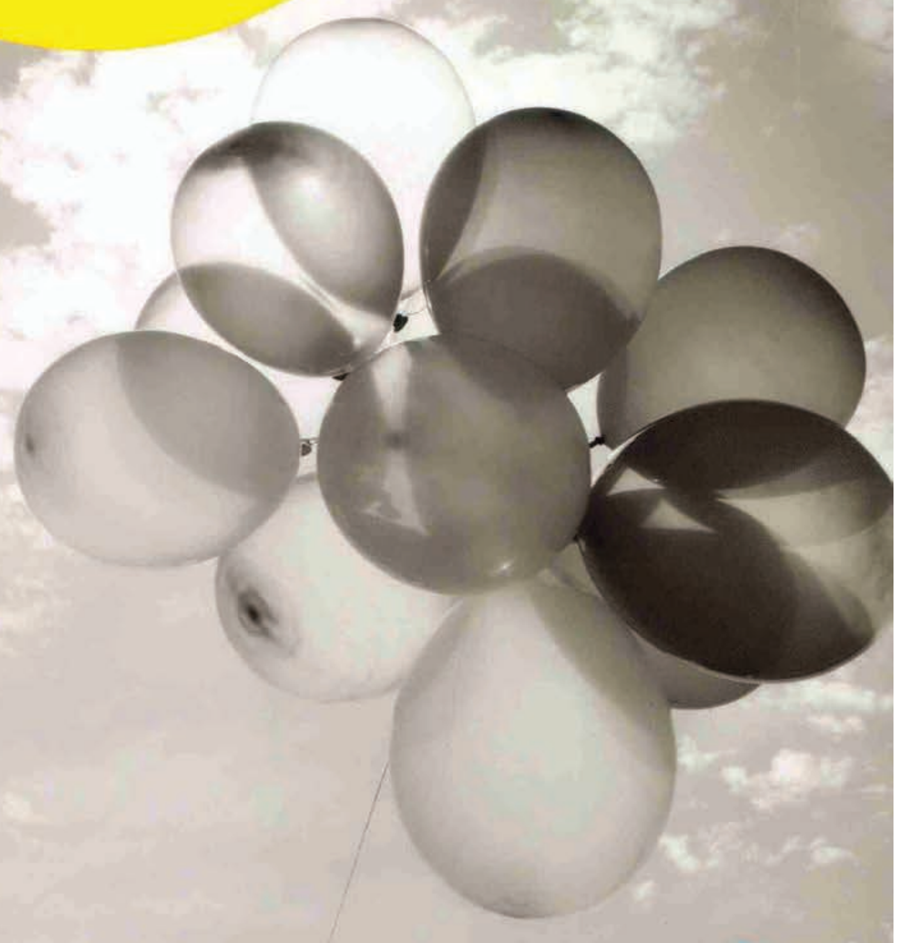
Rick **Armstrong** | Rachel **Whan** | Elani **McDonald** | Gareth **Jones** | 2nd edition

Science 2

for the international student



NELSON
CENGAGE Learning

Rick Armstrong
series editor

Rick **Armstrong** | Rachel **Whan** | Elani **McDonald** | Gareth **Jones** | 2nd edition

Science 2

for the international student

NELSON
CENGAGE Learning

Australia • Brazil • Japan • Korea • Mexico • Singapore • Spain • United Kingdom • United States

NELSON
CENGAGE Learning

Science 2 for the International Student
2nd Edition
Rick Armstrong
Rachel Whan
Elani McDonald
Gareth Jones
Jenny Sharwood
Neil Champion
Julie Hall
Tanith James
Katrina Mitchell

Publishing editor: Sarah Craig
Editor: Jane Fitzpatrick
Proofreader: Stephanie Ayres
Cover design: Aisling Gallagher
Cover image: Stocksy United Photography/Marcel
Text design: Aisling Gallagher
Permissions researcher: Karen Forsythe
Production controller: Emma Roberts
Typeset by: Macmillan Publishing Solutions

National Library of Australia Cataloguing-in-Publication Data
Armstrong, Rick, editor.
Science 2 for the international student / Rick Armstrong, Rachel Whan, Elani McDonald, Gareth Jones, Jenny Sharwood, Neil Champion, Julie Hall, Tanith James, Katrina Mitchell.
2nd edition.
9780170353472 (paperback)
Science for the international student.
Includes index.
Series editor: Rick Armstrong.
For secondary school age.
Science--Textbooks
Science--Study and teaching (Secondary)--Australia.
International baccalaureate--Study guides.

Whan, Rachel, author. McDonald, Elani, author.
Jones, Gareth, author. Sharwood, Jenny, author.
Champion, Neil (Neil Douglas), author. Hall, Julie, author.
James, Tanith, author. Mitchell, Katrina, author.

500

Cengage Learning Australia
Level 7, 80 Dorcas Street
South Melbourne, Victoria Australia 3205

Cengage Learning New Zealand
Unit 4B Rosedale Office Park
331 Rosedale Road, Albany, North Shore 0632, NZ

For learning solutions, visit **cengage.com.au**

Printed in Singapore by 1010 Printing International Limited.
1 2 3 4 5 6 7 20 19 18 17 16

Contents

UNIT 4 MAKING SENSE OF ELEMENTS AND COMPOUNDS 63

UNIT 5 MIXING AND SEPARATING 83

UNIT 6 USEFUL ENERGY 103

UNIT 7 FLOATING, SINKING AND PROPULSION 121

UNIT 8 SPACE: WHAT'S OUT THERE? 139

About the authors

Authors

Rick Armstrong (series editor)

Rick Armstrong has been involved with MYP sciences guide writing since 1994. He has experience with leading sciences workshops in all International Baccalaureate regions, moderation, school visits and authorisations, as an Approaches to Learning workshop leader, and as DP examiner. Rick is currently a freelance educational consultant in Madrid, Spain.

Gareth Jones

Gareth Jones has taught the MYP for the last eight years. He has experience across a range of subjects teaching Science, Mathematics and Physical Health Education. This experience across the disciplines led him to be an examiner for the MYP Interdisciplinary eAssessment. He is currently an MYP and DP science teacher and Student Wellbeing leader at Halcyon London International School.

Elani McDonald

Elani McDonald has dedicated her entire teaching career to working in IB schools. She is a workshop leader and a MYP visiting team member. She has been involved in monitoring and moderation of assessment and was involved in writing the Science and Personal Project 2014 guides, as well as the 2014 Teacher Support Material for Physics. Elani is dedicated to making learning relevant and engaging and was shortlisted for the TES Maths teacher of the year 2014/15 award. Elani is teaching Mathematics and Sciences full-time and doing consultancy work part-time.

Rachel Whan

Rachel Whan studied Veterinary Science before completing a Graduate Diploma in Education. Since then she has taught Chemistry, Biology, Human Biology, Science, Mathematics and Agriculture in a variety of schools in Queensland and Western Australia. Rachel has taught in MYP schools since 2006 and has been the Science Team Leader at St Brigid's College in Lesmurdie, WA, Australia since 2007.

How to use this series

The *Science for the international student* series provides students with a variety of engaging and stimulating formats for learning, understanding and immersion within the Middle Years Programme (MYP) philosophy of the International Baccalaureate (IB). The features of the student book have been specifically designed to support this and to deliver exciting content in a variety of ways.

Specific MYP features

Each unit begins with a unit opening page that specifies:

- the key concept that is covered in the unit
- the related concepts that are covered in the unit
- the Global Context of the unit
- the Statement of Inquiry
- inquiry questions, divided into factual, conceptual and debatable questions.

Key and related concepts

Each unit is based around one *key concept* of an enduring transdisciplinary nature, and a small number of *related concepts* designed to help frame the unit in the minds of the students.

Global Context

Students will be encouraged to see science in diverse global contexts. These include historical developments in science; how scientific discoveries have affected medicine, space exploration, materials technology and nutrition; and the role of science in environmental sustainability and equitable access to resources in the developing world.

Statement of Inquiry

The *Statement of Inquiry* drives the unit and is strongly related to the unit's concepts and context.

Inquiry questions

The inquiry questions are divided into factual, conceptual and debatable questions. Factual questions are related to the unit content, conceptual questions are related to the unit concepts and debatable questions are related to both and designed to stimulate deeper thinking.

Performance assessment tasks

Opportunities for assessment tasks occur throughout each unit and these are each identified by a *performance assessment task* icon.

The *summative performance assessment task* associated with the Statement of Inquiry is identified at the beginning of each unit. The criteria assessed by the assessment task are also identified.

Approaches to Learning

Opportunities to develop and apply *Approaches to Learning* skills are identified by an 'ATL' icon. Teachers can use these prompts to discuss and reinforce learning strategies.

Investigations

Investigations challenge students to design and perform their own experiments either individually or in groups. Investigations are designed to satisfy criteria B and C (see Appendix 2).

Experiments

Experiments provide students with the opportunity to develop and practise their skills by following processes and procedures, to discover information for themselves and to build a greater understanding of, and interest in, scientific concepts. Most experiments are designed to satisfy criterion C (see Appendix 2), but some additional important experiments are also included (and the NelsonNet teacher website has further experiments).

Taking action

Taking action suggestions are identified by a 'TA' icon and are designed to satisfy the MYP requirements for service as action.

Other features

Review

Review boxes contain questions and break the content into smaller sections, allowing students to review what they have learnt so far.

Activity

Activity boxes reinforce or develop concepts and skills through short, fun, hands-on activities.

Weblinks

Weblinks are identified by an icon and direct students to exciting websites to further explore the world of science.

Unit questions

Unit questions conclude each unit. They include review questions sorted under the MYP assessment criterion A, levels 1–8. Reflection questions are included to review the concepts underpinning the unit, to encourage further consideration of the debatable inquiry questions and at times to consider further lines of inquiry.

NelsonNetBook

The *Science for the international student* NelsonNetBook is an interactive ebook that can be used online or offline. It is compatible with interactive whiteboards, computers and tablets, with optional Web 2.0 functionality for class groups. Students can add highlights, annotations, audio and video clips, and weblinks, and teachers can use it to share students' personalised versions with the class.

Visit the NelsonNet portal at www.nelsonnet.com.au to find out more, register or log in.

NelsonNet teacher website

The NelsonNet teacher website contains further valuable advice, including draft MYP unit plans covering the first two pages of the revised MYP planner and also a curriculum overview as required by the IB. Other resources include blackline masters (BLMs) containing possible further experimental work and classroom activities, ideas for further resources, and further advice relating to teaching in a conceptual way and the use of the Approaches to Learning framework. Answers will also be provided for all questions, along with a list of extra resources for each unit.

Contact your sales representative for information about access codes.

Introduction

To the student

We hope you will enjoy using this exciting student book, which has been designed to provide an up-to-date science experience based around the principles of the new enriched Middle Years Programme (MYP) offered by the International Baccalaureate (IB). You are probably already an experienced MYP student, proud of being *internationally minded*, and familiar with the distinctive way MYP students work in science. These revised books provide a greater emphasis on the global contexts for learning in science, from the challenge to provide better and more equal access to medicines worldwide, to environmental challenges such as global warming. The books emphasise investigative and experimental work and expect you to work and think like a real scientist. As you will be well aware, the MYP is also about encouraging you to develop effective learning skills that will stay with you for life and you will see in these books many suggestions to help you with this challenge. We wish you all the success possible with MYP Science and beyond.

To the teacher

We have reviewed our original series, published in 2010–2011, to take account of the innovative developments and improvements in the MYP. In this new edition, we have deepened our coverage of MYP principles within each unit. The units are now much more contextual and more explicitly driven by the Statement of Inquiry. As you will be aware, the IB has attempted to give schools more flexibility in their delivery of the MYP and there is certainly no 'correct' model of how to put the MYP into practice. For that reason, we feel we should explain some of our approaches to constructing our units.

1. **Conceptual framework:** We have closely followed the suggested framework but have added a small number of extra related concepts that will be useful to teachers and will allow coverage of the US cross-cutting concepts. We have also used concepts from other subjects when we felt their use would enhance the unit. Importantly, we accept that the key to teaching conceptually lies in appropriate classroom practices. Accordingly, we have included activities and questions to help strengthen students' understanding of the conceptual framework, as well as some further guidance in the teacher materials.
2. **Content:** We have included academically challenging content that will provide an effective transition from MYP 1-5 to the new e-examinations, and to higher study in the Diploma Programme (DP) or in other national systems. This content should also help teachers meet the requirements of local curricula. We have covered all the expected content for MYP Sciences e-examination in Books 4/5. Some of this content is also covered in more detail in Books 1, 2 and 3. We have ensured that the scope and sequence of our MYP Books 1–5 is well thought out and offers a coherent framework for the development of deep understanding based on the big unifying concepts in science.
3. **Global Contexts:** The development of Areas of Interaction into Global Contexts is very liberating and opens the door for much more creative uses of contexts in the planning of MYP units. To take advantage of this potential, we have associated the Global Context chosen for the unit with a more specific 'exploration into' statement. This 'exploration into' feeds clearly into the Statement of Inquiry for each unit. This has helped us to make the science content up to date, interesting and relevant to the real world.

4 **Statements of Inquiry:** We have written simple and clear Statements of Inquiry that are understandable to students and to teachers. We have been flexible in trying to build all the chosen concepts into the Statements of Inquiry. Our priority has been to ensure that the Statement of Inquiry is easy to understand, has a conceptual feel and, importantly, relates to the chosen Global Context.

5 **Assessment tasks:** Most science units will require more than one summative performance assessment task because it is artificial to try to bring together a number of the sciences criteria in one task. Therefore, most units include assessments relating to investigation work (criteria B and C), a performance-type task relating to the impacts of science (criterion D) and end-of-unit questions to assess knowledge and understanding (criterion A). At the beginning of each unit, you will see a summative performance assessment task that relates closely to the Statement of Inquiry. We have given this task the most authentic performance nature possible. Other performance assessment tasks are included in each unit that can be used summatively or formatively. We expect that not all of the assessment suggestions will be used for summative purposes.

6 **Approaches to Learning:** We are very impressed by the revised Approaches to Learning framework based on the ten clusters of ATL skills. We understand that the effective implementation of ATL is a whole-school challenge but have made suggestions for when teachers can explicitly introduce these skills and dispositions, both as part of summative assessment tasks and also more generally in their daily teaching. You will also see a simplified ATL framework in the appendices that we think will be of great help to teachers.

7 **Service learning:** We have also suggested a possible service learning activity (labelled 'TA' (Taking action)) for each unit.

The NelsonNet teacher website contains draft MYP unit plans, curriculum overviews, BLMs for experimental work and classroom activities, ideas for interdisciplinary tasks, further resources and advice for using the ATL framework, and answers to all questions.

We realise there may seem to be an inherent conflict between the idea of teachers working in a creative and collaborative way to produce MYP units of work and the use of a textbook. Schools will use this book in different ways. Some new schools might find it an invaluable stepping stone to getting a MYP Sciences programme up and running. Others may use it to enhance their existing courses. We encourage you not to use these books the way traditional textbooks have been used. Be creative, add to them, choose the bits you like, encourage the students to interact with them. They are there to help students in their deep learning of science, to encourage their interest and motivation. We hope the availability of materials of this kind will make your life as the teacher a little easier and give you more time to focus on the actual teaching and learning. Enjoy them.

Rick Armstrong (Series editor)

UNIT 1

FORENSIC SCIENCE: EVIDENCE AND PATTERNS

KEY CONCEPT
Relationships

RELATED CONCEPTS
Evidence
Patterns

GLOBAL CONTEXT
Scientific and technical innovation: an exploration into how scientists work to solve crime in our communities

STATEMENT OF INQUIRY
Scientists apply their knowledge and use technology to uncover evidence, identify patterns and construct arguments, enabling them to solve crimes and make new discoveries.

INQUIRY QUESTIONS

FACTUAL
1 What methods do we have to acquire evidence?
2 What methods do we have to analyse evidence?

CONCEPTUAL
3 How can we analyse unknown substances?
4 How can we bring evidence together to construct an argument?

DEBATABLE
5 To what extent can we rely on DNA evidence?
6 To what extent should individuals' genetic records be kept on file by authorities?

Introduction

Whether in books, podcasts, TV shows or computer games, scientists are not often seen as the heroes of crime drama. Every day, scientists work in a huge range of fields; for example, researching new drugs, investigating new methods of generating electrical energy and carrying out other studies vital to our society. Scientists gather evidence and look for relationships and patterns in data; for example, to inform them of whether a drug is working or a method of energy generation is practical and efficient. It is these same scientific abilities to collect evidence and identify patterns that are used by scientists to help solve crimes. **Forensic science** is the science of collecting and analysing evidence relating to crime and the law.

A great example of how evidence can be collected to identify patterns and solve a crime can be heard by listening to the hit podcast *Serial*, which tells the story of a real-life case. Go to http://mypsci2.nelsonnet.com.au and click on **Serial**. (The podcast is very long so choose an episode.)

Forensic scientists use many different areas of science to help solve crimes and provide answers to other legal questions. Forensic science is not only used in burglary and murder cases; it is also used to support legal cases relating to such things as environmental issues, insurance fraud, traffic accidents, missing persons and identification of the biological parents of a child.

SUMMATIVE PERFORMANCE ASSESSMENT TASK
CRITERIA A (I AND II) AND D

Gathering evidence

On a gloomy night in winter a window was broken and a house was burgled. Some blood was later found on the windowsill and some footprints in the soaking wet flowerbeds. A glass was left that it appeared the burglar had used to take a drink. The drawers were left open in a filing cabinet in the study. From one drawer, an envelope had been taken and replaced by a scrawled note with the words 'I know'.

1 You are the forensic scientist at the scene. Your job is to construct a plan of action to present to the police force for how to proceed with gathering evidence to help solve the crime. Your plan should contain the following information:
   - a summary of the evidence you will collect
   - the reason for collecting each piece of evidence
   - a description of how you will analyse each piece of evidence.
2 Now imagine the police have identified a **suspect**. Write an imaginary report based on your analysis that either confirms or raises doubt about the suspect's involvement. Include your imaginary scientific results in the report.

ATL

COMMUNICATION

Express your ideas clearly, precisely and persuasively when constructing a plan of action for others. This will help you convince your audience that your plan of action is the best one.

How do we collect evidence?

FIGURE 1.1 A crime scene

The job of forensic scientists is to collect, analyse and present evidence that may be relevant to a case. They look for facts and evidence, and use them to complete a pattern to help the correct decisions to be made at court. To do this, they need to be very accurate and unbiased in their decision-making.

After a crime has been committed the police will often seal off the crime scene for the collection of evidence. The police will interview each **eyewitness** and question any suspects in the case. The facts and evidence provided by witnesses and suspects are important to the forensic scientist.

FIGURE 1.2 Police collecting evidence

Observational evidence

One of the first jobs a forensic scientist will do is observe the scene of a crime or activity. This will allow them to see if they can identify anything that will be relevant to a case. Complete the following activity to see what your observational skills are like.

ACTIVITY Are you a good eyewitness?

An eyewitness is someone who witnesses a crime. Sometimes the crime happens so quickly and unexpectedly that they do not have time to see what is going on, let alone take it in. Eyewitnesses who witness the same crime can have very different stories to tell.

FIGURE 1.3 A witness in a courtroom

PROCEDURE

1 Look at Figure 1.4 for 10 seconds.
2 Cover the picture and try to answer the following questions.
   a What window has been smashed?
   b What colour are the computers?
   c What was the colour of the coat hanging on the back of the chair?
   d What was the colour of the soft-drink can next to the computer?
   e What was the weather like outside the window?
   f How many students were looking through the broken window and were they male or female?
3 Look back at the picture and check your answers. How many did you get right? Compare your results with those of the rest of the class.

DISCUSSION

- How observant were you? How good an eyewitness would you make?
- Did anyone in the class answer all of the questions correctly?

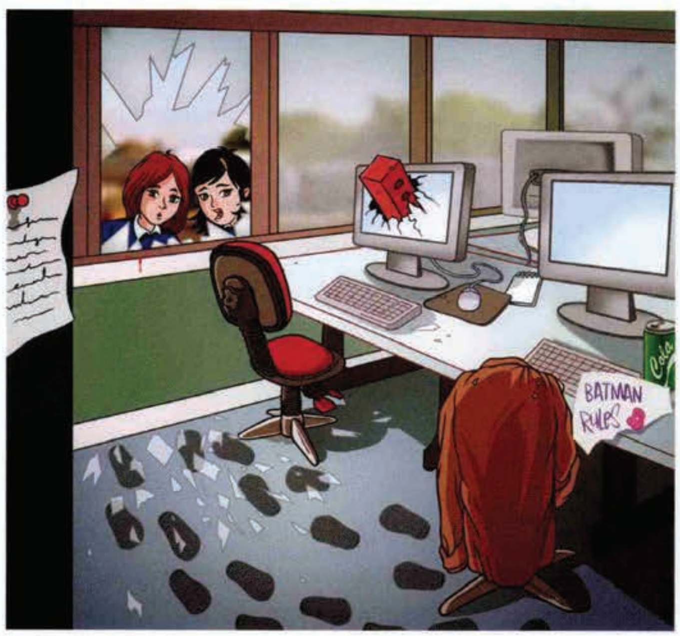


FIGURE 1.4 The computer lab in chaos

To watch a TED Talk on the potential unreliability of eyewitnesses, go to http://mypsci2.nelsonnet.com.au and click on **Eyewitnesses**.

To read more about reliability of eyewitnesses, go to http://mypsci2.nelsonnet.com.au and click on **Eyewitnesses' reliability**.

To test your eyewitness skills, go to http://mypsci2.nelsonnet.com.au and click on **Eyewitness skills**.

- How do you think you would perform on these questions if you had looked at the picture for 10 seconds yesterday and were only asked the questions today? Use your response to explain why police ask everyone who was near the scene of a crime what they saw as soon as possible after the crime has taken place. Why is it best to have as many eyewitnesses as possible?

Observational games

ACTIVITY

Throughout history, games have been played that help us develop good observational skills. Follow the link to play the global classic 'Where's Waldo?' (or Wally).

For the Where's Waldo activity, go to http://mypsci2.nelsonnet.com.au and click on **Where's Waldo?**

TA FORENSIC SCIENCE ON TV

During this unit, watch some forensic science TV programmes with your family or friends. Try to use what you have learnt to help your family or friends to better understand the science in the programme. Also find out how much your family or friends know about forensic science in general.

Types of evidence

Once the observational evidence has been recorded, more specific information must be collected. This includes collection of:

- fingerprints
- fibres and hair
- copies of impressions (for example, footprints)
- soil
- inks and dyes
- blood
- DNA.

Once collected, these items can be analysed. Then the forensic scientist can see if the results fit a pattern and provide enough evidence to convict a suspect or identify another suspect.

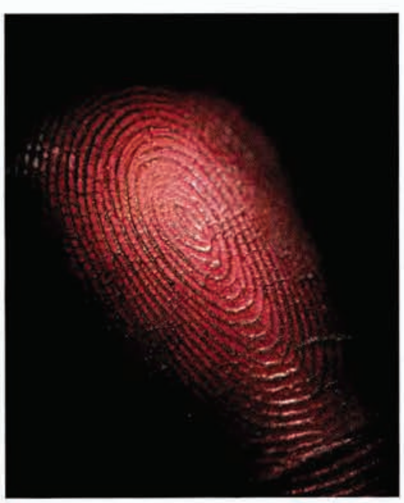


FIGURE 1.5 The tip of a human finger, showing the pattern made by tiny ridges in the skin

Analysing the evidence

Fingerprints

When we touch objects we leave **fingerprints**, prints that reflect the pattern of tiny ridges in the skin of the finger tips. This is because we have small amounts of perspiration and oil on our skin. When we touch something, a small amount of moisture is deposited in the pattern of the ridges.

Every person's fingerprints are unique – even identical twins have different fingerprints. This makes fingerprints a vital piece of evidence because they can reveal if a suspect has been at the scene of a crime.

After a police photographer takes photographs of the crime scene, a forensic scientist looks for any fingerprints. Where fingerprints are found, fine powder is dusted softly onto surfaces and sticks to the traces of perspiration and oil. Photos are taken, then the fingerprints can be lifted off the surfaces with tape.

Fingerprints are checked using an Automated Fingerprint Identification System (AFIS), in case the suspect's fingerprints are already on file. The computerised system rapidly compares crime scene fingerprints with a computer database of the fingerprints of known offenders.

Go to http://mypsci2.nelsonnet.com.au and click on **Fingerprinting**. Have a look at the seven major fingerprint patterns, print these out and stick them into your science workbook. You will need to refer to these when you do the 'Identifying fingerprints' experiment.

EXPERIMENT 1.1 Identifying fingerprints

PERFORMANCE ASSESSMENT TASK
CRITERION C (I AND II)

AIM

To lift fingerprints off some objects and determine who left them.

MATERIALS

- inkpad
- A3 sheet of paper
- fine carbon powder in a sprinkling container
- soft make-up brush
- clean, dry aluminium drink can
- clean, dry drinking glass
- clean, dry china coffee cup
- clean, dry plastic lunchbox lid
- dropper bottle of oil
- sticky tape
- newspaper
- four pairs of latex gloves

PROCEDURE

1 Make a print of your forefinger by pressing the inkpad and then carefully pressing the A3 sheet of paper. Then write your name next to your print. The A3 sheet should then be displayed for everyone to see. Use the fingerprint patterns from the weblink to identify each person's pattern.
2 Divide into groups of four. (There needs to be an even number of groups, so if necessary, adjust your group size.)
3 Lay the newspaper over your workspace. One group member puts on the latex gloves and carries the clean objects over to the newspaper. No one else must touch these items.
4 Over the newspaper, each group member places one drop of oil on their forefinger and rubs it in well, so there is only a small residue of oil left on the skin. Then each member of the group presses their forefinger on one of the objects only, so that each object has been touched by only one person. Only the group knows who has touched each object.
5 Swap places with another group. Do not touch their objects. Your task is to deduce which group member from that group touched which object. Each group member in your group will identify the fingerprint on one object.
6 Put on the latex gloves. Sprinkle a small amount of carbon powder over the print you are testing. Gently remove the excess powder with the make-up brush or by gently shaking the object.
7 Place a strip of sticky tape across the now-visible fingerprint. Then lift up the sticky tape and stick it on a blank piece of white paper.

>

FIGURE 1.6 Lifting a fingerprint

8 Label the print by writing the date and the surface it was lifted from.
9 Inspect the A3 sheet with each person's fingerprint on it. Identify which group member touched the object you tested.
10 Put away everything you used, according to your teacher's instructions.

CONCLUSION

Can you identify the person who touched the object you tested?

DISCUSSION

1 You used carbon powder to make a black print that can be seen when placed on white paper. Talcum powder can also be used to dust for fingerprints. What coloured paper would you stick a talcum print on to?
2 Which surfaces were easiest to collect fingerprints from? Why? Which surfaces were hardest? Why?
3 Why do you suppose that the objects were only to be handled by someone wearing gloves?
4 What problems might police have when dusting for prints at the scene of a crime? Why is it difficult to get clear fingerprints from a crime scene?
5 Where are fingerprints likely to be found at a crime scene?
6 From your experience, what might be the advantages of using an Automated Fingerprint Identification System to identify fingerprints found at crime scenes?

Alternative ways to collect fingerprints

There are two different ways to acquire fingerprint evidence. One is to use magnetic fingerprint powder and the other is to use ultraviolet light. The use of magnetic fingerprint powder is similar to the method in the 'Identifying fingerprints' experiment. When fingerprints are on a surface that it is hard to get prints from, such as a plastic bag, the surface can be brushed with a magnetic fingerprint powder. The brush consists of a magnet carrying thousands of tiny iron flakes. A coating on the flakes makes them 'stick' to the greasy fingerprint. Excess powder is removed with a magnet. Because the brush does not have bristles, the fingerprint image is very clear.

FIGURE 1.7 Finding fingerprints using ultraviolet light

You can search a large area for prints quickly using ultraviolet light. This can help to identify where the prints are before lifting them. As you shine ultraviolet light over an area, the oils in the fingerprints reflect the light as visible light, making them show up.

REVIEW

1. State four different types of evidence.
2. Define the term 'eyewitness'.
3. State the main elements of a forensic scientist's job.
4. Outline how you can lift fingerprints from a crime scene.
5. Describe how you could use ultraviolet light to find prints at a crime scene.
6. Describe the different type of patterns that can be seen in different people's fingerprints.

Fibres and hair

Fibres from fabric and hair from humans and animals are another type of evidence that can prove a suspect has been at the scene of a crime. Fibres may be found on the floor, on clothes or perhaps caught on a piece of furniture. Various types of microscopes are used to identify and compare fibres. Microscopes can identify whether a hair is from a person or an animal, whether

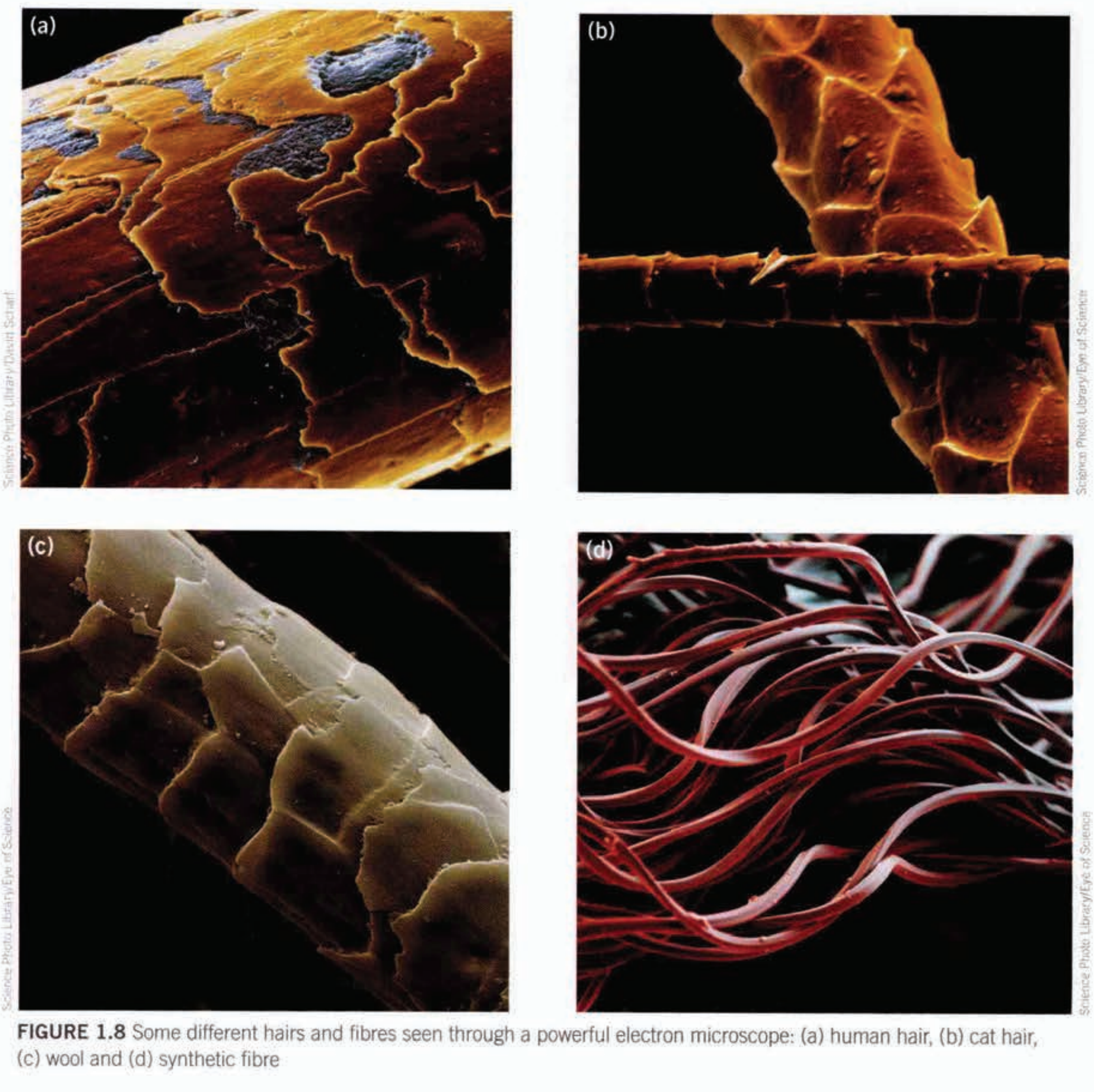


FIGURE 1.8 Some different hairs and fibres seen through a powerful electron microscope: (a) human hair, (b) cat hair, (c) wool and (d) synthetic fibre

Go to http://mypsci2.nelsonnet.com.au and click on **Pollen analysis**. Look at the different pollens shown. Click on each image to see an enlargement. Which types of pollen are most similar? What similarities do they have?

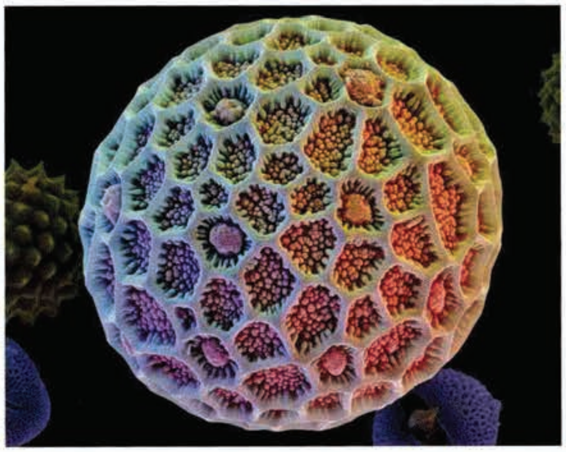


FIGURE 1.9 Knotweed pollen viewed through an electron microscope

FIGURE 1.10 A forensic scientist makes a cast of a footprint

a fibre is from carpet or clothing, whether the fibre has been cut and, if so, by what type of cutting tool. Forensic scientists may be able to match up fibres found at the scene of the crime with those from a suspect's house.

Other items of evidence can sometimes be found *in* the fibres found at a crime scene. Pollen from plants can become embedded in the fibres of clothes. Each plant produces its own kind of pollen. Pollen can sometimes point to the area that someone has moved through, or where they live or work.

Impressions

Footprints

Footprints found at the scene of a crime can be used to connect a suspect with a crime. This sort of evidence requires a forensic scientist to make a plaster cast of the indentation. This is analysed by comparing it with a database of shoes to identify which shoe made the print and when it was likely to have been purchased. If a suspect has been caught, their shoes will be checked against the plaster cast. If the suspect owns that brand of shoe, and if soil scrapings from the suspect's shoe can be matched with the soil at the crime scene, this is very strong evidence that the suspect was there.

Analysing footprints

ACTIVITY

MATERIALS

- shallow tray larger than your foot
- damp sand or soil
- plaster of Paris
- disposable cup
- icy-pole stick
- ice-cream container
- felt-tip pen
- soft brush

>

PROCEDURE

1 Place the damp sand or soil in the tray.
2 With your shoes on, make a footprint in the tray by stepping onto the sand and carefully pressing down as heavily as possible.
3 Place one cup of plaster of Paris into the ice-cream container. Add small amounts of water from the disposable cup to the plaster of Paris and stir with the ice-cream stick. Continue doing so until it has the consistency of a cake mixture or porridge.
4 Pour the plaster mixture into the mould quickly, before it begins to harden. Spread it over the entire footprint.
5 Leave the mould and plaster to dry overnight.
6 When the cast has hardened, lift it out carefully and remove the excess sand with a soft brush.
7 Label your cast with the felt-tip pen.

DISCUSSION

1 The depth of a footprint depends on a number of factors. What might two of these factors be?
2 What difference would there be between the footprints made by:
- a new shoe and an old shoe?
- a person walking and a person running?
- a child and an adult?
- someone who walks normally and someone who walks with a limp?

Other impressions

FIGURE 1.11 Tyre prints can provide evidence.

Impressions other than those of shoes can sometimes be found at crime scenes. These include tyre prints, which are often used in investigating car accidents. Sometimes impressions of writing can be found. This happens because the pressure put on paper when you write with a pen or pencil can be transferred to the sheet below. Even though the pressure on this second sheet is not as great, it can leave slight indentations in the paper. These are sometimes called **imprints**. They can lead to vital evidence in an investigation; for example, by revealing where a person has been or whom they may have contacted. One simple way of revealing what was written on a missing page is to rub a very soft pencil over the remaining sheet of paper.

Imprints

ACTIVITY

MATERIALS

- notepad
- pen
- soft pencil

PROCEDURE

1 Write a secret message on the top sheet of the notepad using the pen. Do not let your partner see what you write.
2 Remove the top sheet and swap notepads with your partner.
3 Gently shade over the imprint area with the soft lead pencil. Can you read the message?
4 Stick your original message and its imprint into your workbook.

CONCLUSION

1 What did you discover?
2 What was the message that your partner wrote?

DISCUSSION

1 How easy was it to work out the message?
2 How might an imprint found at a crime scene (Figure 1.11) help identify the person who committed the crime?

Another type of impression may be found if there is food left at the site of a crime; for example, a piece of chewing gum may have imprints of a suspect's teeth.

Food tells it all

ACTIVITY

MATERIALS

- a range of different kinds of food

PROCEDURE

Complete this activity in an area where food can safely be prepared. Each student should take one bite out of one of the foods provided. Look at the bite marks. Are they clear and obvious?

CONCLUSION

Which food provides the clearest imprint of teeth?

DISCUSSION

1 Identify one other deduction that might be made from food or food wrappers left at a crime scene.
2 How do you think forensic scientists would go about proving that bite marks in a food sample were made by a particular suspect?

>

FIGURE 1.12 Bite mark made during a crime

Teeth

Impressions are not the only reason why teeth are important in crimes such as a murder. They can often be one of the best ways to identify a victim. Teeth can withstand high temperatures and treatment with many different materials; they are far less likely to decompose than other elements of a body. A victim's dental records can enable us to identify who they are. A forensic scientist who deals with this type of evidence is called a forensic dentist.

Soil

Agricultural scientists often analyse soil to see what types of crops can grow in certain areas. The soil's pH is of huge importance. Scientists have investigated plant growth in different soils to see what pH works best for certain plants. These tests have helped us to realise that soils can have a wide range of compositions and pH, and this knowledge is useful in forensics. For example, the pH of soil from the shoes of a suspect can be tested to see if it matches soil at the crime scene. However, pH is just one chemical property of soil; other properties will also be considered, such as the physical make-up of the soil and how much of it is mineral, vegetable or animal matter.

EXPERIMENT 1.2 Analysing soil

PERFORMANCE ASSESSMENT TASK
CRITERION C (I AND II)

MATERIALS

- cup of soil from each of three locations
- distilled water
- universal indicator paper, a pH probe or a garden pH-testing kit
- beaker

PROCEDURE

1 Collect a cup of soil from each of three locations (you could choose your garden, the school garden and another local site, as directed by your teacher). Make a note of the different plants that grow in each area.

2 Mix each sample into a labelled beaker of distilled water.

3 Test the water using either the universal indicator paper, a pH probe or a garden pH-testing kit. Record the pH.

CONCLUSION

1 What types of plants did you find growing in the different soils?

2 What was the pH of the soil samples?

DISCUSSION

How could this information help us when investigating a crime?

REVIEW

1 Suggest why microscopes are useful in crime investigations.

2 Discuss why finding soil on a suspect's shoe could be useful to an investigation.

3 Discuss the different ways that teeth can provide forensic evidence.

4 State two types of impression evidence.

5 Discuss why finding pollen on an item of a suspect's clothing could be useful to an investigation.

Inks and dyes

What looks to you like purple or orange or even a primary colour, such as red, may not be a single colour at all. As you have no doubt discovered in art, you can make new colours by mixing different coloured paints. Similarly, the inks used in pens are produced by mixing particular coloured **pigments** together. Each brand of pen uses its own mix. A simple separation technique called **paper chromatography** can help identify what type of pen a writing sample was made by.

Paper chromatography uses the fact that different coloured substances will move up a narrow strip of wet paper at different speeds. The special paper used is known as **chromatography paper**. Other types of paper, such as filter paper, can be used but are not as effective. The solution that moves up the paper, carrying the colours that make up the ink, is usually a watery mixture. The final paper showing the separated coloured spots is called a **paper chromatogram**. An example of a paper chromatogram is shown in Figure 1.13. The chromatogram you get for a particular mixture will be different if you use a different solution.

FIGURE 1.13 A paper chromatogram

EXPERIMENT 1.3 Separating colours using paper chromatography

AIM

To use paper chromatography to separate the colours in the dye of felt-tip pens.

MATERIALS

- chromatography paper
- watchglass
- water
- a selection of felt-tip pens
- hair dryer

PROCEDURE

1 Carry out the procedure shown in Figure 1.14. Note: The best separation of the coloured components of ink is achieved using very small dots (like tiny pinpricks) of ink. It takes practice to get these right.

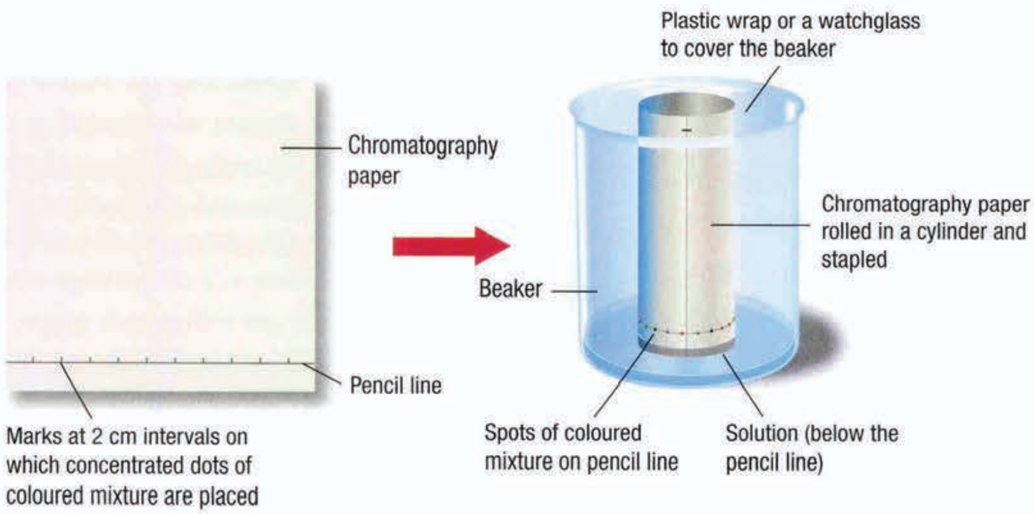


FIGURE 1.14 Paper chromatography

2 Before the solution gets right to the top of the paper, stop the process and dry the paper with a hair dryer to produce your paper chromatogram.

RESULTS

Describe how the colours from the different coloured felt-tip pens separated out.

CONCLUSION

Write your general conclusion about how paper chromatography works. Include an explanation for why this separation happens.

PERFORMANCE ASSESSMENT TASK
CRITERIA B AND C

INVESTIGATION 1.1

Paper chromatography

YOUR CHALLENGE

To investigate one factor that could affect the results of chromatography.

THIS MIGHT HELP

Use the technique described in the previous experiment.

Carry out and write up your investigation following the guide in Appendix 3 on page 165 of this book or as advised by your teacher.

ATL

CRITICAL THINKING

Construct a logical investigation and analyse its results. This is key for developing your critical thinking skills and enabling you to use logic in everyday life. In the investigation above, you have to think about what variable to test and then create a hypothesis. At the end you will need to identify the patterns in the results to draw conclusions and see if your hypothesis was correct.

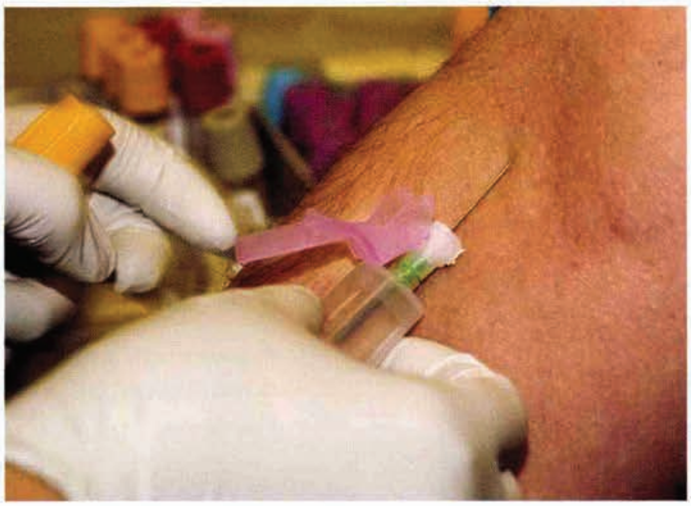


FIGURE 1.15 A person having their blood taken

Blood

Blood samples are often analysed during the investigation of a crime or accident. For example, blood could be found (often mixed with other substances) at a violent crime scene. It must be separated so that it can be analysed to see whom it belongs to and whether it contains particular substances. Blood from the driver in a car accident is tested to find out if they have taken alcohol or drugs. Police can test blood samples from suspects to find their blood type(s) and see what substances the blood contains. Blood can provide essential evidence to piece together a crime.

FIGURE 1.16 Blood at a crime scene

EXPERIMENT 1.4 Your forensic challenge: separating 'blood'

PERFORMANCE ASSESSMENT TASK
CRITERION C (I AND II)

BACKGROUND

Your teacher has mixed some synthetic blood with sand, saline solution and cooking oil. Assume this sample was taken from a crime scene (a restaurant on a beach) and the forensic team need to separate the blood from the other substances for analysis.

AIM

To separate blood from a sample found at a crime scene.

MATERIALS

- beaker
- sample comprising a mixture of synthetic blood, sand, saline solution and cooking oil
- any other materials and equipment needed for the separation

PROCEDURE

Designing the procedure is the challenge! You need to design a method to separate the substances and end up with just the synthetic blood. Check your method with your teacher first, to ensure it is safe and that you have the right equipment.

CONCLUSION

Did you successfully separate the mixture?

DISCUSSION

1 To what extent were the methods used by your class successful? Discuss which elements were successful and which were unsuccessful, and why this was the case.
2 What improvements would you make to your method?
3 Why do you think the blood to be analysed must be separated from other substances?
4 What tests would a forensic scientist do on the blood after separating it?

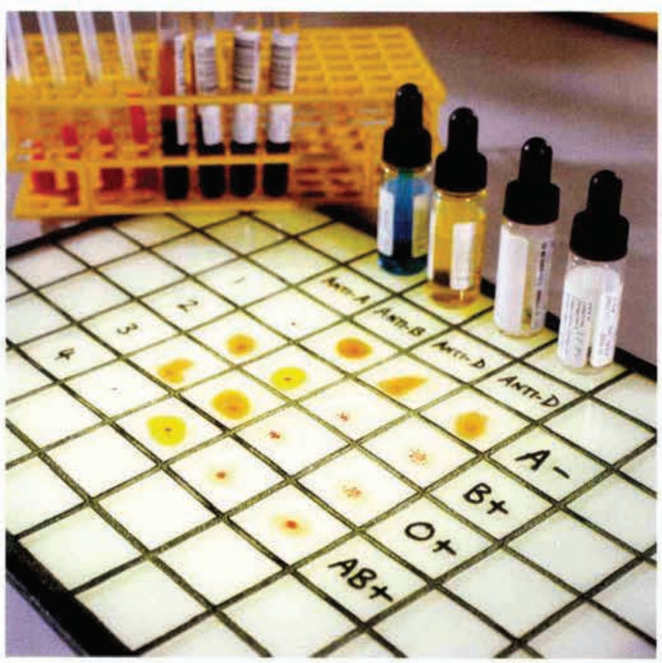
ATL

COLLABORATION

Collaborate effectively in experiments. This is an important skill for scientists. Consider how well you collaborate during this experiment. Do you encourage all members of your team to participate in planning and discussion?

Analysing blood

There are many ways to analyse the blood from a crime scene. One way is to find the blood type using ABO typing. This tests if you have the blood type A, B, AB or O. There are different forms of each of these types (e.g., Rh-positive or Rh-negative) and they can also be found by testing. If there has been an accident, a person may need a blood transfusion. The blood type must be found so the correct blood type is given because otherwise it can be fatal.



Science Photo Library/TEK Image

FIGURE 1.17 Blood being tested for its type

It is possible to do ABO typing tests at school with synthetic blood. If you cannot access a synthetic blood typing kit, you can play a blood typing game on the Nobel Prize Educational website by going to http://mypsci2.nelsonnet.com.au and clicking on **Blood typing game**.

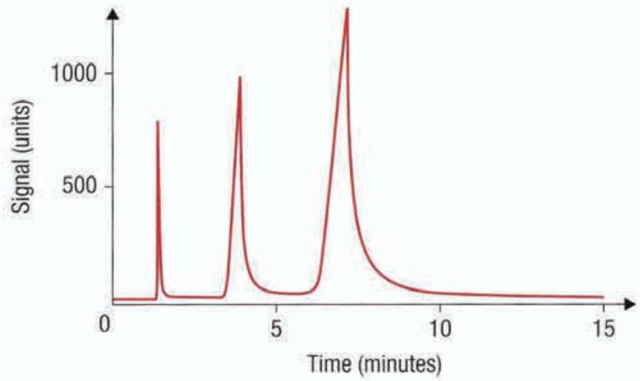


FIGURE 1.18 The peaks on a gas chromatogram represent what is present as well as the amount.

Blood can be tested to find out if alcohol or drugs are in a suspect or victim's blood. We test for this using a special type of chromatography called gas chromatography. The blood sample is heated and because the different substances in the blood have different boiling points, they separate from the sample as different temperatures are reached. As well as discovering what is present, we can tell how much of each substance was in the blood.

The final method of blood analysis is used to identify a victim or suspect from blood at the crime scene. This involves analysing the genetic material in the blood, known as DNA.

REVIEW

1 State a method for separating a mixture of sand and water.
2 Outline a method for finding out what components make up the ink in a purple pen.
3 State three different reasons for analysing blood.
4 State the different blood types.
5 Describe gas chromatography.

DNA

One of the most powerful modern methods used by forensic scientists is DNA testing. DNA is the genetic material that controls inheritance of eye colour, hair colour, skin colour, shape of earlobes, height and many other human characteristics. Each person's DNA is unique. Variations in DNA can be used to identify people or at least distinguish one person from another. DNA can be extracted from all parts of the body and the body's products, including blood, saliva and hair.

Extraction of strawberry DNA

EXPERIMENT 1.5

For DNA to be analysed it must first be extracted. You can extract DNA from many different items in a science class, including your cheek cells or a strawberry.

AIM

To extract DNA from strawberries.

MATERIALS

- two strawberries
- resealable plastic bag
- detergent
- salt
- distilled water
- beaker
- funnel and filter paper
- rubbing alcohol
- tweezers or a splint

>

PROCEDURE

1. Remove the leaves from the strawberries.
2. Place the strawberries in the plastic bag and seal it.
3. Gently crush the strawberries until they are completely crushed.
4. Mix 10 mL of detergent, 5 g of salt and 100 mL of distilled water in a beaker.
5. Take 10 mL of the detergent mix and add it to the crushed strawberries. Mix together for a minute.
6. Filter the mixture into a clean beaker. Tip: At the end, squeeze the filter paper to get as much liquid as possible.
7. Estimate the volume of strawberry liquid, and add the same volume of rubbing alcohol to the beaker.
8. DNA will start to become visible in the beaker; it will appear as a cloudy, white substance. Pick it up with tweezers or a splint.

DISCUSSION

1. What does the DNA look like?
2. Why do you think it is so hard to get uncontaminated DNA?

After DNA is extracted it can be analysed (Figure 1.19). The possibility of someone showing the same DNA test result as another person is approximately one in a billion. Since DNA tests became available, they have shown that a number of people convicted of serious crimes were in fact innocent.

However, DNA test results are not as reliable as they could be, because there is a chance of contamination (where DNA from another source gets mixed into the sample). This contamination could come from material at the crime scene or material in the laboratory.

DNA testing is not approved of by the many people who oppose genetic records being kept. These people say that keeping genetic records is a breach of human rights and privacy. However, if there were genetic records of everyone it would be easier to catch criminals who had not previously offended or been caught.

Science Photo Library/TEK Image

FIGURE 1.19 Studying DNA test results

PERFORMANCE ASSESSMENT TASK CRITERION D

Genetic records debate

ACTIVITY

Your class will be split into two groups: one group *for* keeping all people's genetic records and one group *against*. Take 30 minutes to research your arguments and for each person in your group to write a 1–2 minute speech for your side of the argument. Check within your group that you do not have too much repetition in your arguments.

The teams should alternate giving their speeches and asking each other questions (with a limit of three questions and a 1-minute reply to each). When the speeches are complete, you may leave your side and if you feel comfortable to do so, discuss your actual views.

To learn about some forensic cases, go to http://mypsci2.nelsonnet.com.au and click on **FBI cases**.

Completing a case

The evidence collected and analysed by forensic scientists can help investigators to **deduce** a story of events and, in some cases, to find the solution to the case. Forensic evidence can enable the truth to come out and convictions to be made. It makes convictions more reliable, but it is important to remember errors can still happen with forensic evidence. Forensic scientists are still striving to improve their methods of investigating and finding evidence.

PERFORMANCE ASSESSMENT TASK CRITERION D

Reporting on injustice

ACTIVITY

Write a newspaper report on a false conviction. To do this, research a criminal case in which a conviction was based on incorrect forensic evidence, or a person was falsely accused of committing a crime. Summarise the forensic evidence given and why it was misleading or flawed. Discuss which methods of evidence collection and analysis could have been done better to improve the case. Discuss in general terms why forensic scientists need to be very careful about how their evidence is presented to the courts.

A false conviction based on incorrect evidence caused Kirk Odom to spend 22 years in prison. Go to http://mypsci2.nelsonnet.com.au and click on **Kirk Odom** to read about the case.

REVIEW

1. State what DNA is.
2. Explain why the identification of DNA is so useful to forensic scientists.
3. Suggest reasons why the contamination of DNA samples is such an important problem in forensic science.
4. Discuss why the setting up of DNA databases is a controversial issue.

UNIT QUESTIONS

CRITERION A

EXPLAINING SCIENTIFIC KNOWLEDGE

1 Name four different types of evidence that a forensic scientist may find useful to analyse. (Level 1–2)

2 State the first steps you would take when arriving at a crime scene as a forensic scientist. (Level 3–4)

3 State what we mean by 'impression evidence'. (Level 3–4)

4 Outline the importance of an eyewitness. (Level 5–6)

5 Outline why the analysis of soil is so useful to forensic scientists. (Level 5–6)

6 Describe the scientific principles of paper chromatography. (Level 7–8)

7 Describe the importance of DNA testing in forensic science. (Level 7–8)

APPLYING SCIENTIFIC KNOWLEDGE AND UNDERSTANDING TO SOLVE A PROBLEM

8 Fibres from a jacket are found at a crime scene. Suggest a piece of equipment that could be used to analyse them. (Level 1–2)

9 During a burglary a glass window has been broken. Suggest some tests that could be carried out on materials found at the scene. (Level 3–4)

10 A suspect for a robbery was brought in for questioning. She had ink on her shirt. Detective Ispy, having noted that there was a leaking pen at the crime scene, asked the forensics department to compare the inks. Describe what type of test they would use and how you would interpret the results. (Level 5–6)

11 Blood has been found at the scene of a car crash, but no one is in the car and there are no witnesses. Discuss how blood could be important in solving this case. (Level 7–8)

INTERPRETING INFORMATION

12 A fingerprint has been found at the scene of a crime (Figure 1.20). State why fingerprints are useful to forensic scientists. (Level 1–2)

13 Outline how a fingerprint could be used to catch a criminal. (Level 3–4)

Shutterstock.com/Marfo

FIGURE 1.20 Fingerprints from a crime scene

Dreamstime/© Dmitry Ermolenko

FIGURE 1.21 Tyre tracks from near the burgled house

14 A house was broken into and expensive items, including a large-screen television and surround-sound stereo system, were taken. There were tyre marks in the mud at the back of the house that did not match the owner's vehicle but did match the tyres of a suspect's car (Figure 1.21). Write a statement to the courts describing the evidence you could give for this case. (Level 5–6)

15 Here are the results of a chromatography experiment, comparing the black ink from three different pens with ink found at a crime scene (Figure 1.22). (Level 7–8)

a What conclusions can you draw from these results?

b How would you present this evidence to a court?

c What questions can you imagine the defence lawyer would ask you and how would you answer?

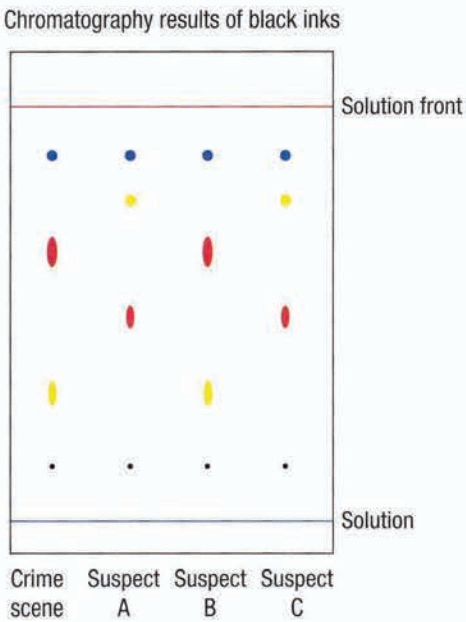


FIGURE 1.22 Chromatography results

REFLECTION

1 Discuss why you think it's important for forensic scientists to be open minded and ask lots of questions when they are investigating a case.

2 To what extent can we rely on DNA evidence?

3 What questions could a defence lawyer ask about DNA evidence?

4 Give your opinion about the extent to which an individual's genetic records should be kept on file by the authorities.

UNIT

2

INTRODUCING CELLS

KEY CONCEPT

Systems

RELATED CONCEPTS

Balance

Form

Function

GLOBAL CONTEXT

Scientific and technical innovation: an exploration into how our knowledge of cells is leading to new medical treatments

STATEMENT OF INQUIRY

Recent research into the form and function of cells in biological systems is leading to exciting, though sometimes controversial, developments in medicine.

INQUIRY QUESTIONS

FACTUAL

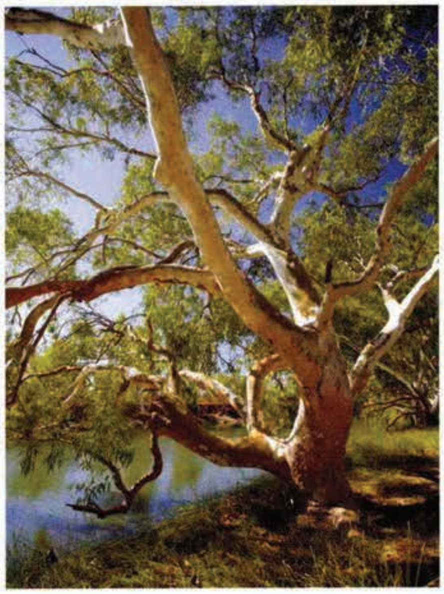
1 How do we see cells?
2 What is inside a cell?
3 What do cells need to survive?

CONCEPTUAL

4 How do cells differ in form?
5 How does the form of a cell relate to its function?

DEBATABLE

6 Should stem cells be utilised in medical techniques and research?



Introduction

If we consider a towering eucalypt tree, a snake, *E. coli* bacteria, yeast and a human, they appear to have nothing in common. They do not look the same and they certainly behave differently. However, if we look very closely, they are all composed of the same basic structures – **cells**.

Cells differ widely; even the cells within one **organism** can vary greatly. Multicellular organisms are made up of many different cells that vary in their **form** (structure) and, as a result, how they **function** or work. Types of cells include those that make up the skin, heart, hair, eggs, muscle and blood. Some are even able to develop into a number of different types of cells. These special cells are called **stem cells**. Each cell has requirements it needs to survive and the different parts of a cell work together as a **system** to provide them.

FIGURE 2.1 All organisms are made up of cells.

As scientists have learnt more about different cells and how they work, they have been able to apply their knowledge to help treat many medical conditions. For example, cancer drugs have been designed to stop certain cells from multiplying, thereby stopping the growth of the cancer. Bacterial cells have been manipulated so that they produce proteins used in the treatment of diseases such as diabetes. Another exciting development is the use of stem cells to treat some diseases or conditions. However, as is the case with any new technology, the use of stem cells needs to be carefully considered, regulated and monitored.

Should we use stem cells?

SUMMATIVE PERFORMANCE ASSESSMENT TASK – CRITERION D

Stem cells are special cells that are able to give rise to other specific types of cells. Stem cells can be classified as embryonic stem cells or adult stem cells based on where they are found; in addition, stem cells can now be artificially produced from other cells. Scientists have been conducting research using stem cells and have succeeded in using them to treat some medical conditions.

Your task is to research one application of stem cells and to write an informative letter to your Minister for Health either in support of or against this usage. You may choose to investigate:

- the research being conducted using stem cells
- the use of stem cells in treating medical conditions.

To write an effective letter that clearly expresses your understanding and viewpoint, you should include:

- a brief explanation of stem cells
- a brief explanation of what stem cells are being used for
- factors to consider with stem cell research or use
- appropriate referencing of your sources of information.

ATL

COMMUNICATION
Communicate your viewpoint clearly, precisely and persuasively, and support it with valid explanations.

Go to http://mypsci2.nelsonnet.com.au and click on **Stem cells** as a starting point for your research.

How do we see cells?

We cannot see cells, so how do we know what they look like?

In ancient times people noticed that pieces of glass, drops of water, or very smooth, clear pebbles could magnify objects. The curved shape of the transparent substance acted like a simple lens.

In 1590, a Dutch boy, Zacharias Janssen, and his father Hans were stacking lenses when they made a significant discovery. Zacharias was looking through a tube with the lenses when he realised that nearby objects were magnified. The Janssens had created the first **compound microscope**; a microscope that uses two or more lenses to magnify. Their invention gave people the opportunity to view objects magnified to ten times their normal size.

In the 1650s, a young English scientist, Robert Hooke, was invited by King Charles II to develop a magnifying device. Hooke had amazing technical skills and soon invented a magnifier that could enlarge details by up to 50 times (Figure 2.2).

ATL

ORGANISATION
Set personal goals so that you have something to work towards. Reflect on your previous science units. Were you focused in class, did you revise for tests, did you complete homework, was your assessment handed in on time? Choose one aspect that could be improved on and make this your personal goal for this unit. At the end, reflect and assess whether you reached your goal.

Lice, fabric, leaves and rocks were examined with enthusiasm, but when Hooke placed a very thin slice of cork under his microscope, he was astonished to see a block-like pattern (Figure 2.3). Hooke named the structures he saw 'cells' because they reminded him of the little, box-like rooms (called *cellae*) where monks prayed.

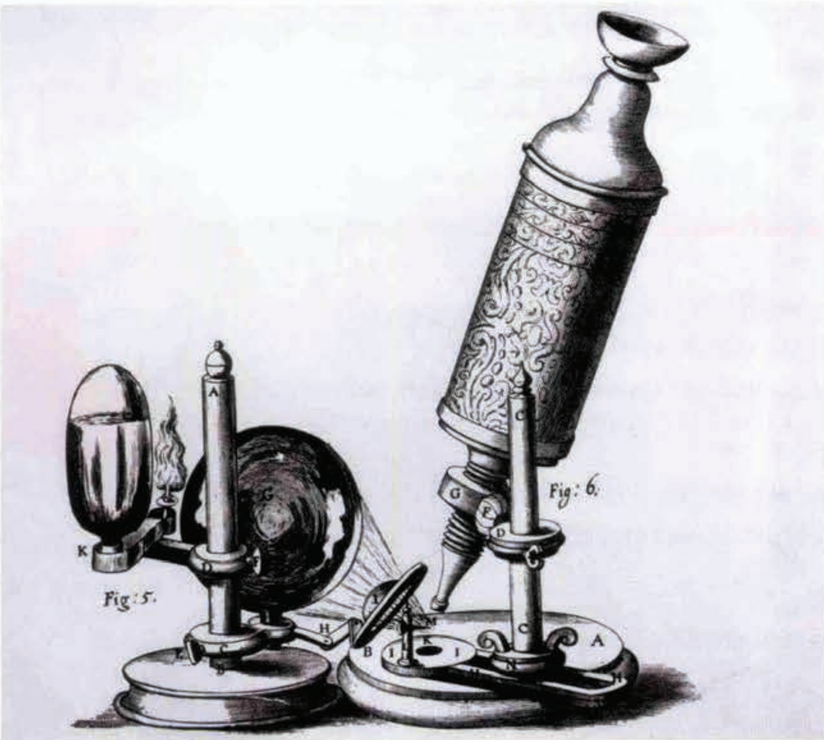


FIGURE 2.2 Hooke's microscope

Around 1670, Dutch scientist Antonie von Leeuwenhoek built a device that could magnify objects by up to 200 times. He became the first person to see and describe bacteria, yeast cells, blood cells and 'creatures' in a drop of pond water. The astonished Leeuwenhoek called the cells 'animalcules'.

Leeuwenhoek is considered to be the first **microbiologist**, but other people continued to observe cells in all kinds of living and dead organisms, plants and animals. They recorded their observations by drawing them. Their results showed that cells come in many different shapes and sizes, and some are even able to move around.

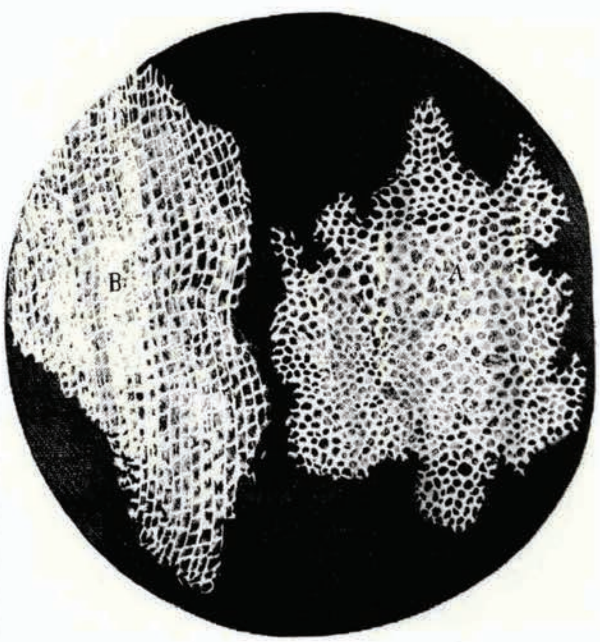


FIGURE 2.3 Hooke's drawing of the first evidence of cells

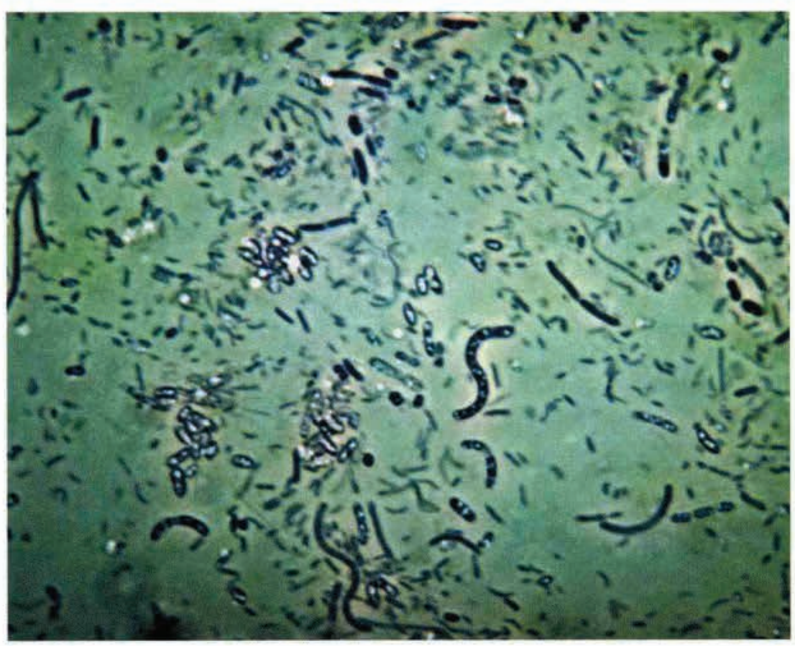


FIGURE 2.4 Some 'animalcules' that can be seen in a drop of polluted water

FIGURE 2.5 A light microscope

To read more about using a light microscope go to http://mypsci2.nelsonnet.com.au and click on **Light microscope**.

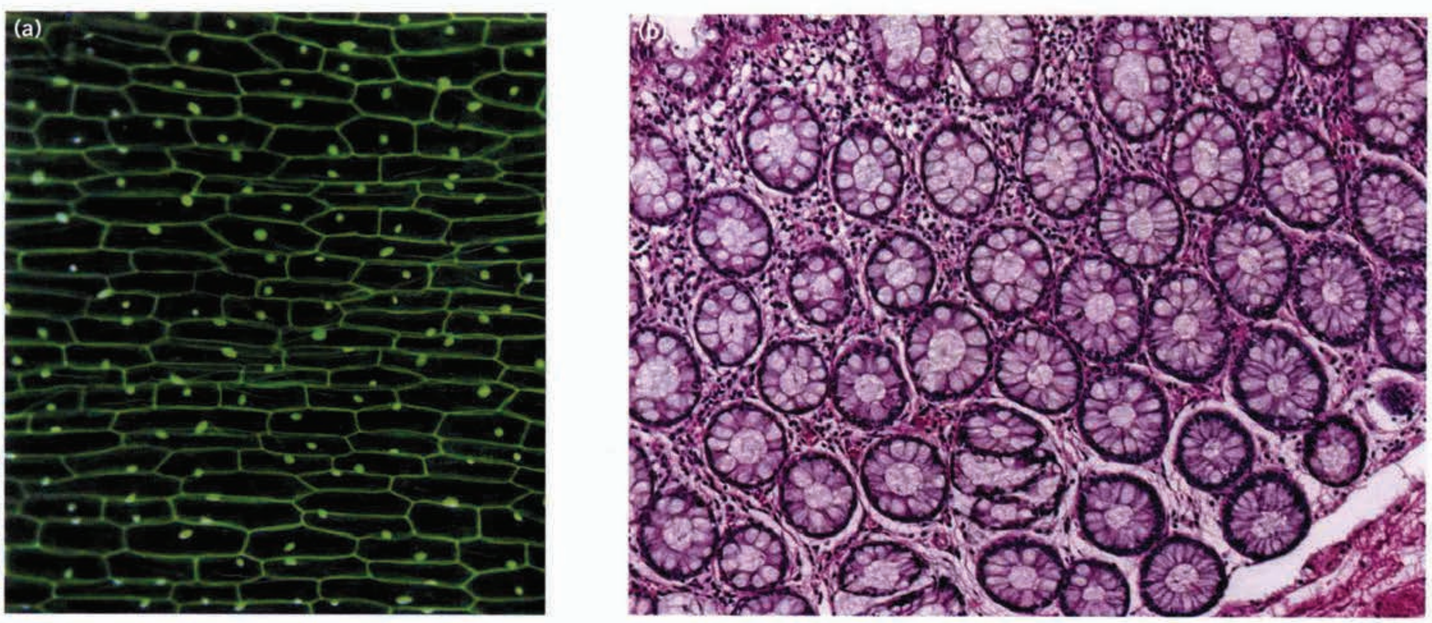


FIGURE 2.6 Some cells from (a) a plant and (b) an animal

Observing cells

EXPERIMENT 2.1

AIM

To use a microscope to observe different samples containing cells.

MATERIALS

- microscope
- prepared slides of plant tissue, such as root tips and leaf sections
- a very thin slice of cork
- pond water
- slides

PROCEDURE

Go to http://mypsci2.nelsonnet.com.au and click on **Light microscope instructions** for some advice.

1. Follow your teacher's instructions on how to use the microscope. You may also refer to the weblink.
2. Look at the prepared slide of plant cells under the lowest magnification. Sketch what you see.
3. Without moving the slide, observe the plant cells under medium magnification. Sketch what you see and record the effect of increasing the magnification.
4. Carefully move the slide towards you while looking through the lens. Record what you observe.
5. Carefully move the slide to the left while looking through the lens. Record what you observe.
6. Place a drop of pond water on a slide and view it under low magnification. Sketch what you observe.
7. Place the thin slice of cork on the stage and view it under low magnification and then higher magnification. Sketch what you observe.
8. Observe other items, such as a piece of hair or pieces of paper made from different materials. Ask your teacher before you use something. Sketch what you observe.
9. Carefully pack your microscope and equipment away, following your teacher's instructions.

RESULTS

Collate your sketches in a table, with each sketch clearly labelled with the name of the object observed and the magnification it was viewed under.

DISCUSSION

1. What happens to the size of the object viewed when the magnification is increased?
2. What happens to the object being viewed when the slide is moved down?
3. What happens to the object being viewed when the slide is moved to the left?

CONCLUSION

Write a conclusion regarding the function of the microscope.

ACTIVITY Creative science

Have you ever considered what your clothes are made from? Perhaps leather, cotton, nylon or wool, most of which have been in use for centuries. Radically new materials are not common. Gary Cass is an Australian science professional who is challenging perceptions of how science can be used. One day he noticed a layer of material floating on the surface of the wine in a vat and wondered whether he could use it to make clothes. From this idea he developed his 'red wine dress', which was made using cellulose grown by bacteria and fungi cells. Gary didn't limit his creativity to making clothes. One of his other ideas has led to an app that uses your DNA to make music.

Suzanne Lee is a London fashion designer who has made creative use of science and is making clothes from materials grown by cells, including bacteria, fungi and algae.

Use the weblinks to learn more about the work of Gary and Suzanne. Discuss what you have learnt with your class. How have Gary and Suzanne's knowledge of cells allowed them to bring their ideas to reality? What might be some possible outcomes that arise from their ideas? Can you think of other examples of when creative ideas have led to scientific advances?

Go to http://mypsci2.nelsonnet.com.au and click on **Red wine dress** and **Suzanne Lee's tea clothes** to learn more about creative use of science.

ATL

CREATIVE THINKING

Be innovative. Creative thinkers enjoy being creative and imaginative, and playing with ideas; they allow divergent thinking, are willing to let go and take risks, tolerate ambiguity and see mistakes as opportunities for learning.

Advances in science are only possible due to the creative thinking of scientists. They think of new ideas and try them out. These ideas are not always successful, but they can lead to amazing advances.

EXPERIMENT 2.2 Preparing an onion skin slide

AIM

To prepare a slide of onion skin and to view it under a light microscope.

MATERIALS

- piece of onion
- knife
- tweezers
- microscope slide
- coverslip
- iodine
- paper towel
- light microscope

PROCEDURE

1 Cut a piece approximately 2 cm x 2 cm from a layer of fresh onion.
2 Use the tweezers to carefully peel off the outer, shiny layer of skin from the onion piece.
3 Carefully place the onion skin onto a microscope slide so that it is lying flat.
4 Place a drop of iodine onto the onion skin. Be careful: the iodine will stain if you get it on your skin or clothes.
5 Place one edge of a **coverslip** just to the side of the onion skin and lower the other edge down gradually until it is lying flat on top of the skin. If you do this carefully you should be able to avoid getting air bubbles under the coverslip.
6 If there is excess iodine, hold a piece of paper towel at the edge of the coverslip to absorb it.
7 Set up the microscope as you learnt in Experiment 2.1.
8 View the onion cells under low power (10X objective lens and 10X eyepiece lens).
9 Sketch what you observe, recording the magnification with your sketch.
Note: Magnification = eyepiece lens magnification x objective lens magnification.
10 Rotate the revolving nosepiece to the next largest lens.

>

11 View the onion cells under this higher magnification. Sketch what you observe, recording the magnification with your sketch.

12 Pack up your equipment and place the slides in the container provided by your teacher.

DISCUSSION

1 Explain why iodine was put on the onion skin.

2 Describe what happened to the apparent size of the cells when the magnification was increased. Did the size of the cells actually change?

3 Explain why it was important that the onion skin was placed flat on the slide.

Super microscopes

The light microscope allows us to see objects in more detail than a magnifying glass, but other types of microscope reveal even greater detail.

The **electron microscope** was invented in 1933 by Ernst Ruska, a German scientist. Instead of using light to illuminate the object, the electron microscope uses tiny particles called electrons to magnify objects by up to a million times. This magnification is nearly 700 times greater than even the most powerful light microscope (which can magnify up to 1500 times) and therefore enables biologists to examine cells in much greater detail.

The electron microscope has two disadvantages:

- the electron beam only works in a vacuum, so specimens must be dead before they can be examined
- it can only produce black and white images, although colours are often added to enhance the image and help with interpretation of details.

Go to http://mypsci2.nelsonnet.com.au and click on **Virtual microscopes** to practise using light microscopes and electron microscopes.

FIGURE 2.7 An electron microscope

FIGURE 2.8 A computer-enhanced electron microscope image of a louse