STUDENT FACT FILE YEARS 7–10

FUTURE HEALTH

STELR

3D PRINTED PROSTHETICS

DISEASE DETECTION

University of Wollongong
Southern Cross University
Charles Darwin University

THE FUTURE OF HEALTH

PROSTHETICS AND BIONICS

Prosthetics are artificial body parts and have been manufactured by humans for thousands of years. Today, prosthetics can be extremely advanced in the way they interface with the brain and nervous system, and can be manufactured more cheaply than ever before using durable, lightweight materials. Bionics are artificial and typically electromechanical body parts. An artificial heart, for example, can strengthen the pumping process and restores blood flow to the heart and the rest of the body.

HEARING/AUDIOLOGY

Technologies like hearing aids can help to restore hearing, for example, by increasing the volume of sound that is heard. Cochlear, an Australian company that specialises in helping people overcome hearing loss, have pioneered the cochlear implant, a device that can replace the function of a damaged inner ear. Rather than just making sounds louder like hearing aids do, the implant replaces the function of the inner ear, converting sounds into nerve signals and sending them to the brain.

PERSONALISED MEDICINE

We are unique because we all have unique genetic information contained in our DNA, the molecules that carry instructions for growth, development and function of our bodies. These differences in our genetic code are important, especially when it comes to health. The genetic data of a person can determine if certain medications will work, or if they are at risk of developing certain diseases. Unlike traditional medicine, where disease diagnosis is based on symptoms, personalised medicine is guided by each individual's unique genetic code and family history.

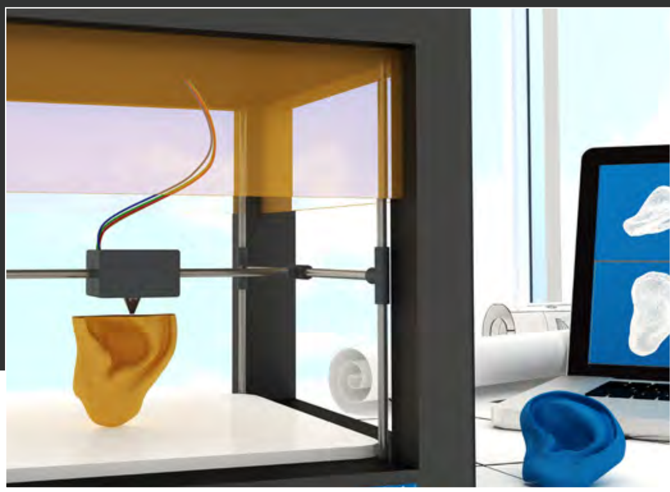
MOLECULAR BIOLOGY

If we understand how a disease affects the human body, we can develop better treatments. Molecular biology is a medical and research field that looks at the structure and function of molecules that are essential to life to understand diseases at their smallest scale. When molecular sources of diseases are found, it can help researchers develop better treatments and allow doctors to diagnose diseases more accurately.

> "If we understand how a disease affects the human body, we can develop better treatments."

CASE STUDY 1

3D PRINTED PROSTHETICS



THE FIRST PROSTHETIC WE KNOW ABOUT WAS CREATED 3000 YEARS AGO IN ANCIENT EGYPT – a single wooden toe that was found attached to a mummified body with leather straps. Throughout history people have built wooden limbs and glass eyes to replace damaged body parts. Early prosthetics were usually made of bone, glass or wood and were created to look like the missing body part, but they couldn't replicate the part's function. They were also often heavy and inflexible, and sometimes even painful to wear.

Engineering techniques have improved over time, and it is now possible to construct prosthetics that look and function much like real limbs. Modern prosthetic arms, for example, have joints and fingers that can bend and flex naturally and are freely controlled by the person. But they can be expensive, especially for children who need to have continual prosthetic replacements because they are still growing.

Today, 3D printing is revolutionising medicine. Lightweight and affordable plastic prosthetics can be 3D printed and custom-made to fit an individual. In 2012, for the first time, a 3D printed part of a jaw was successfully transplanted to an 83-year-old patient. Today, medical technology companies like Melbourne's Anatomics produce 3D printed implants and prosthetics to treat a wide range of conditions, using a specially developed polymer that can bond with human tissue. Meanwhile, researchers are investigating ways we could use 3D printing in the future to create human organs from scratch, using living cells.

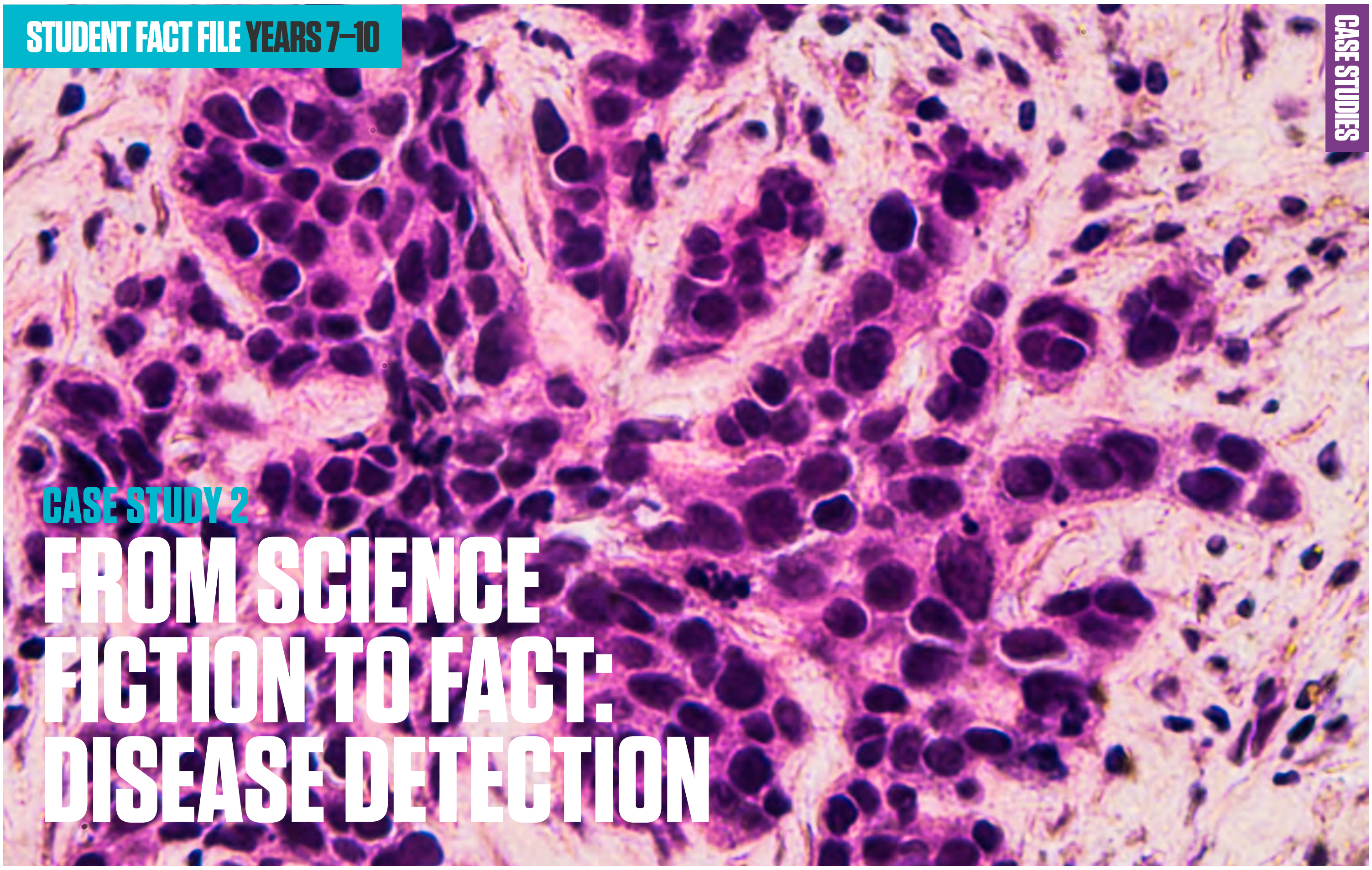
The University of Wollongong (UoW) is leading the field in 3D printing education and research. An additive manufacturing subject has been popular with students from the School of Mechanical, Materials and Mechatronic Engineering since 2014. Students go through the whole design and build cycle, from identifying a product that is suitable for 3D printing through to product design and testing. "It's all about rapid prototyping and customisation these days," says subject co-ordinator Dr Steven Harvey.

UoW is also home to the Intelligent Polymer Research Institute (IPRI), where researchers from six Australian and five international universities are hard at work trying to find a way to manufacture human tissue like nerve, bone and muscle using 3D printing technology – a process called biofabrication. So far they have worked out how to pass human stem cells through a printer nozzle without destroying them. One day soon they might be making viable organs like kidneys and hearts – a development that will transform the world of organ transplantation.

Anyone interested in learning more about biofabrication can take a free online course created by UoW and offered on the learning platform FutureLearn. Led by IPRI's Director, Professor Gordon Wallace, the four-week course explains the materials and processes involved in bioprinting and looks at how they are being implemented now, and how the field might develop in the future.

"Revolutionary scientific advances in 3D printing technology, and the development of amazing biomaterials that can seamlessly integrate into the body, means we may be only a few years away from a time when every major hospital will contain 3D printing capabilities," says Professor Wallace.

"We are now seeing previously unimaginable developments, such as prosthetic limbs controlled by thought alone, bionic implants to restore lost senses, and of course – 3D printing of human organs."



CASE STUDY 2

FROM SCIENCE FICTION TO FACT: DISEASE DETECTION

RESEARCHERS TODAY ARE DEVELOPING MEDICAL DEVICES capable of detecting diseases instantly, bringing what used to be science fiction into reality.

In the movie *Star Trek: Into Darkness* Chief Medical Officer Doctor McCoy had a hand-held device called a tricorder that was capable of diagnosing diseases simply by scanning the device over a crewmember's body. At the time this idea of instant disease detection was pure science fiction. But the early and rapid detection of disease has always been a goal in medicine. With many types of cancer, diagnosis occurs in the late stages of the disease once symptoms have appeared. Often when diseases are diagnosed earlier, the effectiveness of the treatment and the likelihood of survival can be improved.

Today, a machine that is capable of collecting and giving medical information almost instantly doesn't seem so impossible. Many scientists and engineers today are focused on creating portable medical devices capable of almost instant diagnoses, like the rHEALTH sensor created by the DNA Medical Institute in the USA. This is a handheld device that can identify more than 100 diseases with a single drop of blood by scanning your blood for early warning signs of illness, including bacteria and viruses.

Doctors often use blood tests to diagnose diseases because every disease has a signature in the blood that can be detected. But new technologies like the rHEALTH medical device can find traces of disease within minutes, whereas blood tests can take a week to analyse.

rHEALTH's greatest potential is that it can deliver high quality healthcare to people living in remote areas, who can't easily reach hospitals and labs for testing.

Researchers from medical technology company Owlstone in the UK and biomedical start-up company Astraeus Technologies in the USA have developed breathalyser devices capable of detecting early lung cancer.

Lung cancer is the leading cause of cancer deaths – almost a fifth of all cancer deaths worldwide. The chances of surviving lung cancer depend on how early it is caught, because the survival rate is 10 times lower in late stage lung cancer compared to early stage lung cancer. The lung cancer breathalyser is revolutionary because it's able to detect early signatures of lung cancer in a person's breath.

What about creating an all-purpose disease detection device? Google X is working on developing a capsule that is filled with nanoparticles that are capable of finding diseases like cancer and heart disease in the blood. Nanoparticles are so small that around 200 particles can fit on a single red blood cell!

The nanoparticles are all packed into pills, which can be swallowed and digested. The disease-detecting nanoparticles are then absorbed into the bloodstream and travel through the human body to track down signs of illness.

The nanoparticles are designed to recognise a wide range of disease signatures and send back data to a sensor on a wristband. The aim is to catch signs of diseases even before symptoms appear.

New methods of rapid disease diagnosis could be a real gamechanger in the field of medicine. Although it is still some time before any of the devices currently being developed will become widely available, researchers will continue to look to science fiction for inspiration when it comes to improving the future of medicine.

PROFILE 1

CREATIVE ENGINEERING

GRADUATE ELECTRICAL ENGINEER MICHAEL RAIVARS had always enjoyed problem solving. "As an engineer, I love solving problems, and transforming scientific theories from the classroom into something like a building that will be used by society."

After graduating high school in 2008 Michael enrolled in an engineering degree at Monash University in Melbourne, where he discovered biomedical engineering – a field that combines physiology and engineering, and is responsible for many medical breakthroughs, like the invention of the X-ray.

Michael is now a graduate electrical engineer working with Australian biomedical company Cochlear, which pioneered the first cochlear implant. Unlike hearing aids, which work by increasing sound volume, the cochlear implant restores hearing by replacing the function of the damaged inner ear (the cochlea).

Hearing occurs when sound travels through the outer ear through the ear canal. The signal is then converted to mechanical energy. When the sound reaches the cochlea, the fluid in this organ moves in time with the sound energy and stimulates hair cells, which send electrical impulses to the nerves. This translation of mechanical energy to electrical energy is necessary for the nerve signal to be able to reach the brain. When the cochlea is damaged, it is no longer able to translate that energy, causing hearing loss. The cochlear implant stimulates nerves in the cochlea, enabling the delivery of nerve signals to the brain.

Since its invention in 1969 the cochlear implant has helped restore hearing to over 300,000 people.

The graduate program at Cochlear has given Michael opportunities to experience the complex processes of developing a biomedical device. His responsibilities have included designing, building and testing circuit boards, and developing early versions of equipment, called prototypes.

"The most rewarding part of my job is being able to show how the implants make a difference, for example, seeing infants hear their parent's voice for the first time. Occasions like this leave you energised and motivated to jump out of bed and come to work each day."

Even in a society where computers crunch most of the numbers, he says having a good foundation in maths really strengthens your ability to problem solve. Michael says having strong skills in problem solving is especially valuable as an engineer.

"In algebra, you can be given something horribly complicated but you can boil it down to a nice, simple, elegant solution. The thinking process you learn from solving these problems is a skill worth practising.

"Many areas of maths you study at school like calculus, statistics and trigonometry are the foundations of engineering principles. It's like any skill: if you want to be really good at something, you need to master the basics. The better you understand maths, the more effective and creative you can be as an engineer."

For students interested in the biomedical industry, finding an experienced mentor can be invaluable.

"The tricky thing about the biomedical industry is there are so many different pathways and careers that aren't obvious," Michael says. "Being able to talk to someone, like a lecturer or industry professional, with experience in your area of interest is really important.

"Having a mentor who can guide you and introduce you to people and opportunities to which you'd otherwise be oblivious to is invaluable."

Michael is now focused on continuing to learn and develop as an engineer, but he's also interested in doing research around visual prostheses, also known as the bionic eye, to design a device to restore sight.

"I'd love to be involved in restoring sight to people with vision impairments," he says.

"The most rewarding part of my job is being able to show how the implants make a difference, for example, seeing infants hear their parent's voice for the first time."

PROFILE 2

GENETIC DETECTIVE

OUR DNA, THE MOLECULES THAT CARRY INSTRUCTIONS for our bodies, holds the genetic instructions for how our bodies grow, develop and function. Buried within these genetic instructions is information about whether a person at risk of developing certain types of cancers.

Louise Lynagh, an associate genetic counsellor at Sydney's St Vincent's Hospital in NSW, is working with families at The Kinghorn Cancer Centre to find out whether there is a genetic link between family members to certain cancers.

Being a genetic counsellor involves a lot of detective work for Louise. "My job is to gather information from families to determine if genetic testing might be useful. I then support families through the process of genetic testing, and help them make sense of their results."

Maths and statistics play a crucial role in her work, as she interprets inheritance patterns in families and calculates probabilities and risks of disease from the test results.

This includes painstakingly sifting through genetic databases, which record patient information, and family trees. Using pedigree drawing software, Louise is able to draw a genetic family tree and reveal patterns and links in the genes of family members. She can then use this information to map and calculate genetic risks to cancers in families.

In one memorable case, Louise was able to find the genetic cause of a cancer from a patient that had passed away 10 years prior. She was able to track down DNA samples that had been stored before the patient's death.

"The lab was able to use this DNA to perform a genetic test, which revealed a genetic cause of the cancer: Lynch Syndrome."

From this information she was able to discover and reveal to the patient's children that they were at risk of inheriting this condition. From their father's genetic information, the children were able to have a preview of any possible cancer risks they may have inherited.

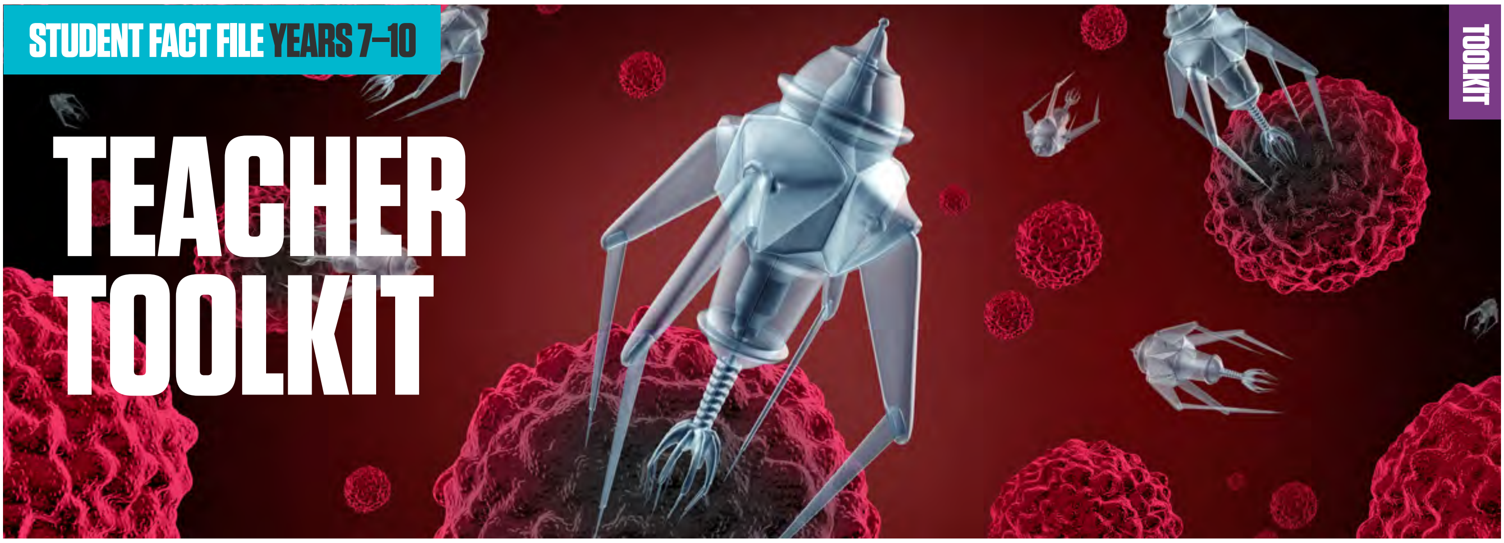
"They chose to have a genetic test to find out if they needed extra cancer screening. One of them now knows they didn't inherit Lynch Syndrome, and the other, who does have the condition, is on a screening program that is known to reduce risk of developing the cancer."

Louise's lifelong interest in science has taken her on a journey spanning across three countries. After finishing high school in Scotland, she did an undergraduate degree in biochemistry at the University of Bristol in the UK – where she especially loved the lectures on medical genetics. She then did a graduate diploma in genetic counselling at the University of Newcastle in Australia, where she discovered how exciting the area of work could be.

"It's very rewarding to be able to use genetic information to detect cancer at an early stage, or prevent it altogether," says Louise.

Louise is excited about the rapid evolution of the field of genetics and technology, and says there are no shortages of new areas to specialise in. "It's a very exciting time to be in genetics," she says.

> "It's very rewarding to be able to use genetic information to detect cancer at an early stage, or prevent it altogether."

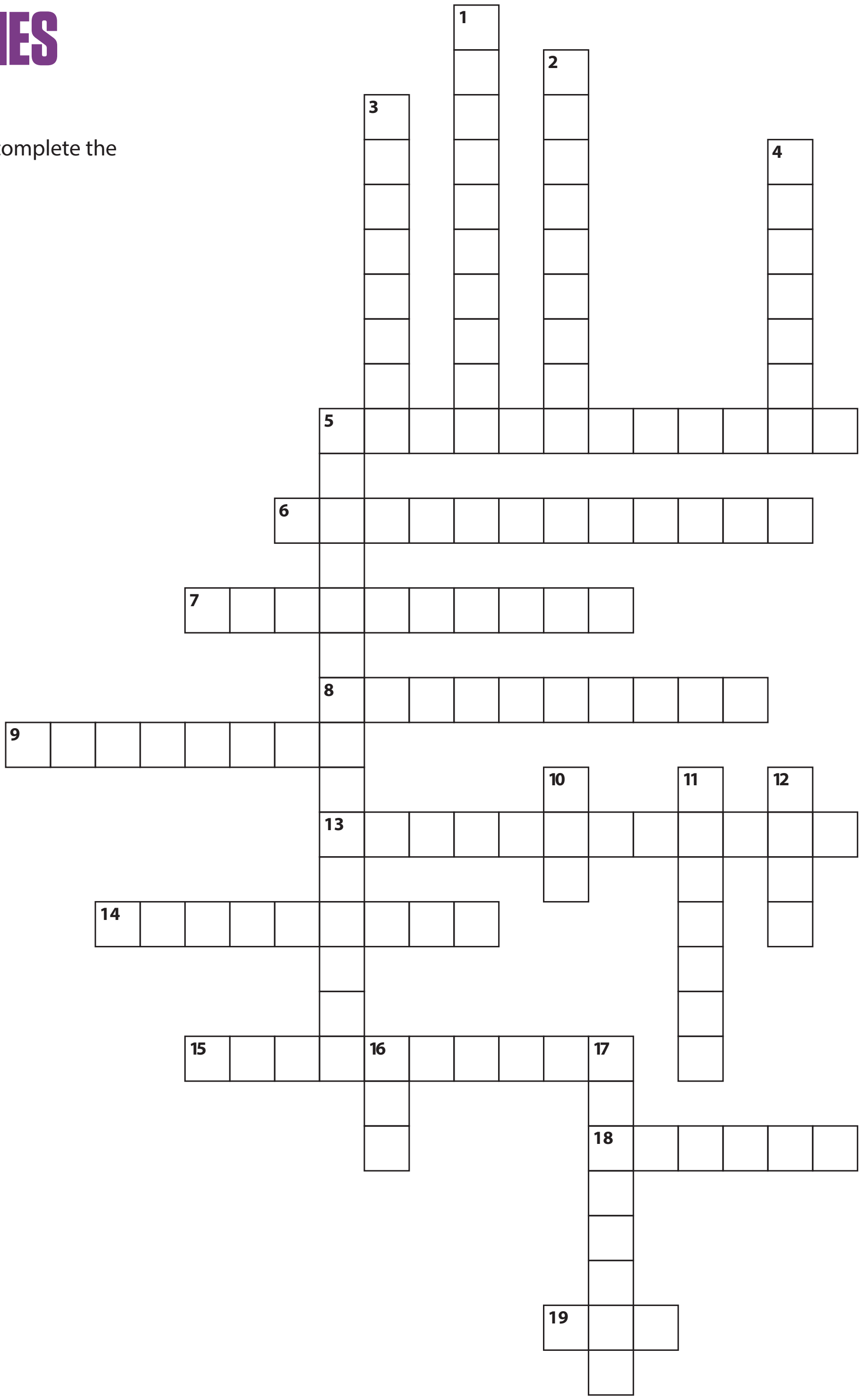


TEACHER TOOLKIT

GENERAL CAPABILITIES

Literacy

After reading the profiles and case studies complete the following crossword.

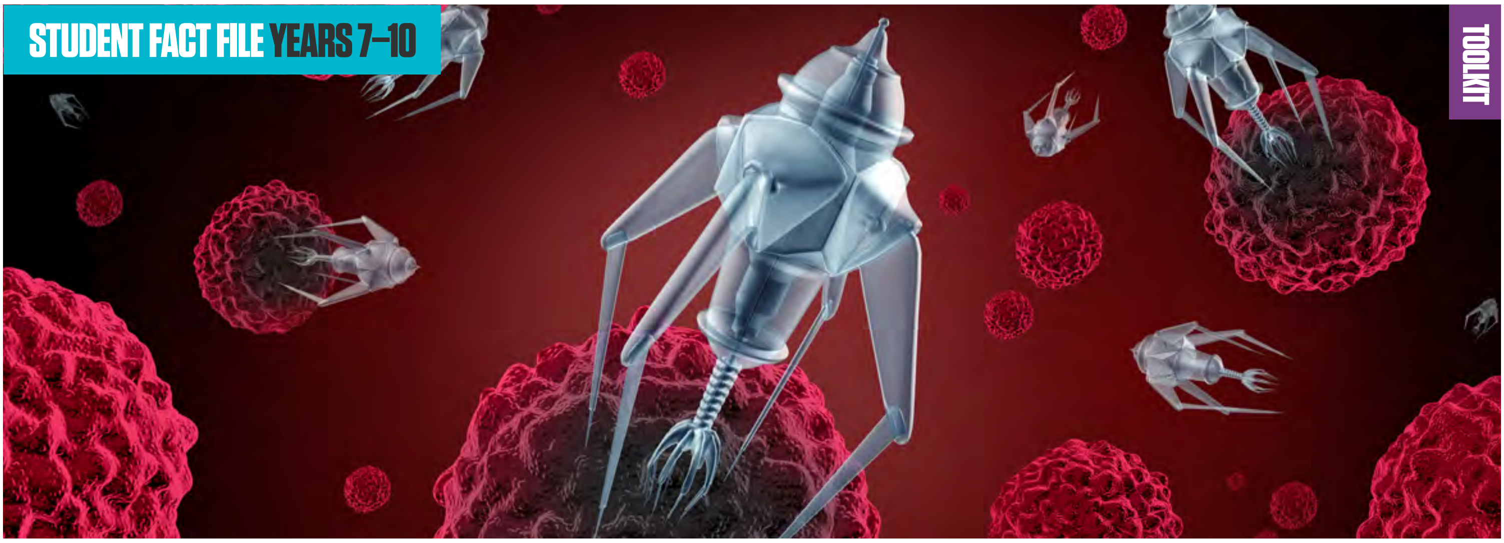


ACROSS

5 ________ medicine can help find out if an individual is at risk of developing disease.
6 A tiny particle a billionth of a metre in size that can help detect disease.
7 Type of engineering that makes health related tools.
8 Helps families understand any medical conditions they may have.
9 Where medical information is stored.
13 An area of maths.
14 Another name for the visual prosthesis being developed.
15 A man-made body part.
18 You have a better chance of surviving this disease if you can detect it earlier rather than later.
19 First 3D printed prosthetic.

DOWN

1 Early versions of machines.
2 The 'D' in 3D printing.
3 Visualisation of a family tree.
4 In some circumstances, our DNA can determine if we are at risk of this.
5 Chemical that help treat some diseases.
10 All our genetic material.
11 Does not have a disease or injury.
12 Medical technology that takes images of inside our body.
16 The oldest prosthetic known.
17 This implant helps amplify the sound in the ear.



Numeracy

Graeme Clark, who invented the cochlear implant (see Profile 1 of Michael Raivars), says that he was inspired with an idea for the design of the bundles of electrodes that fit inside the cochlear implant when he was on a holiday. In the lab the electrodes had been clumping together and he couldn't figure out how to stop this. When he was on the beach during his holiday he used a spiral sea shell to represent the cochlear of the ear and blades of grass to represent the electrodes and tried inserting blades of grass of different length to find out which length can be most easily pushed inside a spiral shell. When he returned from holiday he was inspired to return to the lab and fix the problem with the electrodes.

Carry out an investigation to model Graeme Clark's holiday experiment.

MATERIALS

- a hollow sea spiral sea shell or a pasta shell from the supermarket
- several blades of grass of different lengths
- forceps

METHOD

1. Collect several blades of grass of different lengths from your school oval. Make sure you take the whole blade, including the white part near the root and not just the tip of the blade of grass.
2. Back in the laboratory try pushing the blade of grass into the spiral of the shell by holding the stiffer part of the blade that was near the root with a pair of forceps
3. Note which length of grass is the easiest to insert into the spiral shell by recording your results in Table 1 below.

RESULTS

Table 1 – Length of grass best suited to being pushed inside a cochlear

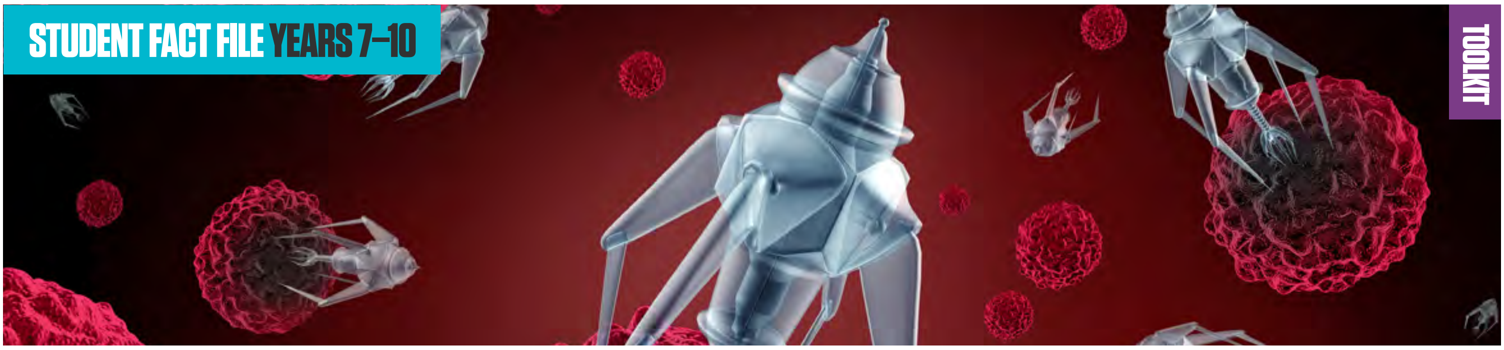
LENGTH OF BLADE OF GRASS (CM)	DISTANCE BLADE OF GRASS CAN BE PUSHED INTO SPIRAL SHELL

DISCUSSION QUESTIONS

1. In this investigation, what do the blades of grass represent in the cochlear implant?
2. Which part of the ear do the spiral shells represent?
3. How did this simple activity of pushing blades of grass into spiral shells inspire Graham Clark and help him solve one of the many design issues when building his cochlear implant?
4. Identify any difficulties you had when trying to push the blade of grass into the spiral shell. How did you overcome these difficulties?
5. Describe the blade of grass you were able to push the furthest into the cochlear shell or pasta.
6. Was there an optimal ratio of grass blade length to cochlear cavity size? Compare your results with the class to find out.

Digital Technologies

Imagine you are a health worker interested in nanotechnology and have been asked to write a 300-word profile or case study of a new technology, such as drug delivery or disease prevention. There are plenty of YouTube videos that explain some of the new nano-medicine technologies, so start with these to help you find and be inspired by all the new technologies and how they might work. Case study 2 on disease detection is one of many new inventions, so use this as a guide to shape your own piece of science writing.



Critical and Creative Thinking

Case Study 1 talks about using 3D printers to make prosthetics for the human body. Materials that come into contact with our tissue need to be biologically compatible, water resistant, non-corrosive , durable and sometimes flexible. Investigate the properties of silicone that make it a useful material to use to print 3D prosthetics.

COLLECT THE FOLLOWING MATERIALS

- tube of silicone sealant (can be purchased at hardware stores).
- disposable gloves
- 1M HCL
- incubator set to 370°C
- 6 sugar cubes
- water
- 3 250ml beakers
- 3 petri dishes
- retort stand and clamp
- scales/balance

RISK ANALYSIS

- Always wear gloves when using the gel.
- Use in a well-ventilated area.
- Read the safety instructions on the silicone tube and follow the manufacturers advice.

WHAT TO DO

Preparation – make 9cm strips of the silicone and leave to harden and solidify before using in Parts A and C below.

Part A – Acid Resistance

1. Collect 3 x 3cm strips of silicone from the teacher.
2. Allow the strips to dry.
3. Weigh the strips and record information about their appearance or take a photograph.
4. Place 3 of the strips in a beaker with 50ml of HCL. Observe the strips for 5 minutes looking for any signs of a reaction.
5. Leave the strips overnight.
6. Remove the strips from the acid and rinse with water.
7. Record and changes in the strips' appearance.
8. Reweigh and record results.

Part B – Water resistance

1. Take 3 sugar cubes.
2. Cover each sugar cube in the silicone gel. Make sure there are no gaps.
3. Place 3 sugar cubes that are uncovered in 100ml water in a beaker and leave overnight.
4. Place the silicone covered cubes in another beaker with 100ml of water and leave overnight.
5. Observe the results after 24 hours and record observations of the two sets of cubes.

Part C – Flexibility

1. Obtain 3 strips of the hardened silicone.
2. Fold the strips over and place in a clamp
3. Leave overnight.
4. Remove from the clamp and observe what happens to the shape of the silicone.

RESULTS

Create a data table to record your results in.

DISCUSSION QUESTIONS

Part A

1. Did the strips take up any of the HCL?
2. Was there any reaction between the HCL and the silicone?
3. Why is acid resistance a property that is advantageous for a biomaterial?

Part B

1. What happened to the uncovered sugar cubes in the water?
2. What happened to the silicone covered sugar cubes?
3. What property does the silicone have that this experiment is testing?
4. Why is this property advantageous for a biomaterial?

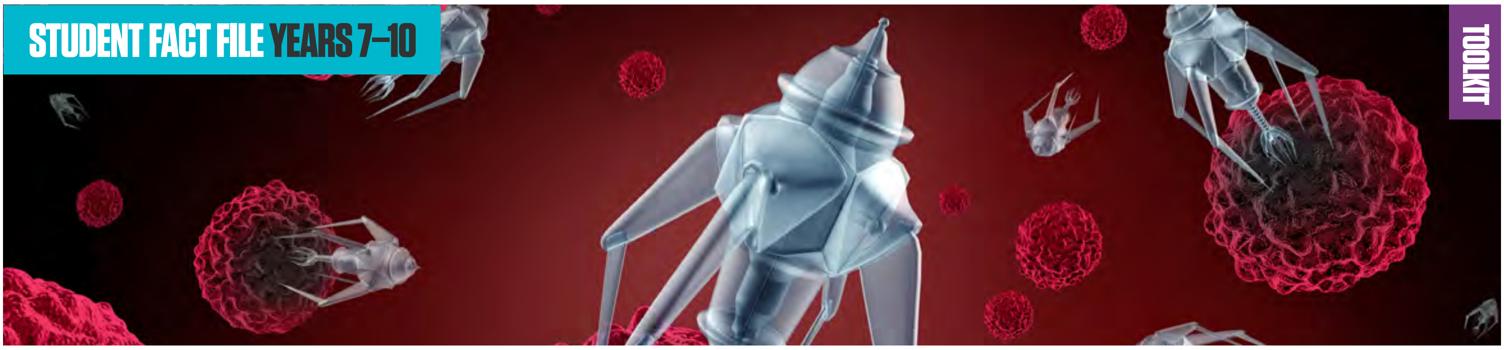
Part C

1. Did the silicone revert to its shape before it was put in the clamp?
2. Silicone is used to make artificial joints in the fingers and toes. What types of movements would the silicone implant be subjected to in this area?
3. Why would flexibility be a favourable characteristic for this type of bionic part?
4. Research some of the other properties that silicone has to make it a successful biomaterial and outline a method you could use to test one of these.
5. Other materials such as titanium and stainless steel are used for hip implants. What are some of the additional or different properties these types of materials would need to make them a successful implant for this area.
6. What types of materials do you think would have to be used for the cochlear implant? Make a list of the properties these materials would need to be a successful cochlear implant.

CONCLUSIONS

What do you conclude about silicone as a biomaterial for printing 3D prosthetics? Write a statement of recommendation (or not) justifying your response.

Now design your own experiment to test how durable silicone is.



Personal and Social Thinking

Unlike early models, modern prosthetic limbs, as discussed in Case study 1, are often flexible so they can carry out some of the tasks a real limb can. In this activity you can construct and test a model for a 'skeleton' to go inside a prosthetic arm to see how strong and flexible it is. Construct a model of a bionic arm and investigate one of its functions.

COLLECT THE FOLLOWING MATERIALS

For the prosthetic arm model

- 3 pieces of cardboard cut to a size of 5cm x 30cm
- 2x German Helmet split pins
- ball point pen
- S hook

For the remote operator

- 1 metre of wood doweling
- 1 picture hook screw

METHOD

1. Using the tip of the ball point pen, make a hole 2cm from the end of each piece of cardboard.
2. Joint the pieces of cardboard lengthways using the split pins making sure the join is neither too loose or too tight.
3. Attach the S hook to a hole at the end of the last piece of cardboard.
4. Screw the picture hook into the end of the wood doweling
5. Holding the end of the bionic arm that does not have the S hook in one hand and the remote operator in the other hand, practice using the wood doweling as a remote operator to control your prosthetic arm.
6. Try lifting a few objects, such as 50gm masses (with hooks!), paperclips, the plastic monkeys from 'a barrel of monkeys', or any other suitable item you have handy.
7. Design an experiment you can carry out that will test one feature of your prosthetic arm. Some suggestions include:
   - How much mass can your prosthetic arm pick up?
   - How quickly can your prosthetic arm transfer 10 paper clips from one container to another?
   - How well can your prosthetic arm draw a sketch of a smiling face? (You will need to cello-tape a pencil or texta to the end of your prosthetic arm instead of an S hook)

Figure 1: The bionic arm

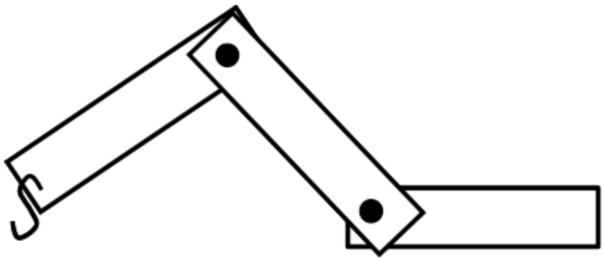
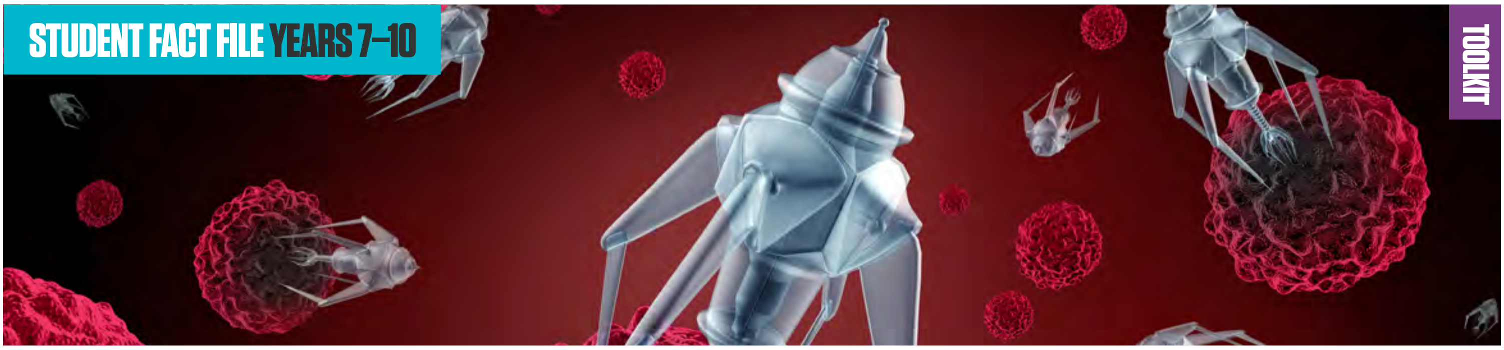


Figure 2: The remote operator

DISCUSSION QUESTIONS

1. Describe how well your prosthetic arm performed. What could it do? How strong was it?
2. Identify any building difficulties you had when you were putting together your prosthetic arm. How did you overcome these difficulties?
3. Could you recommend a better, more improved design to build a prosthetic arm?
4. Identify any operating difficulties you encountered when working with your bionic arm. Suggest any tips for future users of your prosthetic arm that would make operation easier.
5. What might be the benefits of working alone or working in a group when building and testing your model prosthetic arm?
6. Suggest how society might make use of a prosthetic arm.



Ethical Thinking

Which is the most vital to our health, the development of medical technology or the development of scientific understanding of how our bodies work? Use what you have read in the profiles and case studies, as well as your own research to identify the roles of technology and science in medicine, the amount of funding they each may need, the impact they have on our everyday lives and the depth of the relationship between them.

Intercultural Understanding

Many medical techniques available to us in the developed world are not available to people in developing countries. In this activity simulate the use of a small, inexpensive and easily portable medical technology that could be used to detect various infectious diseases or genetic conditions, similar to the work Louise Lynagh is doing at the Kinghorn Cancer Centre in Profile 2. This technology consists of a skin patch the size of a stamp that is capable of detecting disease.

Imagine you are living in a remote village in Papua New Guinea. You have been feeling very sick for the last couple of days. The nearest doctor is two days drive away. You don't think you can travel that far. The village medical centre has the treatments for several diseases on hand but they must know what disease you have to treat you successfully. Luckily the medical centre can diagnose the disease you have with a diagnosis stamp.

YOU WILL NEED

- universal indicator paper
- 0.1M hydrochloric acid
- 0.1M sodium hydroxide
- water
- droppers
- unknown solution

METHOD

1. Look at your list of symptoms on page 12.
2. Diagnose what disease you think you might have from your list of symptoms and write it in the results section.
3. Take a piece of universal indicator paper.
4. Use a dropper to take a sample of the solution.
5. Place a drop of the sample on the paper.
6. Record the colour the paper changes.
7. Record the disease you have by using the diagnostic table.

RESULTS

1. Predicted disease:

___

2. Colour of universal indicator paper:

___

3. Diagnosed disease from the diagnostic stamp test:

___

DISEASE	COLOUR CHANGE
Cholera	Red
Malaria	Blue
Hepatitis	No change

DISCUSSION QUESTIONS

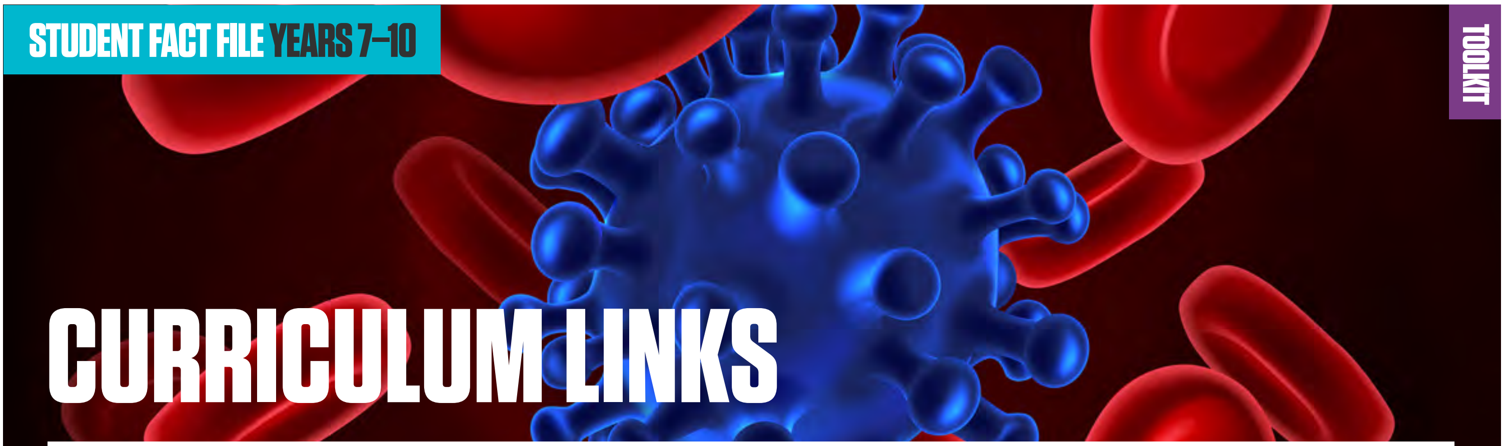
1. What are the benefits of using the diagnostic stamp to diagnose disease in remote areas?
2. Do some more research into the nanotechnology used in the diagnostic stamp invented by George Whitesides. Could it be used in any other areas?
3. Did you think this was a good simulation of the diagnostic stamp technology? Why/why not? How would you improve or change the simulation to make it better?

TEACHER INSTRUCTIONS

Each student is given a sample of either HCl, NaOH or water representing their blood sample. Each student should also be given a matching list of symptoms they have been experiencing. They should not be shown which disease they have. Students then carry out the test to see which disease they have.

The Table below shows which disease is represented by which chemical.

CHEMICAL	DISEASE IT REPRESENTS	SYMPTOMS	COLOUR CHANGE
HCl	Cholera	Watery diarrhoea - usually severe but painless, vomiting, muscle cramps	Red
NaOH	Malaria	Headache, nausea, fever, vomiting and flu-like symptoms	Blue
Water	Hepatitis	Short, mild, flu-like illness, nausea, vomiting and diarrhoea; loss of appetite, weight loss, jaundice (yellow skin and whites of eyes, darker yellow urine and pale faeces); itchy skin	No change



CURRICULUM LINKS

SCIENCE UNDERSTANDING

YEAR 7
Physics
Change to an object's motion is caused by unbalanced forces on the object **(ACSSU117) PST**

YEAR 8
Biological Sciences
Multi-cellular organisms contain systems of organs that carry out specialised functions that enable them to survive and reproduce **(ACSSU150) Lit**

YEAR 9
Biological Sciences
Multi-cellular organisms rely on coordinated and interdependent internal systems to respond to changes to their environment **(ACSSU175) Lit, DT, CCT**

Chemical sciences
Chemical reactions, including reactions of acids, are important in both non-living systems and involve energy transfer **(ACSSU179) Lit, DT, CCT**

YEAR 10
Physical Sciences
The motion of objects can be described and predicted using the laws of physics **(ACSSU229) PST**

YEAR 10
Biological Sciences
Transmission of heritable characteristics from one generation to the next involves DNA and genes **(ACSSU184) Lit**

SCIENCE AS A HUMAN ENDEAVOUR

YEAR 7 AND 8
Nature and development of science
Science knowledge can develop through collaboration across the disciplines of science and the contributions of people from a range of cultures **(ACSHE223) PST**

Use and influence of science
Solutions to contemporary issues that are found using science and technology may impact on other areas of society and may involve ethical considerations **(ACSHE120)**
DT, PST, ET, ICU

People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity **(ACSHE121)**
Lit, DT, PST, ET, ICU

YEAR 9 AND 10
Nature and development of science
Advances in scientific understanding often rely on developments in technology, and technological advances are often linked to scientific discoveries **(ACSHE158)**
Lit, Num, DT, CCT, ET

Use and influence of science
People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people's lives, including generating new career opportunities **(ACSHE160)**

All capabilities
Values and needs of contemporary society can influence the focus of scientific research **(ACSHE228)**
Lit, DT, PST, ET, ICU

SCIENCE INQUIRY SKILLS

YEAR 7 AND 8
Questioning and predicting
Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge **(ACSIS124) CCT**

Planning and conducting
Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed **(ACSIS125) Num, CCT**

Measure and control variables, select equipment appropriate to the task and collect data with accuracy **(ACSIS126)**
Num, CCT, PST, ICU

Processing and analysing data and information
Construct and use a range of representations, including graphs, keys and models, to represent and analyse patterns or relationships in data using digital technologies as appropriate **(ACSIS129)**
Num, CCT, PST, ICU

Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence **(ACSIS130)**
Num, CCT, PST, ICU

Evaluating
Reflect on scientific investigations including evaluating the quality of the data collected, and identifying improvements **(ACSIS131)**
Num, CCT, PST, ICU

Communication
Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate **(ACSIS133)**
Num, DT, CCT, PST, ET, ICU

YEAR 9 AND 10
Planning and conducting
Plan, select and use appropriate investigation types, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods **(ACSIS165) CCT**

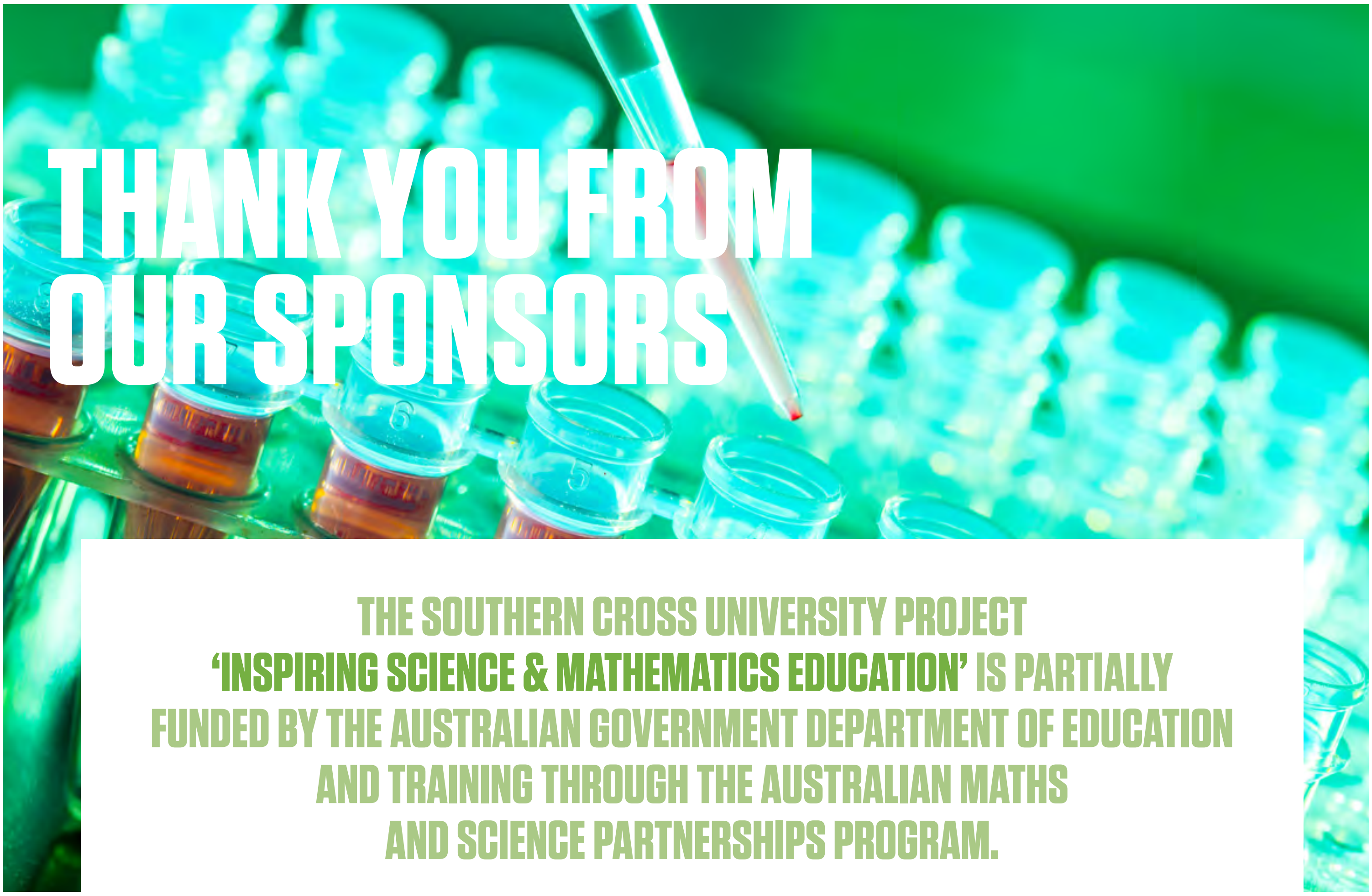
Select and use appropriate equipment, including digital technologies, to collect and record data systematically and accurately **(ACSIS166) Num, CCT**

Processing and analysing data and information
Use knowledge of scientific concepts to draw conclusions that are consistent with evidence **(ACSIS170)**
Num, CCT, PST, ICU

Evaluating
Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data **(ACSIS171)**
Num, CCT, PST, ICU

Critically analyse the validity of information in primary and secondary sources and evaluate the approaches used to solve problems **(ACSIS172)**
Num, DT, CCT, PST, ET, ICU

Communicating
Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations **(ACSIS174)**
Num, DT, CCT, PST, ET, ICU



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