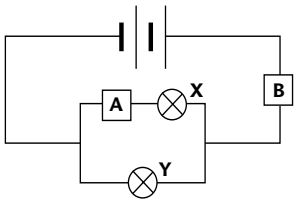


lamp is not lit



lamp is lit

Materials A and B are connected to another circuit as shown below.



Will the bulbs, X and Y, light up? Explain your answer.

Bulb X will not light up [1] but bulb Y will [1]. Material A does not allow electricity to pass through [1] but material B allows electricity to pass through.

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PSLE Revision Schedule — Diversity

Time required	Chapter	Specific learning objectives in My Pals are Here!	Syllabus from:	
			Lower block	Upper block
Term 3 Week 1 (one period)	Chapter 1 Classifying things	In this chapter, pupils will learn and be able to: • Classify things based on the similarities and differences in their characteristics or properties • Identify the characteristics or properties by which a set of things are grouped into • Recognise that the same set of things can be classified in different ways based on common observable characteristics, such as the properties of the things or the usage of the things • Explain why classification is important • List some examples where classification has been used • Classify things using tables and diagrams • Construct a classification system with multiple stages and identify the characteristics or properties selected at each stage of the classification	✔	
	Chapter 2 Living and non-living things	In this chapter, pupils will learn and be able to: • Recognise that there is a variety of things in our surroundings • Differentiate between living things and non-living things • Classify a variety of things as living things or non-living things • State that plants and animals are living things • Identify the differences in characteristics between living things and non-living things • State that living things need air, water and food to stay alive, while non-living things do not • List some examples of how living things change as they grow • State the different ways how living things can move by themselves • Explain why most animals move from place to place • List some examples of how living things respond to changes around them • Differentiate between living things and non-living things in terms of reproduction • Explain why living things reproduce • Explain why living things die	✔	

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Time required	Chapter	Specific learning objectives in My Pals are Here!	Syllabus from:	
			Lower block	Upper block
Term 3 Week 1 (one period)	Chapter 3 Plants	In this chapter, pupils will learn and be able to: • Recognise that plants are living things, which need air, water and food to stay alive • Recognise that there is a variety of plants in our surroundings • Observe a variety of plants and infer differences between them • Classify plants into broad groups based on similarities and differences of common observable characteristics • Identify the parts of a plant • Infer that most plants have the same basic plant parts • Identify the types of roots of some plants • Infer that the different types of roots will determine the different adaptive features of plants • Identify the types of stems of some plants • Infer that the different types of stems will determine the different adaptive features of plants • Identify the types of leaves of some plants • Identify the types of flowers of some plants • Classify plants into flowering plants and non-flowering plants • Compare different types of fruits	✔	
	Chapter 4 Animals	In this chapter, pupils will learn and be able to: • Recognise that animals are living things, which need air, water and food to stay alive • Recognise that there is a variety of animals in our surroundings • Identify, draw and name some common animals • Observe a variety of animals and infer differences between them • Classify animals into broad groups based on similarities and differences of common observable characteristics • Describe and compare the different sizes, shapes and colours of animals • Identify the types of outer coverings that animals have • Describe and compare the different functions served by the different types of outer coverings that animals have • Classify animals based on their diet • State the different ways how animals can move by themselves • State the different ways how animals can reproduce • Explain why animals reproduce	✔	
	Chapter 5 Classifying animals	In this chapter, pupils will learn and be able to: • Classify animals into broad groups based on similarities and differences of common observable characteristics • State the main groups of animals • State the common characteristics of mammals • List some examples of mammals • State the common characteristics of birds • List some examples of birds • State the common characteristics of fish • List some examples of fish • State the common characteristics of insects • List some examples of insects	✔	

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Time required	Chapter	Specific learning objectives in My Pals are Here!	Syllabus from:	
			Lower block	Upper block
Term 3 Week 2 (one period)	Chapter 6 Fungi and bacteria	In this chapter, pupils will learn and be able to: • State that fungi come in various sizes • List some examples of fungi of various sizes • State that micro-organisms are living things that can only be seen using a microscope • State that living things are also called organisms • State that some fungi are micro-organisms • Recognise that fungi are living things, which need air, water and food to stay alive • Differentiate between fungi and plants • State how fungi reproduce • Describe how some fungi are useful and how some fungi are harmful • Recognise that bacteria are living things, which need air, water and food to stay alive • State that bacteria are micro-organisms • Describe how some bacteria are useful and how some bacteria are harmful	✔	
	Chapter 7 Exploring materials	In this chapter, pupils will learn and be able to: • Recognise that there is a wide variety of materials • State that some common types of materials are wood, rubber, metals, fabric, ceramics, glass and plastics • Identify some common types of materials • Relate the properties of materials to their uses • Recognise that objects can be classified based on the materials they are made of • State the different properties of materials • Classify materials into broad groups based on similarities and differences of common observable characteristics • State the ways to test the properties of materials • Common materials based on their physical properties • Observe a material and describe its properties • Identify the appropriate materials to use for different objects based on what the objects are used for	✔	

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PSLE Revision Schedule — Cycles

Time required	Chapter	Specific learning objectives in My Pals are Here!	Syllabus from:	
			Lower block	Upper block
Term 3 Weeks 2 and 3 (two periods)	Chapter 1 Life cycles	In this chapter, pupils will learn and be able to: • Show an understanding that all living things go through a life cycle • Show an understanding that a cycle is a repeated pattern of change • Recognise that there are stages in the life cycles of living things • Show an understanding that living things change during their life cycles • Recognise that the length of a life cycle differs from one living thing to another	✔	
	Chapter 2 Life cycles of some animals	In this chapter, pupils will learn and be able to: • Identify the stages in the life cycle of a chicken • Describe briefly the appearance at each stage in the life cycle of a chicken • Identify the stages in the life cycle of a frog • Describe briefly the appearance at each stage in the life cycle of a frog • Describe briefly how a tadpole develops into an adult frog • Differentiate between a three-stage and a four-stage life cycle • Identify the insects with a three-stage life cycle and the insects with a four-stage life cycle • Identify the stages in the life cycles of a butterfly, a cockroach and a grasshopper • State the term used to name each stage in the life cycles of a butterfly, a cockroach and a grasshopper • Describe briefly the appearance at each stage in the life cycles of a butterfly, a cockroach and a grasshopper • Describe briefly the activity at each stage in the life cycles of a butterfly, a cockroach and a grasshopper • Compare the different stages in the life cycles of a butterfly, a cockroach and a grasshopper • Identify the similarities and differences between the life cycles of a butterfly, a cockroach and a grasshopper	✔	
	Chapter 3 Life cycles of plants	In this chapter, pupils will learn and be able to: • Identify the stages in the life cycle of a plant grown from seeds • Describe briefly the stages in the life cycle of a plant during its growth from a seed to a young plant and eventually, to an adult plant	✔	

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Time required	Chapter	Specific learning objectives in My Pals are Here!	Syllabus from:	
			Lower block	Upper block
Term 3 Week 3 (one period)	Chapter 4 What is matter?	In this chapter, pupils will learn and be able to: • Observe that different forms of matter may have different shapes, colours, sizes and textures • Recognise that all forms of matter have mass and volume • Identify that air is a form of matter as it has mass and volume	✔	
	Chapter 5 The three states of matter	In this chapter, pupils will learn and be able to: • Identify the three states of matter — solid, liquid and gas • State that a solid has a definite shape and a definite volume • Recognise that a solid cannot be compressed • State that a liquid has no definite shape but has a definite volume • Compare a solid and a liquid and recognise that a liquid also cannot be compressed • State that a gas has no definite shape and no definite volume • Compare a solid, a liquid and a gas and recognise that a gas can be compressed • Measure the mass of a solid using a lever balance and an electronic balance • Measure the mass of a liquid using an electronic balance • Measure the volume of a liquid using a measuring cylinder and a syringe	✔	
Term 3 Week 4 (two periods)	Chapter 1 From parents to young	In this chapter, pupils will learn and be able to: • State why living things reproduce • Recognise that heredity is the process where parents pass on their characteristics to their young when they reproduce • List examples of characteristics that can be passed on from humans to their young • Identify the characteristics that a young can inherit from its parents • List examples of characteristics that can be passed on from parent plants to their young		✔
	Chapter 2 Reproduction in flowering plants	In this chapter, pupils will learn and be able to: • List the parts of a flower • Identify the male and female parts of a flower • Recognise that pollination is the transfer of pollen grains from the anther to the stigma of a flower • Identify the agents that help in pollination • Describe the processes involved in fertilisation • Describe what happens after fertilisation has taken place • State the reason why the young does not grow near its parents • Recognise that dispersal is the scattering of fruits or seeds • Show an understanding of the different dispersal methods of fruits and seeds • Identify the dispersal methods of fruits and seeds by a plant • State the conditions necessary for germination to take place • Trace the stages of growth for different parts of a plant • Recognise that non-flowering plants grow from spores		✔
	Chapter 3 Reproduction in humans	In this chapter, pupils will learn and be able to: • Recognise that sexual reproduction occurs between a male and a female • Show an understanding of a baby's formation during internal fertilisation in humans • Identify the male sex organs and reproductive cells in humans • Identify the female sex organs and reproductive cells in humans • Relate the formation of a new life to the fertilisation of an egg in the female by a sperm from the male • Describe what happens to an egg after fertilisation • Infer that the sperm and egg contain the hereditary information that is passed on from parents to their young • Compare the reproductive processes in humans and flowering plants		✔

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Time required	Chapter	Specific learning objectives in MY PALS ARE HERE!	Syllabus from:	
			Lower block	Upper block
Term 3 Week 5 (one period)	Chapter 4 Water and changes of state	In this chapter, pupils will learn and be able to: • List examples of water in each of its three states • Recognise that a change in state can occur when water gains or loses heat • State the freezing point of water, boiling point of water and melting point of ice • Describe the changes of states and the heat transfer that takes place during freezing, condensation, boiling, melting and evaporation • Identify the similarities and differences between boiling and evaporation • Investigate the factors that affect the rate of evaporation		✔
	Chapter 5 The water cycle	In this chapter, pupils will learn and be able to: • Recognise that the water cycle ensures a constant supply of fresh water on Earth • Describe the water cycle with the help of a cycle diagram • Relate evaporation and condensation to the roles they play in the water cycle • Recognise that the water cycle helps to refresh water on Earth in a natural way		✔
	Chapter 6 Water — A precious resource	In this chapter, pupils will learn and be able to: • Identify the roles of water in the functions carried out by different human body systems • Identify the roles of water in germination and other life processes of plants • Recognise that water is precious • List some human activities that cause water pollution • Show an understanding of the effects of water pollution • Recognise that water conservation is using water carefully and not wasting it • Identify the ways to conserve water		✔

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PSLE Revision Schedule — Systems

Time required	Chapter	Specific learning objectives in My Pals are Here!	Syllabus from:	
			Lower block	Upper block
Term 3 Week 5 (one period)	Chapter 1 What is a system?	In this chapter, pupils will learn and be able to: • Describe what a system is • Recognise that a bus or a car are examples of complex man-made systems • Explain how a slipper is a system • Recognise that systems can also be found in living things, such as animals or plants • Explain how a living thing can be considered a system • State the functions of the various parts of an animal, such as the eyes, mouth, nose, ears and wings • Explain how a plant can be considered a system • List the parts of a plant system	✔	
	Chapter 2 Your amazing body	In this chapter, pupils will learn and be able to: • List the five main organ systems in the body • State the function(s) of each organ system • State the major parts in each organ system • Recognise that for the body to function properly, all the organ systems in the body must work together properly	✔	
Term 3 Week 6 (one period)	Chapter 3 The digestive system	In this chapter, pupils will learn and be able to: • Recognise that the food eaten must be digested before the body can use it • Show an understanding that digestion refers to the process where food is chewed or broken down into simple substances in the body • List the five major organs in the digestive system • Describe the functions of the mouth, gullet, stomach, small intestine and large intestine	✔	
	Chapter 4 Plants and their parts	In this chapter, pupils will learn and be able to: • Show an understanding of how a plant is a system • Appreciate that plants have the same basic parts, even though they vary in shapes and sizes • Identify the parts of a plant, which are the leaves, roots and stem • Classify leaves according to shape, size, colour, texture and smell • Identify the parts of a leaf, which are the leaf stalk, leaf blade and veins • State the function of the leaves of a plant • State the functions of the roots of a plant • Recognise that roots of different plants vary in shapes, sizes and colours • Explain how some roots are considered special • Compare the stems of different plants according to shape, size, colour and texture • State the functions of the stem of a plant • Explain how the stem is connected to the leaves and roots of a plant	✔	

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Time required	Chapter	Specific learning objectives in MY PALS ARE HERE!	Syllabus from:	
			Lower block	Upper block
Term 3 Week 6 (one period)	Chapter 1 The plant transport system	In this chapter, pupils will learn and be able to: • Show an understanding of what a system is • Recognise that a plant's transport system is crucial to its survival • Identify the parts of a plant that help it to transport substances • List the substances that are transported by a plant's transport system • State the function(s) of each part of a plant's transport system • Observe how a stem transports water from the roots to the other parts of a plant • Differentiate between the water-carrying tubes and the food-carrying tubes in a plant		✔
	Chapter 2 Air and the respiratory system	In this chapter, pupils will learn and be able to: • Recognise that air is a mixture of different gases • List the components of air • Recognise that moving air is wind • Discuss the uses of some of the gases present in air • Recognise that breathing is the process of taking air into the body and giving it out • Identify the organs that make up the human respiratory system • Describe how the human respiratory system carries out gaseous exchanges with its surroundings • Observe the respiratory system of a fish • Compare the respiratory systems of humans and other animals • Recognise that plants keep a healthy balance of oxygen and carbon dioxide in the air • Describe how a plant carries out gaseous exchanges with its surroundings • Explain why stomata are usually found on the underside of the leaves, away from direct sunlight		✔

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Time required	Chapter	Specific learning objectives in My Pals are Here!	Syllabus from:	
			Lower block	Upper block
Term 3 Week 7 (one period)	Chapter 3 The human circulatory system	In this chapter, pupils will learn and be able to: • Recognise that the heart is the vital organ of the human circulatory system that pumps blood all the time, to all parts of the body • Describe how the heart works • State the function(s) of the blood • Recognise that the heart is made of a special muscle called the heart muscle • State the function(s) of the blood vessels • Identify the organs that make up the human circulatory system • State the functions of the human circulatory system • List the substances that are transported by the human circulatory system • Trace the flow of blood and the path that substances take as they are transported by the human circulatory system • Show an understanding that each heartbeat is a cycle of contraction and relaxation of the heart muscles • Investigate how the rate of our heartbeat changes with age, health and type of activity • Recognise that the human respiratory and digestive systems work together with the human circulatory system to carry out life processes		✔
	Chapter 4 The unit of life	In this chapter, pupils will learn and be able to: • Recognise that a cell is the smallest unit of life in the body • List some organisms that are made up of only one cell • Recognise that the cells in an organism differ in shape, size and function • State the relationship between a cell, a tissue and an organ • Identify the parts of a plant cell and relate them to their function(s) • Identify the parts of an animal cell and relate them to their function(s) • Compare a plant cell and an animal cell • Show an understanding that new cells are produced to replace the dead or damaged cells and to enable living things to grow		✔

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Time required	Chapter	Specific learning objectives in MY PALS ARE HERE!	Syllabus from:	
			Lower block	Upper block
Term 3 Weeks 7 and 8 (two periods)	Chapter 5 Electric circuits	In this chapter, pupils will learn and be able to: • Recognise that an electric circuit is an electrical system because it is made up of components that work together, where each has its own function • Recognise that an electric current is a flow of electricity along an electric circuit • Identify the different components of an electric circuit and relate them to their function(s) • Communicate the set-up of an electric circuit through a circuit diagram, using the symbols of electrical components, such as a battery, wire, bulb and switch • Construct a simple electric circuit based on a circuit diagram • Differentiate between a closed circuit and an open circuit • Observe that an electric current flows only when an electric circuit is closed		✔
	Chapter 6 Using electricity	In this chapter, pupils will learn and be able to: • Recognise that a series connection of batteries involves connecting the positive terminal of one battery to the negative terminal of another battery • Investigate how the number of batteries in an electric circuit can affect the brightness of a bulb • Recognise what a fused bulb is • Recognise that a series connection of bulbs involves connecting the bulbs one after another • Investigate how the number of bulbs in an electric circuit can affect their brightness • Recognise that a parallel connection of bulbs involves connecting the bulbs such that an electric current flows along separate paths to each bulb • Investigate how the arrangement of bulbs in an electric circuit can affect their brightness • Investigate which arrangement of bulbs in an electric circuit allows the bulbs to work independently of one another • List the factors that affect the brightness of a bulb in an electric circuit • Identify electrical appliances that need electricity to work • Trace the source of electricity from an electrical appliance to a power station • Recognise the need to conserve electricity • List ways in which one can help to conserve electricity		✔
	Chapter 7 Conductors of electricity	In this chapter, pupils will learn and be able to: • Recognise that an electrical conductor is a material that allows electric current to flow through easily • Recognise that an electrical insulator is a material that does not allow electric current to flow through easily • Recognise that metal is a good conductor of electricity, as well as heat • Construct a circuit tester to distinguish between electrical conductors and insulators • Classify different materials as electrical conductors or insulators • Recognise the need to handle electricity and electrical appliances safely • Communicate the ways in which one can handle electricity and electrical appliances safely		✔

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PSLE Revision Schedule — Interactions

Time required	Chapter	Specific learning objectives in My Pals are Here!	Syllabus from:	
			Lower block	Upper block
Term 3 Week 8 (one period)	Chapter 1 Magnets and their characteristics	In this chapter, pupils will learn and be able to: • Recognise that there are natural magnets (lodestones) and man-made magnets • State that man-made magnets are made of iron or steel • Identify some common types of magnets • Show an understanding that magnets interact only with magnetic materials • Differentiate between metals which are magnetic and metals which are not magnetic • Infer that all non-metals are non-magnetic • Recognise that a magnet has two poles • State that the two poles of a magnet have the strongest attraction • Observe that a magnet, when freely suspended, will always come to rest in the North-South direction • Identify the north-pole and the south-pole of a magnet • State that the same poles of two magnets are like poles and the opposite poles are unlike poles • Recognise that the like poles of two magnets repel each other and the unlike poles attract	✔	
	Chapter 2 Making magnets	In this chapter, pupils will learn and be able to: • Observe that only magnetic materials can be made into magnets • Describe the steps involved when making a magnet using the stroke method • Recognise that a permanent magnet can lose its magnetism or become weaker if it is not properly cared for • State the definition of an electromagnet • Construct the set-up to make an electromagnet using the electrical method • Show an understanding that an electromagnet is a magnet only when it is connected to a battery or a source of electricity	✔	
	Chapter 3 Magnets, magnets, everywhere	In this chapter, pupils will learn and be able to: • List some uses of magnets in everyday objects • State the functions of magnets in everyday objects • Recognise that magnets can be used in many different ways	✔	

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Time required	Chapter	Specific learning objectives in MY PALS ARE HERE!	Syllabus from:	
			Lower block	Upper block
Term 3 Week 9 (one period)	Chapter 1 Forces	In this chapter, pupils will learn and be able to: • Classify the forces observed in our daily activities as a push or a pull • Discuss examples of pushing and pulling forces in our daily activities • State that a force is a push or a pull • Describe the effects of a force using examples from common observations • Show an understanding of the effects of forces on an object • State that a force can move an object at rest • State that a force can speed up, slow down or stop a moving object • State that a force can change the direction of a moving object • State that a force may change the shape and size of an object • Infer that a force is present from the change in the movement, direction or shape and size of an object • Observe from common phenomena and activities that a force can be useful or harmful		✔
	Chapter 2 Types of forces	In this chapter, pupils will learn and be able to: • Identify the different types of forces — frictional force / friction, elastic spring force, gravitational force / gravity and magnetic force • Describe friction as a force that opposes motion and is produced when two surfaces are rubbed against each other • Investigate the effects of friction on the movement of objects • Manipulate the conditions that affect friction • State that friction can be useful or can be a problem • List the advantages and disadvantages of friction • Discuss ways to reduce friction • Describe elastic spring force as a force that causes an elastic object to return to its original shape, after it has been stretched or compressed • Recognise that some materials and objects are elastic • Observe that a pulling force on a spring causes it to stretch • Observe that a pushing force on a spring causes it to compress • Identify when an elastic spring force is exerted • Observe that a larger pulling force on a spring causes it to extend more • Identify gravity as a force that can act at a distance • Describe gravity as the force of attraction between objects • Identify the factors that affect the strength of gravity • Discuss the actions of gravity • Recognise that the force of gravity between objects and the Earth causes the objects to have weight • State the instruments that can be used to measure weight • Identify the similarities and differences between weight and mass • Identify magnetic force as a force that can act at a distance • Describe magnetic force as a force that is caused by the pushing and pulling actions of magnets • Observe that like poles of magnets repel or push each other apart • Observe that unlike poles of magnets pull or attract each other		✔

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Time required	Chapter	Specific learning objectives in My Pals are Here!	Syllabus from:	
			Lower block	Upper block
Term 3 Week 9 (one period)	Chapter 3 Living together	In this chapter, pupils will learn and be able to: • Show an understanding that an organism is a living thing • Show an understanding that a population is a group of organisms of the same kind, which live together and reproduce in a particular place • Show an understanding that the population size is the number of organisms in a population • Identify the factors that affect the population size of an organism • Show an understanding that a habitat is the place where an organism lives • Recognise that habitats provide organisms with food, water, air, space and shelter for protection • Recognise that all the populations living in a habitat are interdependent for survival • Show an understanding that a community consists of all the different populations of organisms, which live together in a habitat • Recognise that different habitats support different communities, such as a pond, field, single plant, seashore, garden and other habitats • List examples of populations living in different habitats, such as a pond, field, single plant, seashore, garden and other habitats • Differentiate between the terms: organism, population, habitat and community		✔
	Chapter 4 Characteristics of the environment	In this chapter, pupils will learn and be able to: • Identify the living and non-living factors that affect the survival of an organism • Describe the importance of the type of soil • Describe the importance of the presence of other organisms • Describe the importance of the availability of food • Describe the importance of the temperature • Describe the importance of the amount of sunlight • Describe the importance of the availability of air • Describe the importance of the availability of water • Show an understanding that the characteristics of the environment in each habitat are unique, in terms of the type of soil, presence of other organisms, availability of food, temperature, amount of sunlight, availability of air and availability of water • Observe and describe the characteristics of a local environment • State the instruments that can be used to collect data on the characteristics of an environment		✔

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Time required	Chapter	Specific learning objectives in My Pals are Here!	Syllabus from:	
			Lower block	Upper block
Term 3 Week 10 (one period)	Chapter 5 Food chains and food webs	In this chapter, pupils will learn and be able to: • Trace how energy from the Sun is transferred to organisms • State how energy is obtained and used by organisms • Show an understanding that a producer uses the Sun's energy to produce food • Describe the role of a producer • Show an understanding that a consumer cannot produce its own food and gets its food either directly or indirectly from food producers • Identify different types of consumers • Show an understanding that a predator hunts and feeds on other animals • Show an understanding that a prey is hunted and eaten by other animals • Describe the roles of a predator and a prey in a community • Show an understanding that a food chain shows the food relationship between different organisms and how energy is transferred from one organism to another • Construct a food chain • Show an understanding that a food web is made up of food chains that are interconnected or linked together • Construct a food web • Recognise the effects on the rest of a food chain when there is a change in the population size of organisms • Recognise that the populations of all the producers and consumers in a food chain or food web are kept in balance • Show an understanding that a decomposer breaks down dead matter and animal wastes into mineral salts, water and carbon dioxide • List some examples of decomposers • Describe the role of a decomposer • Recognise that some animals help decomposers to break down dead organisms into simple substances more quickly		✔
	Chapter 6 Adaptations for survival	In this chapter, pupils will learn and be able to: • Recognise that adaptations are special characteristics that organisms need to help them survive in their natural habitats • Classify adaptations into structural adaptations and behavioural adaptations • Show an understanding that structural adaptations are special parts an organism has that help it to survive in its natural habitat • Show an understanding that behavioural adaptations are special ways an organism behaves to survive in its natural habitat • Recognise when an organism is adapted to its environment • Describe adaptations of organisms for breathing in water • Describe adaptations of organisms for movement • Describe adaptations of organisms for catching prey • Describe adaptations of organisms for obtaining sunlight • Describe adaptations of organisms for coping with extreme temperatures • Describe adaptations of organisms for protection • Describe adaptations of organisms for reproduction • Relate how certain adaptations in organisms serve to enhance survival		✔

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Time required	Chapter	Specific learning objectives in My Pals are Here!	Syllabus from:	
			Lower block	Upper block
Term 3 Week 10 (one period)	Chapter 7 Man's impact on the environment	In this chapter, pupils will learn and be able to: • Show an understanding that Man depends on Earth's natural resources for his survival • List examples of the positive impacts Man has on his environment • List examples of the negative impacts Man has on his environment • Show an understanding that deforestation is the removal of a large section of a forest by cutting down or burning trees • Identify the impacts of deforestation • Show an understanding that global warming is the rise in temperature on Earth • Identify some causes of global warming • Describe how carbon dioxide in the air causes the Earth's temperature to rise • Show an understanding that the greenhouse effect refers to the way greenhouse gases, such as carbon dioxide, retain heat around the Earth • Identify the effects of global warming • Identify the sources of man-made land, water and air pollution • Describe ways to save Man's environment		✔

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PSLE Revision Schedule — Energy

Time required	Chapter	Specific learning objectives in My Pals are Here!	Syllabus from:	
			Lower block	Upper block
Term 4 Week 1 (one period)	Chapter 1 Light and shadows	In this chapter, pupils will learn and be able to: • Differentiate between objects which are light sources and objects which are not • Recognise that the Sun is a source of light • State that we need light to see • Infer that objects can be seen if they can reflect light • Suggest ways to use light in safety devices • Differentiate between materials which allow light to pass through and materials which do not • Identify materials that allow light to pass through • Identify materials that allow some light to pass through • Identify materials that do not allow light to pass through • Measure light using a light sensor that is connected to a datalogger • Explain how a shadow is formed • Relate the shapes and sizes of shadows to the positions of the object and the light source	✔	
	Chapter 2 Heat and temperature	In this chapter, pupils will learn and be able to: • State that heat is a form of energy which makes things hot • List some common sources of heat • Recognise that heat can be felt by our sense of touch • Investigate why our sense of touch is not an accurate and reliable measurement of temperature • State that the temperature of an object is a measurement of its degree of hotness • Identify different types of thermometers for different uses • State that the unit of temperature is degree Celsius (°C) • Trace the four essential steps required to read the temperature on the thermometer correctly • Measure temperature using a thermometer or a heat sensor that is connected to a datalogger • Differentiate between heat and temperature • Relate the change in temperature of an object to the gain or loss of heat by the object • Show an understanding that heat flows from a hotter to a colder object until both reach the same temperature	✔	
	Chapter 3 Effects of heat	In this chapter, pupils will learn and be able to: • Relate an increase in size to expansion • Relate a decrease in size to contraction • Recognise that expansion is an effect of heat gain and contraction is an effect of heat loss • Recognise the effects of expansion and contraction around us • List some applications of expansion and contraction in our everyday life • Show an understanding that heat gain and heat loss can cause a change in the state of a solid, a liquid and a gas • Recognise that different materials conduct heat at different rates • Identify good and bad conductors of heat	✔	

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Time required	Chapter	Specific learning objectives in My Pals are Here!	Syllabus from:	
			Lower block	Upper block
Term 4 Week 1 (one period)	Chapter 1 Energy in food	In this chapter, pupils will learn and be able to: • Show an understanding that animals depend on plants for their source of energy • State the conditions and the products of photosynthesis • Relate what happens during the process of photosynthesis • Trace the energy pathway for plants and animals to the Sun		✔
	Chapter 2 Forms and uses of energy	In this chapter, pupils will learn and be able to: • Differentiate between the different forms of energy • Describe some examples of the different forms of energy and their uses • Observe the conversion of energy from one form to another and report the findings		✔
	Chapter 3 Sources of energy	In this chapter, pupils will learn and be able to: • Describe some examples of the various sources of energy and their uses • Observe the conversion of energy from one form to another and report the findings • Understand the need and importance of using energy wisely in daily life		✔

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MY PALS ARE HERE! Science Teacher's Guide is a component of the teacher's support package, which serves as a detailed and comprehensive guide to equip teachers for inquiry-based teaching. During the inquiry process, teachers take on the role of facilitators to spark curiosity, cultivate the skills needed for inquiry and guide pupils along the way.

MY PALS ARE HERE! Science Teacher's Guide comprises:

- BSCS 5E Instructional Model
- Inquiry Table
- Theme Overview
- Gap Chart
- Chapter Overview
- Reading Materials For Teachers
- Lesson Plans
- Textbook Wraparound
- Activity Book Wraparound
- PSLE Revision Schedule

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